THE

AMERICAN NATURALIST,

An Illustrated Magazine

OF

NATURAL HISTORY.

EDITED BY

EDWARD D. COPE AND J. S. KINGSLEY,

ASSISTED BY

W. S. BAYLEY, CHARLES E. BESSEY, F. S. LEE, T. H. MORGAN,
CLARENCE M. WEED, THOMAS WILSON,
C. O. WHITMAN.

VOLUME XXV.¹

Philadelphia:
FERRIS BROS., PUBLISHERS,
COR. SEVENTH AND FILBERT STS.,
1891.

CONTENTS.

INDEX.

.00 per Year. 40 cts. per Copy.

THE AMERICAN NATURALIST

A MONTHLY JOURNAL
DEVOTED TO THE NATURAL SCIENCES
IN THEIR WIDEST SENSE.

ol. XXV. JANUARY, 1891. No. 289

CONTENTS.

PHILADELPHIA:

FERRIS BROS., PUBLISHERS

SIXTH AND ARCH STREETS

ered at the Philadelphia Post-Office as second-class matter.

To Scientific Investigators.

One of the greatest needs of American science at the present time is a convenient medium in which brief preliminary notices of the results of investigation can be published. A considerable length of time of necessity elapses between the conclusion of any series of observations and their appearance in print, and it is of great advantage to the observer, and still more to his fellow-workers, to have the results made known as soon as possible, thus insuring priority of discovery to the one, and allowing the others to keep more perfectly posted with what is going on in the scientific world around them.

A preliminary notice should be published *at once* to be of value, and hitherto there has been no scientific periodical in this country, published at sufficiently brief intervals, and open to all investigators, which has specially opened its columns to the publication of such notices, and has undertaken to make them public with as little delay as possible. This the Naturalist proposes to do, and invites the coöperation of all investigators in an attempt to inaugurate a department for the prompt and satisfactory publication of preliminary notices of the results of scientific investigations.

NOTICES.

Notices for scientific societies and private individuals inserted under this head free of charge. For business houses, two cents per word.

MINERALOGY. — Course conducted by correspondence. First collection and book $1. Postage 25 cents. Address

GUSTAVE GUTTENBERG,
Central High School, Pittsburgh, Pa.

WANTED—To correspond with conchologists in America, especially in California, with a view to exchange. Many British land, fresh-water, and marine duplicates; some foreign. Address Mrs. Falloon, Long Ashton Vicarage, Bristol, England.

WANTED—Position in Academy, Normal or High School, as teacher of the Natural Sciences and Modern Languages. Latin taught in addition, if necessary. Address G., box 441, Hanover, N. H.

A COLLEGE PROFESSOR of Natural Sciences and German, of four years experience and special Biological training received at the Universities of Leipzig and Bonn, Germany, is open for a position in a college. Good references.

Address, C., Box 136, New Berlin, Pa.

FOR EXCHANGE.—14 Volumes (1883–1889) AMERICAN JOURNAL OF SCIENCE; 10 volumes (1880–1889) AMERICAN NATURALIST; 21 volumes (1879–1890) ENGLISH MECHANIC; all in good condition for binding; also, Morris Typewriter. If you have a good Microscope, Camera, or anything else to offer, please send full description.

E. R. CHADBOURN, LEWISTON, ME.

FOR SALE.—Beautiful sets of Fossil Plants from the Dakota Group Cretaceous. On receipt of $3.00 I will forward, prepaid, to any address in Europe or America, 20 different species and varieties of Dakota Plants. Send 5 cents for plate illustrating the set. The specimens will equal the figures. CHAS. H. STERNBERG,

P. O. Box 60, Lawrence, Kans.

WANTED—Hall's works on Palæontology, and other works giving plates which show fossils of the Niagara Epoch. Address M. D. Sullivan, St. Ignatius College, Chicago, Ill.

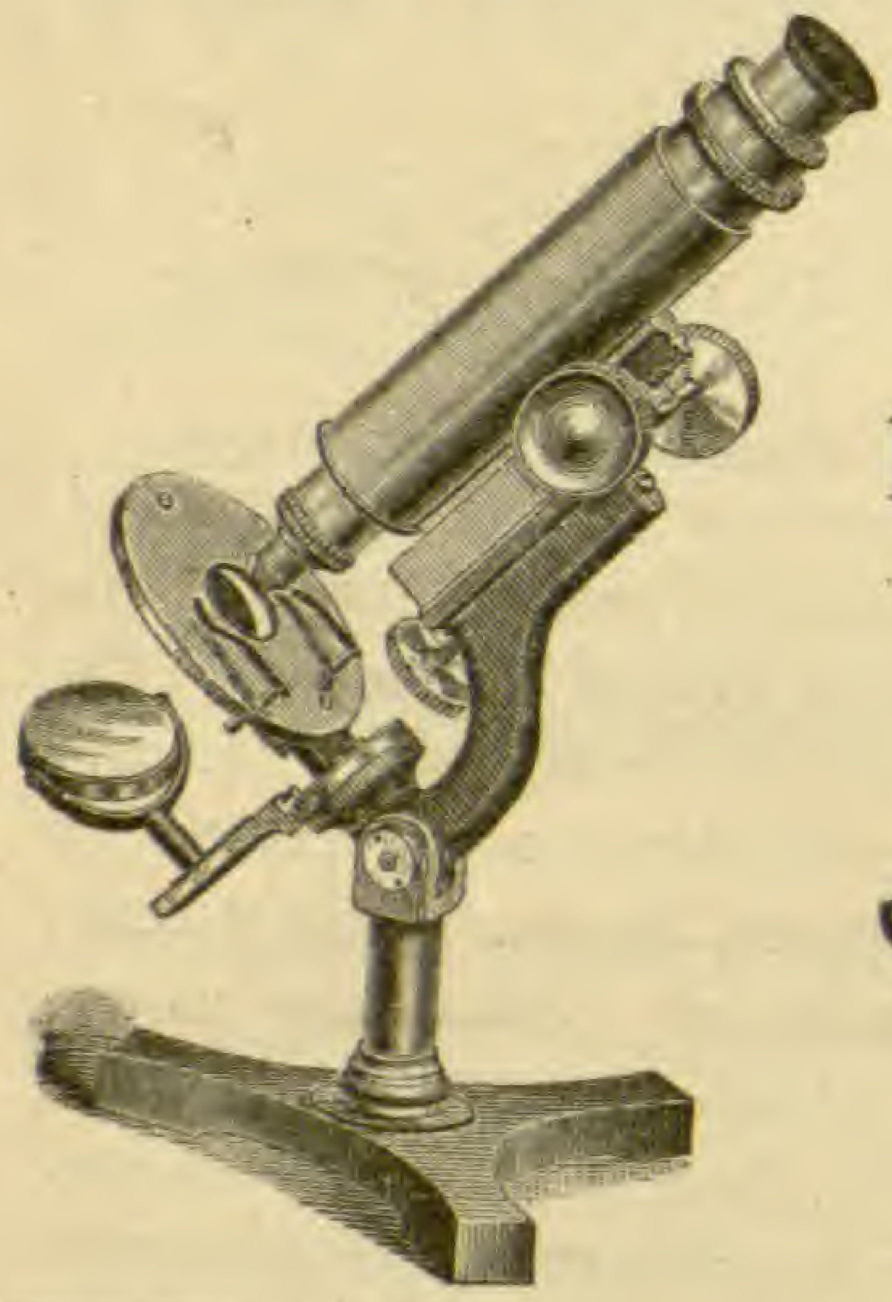
VOLUMES I., II., III., and IV., of THE AMERICAN NATURALIST, in first-class condition, bound in half Morocco, for sale. Price $16.00. Address GEO. W. MACKAY,

25 Congress St., Boston, Mass.

WANTED—For dissection and microscopic work, Polyps, Jelly-fish, or other Hydrozoa, Actinozoa, and Ctenophora; also Echinodermata and Mollusca. Cash or exchange given. J. A. Leighton, Trinity College, Toronto, Can.

I HAVE FOR EXCHANGE for other shells from sea or land, very fine specimens of *Unios trigon, occidens, coccineus, lacrymosus, lævissimus, rectus, alatus, gracilis, turberculata, ventricasus; Margaritania confrogosis, complanata, rugosa, gibbosus,* and others; *Anadonta corpulenta* and *suborbiculata.* Will send six of the beautiful *Anadonta suborbiculata* by mail for one dollar.

DR. W. S. STRODE, BERNADOTTE, ILL.



THE

AMERICAN NATURALIST

VOL. XXV. JANUARY, 1891. 289.

SOME RECENT PAPERS ON EARTHWORMS.

BY J. S. KINGSLEY.

THE Oligochætous worms were long neglected, but within recent years the literature relating to them has extended to very considerable dimensions. It is the intention to present here an abstract of some of the work lately done on the group. The two papers[1] by Dr. Wilson on the embryology of these forms may be considered together. The forms studied are called *Lumbricus terrestris*, *L. communis*, and *L. fœtidus*.

The segmentation is unequal, but varies in its details in individual eggs of the same species. It results in the formation of a blastula, in which, at intervals, the blastocœl is in communication with the exterior by a cleavage pore. Some points of difference are shown between the species studied and that which formed the basis of Kleinenberg's classic paper.

Like Kleinenberg, Dr. Wilson finds that the "primary mesoblasts" are differentiated before gastrulation as two large cells lying side by side, at first on the surface but later sinking into the blastocœl. Before this insinking they begin to bud off the mesoderm in the shape of two parallel rows of cells. During this process gastrulation takes place. The egg becomes flattened, and a differentiation of the cells of the two sides occurs, the upper

[1] Wilson, Edmund B. The Germ-Bands of Lumbricus. *Journal of Morphology*, I., p. 183, 1 pl., 1887.

——The Embryology of the Earthworm; *l. c.*, III., p. 387, 7 pls., 1889 [1890].

(ectodermal) becoming flattened, while the entodermal are larger and more columnar. Next the sides of this placula-like structure are bent downwards, the approaching edges forming the slit-like blastopore, which closes behind, leaving the anterior end open as the mouth. In this operation the primary mesoblasts lie side by side at the posterior lip of the blastopore, the bands extending forward and eventually uniting in front of the mouth. During this process the ectoderm becomes thickened immediately over each band, but retains its character of a layer a single cell in thickness. At the same time, although the blastopore never closes, the inpushing of a stomodæum occurs.

The next feature of interest is the formation of the middle layer of the germ-bands, the existence of which was first distinctly recognized in the Oligochætes by Dr. Wilson. According to his account, this first appears as a linear arrangement of the ectoderm[2] cells, terminating behind in a larger cell. These terminal cells (which, like the primary mesoblasts, are called teloblasts) sink, together with the corresponding cell-rows, into a position between the ectoderm and the germ-band proceeding from the mesoblast. There may be either three or four of these rows on either side. The one towards the median line gives rise to the nervous system, the next two (nephric rows) to the nephridia and to the inner series of setigerous glands, while the outer (not constant) has a problematical fate. The corresponding teloblasts are called neuroblast, nephroblast, and lateral teloblast.

With the gradual elongation of the embryo these teloblasts continue to bud off new cells, which add to the corresponding row, which derive nothing from any other source. Behind, the rows are but a cell in width, but anteriorly they are wider, the two nephric rows becoming fused. Later the teloblasts disappear, and the bands of the opposite sides unite from before backwards. Certain cells budded from the rows wander between ectoderm and entoderm and form "migratory mesoderm," while the remainder, in which the cœlomic cavities appear, is the "trunk mesoderm." The former is mesenchymal in character, and gives rise to larval muscles, which are later replaced by true mesothelial muscles. The

[2] See below for Bergh's account, which differs considerably.

cœlomic cavities are schizocœlia, and are formed in the mesodermal bands behind the point of concrescence; the most anterior pair lie at the sides of the stomodæum, while a head cavity, which is always unpaired, occurs in front of the mouth.

The first blood vessel to appear is the subintestinal. It is at first without proper walls, and is apparently a remnant of the cleavage cavity. The dorsal vessel is at first double.[3] The two halves concresce from in front backwards.

Concerning the alimentary canal little need be said in this abstract. The stomodæum pushes inward as far as the sixth segment, and in one species its lips are at one time armed with a peculiar structure which may be either sensory or may serve as a larval digestive organ. As soon as the stomodæum is formed the larva begins to swallow the albumen with which it is surrounded and the particles of this are apparently swallowed amœba-like by the entoderm cells. The œsophagus with its calciferous glands is entodermal. The proctodæum is long delayed, and when it appears it is formed in the region where the primary mesoblasts break up; but our author was not able to decide whether in front or behind them, *i.e.*, within or without the limits of the blastopore.

The nervous system arises from the neural rows budded from the neuroblasts. The two most important statements made are: that the brain arises from these rows, and that it has a primitively paired condition and does not arise from a scheitelplatte. Dr. Wilson was unable to find any mittelstrang in the ventral cord. With growth the brain is carried backward from an extreme anterior position to the third somite, while by the same process the ganglia of the two anterior pcst-oral somites are pushed back upon that of the third to form the infraœsophageal ganglion. The giant fibres are apparently specially modified nerve fibres,—a view in conflict with Vejdovsky's account.

The origin of the excretory system as described by Wilson is quite different from the accounts of Bergh summarized farther on. First in the history comes the larval excretory organs or "schluckzellen," which are at first large ectoderm cells forming the anterior lip of the blastopore, and connected with a delicate system of

[3] This condition is permanent in many earthworms belonging to the family Perichætidæ.

ciliated canals lying between ectoderm and entoderm. They soon disappear. These were not carefully studied, nor were the pronephridia or head-kidneys. The permanent nephridia are regarded by Wilson as arising partly from the nephric rows, which are, as we have seen above, ectodermal in origin, and comparable in every early ontogenetic feature with the neural rows; the funnel is regarded as derived from the mesoderm proper. According to the account and figures, the nephric rows send upgrowths into every somite; these join a large cell on the anterior wall of each dissepiment. The large cell develops the funnel, while the cells of the nephric upgrowth becomes perforated to form the tubular portion of the nephridium. From each nephridial anlage a process is developed which becomes hollow, and the setæ of the inner row are developed in the cavities thus formed.

The speculations with which Wilson concludes his paper are of extreme interest, but as they deal with problems of general morphology they may be omitted here.

R. S. Bergh has also studied the development of the earthworm, with especial reference to the nervous system and Wilson's germ-bands. His account [4] differs in so many particulars that we cannot consider the fate of the germ-bands as settled.

Bergh paid no attention to the segmentation and gastrulation, but begins his account with the formation of the germ-bands. As his account of the fate of the different portions differs from Wilson's interpretation, he has applied different names to different portions, as is seen by this schedule:

WILSON.		BERGH.
Primary mesoblast	=	Posterior myoblast.
Neuroblast	=	Neuroblast.
Nephroblasts Lateral teloblast	} =	Anterior myoblasts.

In the earliest stage studied by Bergh there is present on either side the posterior myoblast, the neuroblast, and a single

[4] Bergh, R. S. Neue Beiträge zur Embryologie der Anneliden. I. Zur Entwicklung und Differenzirung des Keimstreifens von Lumbricus. *Zeitschr. f. wiss. Zoologie*, Bd. L., p. 469, 3 pls., 1890.

one of the anterior myoblasts, each budding off its corresponding row. In next stage observed there were present two anterior myoblasts. The connection between these was not made out, but Bergh thinks from certain features that the new one was budded from the earlier one, and that the first to appear corresponds to Wilson's inner nephroblast, the second to his lateral teloblast. A later stage showed the budding off from the inner myoblast of the middle myoblast, and still later this was seen to form a row which becomes insinuated between the other rows. All of these cells are as yet ectodermal, and the neuroblasts and the neural rows are the first to become covered by the ectoderm. Apparently the bands are solely derived from the teloblasts, and the ectoderm contributes nothing further to this growth.

Bergh describes a new element in the nervous system as a plexus of nerve cells and nerve fibres, which develop along the middle of the ventral surface between the neural rows. In the ectoderm of this region, just beneath the ciliated line, are certain uni- and bipolar cells, the processes of which run lengthwise of the animal, and form a temporary nervous system before the permanent nervous system has begun the development of nerve fibres. These cells are regarded as arising independently of the neuroblasts from the ectoderm, the fact that they extend behind the neuroblasts being strongly confirmative of this view. Later this plexus is included in the permanent nervous system, while the ciliated cells are resorbed, and, contrary to Kleinenberg's view, do not form part of the regular ectoderm. Bergh suggests that the ventral median multipolar elements described by Friedländer may originate from this plexus. Hatschek's median invagination does not exist in Lumbricus.

The three remaining germ-bands, says Bergh, have nothing to do with the formation of the nephridia, and at no place do they project inwards, as described by Wilson, into the inner muscle plate. They rather spread out between ectoderm and the product of the hinder myoblast, and give rise to the circular muscles of the adult worm. These muscles are first formed ventrally, and later reach the dorsal surface.

The nephridia are, on the other hand, derived wholly from the inner mesoderm, the first portion to be distinguished being the large funnel cells, which are recognizable before the formation of the cœlomic cavities. With the formation of the cœlom a row of cells buds off from the hinder surface of each dissepiment, just behind the funnel cell, to give origin to the tubular portion of the nephridium. The anterior myoblasts contribute nothing towards the formation of the nephridia, and these organs from the first have no structure uniting the successive somites. Bergh thinks that Wilson has misinterpreted his sections, and has missed some of the stages. The bristle sacs which Wilson thinks are derived from the germ-bands are, according to Bergh, formed as ingrowths from the ectoderm. With such differences of interpretation it, is difficult to say which is right. The work is in each case apparently thoroughly done, and a comparison of plates does not serve to reconcile the two accounts.

Benham's recent paper on the genera and species of earthworms[5] will prove of great value to students of the group, and an abstract is given here in the hope that it may aid American students of the group. The forms occurring in the United States are scarcely known. The Oligochætes are divided into:

NAIDOMORPHA.

Small worms of relatively few somites; blood uncolored; male genital pores in, or in front of, somite VII.; asexual and sexual reproduction; eye spots frequently present; embraces the families Aphanoneura, Naidæ, Chætogastridæ, and the genus Ctenodrilus.

LUMBRICOMORPHA.

Male genital pores behind somite VII.; reproduction only by sexual process; somites behind the peristomium all similar; no eye spots.

The characters separating the two divisions are not constant, except that which refers to the network of blood-vessels on the nephridia.

[5] Benham, W. B. An Attempt to Classify Earthworms. *Quarterly Jour. Micros. Sci.*, XXXI., p. 201, 1890.

MICRODRILI (Water Worms).

No capillary network of blood-vessels on nephridia ; small size, thin, transparent body wall ; setæ always in four groups per somite ; prostomium not separated from peristomium by a groove. Contains families Discodrilidæ, Enchytræidæ, Phreoryctidæ, and Lumbriculidæ.

MEGADRILI (Earth Worms).

Large forms from one inch to six feet in length. Body wall thick and opaque; prostomium (when present) separated from peristomium by a groove; capillary network of blood-vessels on the nephridia; clitellum always occupying more than two somites. These are divided into PLECTONEPHRICA, with the nephridia in the form of delicate tubules in each somite, uniting to form a network, with more or less numerous external apertures; and MEGANEPHRICA, with the excretory network absent, replaced by a pair (rarely two pairs) of large nephridia in each somite. The members of each division are given below, the genera known to occur in the United States being given in italics .

PLECTONEPHRICA.

Family TYPHÆIDÆ ; genera Typhæus, Megascolides, Cryptodrilus, Didymogaster, Perissogaster, Dichogaster, Digaster.

Family ACANTHODRILIDÆ ; genera Acanthodrilus, Trigaster, Dinodrilus, Neodrilus, *Diplocardia.*

Family PERICHÆTIDÆ ; genus Perichæta (including Megascolex).

MEGANEPHRICA.

Family MONILIGASTRIDÆ ; genus Moniligaster.

Family EUDRILIDÆ ; genera Eudrilus, Teleudrilus, Pontodrilus, Photodrilus, Microscolex, Rhododrilus, *Plutellus*, Stuhlmannia, Hyperiodrilus.

Family PERIONYCHIDÆ ; genus Perionyx.

Family GEOSCOLECIDÆ ; genera Geoscolex, Urochæta, Diacheta.

Family RHINODRILIDÆ; genera Rhinodrilus, Microchæta, Urobenus, Hormogaster, Brachydrilus.

Family LUMBRICIDÆ; genera *Lumbricus*, *Allolobophora*, Criodrilus, Allurus.

Besides the above, Benham includes four genera of uncertain position, viz., Helodrilus, Echinodrilus, Antæus, and *Eisenia.*

The genera of Megadrili recognized by Benham may be separated by the following key, modified only in method of arrangement from that given by him :

A, Setæ 16 to 80, or more, in a ring.
- *a*, Male pores far apart; small tufts of nephridia; *Perichæta.*
- *aa*, Male pores very close together; large nephridia; *Perionyx.*

AA, Twelve setæ on somite; clitellum on somites 14–16; *Dinodrilus.*

AAA, Eight setæ on somite.
- *a*, Setæ alternate in consecutive somites throughout body; male pore on somite 22; *Diachæta.*
- *aa*, Setæ alternate only posteriorly; male pore 20–21;[6] clitellum on somites 14–22; *Urochæta.*
- *aaa*, Setæ in rows, not alternating.
  - *β*, Male pores 10–11, or 11–12; *Moniligaster.*
  - *ββ*, Male pores on somite 13; *Allurus.*
  - *βββ*, Male pores on somite 15.
    - *γ*, Prostomium dovetailed completely into peristomium; *Lumbricus.*
    - *γγ*, Dovetailed incompletely; *Allolobophora.*
    - *γγγ*, Not dovetailed; *Criodrilus.*
  - *ββββ*, Male pores 15–16; *Hormogaster.*
  - *βββββ*, Male pores on somite 17.
    - *γ*, Clitellum on somites 14–17.
      - *δ*, Setæ separate; *Rhododrilus.*
      - *δδ*, Setæ in couples.
        - *ε*, One pair of sperm sacs; *Typhæus.*

[6] Between somites 20 and 21.

εε, Two pairs of sperm sacs; *Digaster.*
γγ, Clitellum on somites 14–18; setæ in couples; *Eudrilus.*
γγγ, Clitellum on somites 13–17; lobed prostates, one pair; *Microscolex.*
γγγγ, Clitellum on somites 13–20; prostates tubular, two pairs; *Dichogaster.*
ββββββ, Male pores on somite 18.
γ, Two pairs of prostates on somites 17–19.
δ, Male pores in a deep fossa; *Trigaster.*
δδ, Male pores not in a fossa; *Acanthodrilus.*
γγ, One pair of prostates on somite 18.
δ, Clitellum on somites 13–17.
ε, Prostomium dovetailed.
ζ, Prostate convoluted; *Pontodrilus.*
ζζ, Prostate lobate; *Cryptodrilus.*
εε, Prostomium not dovetailed; *Photodrilus.*
δδ, Clitellum on somites (13) 14–17; prostomium dovetailed; setæ separate; *Plutellus.*
δδδ, Clitellum on somites 14–18.
ε, Setæ equidistant; *Didymogaster.*
εε, Setæ in couples; *Perissogaster.*
δδδδ, Clitellum on somites 13–21 or more; *Megascolides.*
γγγ, No prostates; clitellum on somites 16–21; *Brachydrilus.*
βββββββ, Male pores 18–19.
γ, Prostomium broad; setæ simple; clitellum 15–23. *Geoscolex.*
γγ, Prostomium elongate; setæ ornamented; clitellum 15–25; *Rhinodrilus.*
ββββββββ, Male pores on somite 19.
γ, Clitellum 10–25; *Microchæta.*

$\gamma\gamma$, Clitellum 14–17; *Teleudrilus.*
$\beta\beta\beta\beta\beta\beta\beta\beta\beta$, Male pores on somite 20; clitellum 14–25; *Urobenus.*

In explanation of the above key it may be said that the peristomium is regarded as the first segment. The prostomium is sometimes separated from the first somite by a transverse groove; but frequently grooves start on the prostomium and extend back into the first somite, so that the prostomium appears "dovetailed" with the peristomium. If the grooves stop after traversing the first somite for a short distance, the prostomium is partially dovetailed. The external openings of the sperm ducts are the male pores. The term sperm sacs is applied to the vesciculæ seminales, the testes of the older authors; the prostates are diverticula of the sperm ducts near their external opening.

There are several genera which are not included in the above summary. Thus Garman has described[7] a genus Diplocardia, from Illinois, which belongs to the family Acanthodrilidæ, but differs from Acanthodrilus in having the dorsal vessel paired throughout its entire length, and in the absence of a subneural blood-vessel. It agrees with Dinodrilus in the double dorsal vessel, but differs in having but eight setæ. Garman also mentions the existence of Perichæta in Champaign, Ill. A species, apparently of the same genus, occurs in Lafayette, Indiana, where it caused the students no little trouble to make it fit the description of Lumbricus given in Brooks's Zoology.

A paper by Michaelsen[8] has not been seen. It describes several African forms of the family Eudrilidæ, among them a genus Stuhlmannia. Allied to is another African genus lately described by F. E. Beddard.[9] It is called Hyperiodrilus, and presents many interesting peculiarities of reproductive organs.

[7] Garman, H. On the Anatomy and Histology of a New Earthworm (*Diplocardia communis*). Bulletin Illinois State Laboratory of Natural History, III., pp. 47, 5 plates.

[8] Jahrbuch der Hamburg wissinsch. Anstalten, Bd. VII.

[9] Beddard, F. E. Preliminary Note on a New Earthworm Belonging to the Family Eudrilidæ. *Zool. Anzeiger*, XII., 1890.

The genus Deodrilus[10] proposed by Mr. Beddard has its sole representative in Ceylon. It seems to combine the character of several of Benham's families, and its exact position is uncertain. Beddard regards it as nearest Typhæus and the Geoscolicidæ, with some affinities with Pontodrilus and many Eudrilidæ. Beddard announces a forthcoming classification of the earthworms.

In the same paper he describes a connection of the nephridia with the terminal region of the intestine as occurring in the New Zealand species *Acanthodrilus multiporus*. These nephridia are connected with the general nephridial network found in the Plectonephrica. Whether the portion of the intestine with which they are connected is proctodeal or entodermic is unsettled. Beddard makes some interesting comparisons with the respiratory trees of the *Gephyrea chætifera*, and also with the malpighian tubes of the Hexapods.

THE MECHANICAL ORIGIN OF STRUCTURE IN PELECYPODS.

BY ROBERT TRACY JACKSON.

IT is desired in this paper on Pelecypods to call attention to some cases recently studied in which the structure of the animal seems to be the direct consequence of the physiological reaction induced by the mechanical requirements of the environment; or to cases of "mechanical genesis," as they have been termed.[1] Several of our examples are cases in which similar forms are built up on similar lines of development, but in widely separated or totally distinct groups of animals. They therefore afford evidence

[10] On the Structure of a New Genus of Oligochæta (Deodrilus); and On the Presence of Anal Nephridia in Acanthodrilus. *Quart. Jour. Mic. Sci.*, XXXI., p. 467, 2 pls., 1890.

[1] This paper is taken largely from a recently published memoir, to which the reader is referred for a fuller discussion of many facts presented. See Phylogeny of the Pelecypoda, the Aviculidæ and Their Allies; by Robert Tracy Jackson. Mem. Bost. Soc. Nat. Hist., Vol. IV., No. 8, July, 1890, pp. 277–400, pls. XXIII.–XXX.

in favor of definite lines of variation, and in so far support the view that acquired characters are inherited.

Mr. Wm. H. Dall, in a recent highly interesting paper on Pelecypods, explains the form and progressive development of the ligament, cartilage pit, and teeth of that group as the result of the mechanical strains and stresses to which the parts are exposed.[2]

In the development of Pelecypods we find in a late embryonic stage (the phylembryonic) that the shell has a straight hinge line. This is characteristic of Ostrea (Fig. 1), Cardium, Anodonta, and so many widely separated genera that it apparently represents a primitive ancestral condition common to the whole class. Embryology shows that the bivalve shell doubtless arose from the splitting on the median line of a primitive univalvular ancestor. If that ancestor had a saddle-shaped[3] or a cup-shaped[4] shell, as is probable, the first result of the introduction of a hinge in the median line would have been to straighten the shell on the hinge line. This is a simple problem in mechanics, for if one tries to break by flexion a piece of metal which is saddle-shaped or cup-shaped, it will tend to form a straight line on the axis of flexion. A parallel case is seen in the development of a bivalve shell in ancient crustaceans. The ancient Ostracoda: Leperditia, Aristozoe, etc., have a straight hinge line and subcircular valves, which are united dorsally by a ligament. The resulting form of the early condition of the bivalvular shell in these two distinct classes is so strikingly similar, it lends weight to our supposition that the form is induced by the mechanical conditions of the case.

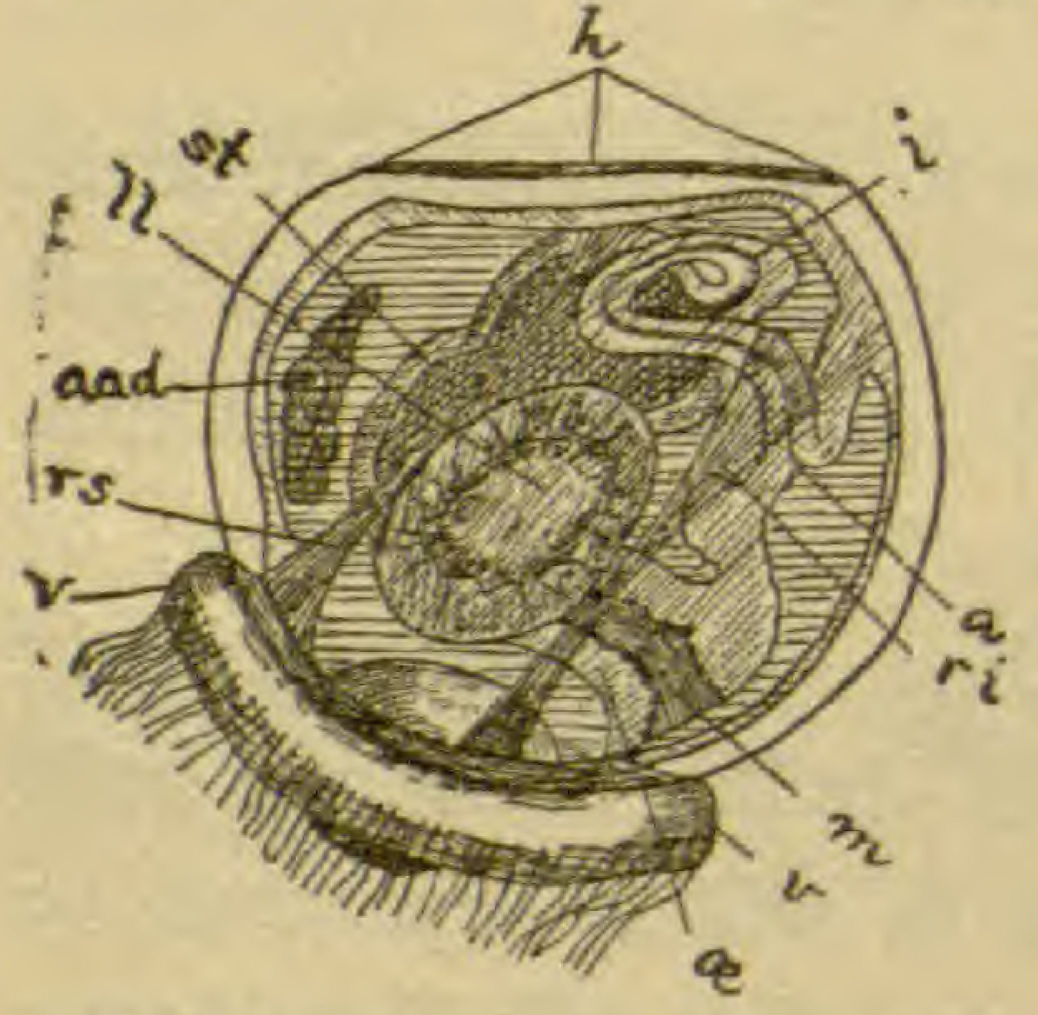


FIG. 1.—*Ostrea edulis*, embryo; *a ad*, anterior adductor muscle; *m*, mouth; *a*, anus; *v*, velum; *h*, hinge of shell; (after Huxley).

I think that the adductor muscles which close the valves may also be demonstrated to be the necessary consequence of the bivalvular condition. In the phylembryo stage (Fig. 1) the valves are closed by a single adductor muscle, which is the sim-

[2] On the Hinge of Pelecypods and Its Development, with an Attempt Toward a Better Subdivision of the Group; by Wm. H. Dall. *Am. Jour. Sci.*, Vol. XXXVIII., Dec.,

plest condition mechanically possible to effect the desired end.[5] This muscle does not seem to be homologous with any muscle in other classes of molluscs, and is probably developed from the mantle muscles as a consequence of the conditions of the case. In support of this view bivalvular crustaceans may again be cited. They have an analogous adductor muscle, developed of course on an entirely different line of descent, but under closely similar mechanical conditions. At the completed prodissoconch stage in all Pelecypods, as far as known, there are two adductor muscles, a second one having developed in the posterior portion of the body. In later life the anterior, the posterior, or both adductors may be retained, reduced, or lost, according as the persistence or changes in correlated anatomical features retain in use or bring into disuse the muscles in question.

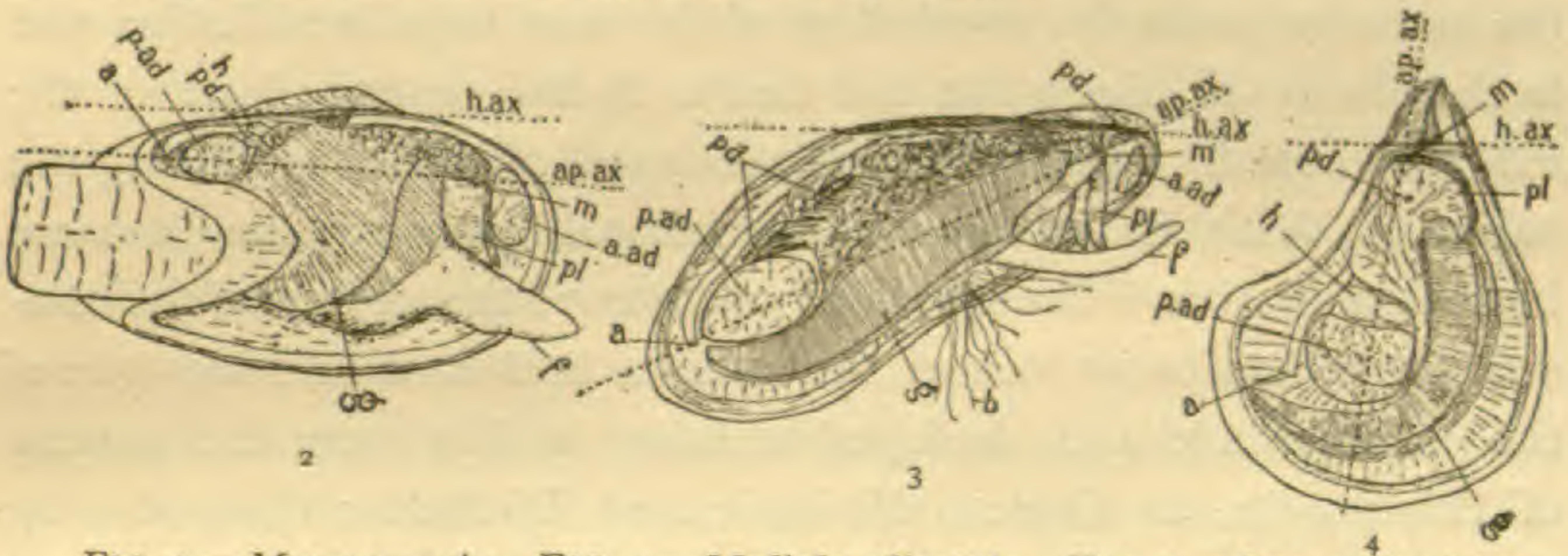


FIG. 2.—*Mya arenaria.* FIG. 3.—*Modiola plicatula.* FIG. 4.—*Ostrea virginiana.* Lettering: *ap ax*, antero-posterior axis; *h ax*, hinge axis; *a ad*, anterior, and *p ad*, posterior adductor muscle; *m*, mouth; *pl*, palps; *a*, anus; *g*, gills; *pd*, pedal muscle; *f*, foot; *b*, byssus; *h*, heart.

Let us look at examples of the retention or loss of the adductors. In typical dimyarian Pelecypods, as Mya (Fig. 2) or Venus, the adductors lie toward either end of the longer axis of the shell. As the hinge occupies a position on the borders of the shell about midway between the adductors, both muscles are nearly or quite in a position to be equally functional in closing the valves. As

1889. The same author explains graphically on a mechanical ground the origin of structures in Gastropods. See pp. 58–65, Trans. Wagner Free Institute, Vol. III., Aug., 1890.

[3] Characteristic of young Dentalium.

[4] Characteristic of the extreme young of cephalous molluscs.

[5] This early adductor appears in the same position in many genera, and is apparently characteristic of the class. It is the anterior of the two adductors found in later stages; but it may be retained or lost in the adult.

a result, both muscles are of about the same size. The condition described is that existent in the completed prodissoconch stage in all Pelecypods, as far as known. In later life, however, a revolution of the axes of the soft parts may take place, so that the antero-posterior axis (represented by a line drawn through the mouth and middle of the posterior adductor muscle), instead of being parallel to the hinge axis (the axis of motion of the valves) as in dimyarians, may present a greater or less degree of divergence from the parallel. In progressive series, as in Modiola (Fig. 3), Perna, etc., as the anterior adductor is brought nearer and nearer to the hinge line, where its mechanical action is less and less effectual in closing the valves, we find that it is more and more reduced until it finally disappears from disuse and atrophy, as in Ostrea (Fig. 4), and Pecten. Conversely, the posterior adductor in the same series in the revolution of the axes is pushed farther and farther from the hinge line and nearer to the central plane of the valves, where its mechanical action is most effectual in closing the valves. With its increase in functional activity the muscle increases in size. The revolved position of the axes, and the consequent reduction or loss of the anterior adductor and increase of the posterior adductor, is found in many widely separated genera of Pelecypods, as Ostrea, Mulleria and Tridacna; thus proving the development of the same features on different lines of descent.[6] In Aspergillum the two valves have concresced so as to form a truly univalvular, tubular shell, so that the adductors would evidently be functionless if existent. The posterior adductor has disappeared and the anterior is reduced to a few disconnected shreds (Fischer), though evidently existent in the young, as attested by the form of the shell in the nepionic stage.

The condition of the foot in Pelecypods depends largely upon its use or disuse. In free-crawling or burrowing forms the foot is highly developed, and is sometimes of a peculiar form which could doubtless be traced to special functional uses. In Pecten, in the nepionic period, the foot is highly developed, and actively

[6] Dr. B. Sharp and I published almost simultaneously closely similar views on the mechanical aspect of the relative size of the adductors. See Proc. Acad. Nat. Sci. Phila., 1888, p. 122, and Proc. Bost. Soc. Nat. Hist., Vol. XXIII., 1888, p. 538.

employed in crawling. In later stages the animal adopts the habit of byssal fixation, and then of free swimming. The foot becomes highly reduced, and in the adult is probably a functionless organ. In shells which are permanently attached by calcareous fixation the foot is highly reduced or absent, as in Chama, Spondylus, and Ostrea (Fig. 4). In Ostrea the shell becomes permanently attached at the close of the free-swimming veliger stage; therefore the foot is unnecessary before fixation and useless afterwards, and it has almost entirely disappeared from even embryonic stages of growth. In *Anomia glabra* the foot is active and well developed in nepionic stages; but later, as the animal becomes permanently attached, it is reduced, and in the adult is highly atrophied.

Ordinarily there are two posterior retractor muscles of the foot in Pelecypods, one situated on either side. In adult Pecten either the left retractor alone exists, or both retractors are wanting (the left doubtless always exists in the young). In studies of young *Pecten irradians* I found that the animal always crawled while lying on the right side, with the foot extended through the notch in the lower valve and pressed against the surface of support. It is evident that while crawling in this position the left retractor is in the plane of traction, and it is retained; on the other hand, the right retractor would not be in the plane of traction, and it has disappeared through disuse and atrophy.[7] A similar disappearance of the right retractors of the foot is seen in *Anomia glabra*, and is explained on similar bases of argument.

The action of the foot in its effect on the form of the shell in some cases presents interesting mechanical features. In dimyarian Pelecypods which crawl freely the foot protrudes from an area on the free border of the valves, nearly opposite to and comparatively far removed from the hinge line. In such cases, by a slight gaping of the valves, a considerable opening is made, through which the foot extends without (ordinarily) the aid of any special notch. On the other hand, in monomyarian Pelecypods, where the revolved position of the axes brings the foot close up to the hinge line, a special notch is required for the extrusion of the foot, as the valves would have to gape very widely to permit of its

[7] Both retractors probably exist in the prodissoconch stage of Pecten and allies.

passage at that area. Such a notch we find in Tridacna, Pecten, and many allies. Young *Pecten irradians* crawls while lying on its right valve by extending the foot over the edge of the valve. The constant extension of the foot would necessarily cause a local retraction of the right mantle lobe at that area; therefore shell growth would proceed less rapidly, and a notch would consequently be formed. By this action no pressure is exerted on the left mantle lobe, and no notch is formed on that side of the shell.[8] In later life the crawling habit is abandoned, the foot atrophied, and the notch nearly or quite disappears, as I have observed in several species of Pecten. The presence of a byssus at such an area may induce a notch, as well as the crawling habit, as may be observed in Avicula and Meleagrina. Young Hinnites and Spondylus are pecteniform and have a deep byssal notch, as I have shown;[9] but as soon as they become attached by cementation to a foreign object the use of the foot is of course abandoned, and the notch is not perpetuated in succeeding shell growth. In the development of Anomia we find that the right valve surrounds the byssus completely, enclosing it at an early stage. In later growth the byssus and calcareous byssal plug become greatly enlarged, the walls of the enclosing foramen receding to give space for the enlargement of the organ. This enlargement of the foramen is apparently to be explained on the physiological principle that constant pressure causes a resorption of tissue.

In free-crawling or superficially burrowing Pelecypods the foot is extended from an area nearly opposite the hinge line, that being the most effectual position for crawling while the valves are in an upright position. In deep-burrowing forms, as Solen, on the other hand, the foot is extended at an area nearer the hinge line and in the plane of the longer axis of the shell. It is evident that in this position it is more effectual in producing a hole, it is in a better position to drag the shell after it, and it offers the least resistance to the surrounding medium. In deep burrowers, as *Mya arenaria*, and especially *Ensatella* (*Solen*) *americana*, it is to

[8] For figures illustrating this stage see this journal, December number, page 1138 Figs. 11, 12.

[9] Phylogeny of the Pelecypoda.

be observed that the borders of the shell gape at either end. This is evidently caused by the constant extension of the foot and siphons, which, pressing on the mantle border, thus keep it back at those areas and modify the direction of shell deposition. Another active cause for the gaping of the valves is doubtless the loss of the habit of withdrawing the organs and closing the valves as a source of protection. Such forms as we are considering are protected in a measure by the surrounding sand or other medium, and in time of danger seek safety by burrowing deeply.

In *Mya arenaria* we find a highly elongated siphon. In the young the siphon hardly extends beyond the borders of the valves, and then the animal lives at or close to the surface. In progressive growth, as the animal burrows deeper, the siphon elongates, until it attains a length many times the total length of the valves. The ontogeny of the individual and the paleontology of the family both show that Mya came from a form with a very abbreviated siphon, and it seems evident that the long siphon of this genus was brought about by the effort to reach the surface, induced by the habit of deep burial.

In the structure of *Pecten irradians* we find the most complete adaptation to the mechanical requirements of the act of swimming. Pecten swims by the rapid opening and closing of the valves, with the resultant violent expulsion of water; but the details of the method are somewhat intricate. In swimming, as well as when at rest, the left valve is always uppermost, and the plane of the edges of the valves is inclined to the surface of the water at an angle of about 45°. The mantle folds are built up in perpendicular walls on the periphery, and these walls perform an important function in swimming. Lying on the bottom, the Pecten suddenly closes its valves by the quick action of the adductor muscle. The first water expelled is driven out posteriorly in the direction of the arrow *a*, Fig. 5, and if this were the only or the main direction in which a current is expelled, the animal would by impact of water be driven in the opposite direction, or anteriorly, which is not the case. When the valves have closed to a slight extent, the borders of the two thick perpendicular mantle walls come in contact, and then no more water is driven out posteriorly; but instead, during further closure of the valves it is ejected from the lower border of one ear, where the mantle wall is low and thin, in the direction of the arrow *b*. The water expelled at this area is the most forcible current, and is probably of the greatest volume, as by its means the animal is impelled in the opposite direction, as indicated by the arrow *c*. The valves open quickly and clap again. The second time as before the first water is driven out posteriorly; but when the mantle walls come in contact the direction of the excurrent is again changed and it is forced out from the lower border of one ear in the direction of the arrow *d*. Being the strongest current, it impels the animal in the direction of the arrow *e*. At successive claps the water is driven out from alternate ears, as shown in the figure. The resultant action of the several currents and successive claps is to drive the animal in the direction of the free borders of the valves, or posteriorly. It is due to the alternate expulsion of water from either ear, as shown in the figure, that the animal presents a series of zigzag jerks in swimming. The action of the first current expelled posteriorly, before the mantle walls come in contact, gives the animal an upward jerk, and it is in virtue of this jerk, combined with the momentum in a posterior direction, that it maintains its position on the surface of the water, and also the high angle to the surface which it presents in swimming. This current is so powerful that by its action water may be squirted by adults to the height of five inches or more from the surface. In the shell a correlated feature of the swimming habit is seen in the incomplete closure of the valves at the eared areas. Water may therefore pass out when the free borders of the valves are in immediate contact, as they are at each clap, as indicated by the sharp clicking noise made in swimming.

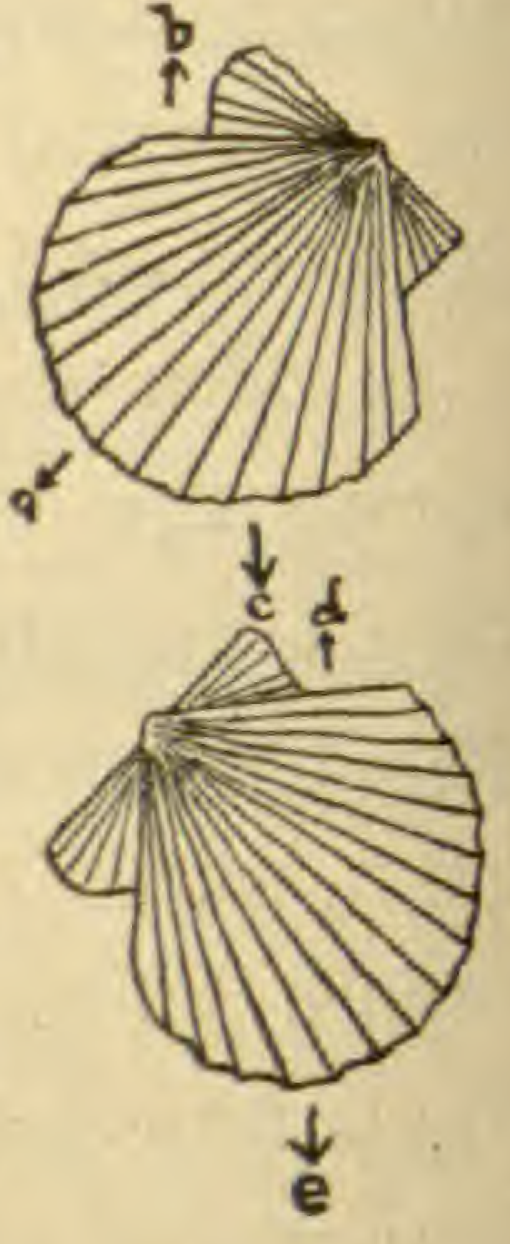


FIG. 5.

The tendency to equalize the form by growth in a horizontal plane in relation to the force of gravity acting in a perpendicular plane, or the geomalic tendency of Professor Hyatt,[10] is seen mark-

[10] Transformations of Planorbis at Steinheim, with Remarks on the Effects of Gravity upon the Forms of Shells and Animals. Proc. Am. Ass. Adv. Sci., Vol. XXIX., 1880.

edly in Pelecypods. In forms which crawl on the free borders of the valves the right and left growth in relation to the perpendicular is obvious, and agrees with the right and left sides of the animal. In Pecten the animal at rest lies on the right valve, and swims with the right valve lowermost. Here equalization to the right and left of the perpendicular line passing through the centre of gravity is noticeable (especially in the Vola division of the group); but the induced right and left aspect corresponds to the dorsal and ventral sides of the animal,—not the right and left sides, as in the former case. Lima, a near ally of Pecten, apparently swims with the edges of the valves perpendicular. In this case the geomalic growth corresponds to the right and left sides of the animal.

The oyster has a deep or spoon-shaped attached valve and a flat or flatter free valve. This form, or a modification of it, we find to be characteristic of all Pelecypods which are attached to a foreign object of support by the cementation of one valve. All are highly modified, and are strikingly different from the normal form seen in locomotive types of the group. The oyster may be taken as the type of the form adopted by attached Pelecypods. The two valves are unequal, the attached valve being concave, the free valve flat; but they are not only unequal, they are often very dissimilar,—as different as if they belonged to distinct species in what would be considered typical forms. This is remarkable as a case of inherited or acquired characteristics finding very different expression in the two valves of a group belonging to a class typically equivalvular. The attached valve is the most highly modified, and the free valve is least modified, retaining more fully ancestral characters. Therefore it is to the free young before fixation takes place, and to the free, least-modified valve, that we must turn in tracing genetic relations of attached groups. Another characteristic of attached Pelecypods is camerated structure, which is most frequent and extensive in the thick attached valve. The form as above described is characteristic of the Ostreidæ, Hinnites, Spondylus, and Plicatula, Dimya, Pernostrea, Ætheria, and Mulleria, Chama and its near allies. These various genera, though ostreiform in the adult, are equivalvular and of totally distinct form in the free young. The several types cited are from widely separate families of Pelecypods, yet all under the same given conditions, adopt a closely similar form, which is strong proof that common forces acting on all alike have induced the resulting form. What the forces are that have induced this form it is not easy to see from the study of this form alone; but the ostrean form is the base of a series, from the summit of which we get a clearer view.

As I stated in an earlier paper,[11] the fullest modification in the ostrean line of variation is the production of a shell in which the attached valve is cup-shaped, conical, or subcylindrical, as seen markedly in species of the Chamidæ and Rudistæ. In this group as a whole, and in progressive stages of growth of its extremest members, all steps may be followed between a simple ostreiform or exogyriform shell and the most highly modified conical type. The Ostrea form is the first step in this line of modification, the Exogyra form is the second step, and the conical form is the last step. What are the mechanical causes which bring about this resultant form? I suggest as an hypothesis the following: The Rudistæ are conical or cup-shaped Pelecypods, with a superficially marked radial symmetry. So striking is the radial feature that they have been classed with the corals or Cirripeds, and the term radial is combined frequently in generic and specific names of the group. *Barretia monolifera*, as described by Woodward, is highly radial, and the infoldings of its thin walls closely resemble the radial septa of corals. In other animals which are permanently attached by calcareous fixation, as corals, some worms and Brachiopods, Cirripeds, and others, we find closely comparable forms which are subcylindrical or subconical, with a very marked degree of radial symmetry. Finding so many similar forms built up on different lines of descent affords strong evidence that common forces acting on all alike have induced the resulting form. The equal impact of moving water on all sides of an attached, growing organism, it seems, would cause an equal effort of resistance on all sides, and therefore induce an equal growth on all sides, thus producing a form

[11] Studies of Pelecypoda, AMER. NAT., Dec. 1890, p. 1135.

circular in section at any one horizon, and subconical, cup-shaped, or globose in its entirety, as are the forms which we are here considering. To strengthen the walls of a round organism we might have solid accumulation, vesicular accumulation, or perpendicular partitions arranged at right angles to the supported wall. Such mechanical supports are characteristic of attached Rudistæ and other Pelecypods, Cœlenterates, Cirripeds, and some worms. As all sides of the periphery of an attached organism are equally exposed to food supply, danger, etc., the organs, as tentacles, nerve centres, and eyes would gradually tend to become situated at all points on the periphery, or radially. It is well known that the external parts of an animal are more easily modified than the deeper-seated parts. It is also known that the modification of deeper-seated parts may be progressively produced from without inward, or centripetally. If we have an attached animal that is round, with some organs arranged on the periphery, a common case, then further modification or development of such organs or parts would tend to be produced centripetally, or radially, for the centripetal variation of a round form would, as a mechanical necessity, be radial variation. In the Hydrozoa there is a strong proof of the correctness of this view. Passing from Protohydra to Hydra, to the hydroid stage of Aurelia, then to the free medusoid stage of Aurelia and other Discophores, we find progressively a more and more perfect radial symmetry built up centripetally. A similar comparison may be made in the development of corals.

Many permanently attached forms of bilateral classes of animals assume a considerable degree of radial symmetry; and, conversely, many free locomotive forms of radiated classes assume a considerable degree of bilateral symmetry. As bilaterality is a feature induced and progressively built up by the conditions of free locomotion, it is believed that radiality is induced and progressively built up by the conditions of permanent fixation, with its attendant influences of environment.[12]

[12] Since this paper was in type my attention has been called to the fact that Haeckel, in his Gastræatheorie, considers the sedentary life of ancestral forms of the zoöphytes as the mechanical efficient cause of their radial symmetry.

SEXUAL IMMOBILITY AS A CAUSE OF THE DEVELOPMENT OF THE SPOROPHYTE.

BY CONWAY MACMILLAN.

IN the *Annals of Botany*, August, 1890, are to be found two very interesting papers on the alternation of generations in plants. One is by Professor F. O. Bowers, who defends Alakovsky's distinction between antithetic and homologous alternation; the other by the late J. Reynolds Vaizey, who shows the impossibility of establishing homologies between sporophores and oöphores. Each of these papers presents somewhat more clearly than usual the problems which underlie all attempts at a general coördination of vascular plants, mosses, and the lower algæ, and in each of them there is some effort to account for the origin of the phenomenon of alternation itself. Bowers is inclined to ascribe entirely different causes to the sporophyte of the Archegoniatæ and the so-called sporophytic plants of Vaucheria, Mucor, or Œdogonium. These latter he conceives to be modified oöphytes,—or gametophytes, to use his terminology,—while the former is an interpolated plant, altogether devoid of homologies with the gametophyte of its own species or that of any other. To the sporophyte of the Archegoniatæ he ascribes change of habit from aqueous to subaërial nutritive media as the producing cause, and proceeds to adduce morphological and phylogenetical evidence in support of the position. The purpose of this brief note is to indicate an opinion of the writer that something quite different, and not altogether overlooked by Bowers, is possibly the sufficient cause for the development of sporophytes, not only in the Archegoniatæ, but wherever sporophytes are developed at all.

In the first place, it should not be overlooked that in animals higher than the Medusæ and Flat Worms (with rare exceptions, *e.g.*, Salpa?)[1] there is nothing comparable with the alternation of

[1] The alternation in plant-lice (Aphidæ) is a different matter entirely, and need not be considered here.

generations—that rhythmic succession of sexual and asexual individuals—which continues with perfect distinctness even into the order Compositæ,—according to Luerssen, the highest family of plants. Why, now, there should be such a rhythm in plants and not in animals is a point to be explained, and very likely the explanation will throw light upon the origin and perpetuation of alternation in the vegetable kingdom. It is of no use to say, as Geddes does, quoted by Bowers, that alternation is "a rhythm between relatively anabolic and katabolic preponderance." For why should such rhythm exist in plants and not in animals? In fine, there seems to be but one explanation readily entertained, and that is this: *Alternation of generations is a phenomenon conditioned upon individual immobility.* It is readily discovered that in almost every species of animal free to move where it pleases alternation is not seen, while in many of the somewhat fixed and immobile alternation is apparent,—for example, in the Cœlenterates. And in the more mobile plants alternation is either indistinct (homologous) or scarcely apparent, while in the more immobile plants alternation becomes exceedingly distinct, and reaches its highest type in in the most immobile plants. Now the sexual act, being conditioned upon the approach to each other of the gametangia or gametes themselves, is accomplished with greater and greater difficulty the more complete the immobility of the sexual individual. In animals immobility is at its maximum; in the higher plants—notably most Angiosperms—it is at its minimum. In other words, the sexual act is easiest of accomplishment in animals, speaking generally, and most difficult in the higher plants; consequently the egg, in animals, is easily produced, but in a plant of the Archegoniate series an egg is produced with great difficulty. In spite of the high gonotropic specializations in other plants, probably not a millionth part of the sexual individuals produced ever accomplish their end. For this reason the egg of an animal is, on the whole, a *cheap* product; the egg of an Archegoniate plant is an *expensive* product.

From the considerations outlined above we have no difficulty in perceiving the physiological conditions which lead to the appearance and to the great development of the sporophyte. In Œdogonium the egg divided into four swarm-spores. For one sexual act four plants may be obtained. In Chara the number of spores produced directly from the egg is still greater, and the carpogone wall becomes thickened and specialized as a covering to protect the result of the sexual act. In Riccia the egg itself develops an epidermal layer, besides the spore-mother-cells within. As the number of these spores becomes greater a columella is required to strengthen the capsule; it appears in the Anthocerotæ. To scatter the spores better the capsule is elevated on a stalk in the Jungermanniæ. To the same end elaters are developed in the Hepaticæ (and later in the Equisetaceæ). The stalk of the capsule becomes longer and the whole sporophyte more complex in the Musci. In the ferns, leaves and roots are assumed by the sporophyte, in order that (having access to more nutriment) it may produce more spores. Throughout the whole upward series of developing, specializing, progressing sporophytes we see one distinct end in view, viz., the making of an egg, when fertilized, go as far as possible.

Now whether there is any difference between the sporophyte developed, under these conditions, in an aquatic plant like Chara or Coleochæte, and the sporophyte developed under exactly similar conditions in an amphibious plant like Ophioglossum, I cannot say. Certainly in either case the meaning of the sporophyte remains the same. It is, wherever we meet it, whether in Chara or in Juglans, in Œdogonium or Taxus, a device for making the most out of that sexual act accomplished with so much difficulty, and with the chances so tremendously against successful consummation.

If the correct explanation of the origin of sporophytes is given above, it is difficult to see why a sporophyte should not in every case be considered an "interpolation" between successive gametophytes. Wherever met, the sporophyte is simply more or less elaborate subdivision of the fertilized egg. In Œdogonium it is a direct subdivision; in Helianthus it is an indirect subdivision. Properly speaking, the gametophyte is the *plant;* the sporophyte

PLATE I.

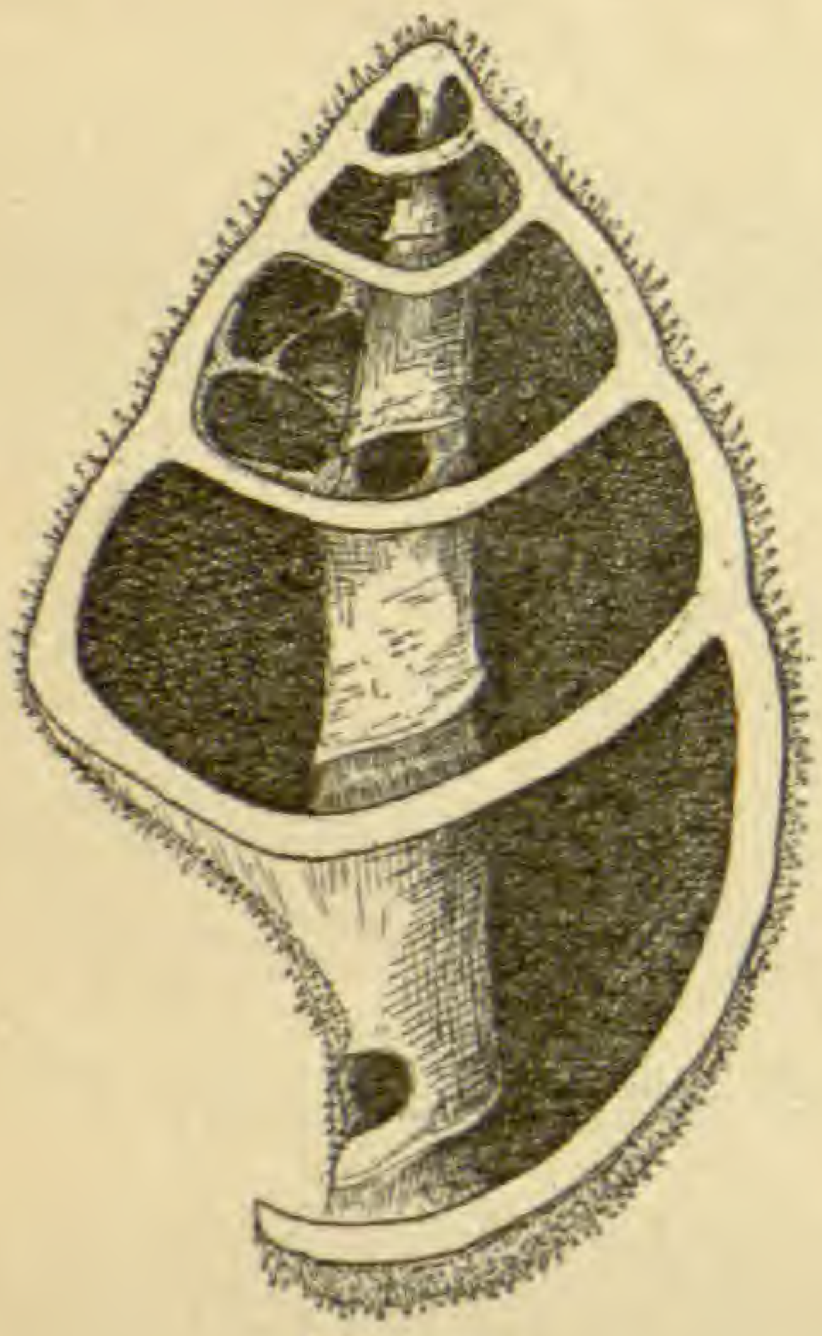


FIG. 1.


FIG. 2.


FIG. 3.


FIG. 4.


FIG. 5.


FIG. 6.


FIG. 7.

Polydora commensalis.

is, at its greatest development, nothing more than a highly complicated, self-supporting *pod.*

The sporophyte, then, may be considered in its widest sense as *a result of vegetative reproduction applied to the fertilized egg.* As the thallus of Marchantia is cut into gemmæ, so the egg of Marchantia may be cut into the cells of the sporophyte. The strict analogy of sporophytes is, I suppose, not questioned. The question as to their homology must be studied from the physiological point of view, as well as through the researches of anatomists and embryologists. Without either dissenting from or endorsing the view of Bowers, the writer has tried only to show that emphasis may be laid upon conditions surrounding the sexual act as a help to a clearer comprehension of the phenomena of alternation.

A COMMENSAL ANNELID.

BY E. A. ANDREWS, PH.D.

CASES in which Annelids are believed to live more or less directly dependent upon other Annelids, upon Crustacea, Gasteropods, Echinoderms, and even upon Cœlenterates, are not unknown, but yet form by far the exception rather than the rule in the economy of this group. Of the reported cases some must be regarded as mere temporary refuge of Annelids in cavities offered by the shells or bodies of other creatures; some are such mechanical associations as are presented in the complicated assemblage of various Annelid tubes in sponges or molluscan shells, etc.; while yet others—and these are few—are illustrations of true commensalism, which may pass over into parasitism, as in the Oliognathus living in Bonellia, the Hæmatocleptes living within another Annelid, or the well-known Alciope living inside Ctenophores.

In 1885 Dr. Brooks called my attention to a very interesting case of commensalism involving an Annelid found at Beaufort, N. C., and which is complicated by the fact that three diverse animals—Annelid, Crustacean, and Hydroid—are here concerned, forming, as it were, a triple alliance, in which each is, moreover, dependent upon the shell of a fourth, a Gastropod.

Over the immense sand-flats of " Bird Shoal " the interdependence of various creatures is especially well illustrated, and this seems in part due to the fact that the entire absence of stones and rocks leads to the burdening of the more securely fixed animals and plants by those less able to resist the changing tides, waves, and moving sand. Thus we find the stout tubes of the Annelid, Diopatra, which project several inches from the sand, seized upon by Algæ, Hydroids, Molluscs, Annelids, and especially by large Ascidians, as the only available, somewhat stable foundation to build upon. Here also occurs in great abundance the small hermit crab (*Eupagurus longicarpus*), inhabiting the empty shells of various small Molluscs, especially the most accessible one,—that of the Gasteropod, *Ilyanassa obsoleta*. Quite a large proportion of the shells so inhabited are covered over almost completely by colonies of the interesting Hydroid, Hydractinia, though the constant moving about of the crab keeps a small circular area of the shell free from this growth, owing to the friction of the shell against the sand as it is dragged along. Undoubtedly the Hydractinian is benefited by this association, since it may obtain some of the food not used by the crab, and since it is upon a surface kept by the crab above the bottom, and protected from the constant danger of permanent burial in the sand. If, on the other hand, the crab, as seems probable enough, is protected by the presence of so well-armed a creature as the Hydroid, we would have here a cause of " mutualism." With this combination of Hydroid and crab is also associated a commensal,—a small Annelid of the family Spionidæ and genus Polydora. Of several hundred shells examined, fifty per cent. were inhabited by this Polydora, in addition to the crab. In those without Hydroids the Annelid is less abundant, but such shells are often very old or broken, or else but temporarily used by the crab. Occasionally an empty shall contains an Annelid; but here we may assume that a crab has recently occupied it and only been out for a short time, since the majority of available shells are either taken possession of by the hermit or else became buried or washed away. In no case could an Annelid be found in a shell containing the original proprietor,—the Ilyanassa.

A somewhat similar case of an Annelid occurring in the dwelling of a hermit crab was long ago noticed by Quatrefages, but there the Annelid, a Nereis, may possibly have taken up only temporary quarters within the shell. This, however, seems not to be the case with the Nereis described by Wirén in 1888, which, it would appear, has been modified by its well-acquired habit of living inside such shells. The Polydora, however, does not merely live within the pre-formed cavity of the Gasteropod shell, as the Nereis would, but, by boring a tunnel in the columella, and by partly filling up some of the spiral cavity of the shell with a calcareous tube of its own manufacture, reconstructs the shell to fit its own needs.

The general character of the dwelling made by the Annelid within the Gasteropod shell may be inferred from a view of the shell cut lengthwise into halves, as in Fig. 1. The external opening of the tunnel is seen on the inner lip of the mouth of the shell as a conspicuous rounded hole, which leads by a long passage inside the columella up to the spiral part of the shell. Here the tunnel opens out again into the apical chamber of the shell by the round hole seen in the figure. The inner opening, however, is continuous with a calcareous tube built into the chamber of the shell in such a way as to completely block it and prevent the posterior end of the crab, or any other object, from pressing up into the smallest terminal spirals. This tube is bent or coiled in various ways, but may present, as in the figure, a cross-section suggesting that of a Mammalian cochlea. Made of a calcareous, cement-like mass, it may be the debris of the bored-out tunnel, but is more probably a special calcareous secretion of the Annelid such as some of its relatives are known to make.

This description applies only to certain cases, since many irregularities are observed both in the calcareous tube and in the tunnel, and some shells present external openings near the apex and apparently communicating with the Annelid's dwelling.

Only one adult Annelid is found in each shell, and this may be seen, in part, even without destroying the shell, since, when the crab is not too active, the anterior part of the Polydora may protrude from the external opening in the columella, reach about in the water, and presumably find and swallow food in the sand or currents of water. Yet it is very easily disturbed, and then to be found only within the columella, or even in the upper calcareous tube, where it may be variously coiled about, since the dwelling is everywhere wide enough for the Annelid to bend back and forth upon itself. The part of the old shell utilized by the Annelid is thus intermediate between that the crab occupies and that covered over by the Hydroid. The former, in drawing in and out of the shell, tends to limit the excursions of the Annelid by dragging its claws over the columella and orifice of the Annelid's tunnel; the latter extends up to the very edge of the Annelid's place of exit. Sometimes the Annelid's tunnel appears to have been cut through into the chamber occupied by the hermit, but then covered in again by a calcareous layer protecting the Annelid from contact with the crab.

Considering how impossible it would be for the Annelid to keep the shell free from sand and prevent its burial, it is obvious that this Polydora, if it lives, as it appears to, only in such a commensal state, is dependent upon the habit of the hermit crab, and thus exists in what is a somewhat recently acquired environment. As, however, other species of Polydora are known to make tunnels into various Gasteropod and Lamellibranch shells, dead or alive, it is evident that this particular species has not departed so widely from the habit of its kind.

Before describing the interesting breeding habits of this commensal Annelid, we will give an account of its structure and of certain organs especially illustrated in the figures.

The body (Fig. 2) is about a millimeter wide, about twenty-five long, and rather flat, with little color except the bright red of the blood in the conspicuous dorsal vessel and in the branchiæ. These reach half way across the back, and each contains a vascular loop that passes from the dorsal vessel to the tip of the branchia, then back again into the body. The limb of this loop nearer the middle line or to the dorsal surface may possibly act as a heart, since it contains peculiar branching, nucleated protoplasmic processes suggesting the cells of an embryonic vertebrate heart, and to be interpreted as part of a mesenchyme, formed, like the blood, outside the cœlom. The ventral side of each branchia, that next the animal's back, bears along it a band of large ciliated cells, each with a large tuft of fine cilia. A similar row of such cells is found extending transversely across the back of each somite, and corresponding nearly to the lines of attachment of the internal septa. The branchia begin upon the sixth somite (Fig. 7), and are present, though very small, at the posterior end of the body (Fig. 8).

The setæ in the dorsal bundles are attenuated, lance-like, and straight (Fig. 3), while in the ventral bundles they present bifid tips, provided with a delicate scroll or enveloping hood (Fig. 4), except anteriorly, where they are entirely replaced by simple, lance-shaped, bent ones (Fig. 5), each with a delicate flange on its convex side. The setæ of the large fifth somite (Fig. 6) are especially modified as a set of about six very stout, golden-colored hooks, each with a prominent flange projecting from its side near the tip. In the figure some of these hooks are still young, and growing up into place beside the perfected ones. In addition to these large spines, there are a few delicate, lance-shaped ones, as seen in the same figure.

The shape of the animal's head is not easily made out, as it is drawn back into the first somite upon the slightest disturbance, and generally remains there in preserved specimens. In Fig. 7 its general form, as made out from living specimens, is represented somewhat imperfectly.

The cephalic lobe or head is slightly emarginate anteriorly, and bears two delicate antennæ that stand just dorsal to the mouth, as a part of the upper lip, and are richly supplied with sensory hairs. In the head are also two pairs of black eyes that on section appear to have only a simple larval structure. Each consists of a minute mass of large, dark-brown pigment granules, forming a sort of cup about fifteen microns in diameter, and partly surrounding a homogeneous spherical mass of equal size, that stains darkly. All this lies some distance from the surface, and may be said to be in the dorsal part of the brain, since the brain is not separated from the epidermis, but lies with its dorsal ganglion cells intermixed with the epithelial cells, in part at least.

As far as the sections go, the appearance of the eye is so simple as to suggest that it may be interpreted as merely one or two epidermal cells, with clear, refracting outer ends, and pigment in the middle part. The inner tips of such cells may be supposed to connect with the brain. It is to be noted, also, that the same sort of pigment granules occur here and there in neighboring epidermal cells in small collections or isolated.

Posterior to the head are the two great tentacles, with a ciliated groove on the under side; while below, on each side of the mouth, is a very prominent, glandular, lateral projection of considerable size. The pharynx is ciliated, and may be everted with definite ridges and grooves between the above two lateral lobes.

At the posterior end of the body (Fig. 8) there is a peculiar series of about fourteen papillæ, placed about an elliptical area, within which the digestive tract terminates in a longitudinal slit.

In the internal anatomy of this Annelid there is one fact of considerable interest,—that is the dorsal opening of the excretory tubes, the nephridia. From the ciliated internal opening of each nephridium (Fig. 9) a somewhat coiled tube proceeds dorsally to make its way between the dorsal longitudinal muscle and the adjacent epidermis, and then, passing towards the middle of the back, opens finally by a small ciliated orifice not far from the median line and about mid-way from one end of the somite to the other. This is shown in a very diagrammatic way in the figure as made out in several sections of preserved specimens.

This dorsal position of the external nephridial openings is very unusual among Annelids, but is not confined to this species nor to those closely related to it. Thus, though the statement of Ehlers concerning numerous dorsal openings in Polynoe seem to have been negatived by the observations of Haswell, Bourne, and Kaltenbach, and those described by Cosmovici in Sthenelais and Hermione may also need investigation, yet other cases seem surely established. Such are the single dorsal openings, anteriorly, in certain Hermellidæ and Serpulacea, the dorsal openings in some of the Capitellidæ, as well as those somewhat dorsal ones in Chætopterus, according to both older observations and the recent account of Joyeux Laffuie. In the Spionidæ, finally, we find dorsal openings recorded by Jacobi in 1883 for two species of Polydora.

That these openings have secondarily moved up from a ventral through a more lateral position to the dorsal one seems to be at present a more probable assumption, considering such lateral openings as those found in Polyophthalmus and the various positions present in different somites of Chætopterus, than that the dorsal lateral and ventral nephridial openings refer back to some ancestral condition where numerous nephridial tubes were present as in certain earthworms.

In the above diagram (Fig. 9) the nerve cord is also shown as two separate strands, each retaining its primitive position within the epidermis; anteriorly, however, the two cords come close together on the ventral mid-line.

A few facts regarding the breeding habits and development of this commensal Annelid also came under observation during July and August, and might be observed, presumably, through a larger part of the summer.

The eggs are laid in peculiar transparent cases within the part of the shell occupied by the Annelid, either in the tunnel or in the manufactured tube, or in both. These cases consist of elongated series of sacs, firmly united into cylindrical masses fastened to the walls of the tube in which they are built. As shown in Fig. 10, each sac or chamber of the case contains a very large number of eggs, of a yellowish color, and often has an irregular stalk on one side that evidently represents the place of final closure when the secreted sac was finished. The entire structure reminds one forcibly of similar egg-cases in certain Molluscs; moreover, as in those animals, we find here also irregularities at the end of the series of sacs. Thus the terminal sacs (Fig. 11) are smaller, contain few eggs, are often quite defective in shape, and may be so aborted as to contain no eggs at all. The eggs also, full of yellow yolk and presenting large irregular cleavage cells, add to this resemblance.

The cleavage of the eggs is complete but unequal, and results in a few large cells full of yolk becoming covered over apparently by smaller cells containing less yolk. The resulting larvæ remain for a long time within the egg-sacs, closely crowded together. At an early stage these larvæ are probably about the same as the pear-shaped larva of Leucodora figured by Meczniknow in 1865, and may be regarded as trochospheres much distended by food-yolk. Such a stage is represented from a ventral view in Fig. 12, where the large triangular mouth lies at the bottom of a ciliated depression of the small anterior end, while the main rounded mass is filled with food-yolk showing imperfectly the outlines of a few large entoderm cells. A ventral ciliated band is present, as well as an imperfect post-oral ring, or rather two lateral ciliated areas, since, as in some other Annelid larvæ, the cilia are absent in the median area, both dorsally and ventrally.

Sections of this larva (Fig. 13) show that there is an outer ectodermal layer surrounding the entodermal yolk,—in which latter, however, the cell outlines do not appear,—that there is a paired mesoblast, and that the œsophagus ends blindly in the yolk mass. Moreover, sections to one side of the median plane show peculiar, large, ciliated cells, about the mouth, of which there is an especially large pair just posterior to the mouth. One of these is seen in the figure.

These larvæ are about .02 mm. long, and pass gradually into a stage with three pairs of setæ bundles and a length of .35 mm. These latter have four eye spots, an additional band of cilia anterior to the anus, but still a large mass of yolk in the thick walls of the digestive tract, surrounded by the body-cavity.

This stage with three pairs of setæ bundles is found for a long time, though much growth in the size of the body takes place, and conspicuous pigment areas appear when the late larval form such as shown in Fig. 14 results. The occurrence of this phase of larval growth, in which three somites are functional for some time, has been observed in several Annelid larvæ, and is suggestive from its resemblance to the Nauplius condition of certain Arthropods.

These older larvæ are found inside the Annelid's dwelling, sometimes in company with younger larvæ and even eggs, though it is probable that they escape out into the water about this stage. In swimming about the provisional setæ are brought into play as organs of defense, apparently, being thrown out at right angles to the body when the animal is disturbed, and trailed a ng close to its sides when it swims quietly by means of the cllia. These setæ are noticably barbed, excessively long, and unlike the adult setæ ; forming a good illustration of the *provisional* Annelid seta.

This larva is conspicuous from the metamerically placed dorsal pigment blotches, which, it will be noticed, precede the external appearance of the somites, and are, moreover, represented upon the heart by a pair of small black areas near the eyes.

The digestive tract now presents three well-marked divisions —a mouth and short, ciliated œsophagus leading abruptly into a capacious intestine, with some yolk in its walls yet, and opening posteriorly into a short rectum that ends at the anus. Here there are two papillæ with long sensory hairs, such as also occur in a tuft upon the median part of the head.

In sectioning the adult Polydora, eggs in various stages of formation are found within the body-cavity. The ovary, in fact, appears as a mere mass of modified peritoneal cells, attached to and covering over the vascular loops near the nephridia (Fig. 9). The youngest ova do not differ perceptibly from the ordinary peritoneal cells over the blood-vessels, but they soon enlarge and become more and more filled up by accumulating yolk globules. In this way there is formed a large botryoidal mass of large and small cells (ova), projecting freely into the body-cavity, and not covered by any membrane. Thus attached to blood-vessels, the ova attain a diameter of .06 mm., and then break loose into and float freely in the body cavity (Fig. 9.) Here they continue to grow till, when apparently ripe, they have a diameter of .09 mm. In the ovum there is a large nucleus, nearly .02 mm. thick, and a very conspicuous nucleolus five microns in diameter. This nucleolus is peculiar in having one or more rounded elevations or lateral protuberances upon it, which may be half as thick as the main body of the nucleolus.

The striking parts of the nucleolus are, I presume, described by Vejdovsky in Sternaspis as "bückelchen," but declared by Giard, in his remarkable observations upon Spio, to be the result of fusion of certain extra nuclear "cells" with the proper nucleolus. The body of the ovum is full of large yolk-spheres, staining dark with osmic acid, and having an average diameter of perhaps 2 microns. Presumably the eggs pass from the body-cavity by the nephridia, but no observations were made upon this point.

Since the eggs, when laid, are concealed within a tortuous passage removed from the external water, and as all the large Annelids examined are females living solitary, one in each shell, there seems a need for some special means of insuring the fertilization of these eggs. In fact, some shells contain, besides the large female, a minute individual about 4 mm. long, which it was thought might be a male. The only one preserved and sectioned, however, does not suffice to decide this question. In its body-cavity there are, however, numerous cells and cilia that strongly suggest spermatozoa in process of formation; and if this be the case, we would have here an interesting case of dimorphism, at least of great discrepancy in size, between the two sexes. Moreover, these small Annelids may occur in many more cases than actually observed, no special attention being given to their detection at that time. If males, living thus in the dwelling of the female, they would furnish a ready solution of the above difficulty in regard to the fertilization of the eggs.

I have not succeeded in finding this commensal Annelid in the shells inhabited by the same hermit crab upon the New England coast, and believe that it, like many other of our southern forms, is an undescribed species, and would suggest the name *commensalis* asdescriptive of its peculiar habits. Its chief characters would be asfollows:

Polydora commensalis, sp. n.

The female (Figs. 2–8). Cephalic lobe usually retracted, slightly emarginate, bearing minute sensory antennæ anteriorily and four black eyes dorsally, the posterior pair nearer together. Tentacles in contraction, as long as the body is wide. Body flattened, of about 100 somites; length, 25 mm.; width, 1 mm.; colorless, translucent posteriorly, intestine dark, blood-vessels conspicuous.

PLATE II.

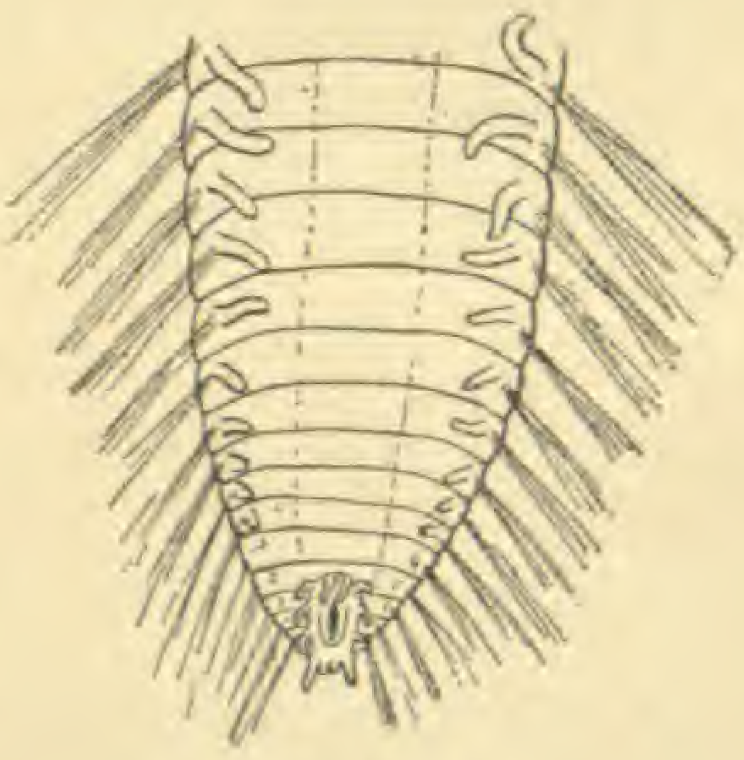


FIG. 8.

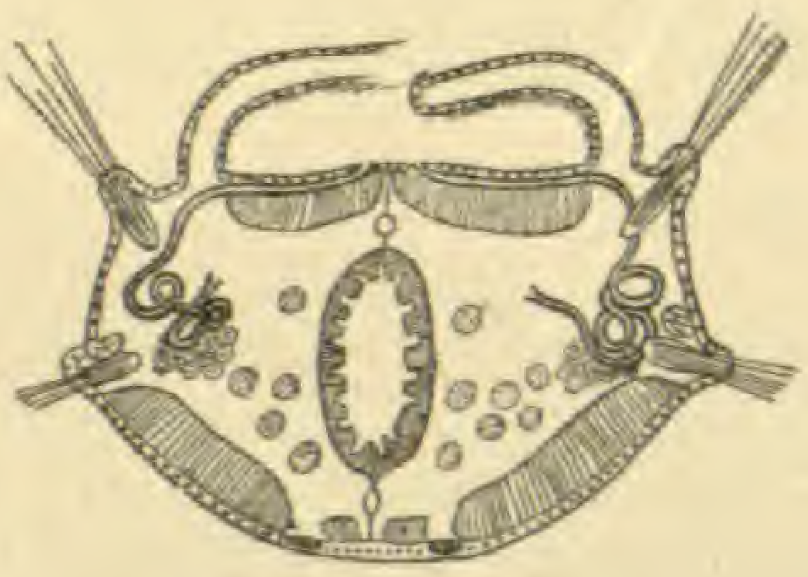


FIG. 9.

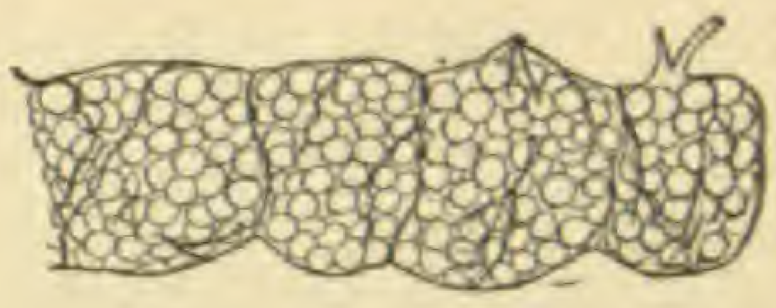


FIG. 10.

FIG. 11.

FIG. 12.

FIG. 13.

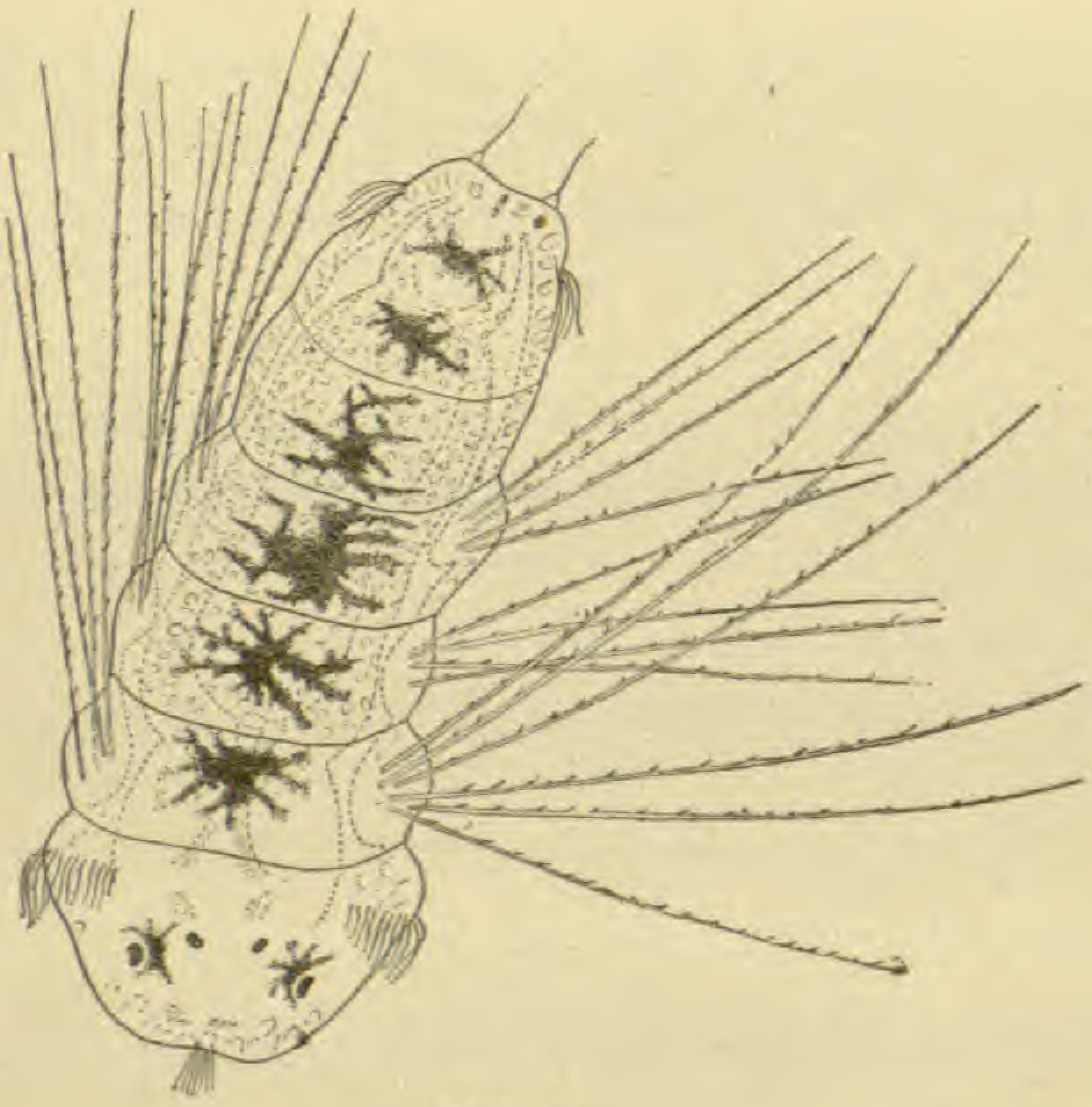


FIG. 14.

Polydora commensalis.

Branchiæ begin on the sixth somite, increase rapidly to equal half width of body, and diminish rapidly near posterior end of body; each has a line of large ciliated cells, as also does the dorsal surface of each somite. Anus surrounded by about 14 papillæ on each side,—a short posterior one, a much longer one, four shorter anterior, and then one still shorter. Dorsal setæ long, acuminate (Fig. 3); ventral setæ curved and with a flange (Fig. 5) till the twelfth somite is reached, then gradually replaced by an increasing number of forked setæ (Fig. 4); setæ of fifth somite six yellow hooks, each with a sharp flange on side near tip, and also a cluster of delicate hair-setæ. Found at Beaufort, N. C., living as a commensal in holes excavated in Gasteropod shells inhabited by *Eupagurus pollicaris* and overgrown by Hydractinia. Eggs laid in series of cases inside these dwellings; larvæ as in Figs. 12–14. Male thought to be much smaller than the above female form, and to live in the same shell.

Explanation of Figures.

Fig. 1.—Shell of Ilyanassa, cut open to show the openings into the columella and the built-up passage in the cavity of the shell on the left, all made by Polydora. × eight diameters.

Fig. 2.—General appearance of *P. commensalis*, dorsal view, preserved specimens. (Camera, Zeiss. 4 A).

Fig. 3.—Ends of dorsal setæ. (Camera, Zeiss. 4 F.)

Fig. 4.—Forked ventral setæ, with flange. (Camera, Zeiss. 4 F.)

Fig. 5.—Pointed, anterior, ventral setæ. (Camera, Zeiss. 4 F.)

Fig. 6.—Setæ of left side in fourth segment. (Camera, Zeiss. 2 D.)

Fig. 7.—Anterior region of the body. (Camera, Zeiss. 2 A.)

Fig. 8.—Posterior end of body. (Camera, Zeiss. 2 A.)

Fig. 9.—Diagram of cross-sections of body, showing dorsal openings ot nephridia, separate nerve-cords, ovary and free ova, digestive tract and blood-vessels, parapodia, muscles, and branchia. (Camera, Zeiss. 2 A.)

Fig. 10.—Part of an egg-case, showing eggs in several chambers. (Camera, Zeiss. 2 A.)

Fig. 11.—End of such a case, showing aborted chambers and cleaving eggs. (Camera, Zeiss. 2 D.)

Fig. 12.—Larva, ventral view. (Camera, Zeiss. 4 G.)

Fig. 13.—Vertical, longitudinal, but not median section of Fig. 12. (Camera, Zeiss. 2 F.)

Fig. 14.—Advanced larva, showing provisional setæ and metamerically arranged pigment blotches. (Camera, Zeiss. 4 G.)

EDITORIAL.

EVERY attempt of our common-school teachers to better their intellectual condition is to be commended, and every step honestly and advisedly taken with that end in view should be encouraged by all. So, in the abstract, we have the greatest interest in the formation of "reading circles" and compulsory teachers' institutes among the teachers of Indiana, for the object is a worthy one. Further than this we cannot go, for the means adopted, so far as science is concerned, could not be worse. Indeed, it is so bad that it almost looks as if the "practical politics" which successful book agents are adepts in had been employed here. To explain: Every teacher is compelled, under certain inducements and penalties, to attend one institute each month, and is obliged to come prepared to discuss and answer questions upon some given subject of school work. The subjects change from year to year, and with the change new books are to be bought. As there are 30,000 copies of each book to be supplied to these reading circles, it is readily seen that the getting of a book on the list means no little profit.

It would be thought that in a matter of so much importance the opinions of experts would be called in to aid in selection, but this was apparently not the case. Both zoology and botany have several good students in Indiana; but so far as heard from not one was consulted in the matter, as can readily be imagined when one learns that the books selected were Steele's "Zoology" and Wood's "How to Study Plants." Certainly no two books could have been selected which were further removed from what text-books should be,—books without a single redeeming feature; books which are conspicuous examples of how not to do it. To render them more useless (if that be possible), some ignoramus has been employed to write up an analysis of each, laying out for each meeting of the institutes the subjects for work and questions for the same. Were the results not so lamentable they would be laughable, and even as it is we hope that readers can gain a grain of amusement from some of the examples that appear below. Still, it must be borne in mind that many thousand teachers have been imposed upon by the cupidity or stupidity of some one in authority.

This year the study is botany, and the work is laid out for each month, but with the least possible expenditure of brain energy on the part of him who evolved the synopsis. He has taken from some other scheme a list of plants and months, and has shifted them about so as to meet the needs of the institutes, but without any regard to seasons. Thus in November the poor teachers are expected to study the dog-tooth violet! while in January the flower and fruit of the strawberry are the subjects of discussion. In December the teachers will be searching their gardens for flowering tulips, and scanning the orchards for the beautiful blossoms of the apple and peach. Could any arrangement be more absurd?

Then the same wise head has thought that technical terms are too strong food for the poor school teacher, and he has therefore tried to translate them into the vernacular. The result can be imagined. In speaking of the mode of branching of the apple tree the term deliquescent is used, but this was too big, too abstruse; so the dictionary has been invoked and a synonym sought, and the poor teacher is requested to notice the "solvent trunk" of the apple tree.

Zoology was studied in the year 1889–'90, and so the mischief is done. Still, we cannot refrain from calling attention to a few points. We miss, it is true, the incongruity between subject and season so prominent on the botanical side, but we find ample compensation in the nonsensical character of the questions. We can imagine some poor teacher turning over the pages of the zoology trying to find the meaning of the term "*homologom*"[1] (*sic*) which he or she is expected to define. Imagine the intellectual drill and the knowledge of zoology which one will get in learning the answers to the following questions selected from a hundred and fifty of similar character: Describe the classification of any branch of the animal kingdom. In what animals do we first find

[1] A friend suggests that this is a mouthful of hot pudding. We are inclined to think it a misprint for homologous.

the sensation of sound produced? What makes the hammer oyster of peculiar interest? Show how the dragon-fly comes into existence. What insects are called the quakers? What is the Sly Silurus? why so called? What superstition was held by sailors in regard to the petrel? What bird has at times been converted by the natives into a lamp? Describe the song of the bobolink. Describe the unicorn. To what use did the Indians put the enamel of beavers' teeth? How does the whale manage to live in the water? Give the significance of the term "snake charmer." What does the author think should be required of students in the study of birds? The answer to the last question is given as an example of the unmitigated bosh of the whole text-book:

"The following is taken from Baird, Brewer, and Ridgway, as a specimen of what every thorough teacher will require from each of his pupils in writing, with simple sketches attached, for every bird that can be obtained in the immediate vicinity: *Turdus migratorius*, Robin, American Redbreast. Tail slightly rounded; above olive-gray, top and sides of head black, chin and throat white"; and so on through a technical description which no *thorough* teacher would ever dream of demanding from any pupil.

The incoming superintendent of public instruction in Indiana is said to be a man of ideas. Certainly one of the first things he should do is to use his position and his influence to put an end to this state of affairs, and to see that in future specialists are employed to select books,—specialists who are proof against the dulcet tones and the frequently more solid arguments of the publishing house.

RECENT BOOKS AND PAMPHLETS.

ABBE, C.—Localities of Scientific Interest in St. Helena. Bull. No. 13, U. S. Scientific Expedition to W. Africa. From the author.

Annual Report Commissioners State Reservation at Niagara for fiscal year, Oct., 1888, to Sept., 1889.

Annual Report Geological and Natural History Survey of Canada, Vol. III., Parts I. and II. From Alford Selwyn, director.

ASHMEAD, W. H.—Descriptions of New Ichneumonidæ in the Collection of the U. S. Museum. Extract Proc. U. S. Nat. Museum, Vol. XII., pp. 387–451. From the Smithsonian Institution.

BAUR, G.—On the Morphology of Ribs, and the Fate of the Actinosts of the Median Fins in Fishes.—On the Morphology of the Vertebrate Skull. Reprints from the *Journal of Morphology*, Vol. III., No. 3. From the author.

BELL, R.—On Glacial Phenomena in Canada. Extract Bull. Geol. Soc. Am., Vol. I., pp. 237–310. From the author.

BERGEN, J. Y., and BERGEN, F. D.—Primer of Darwinism. From the authors.

BERGH, R.—Report on the Nudibranchs. Bull. Harvard Mus. Comp. Zool., Vol. XIX. From A. Agassiz.

BILLINGS, F. S.—Are the German Schweine-Seuche and the "Swine-Plague" of the United States Identical Diseases? Extract from AM. NAT., Oct., 1889. From the author.

BLANFORD, W. T.—Address Delivered at the Anniversary Meeting, London Geol. Soc., Feb. 21, 1890. From the author.

Bulletin No. 4, Agricultural Experiment Station of the Rhode Island State Agricultural School.

Bulletin No. 9, Iowa Agricultural Experiment Station. From the director.

Bulletin No. 8, Iowa Agricultural Experiment Station. From the officers of the station.

Bulletin No. 1, Geological Survey of Missouri. From A. Winslow.

CAPPELLINI, G.—Di un Ittiosauro e di altri importanti fosili cretacei nelle argille scagliose dell' Emilia. Estratto dal Vol. VI°, 1° Sem. From the author.

CLARK, W. B.—Third Annual Geol. Expedition in Southern Maryland and Virginia. Reprint from the Johns Hopkins University Circulars, No. 81.

CRAGIN, F. W.—On the Cheyenne Sandstone and the Necomian Shales of Kansas. Bull. Washburn College Laboratory of Nat. Hist. From the author.

CROZIER, A. A.—On the Effects of Certain Fungicides upon the Vitality of Seeds. Extract *Journ. Mycology*, Vol. VI., No. 1. From U. S. Dept. Agriculture.

——Treatment of Plant Diseases. Extract *Journal of Mycology*, Vol. VI., No. 1. From the Department of Agriculture.

DARAPSKY, L.—Las Aquas Minerales de Chili. From the author.

DAVIS, W. M.—Structure and Origin of Glacial Sand Plains. Extract Bull. Geol. Soc. of America, Vol. I., pp. 195–202. From the author.

DEPÉRET, C.—Note sur l'Age Miocène Supérieur des Limons à Hipparion du Mont Léberon. Extrait Bull. de la Soc. Geol. de France. Tome dix-huitième.

——Sur le *Dolichopithecus ruscinensis*, Nouveau Singe Fossile du Pliocène du Roussillon.—Sur la Découverte d'une Tortue de terre Géante au Mont Léberon. From the author.

DERBY, A.—Retrospecto Historico des Trabalhos Geographicos e Geologicos Effectuados na Provincia de S. Paulo.

——Os Picos Altos do Brazil. Extrahido do Boletina de Sociedade de Geograpia do Rio de Janeira, Vol. V., de 1889. From the author.

ELLS, R. W.—The Stratigraphy of the "Quebec Group." Bull. of the Geol. Soc. of America, Vol. I., pp. 453–468. From the author.

EMMONS, S. F.—Orographic Movements of the Rocky Mountains. Extract Bull. Geol. Soc. of America, Vol. I., pp. 245–286. From the author.

FAXON, W.—Notes on North American Cray-Fishes, Family Astacidæ. Extract Proc. U. S. Nat. Mus., Vol. XII., pp. 619–634. From the Smithsonian Institution.

FERREE, B.—Primitive Architecture. Extract AM. NAT., January, 1889. From the author.

FORBES, S. A.—History and Status of Public School Science Work. From the author.

FOX, W. S.—A History of Spectacles. Extract *Medical and Surgical Reporter*, May 3, 1890. From the author.

FULLERTON, G. S.—On Sameness and Identity: A Psychological Study. Publications of the Pennsylvania University, No. 1, April, 1890. From the editors.

GAUDRY, A.—Sur la Découverte d' un Singe Fossile par M. le Dr. Donnezan. From the author.

GILBERT, G. K.—The Strength of the Earth's Crust. Extract Bull. Geol. Soc. of America, Vol. I., 1889. From the author.

GORDON, C. H.—Notes on a Fossil Wood from the Keokuk Limestone, Keokuk, Iowa.—On Keokuk and Their Contained Fossils.—Observations on the Keokuk Species of Agaricocrinus. Extracts Proc. I. A. S., 1887–'89. From the author.

HECTOR, J.—On the Fossil Reptiles of New Zealand.

HOWARD, L. O.—Annotated Catalogue of the Insects Collected in 1887–'88. Proc. U. S. Nat. Mus., Vol. XII., pp. 185–216. From the Smithsonian Institution.

HYATT, ALPHEUS.—Genesis of Arietidæ. Memoirs of the Museum of Comparative Zoology at Harvard College, Vol. XVI., No. 3. From Alexander Agassiz.

JAMIESON, DR.—Minden Armais, the Man of the New Race. From. C. S. Keyser.

KNOWLTON, F. H.—A Revision of the Genus Araucarioxylon of Kraus, with Compiled Descriptions and Partial Synonymy of the Species. Extract Proc. U. S. Nat. Mus., Vol. XII., pp. 601–617. From the Smithsonian Institution.

LAMB, D. S.—The Olecranon Perforation. Extract *American Anthropologist*, April, 1890. From the author.

LEWIS, T. H.—Effigy Mound in the Valley of the Big Sioux River, Iowa. Extract from *Science*, May 2, 1890. From the author.

LOEFGREN, A.—Dados Climatologicos das Annos 1887 e 1888. Boletin da Comnisão Geographical Geologica. From the author.

MARX, G.—Catalogue of the Described Araneæ of Temperate North America. Extract Proc. U. S. Nat. Mus. From the Smithsonian Institution.

MCCLELLAN, E. S.—The Sewer-Gas Question. From the author.

MELL, P. H.—A Microscopic Study of the Cotton Plant. Bull. No. 13, Agri. Station of Alabama Agri. College. From the author.

MERRILL, G. P.—Notes on the Serpentinous Rocks of Essex County, New York; from Aqueduct Shaft 26, New York City; and from near Easton, Pa. Proc. U. S. Nat. Mus., Vol. XII., pp. 595–600. From the Smithsonian Institution.

MINOT, C.-S.—Die Placenta des Kaninchens. Sonderabdruck aus dem *Biologischen Centralblatt*, Band X., No. 4, Ausgegeben am 1 April, 1890. From the author.

MOORE, J.—Description of a New Species of Gigantic Beaver-Like Rodent. Extract from the Journ. Cin. Soc. Nat. Hist., April, 1890. From the author.

MORRIS, C.—The Aryan Race. From the author.

NICHOLSON, H. A., AND LYDEKKER, R.—A Manual of Paleontology, with a General Introduction on the Principles of Paleontology. Vols. I. and II. From the authors.

OLIVEIRA, PAUL A DE.—Reconhecimento Geologico do Valle do Rio Paranapanema. From the author.

PAQUIN, P.—Texas Fever. Bull. No. 11, Missouri Agricultural College Experiment Station. From the author.

PARKER, W. K.—Osteology of *Steatornis caripensis*. Extract Proc. London Zool. Soc., April, 1889. From the author.

PAYNE, F. F.—A Few Notes Upon the Eskimo of Cape Prince of Wales, Hudson's Strait. Extract Proc. A. A. A. S., 1889. From the author.

PERACCA, M. G.—Descrizione di una nuova specie del gen. Diploglossus. Bollettino dei Musei di Zoologia ed Anatomia Comparata della Universita di Torino, Vol. V. From the author.

PILSBRY, H. A.—On the Anatomy of *Ærope caffra* Fer.—Note on a Southern Pupa. Proc. Phila. Acad. Nat. Sciences, 1890. From the author.

RAMSAY, E. P.—Records of the Australian Museum, 1890. From the author.

Report New York State Museum of Nat. Hist., 1887.

RIDGEWAY, R.—Birds Collected on the Galapagos Islands in 1888. Proc. U. S. Nat. Mus., Vol. XII., pp. 101–128. From the Smithsonian Institution.

ROLF, C. W.—Character and Distribution of the Genera of Brachiopoda. From the author.

RUFFIN, F. G.—The Negro as a Political and Social Factor. From the author.

RUSSELL, I. C.—Notes on the Surface Geology of Alaska. Extract Bull. Geol. Soc. of America, Vol. I. From the author.

SCUDDER, SAMUEL H.—The Fossil Butterflies of Florissant. Extract from the Eighth Annual Report of the Director U. S. Geol. Survey. From the author.

SMITH, J. B.—Contributions Toward a Monograph of the Noctuidæ of Temperate North America. Revision of Some Tæniocampid Genera. Extracts Proc. U. S. Nat. Museum, Vol. XII., pp. 455–496. From the Smithsonian Institution.

STEVENSON, J. J.—Proceedings of the Annual Meeting held at New York, December 26, 27, 28, 1889. Ext. Bull. Geol. Soc. of America. From the author.

T. E. S. T.—The Two Kinds of Truth. From the author.

Thirty-ninth Annual Report N. Y. State Mus. Nat. Hist., 1886.

TROUESSART, E. L.—La Geographie Zoologique.

——Mammifères. Extrait de L' Annuaire Géologique Universel, Tome V., 1888. From the author.

TRUE, F. W.—Contributions to the Natural History of the Cetaceans. A Review of the Family Delphinidæ. Bull. U. S. Nat. Mus., No. 36. From the Smithsonian Institution.

UHLIG, V.—Melchoir Neumayo. Sein Lehen und Wirken. *Jahrbuch der k. k. geol. Reichsanstalt*, 1890. From the author.

ULRICH, E. O.—Contributions to the Micro-Paleontology of the Cambro-Silurian Rocks of Canada. Extract Geol. and Nat. Hist. Sur. Canada, 1889.

WINCHELL, A.—Some Results of Archean Studies. Bull. Geol. Soc. Am., Vol. I., pp. 357–394. From the author.

WINCHELL, N. H.—The History of Geol. Surveys in Minn. Bull. No. 1, Geol. and Nat. Hist. Sur. Minn.

——Natural Gas in Minnesota. Bull. No. 5, Geol. and Nat. Hist. Sur. Minn. From the author.

WOLFF, J. E.—On Some Occurrences of Ottrelite and Ilmenite Schist in New England. Bull. Harvard Mus. Comp. Zool., Vol. XVI. From A. Agassiz.

WOOD, H. C.—The Medical Profession. The Medical Sects. The Law. Reprint from *The New Englander and Yale Review*, Aug., 1889.

——Beginnings of the Classical Heroic Couplet in England. Reprint from *Am. Journ. Philology*. From the author.

WOODWARD, A.—Synopsis of the Cretaceous Foraminifera of New Jersey. Extract Proc. New York Microscopical Soc. From the author.

RECENT LITERATURE.

Hyatt's Insects.[1]—The small volume before us is the eighth in the series of Guides for Science-Teaching issued under the auspices of the Boston Society of Natural History. The series has been rather unequal; some of the numbers, noticeably that dealing with the Crustacea and spiders, have fallen below what such guides should be; but the present volume has gone as far the other way, and makes an admirable introduction to the study of entomology. With this and the still unfinished work of Professor Comstock, already noticed in these pages, the beginning students of insects can enter upon their work and fit themselves to take up the more technical papers.

The treatment of the subject is after the following outline: The grasshopper is made the type of the group of Hexapods, and outlines are given to aid the student in working out for himself the external and internal anatomy. Next follows a chapter upon the principles underlying classification, and then come the characteristics of the fourteen orders which, following Brauer, the authors have recognized. There are many things in this arrangement which please us, but we cannot agree to it in all particulars. Larval stages are an introduced feature in the Hexapod phylum, and those who rely wholly upon them as guides to the affinities and relationships are apt to go astray. Thus the facts hardly seem to warrant the close association of Lepidoptera, Hymenoptera, and Diptera, with the Hymenoptera occupying a position intermediate between the other two; nor can we agree that the May flies are, the Thysanura excepted, the lowest of the Hexapods. There are also other features of detail where we think the authors are at fault, such as the statement (p. 18) that the cerci are not true appendages. We could wish that the authors had availed themselves more of the admirable summary of Hexapod anatomy given in Lang's "Vergleichende Anatomie." On page 12 Professor Hyatt says that he is "disposed to uphold a modified form of the Cuvierian classification. The old names, Radiata, Mollusca, and Articulata, like the name Vertebrata, represent obvious relations and a legitimate grouping of forms." We had thought that the heterogeneous character of the old group Radiata had long ago been demonstrated; while if Professor Hyatt wishes to include metameric forms under the name

[1] Guides for Science-Teaching, No. VIII. Insecta. By Alpheus Hyatt and J. M. Arms. 16mo, pp. xxiii. + 300. Boston, D. C. Heath & Co., 1890.

Articulata, he will be obliged to throw out the Plathelminthes and Nematoid forms, while, on the other hand, his group of Vertebrates will disappear, along with "Vermes" (= Annelids) and Arthropods, in the group for which others have adopted the term Metamerata.

These are, however, but minor points. The good features of the book are many, and Professor Hyatt is to be congratulated in the able coadjutor (or coadjutrix) he has found in Miss Arms. Many of the 223 illustrations are fresh, but there are also some of the old acquaintances. We think the book the best of its kind yet issued, but we cannot help wishing that we had some really first-class text-book of entomology which would attack the subject from every side. For points of structure the student has still to be referred to Newport's article "Insecta" in Todd's "Encyclopædia of Anatomy and Physiology," while for the systematic aspect there is as yet nothing to replace Gerstäcker's account in Carus and Gerstäcker's "Handbuch der Zoologie," or that given in Ludwig's edition of Leunis's "Synopsis."—J. S. K.

General Notes.

GEOLOGY AND PALEONTOLOGY.

A Review of the Discovery of the Cretaceous Mammalia.[1] The following is an abstract of a review of "The Discovery of of the Cretaceous Mammalia," presented to the Society of Morphologists, December 30th, 1890. The review is mainly an analysis of the types upon which the author bases his systematic classification of the collection of mammalian teeth and other parts from the Laramie beds. These mammals are provisionally referred by the author to four mammalian orders and eight families, five of which are new to science. Sixteen new genera and twenty-seven new species are also proposed.

It appears that before accepting this system we must eliminate: 1. The terms preoccupied by other authors. 2. The terms founded upon different parts of the same animal, and thus largely preoccupied by the author. 3. The terms founded upon imperfect or indefinite types. 4. The terms founded upon reptilian or icthyopsidan teeth. This may be expressed as follows:

A. ALLOTHERIA.	. . . . . . MULTITUBERCULATA, Cope.
1. *Cimolomidæ.*	
Cimolomys gracilis.	
Cimolomys bellus.	
Cimolomys digona	
2. *Cimolodontidæ.*	*Plagiaulacidæ.*
Cimolodon nitidus.	. . . . . . Cimolomys, 2 or 3 species.
Nanomys minutus.	
3. *Plagiaulacidæ.*	
Halodon sculptus.	
Halodon serratus.	
Halodon formosus.	

[1] The Discovery of the Cretaceous Mammalia. O. C. Marsh, *American Journal Science and Arts*, Parts I. and II., July and August, 1889.

4. *Dipriodontidæ.* Dipriodon robustus. Dipriodon lunatus. 5. *Tripriodontidæ.* Tripriodon cœlatus. Tripriodon caperatus. Selenacodon fragilis. Selenacodon brevis.	. . . . *Stereognathidæ.* Meniscoëssus, Cope, 2 species.
6. *Allodontidæ.* Allacodon lentus. Allacodon pumilus.	. . . . Probably preoccupied above.
Camptomus amplus	. . . . Probably preoccupied above.
Oracodon anceps.	. . . . Indefinite type, or preoccupied.
?B. PANTOTHERIA.	. . . . Not defined.
?7. *Dryolestidæ.* ?Dryolestes tenax.	. . . . Determination uncertain.
C. MARSUPIALIA.	. . . . Order indeterminable.
Didelphops vorax. Didelphops ferus. Didelphops comptus.	. . . . Didelphops. Not definable.
Cimolestes incisus. Cimolestes curtus.	. . . . Cimolestes. Not definable.
D. INSECTIVORA. Pediomys elegans.	. . . . Order indeterminable. Genus not defined.
E. INCERTÆ SEDIS. 8. *Stagodontidæ.* Stagodon nitor. Platacodon nanus.	. . . . Reptilian or icthyopsidan types.

The full analysis upon which these conclusions are based will be published subsequently.

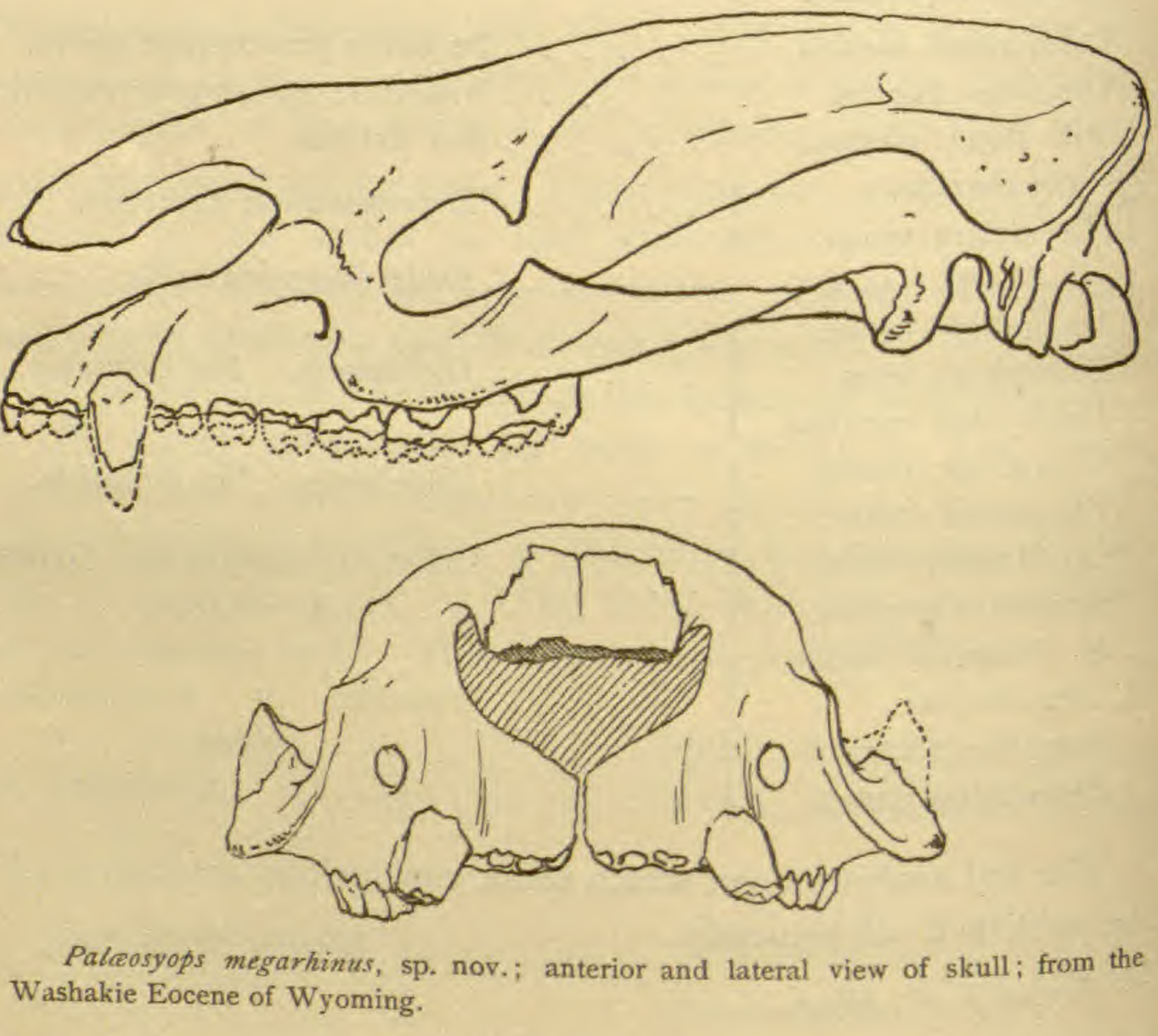
HENRY F. OSBORN.

January 26, 1891.

On a New Species of Palæosyops.—*Palæosyops megarhinus,* sp. nov.—This new species of Palæosyops is established upon a fine skull (No. 10,008) in the Princeton collection from the Washakie Eocene of Wyoming; there is also another portion of a skull (No. 10,041), probably belonging to this species, with the occiput well preserved, from the Bridger proper.

Cranium.—The characters of this skull are quite unique, and depart widely from any of the species of the family that I have examined.

The general form of the skull is broad and depressed. Its dorsal contour is very like that of *Palæotherium crassum,*—namely, there is no frontal depression, which is so characteristic of *Palæosyops paludosus*, and the occipital region is only slightly higher than the frontal. The temporal fossæ are not deeply excavated, and the occipital crests are weakly developed when compared to this region of the skull in Limnohyops. The occiput itself is high and rather narrow. The foramen magnum is wide, bordered by very large condyles. The auditory processes are widely separated. The post-tympanics are broad and heavy. The post-glenoid is peculiar in form; it is very short and



Palæosyops megarhinus, sp. nov.; anterior and lateral view of skull; from the Washakie Eocene of Wyoming.

thick; its form is very different from other species in the collection. An internal glenoid process is present in this species. The mastoid was probably exposed. The form of the zygomatic arch is striking; it is very light, nearly straight, with the temporal portion strongly compressed. The malar portion is also peculiar; the malar insertion is very abrupt and strongly depressed, with the external part very broad, thin, and shelf-like. The infra-orbital foramen is not exposed. The form of the malar in this species is totally different from all other allied forms that I have examined. The orbit is very small, terminates anteriorly above the anterior border of the second superior molar; the post-orbital processes are well marked. The facial region of the skull is very short, compared to the total length of the cranium. The nasals are very long and heavy; their distal portion is expanded and broader than the middle part. The nasal notches are very deep and high. The pre-maxillaries are triangular in outline; their symphysis is short and narrow, with a prominent anterior keel. The canine alveolus is very prominent. The palate is long and narrow, the roof of the same being strongly arched. The posterior termination of the palate is at the second superior molar. The incisive foramina are not divided.

Teeth.—The crowns of the teeth in this skull are badly damaged, but enough remains to give the total measurements and the characters of the last molar. The superior molars in this species form a continuous series, being not interrupted by a diastema. The sections of the incisors are very small. The canines are also very small, and diverge widely. Only the second and third molar of each side are partially preserved. They have a square form with low crowns; externally they are totally without a cingulum. The external V's are rather wide and angular, in this respect approaching that of Telmatotherium. The last molar is without any intermediate conules.

Measurements.—1. Length of skull, from premaxillary symphysis to end post-glenoid 285

2. Length from orbit to premaxillary symphysis		.125
3. Length from orbit to post-glenoid		.160
4. Depth of nasal notch		.084
5. Length of nasals		.100
6. Entire molar series		.148
7. Last super. molar	ant. post	.037
	trans.	.039

E. M. Museum, Princeton College. CHARLES EARLE.

On Two New Perissodactyles from the White-River Neocene of Nebraska.—Dr. Hobart Hare, of the University of Pennsylvania, recently presented to the Museum of the University a collection of fossils from the White-River Neocene beds of Northern Nebraska. This includes parts of skeletons of *Stylemys nebrascensis* Leidy, and *Menodus americanus* Leidy, with some others, among which are two species evidently new to science. One of these is a rhinoceros of the genus Cœnopus Cope, of larger size than any of those hitherto known, and the other is a remarkable species of Menodus, which is characterized by a development of the horn-cores so far unique in the genus. I characterize it under the name of

MENODUS PELTOCERAS sp. nov.—Represented by the nasal region and the horn-cores; the apex of one of the latter being broken away. The peculiarity of the species consists in the immense transverse extent of the horn-cores, and their complete fusion into an osseous wall which extends across the muzzle, forming a huge plate or shield. The superior border of this shield is moderately concave, a protuberant angle on each side representing the apex of each horn-core. The nasal bones form a flattened protuberance much wider than long, which overhangs the nares. Their superior wall slopes directly upwards from the obtuse apex to the crest of the horn-core-plate. The expanse of the base of each horn-core outside of the nares is as wide as the nasal meatus, is flattened from before backwards, and has a narrow external margin. The horn-core-plate is vertical behind at the slightly angulated middle line, and is moderately concave on each side, the apex being slightly recurved. Measurements: Elevation of horn-core-plate at middle line behind, 180 mm.; do. at lateral apex, 190 mm.; total width of do. at middle, 300 mm. Projection of nasal bones beyond lateral base of horn-core-plate, 20 mm.; width of nasal meatus at base of nasal bones, 65 mm.; width of base of horn-core-plate outside of nasal meatus, 90 mm Anteroposterior diameter of base of horn-core above side of and parallel to nasal meatus, 85 mm. This species is nearest the *M. platyceras* S. & O., which has transverse compressed horn-cores. They are, however, distinct from each other, and not nearly so expanded transversely as in the present form. The *M. peltoceras*, in fact, carried a transverse shield on the end of its nose, which must have given it an extraordinary appearance.

CÆNOPUS SIMPLICIDENS sp. nov.—Represented by the last two superior molars of the left side, with a probable humerus and femur. The molar teeth are one-third larger in linear dimensions than those of the *C. occidentalis* Leidy, and lack the external basal cingulum which is present in the corresponding teeth of that species. Internal cingulum wanting, but the anterior and posterior cingula present. The posterior limb of the metacone is represented in the posterior molar by a tubercle at the base of the crown, which rises into a a low ridge which soon disappears. It bounds a fossa with the posterior cingulum just behind it. Transverse crests simple, with a convexity representing the anti-crochet. Paracone distinct, separated by an open groove from the anterior angular cone. Both limbs of the metacone of the penultimate molar are well developed. Measurements: Transverse diameter of M. ii. at anterior cross-crest, 48 mm.; do. at posterior cross-crest, 38 mm.; do. of M. iii. at anterior cross-crest, 45 mm.; anteroposterior diameter of do. at inner base of crown, 42 mm.—E. D. COPE.

The Tertiary Formations of Western Texas.—Mr. Robert T. Hill has made brief mention in three short papers[1] of a very interesting fact concerning the age of the Staked Plains, and the extent of the fresh-water Tertiary formations of the West eastward into the Texas region. The whole of the great mesa known as the Llano Estocado and some of the basins of the Trans-Pecos region, near El Paso, are composed of the sandy loams, grits, and pebbles of this formation. This area in Western Texas and Eastern New Mexico extends in places eastward to the one hundredth meridian, and is a direct continuation southward of the same formation in Kansas and Nebraska. Its southern limit on the Rio Grande is near Del Rio, and the whole area, which is as large as New England, has hitherto been colored Cretaceous and Jurassic upon previous maps. The formation has afforded fossil bones in various places; but these as yet have been unstudied. It rests unconformably upon the Comanche series, the Jura Trias, and the various rocks in the mountain ridges. Everywhere at its base it affords an abundant supply of well water, which has proved of great value to the settlers who are now rapidly locating on the Staked Plains. The Fort Worth and Denver road traverses the formation from Clarendon to Tascosa, and the Texas Pacific from Sweetwater to the Colorado valley, and from thence westward. This additional knowledge upon the former extent of the great inland lakes of Tertiary times is important in that it nearly doubles the areal extent hitherto acknowledged, and enables us to locate the narrow continental divide between the Gulf of Mexico and the Tertiary lakes with greater accuracy. Dr. Otto Lerch has corroborated the extent of these beds in a recent article on the Concho country, in the *American Geologist* for 1890. The great development of this terrane in Southern New Mexico, was pointed out by Prof. Cope, in the Proceedings of the Amer. Philos. Society, 1883, p. 308.

The Eighth Volume of Reports of the Geological Survey of Illinois left the press in July last. The general distribution of the edition—5,000 copies—must, however, be postponed until the Legislature of the State will have provided for its binding. Only fifty copies have been bound in advance, and we have received one of them. We will give a full notice in future number of the NATURALIST.

[1] Notes on the Geology of Western Texas. Bulletin Texas State Geological Soc., September, 1888. Pro. Am. Ass. Adv. of Science, Toronto, 1889.—Topography and Geology of Texas Region. *Am. Geologist*, Jan., 1890.

BOTANY.

Books for Young Collectors.—It is probable that the professional botantist too generally underrates the value of the books designed to aid the young collector. The untechnical and popular style rarely pleases the learned botanist, who long since passed beyond the need of such simple pabulum. But many a young man who is not able to go to college eagerly longs to make a beginning in the work of studying the plants about him, needing only some suggestions as to ways and means. For such a student the "books for young collectors" are most useful.

A recent book by T. S. Smithson, entitled "Pond-Life: Algæ and Allied Forms," is a good illustration of what such a work should be. In the introductory chapter some suggestions are given as to the apparatus required, with instructions as to collecting, etc. This is followed by a popular description of the more common fresh-water algæ, with suggestions as to their treatment. The earnest student can get much help from the book.

A Study of the Snow-Plant.—Professor Oliver, of London, has studied the "snow-plant" (*Sarcodes sanguinea*) of the Pacific coast, and published his results in the *Annals of Botany* for August. After a general description of the plant, the various parts are taken up in detail. The roots are very interesting, being "coralline" in appearance, and covered with a close-fitting sheath of fungal mycelium, constituting a well-marked case of "mycorhiza." The structure of this fungal layer is carefully worked out, and comparisons are made with the similar structure in Monotropa. It appears from these investigations that Sarcodes is not parasitic upon the roots of surrounding plants, but that it is a saprophyte, living upon decaying matter in the soil, in which it is aided by the layer of fungal mycelium.

The stem and leaves show the usual "reduced" condition common in parasites and saprophytes. The flower is essentially like that of Monotropa, with certain minor variations. The pollen shows the two nuclei, viz., the vegetative and the generative, with unusual clearness. The former is spherical, while the latter is spindle-shaped. In an earlier stage the pollen-spore is actually divided into two cells, some of the figures given closely resembling the pollen-spores of the Coniferæ.

The ovules arise as small upgrowths of tissue on the young placenta by the formation of tangential divisions in the layer immediately below the epidermis. At an early period the terminal cell of the hypodermal tissue of the young ovule is seen to be much larger than its neighbors, and is the "archesporium" from which by subsequent development the embryo-sac is to be formed. There is first cut off from the archesporium a single apical cell, and this is followed by another division, thus making a row of three cells, the lowermost of which is the embryo-sac. The latter enlarges and elongates, crowding the cap-cells until they are mere plates.

In the embryo-sac the nucleus divides, each part moving to an opposite extremity, where it divides again, and still again. At this stage there are four nuclei at each end of the embryo-sac. One of these at the micropylar end becomes the germ-cell (egg-cell, oösphere), two become the synergidæ, while the fourth moves downward, and, fusing with an ascending one from the opposite end, forms the nucleus of the first cell of the endosperm. After fertilization the germ-cell and endosperm-cell divide, forming embryo and endosperm.—CHARLES E. BESSEY.

The Annual Report of the State Botanist of New York.—This report from C. H. Peck, bearing date of December, 1889, contains much of interest to the technical botanist. Many new species of fungi are described and figured. Of these the majority are Agarici, there being no less than eleven new species, belonging to seven different genera. Two new Myxomycetes are figured and described, viz., *Comatricha longa* and *C. subcæspitosa*. An interesting Plasmopara (*P. viburni*) is described as occurring on *Viburnum dentatum*. The author says that it is evidently very near to *P. viticola*, "of which it may prove to be only a variety." A curious new genus allied to Helvella is characterized under the name of Underwoodia, in honor of Professor L. M. Underwood, who communicated the specimens. The single species (*U. columnaris*) is a columnar, horn-shaped "receptacle," from four to six inches in height.

Among the "remarks and observations" the author says of the entire-leaved variety of *Rhus toxicodendron*, that "it has been reported to me as comparatively harmless so far as poisonous quality is concerned, and my experience in handling it was entirely without harm."—CHARLES E. BESSEY.

How to Know Grasses by Their Leaves.—Professor McAlpine, of Edinburgh, has written a useful little book of ninety-two pages upon the topic given above, intending it to be a simple guide to the identification of the common grasses by their leaves alone. For the practical man who wishes to know what grass is growing in his meadows and pastures this book will prove of great value; and even to the botanist it will often be quite useful. The author says in his introduction: "If farmers, clergymen, school-masters, and botanists use this method of identification a flood of light will be thrown upon many questions at present involved in obscurity, and the agricultural community will assuredly be greatly benefited.

In the treatment of the subject fourteen "groups" of grasses are defined as follows:

I. Characteristically colored grasses.
II. Variegated grasses.
III. Bulbous grasses.
IV. Cord-rooted grasses.
V. Acute-sheathed grasses.
VI. Net-sheathed grasses.
VII. Bitter-tasted grasses.
VIII. Bristle-bladed grasses.
IX. Hard-bladed grasses.
X. Hairy grasses.
XI. Eared grasses.
XII. Ribless-bladed grasses, with median lines.
XIII. Hairless grasses, with very low and flat ribs.
XIV. Ribs high and prominent, rounded, or acute.

Many good figures are given, thus greatly aiding the student. An admirable feature of the figures is the frequency with which cross-sections of leaves are given. Ligules and leaf-tips are also freely figured. The work, although written for England, will be useful in this country.—CHARLES E. BESSEY.

ZOOLOGY.

Abnormal Repetition of Parts.—Bateson has figured[1] some interesting cases of monstrosities of this sort. In *Cancer pagurus* he finds an external maxilliped which has been converted into a pincer like that of the large claw. In other specimens of the same species he finds three specimens in which the pincer has a tendency to duplicate itself, as is well known to those who have studied these malformations. Another instance is a specimen of *Chrysomela banksii*, with three tarse on the right posterior leg. In a specimen of *Antedon rosacea* a pair of the arms show a branching into four at some distance from the body. The last case is a pilchard with an abnormal number of scales, No discussion is given of these instances, but Mr. Bateson has in progress an essay on the variation of multiple parts.

The Embryology of Spiders.—K. Kishinouye has been studying the development of some Japanese spiders. His descriptions of the early stages[2] are to be regarded as confirmative rather than making an important advance. At one stage he finds the yolk free from nuclei, the germ-layers arising later from the primitive cumulus and the posterior cloud of Claparède. He differs, however, in some points from Claparède and others in the interpretations of the early surface views. Among the interesting points brought out are the following: The first abdominal segment has no appendage at any stage. The lung books are developed in the base of the appendages of the second abdominal segment, in exactly the way necessary to support the view of their homology with the gill books of Limulus. An abortive trachea develops in the same way from next appendage. The coxal glands are shown to consist of a cœlomic pouch and an ectodermal duct,—a fact which goes far to support their homology with nephridia, and to lessen the weight of Eisig's argument. The author is convinced that the malpighian tubes are not ectodermal; he thinks them mesodermal, but apparently is not familiar with the results of those authors who assign them to the entodermal structures. Some facts additional to those of Locy are given regarding the development of the eyes. The stecoral pocket is regarded as developing from an unpaired posterior cœlomic pouch.

[1] Proc. Zool. Socy. London, 1890, p. 579.

[2] Journal of the College of Science, Imperial University, Japan, Vol. IV., 1890.

Insects of Central Africa.—H. Grose Smith catalogues[3] 111 species of Lepidoptera; W. L. Distant, 48 Rhynchota; and H. W. Bates, 73 Coleoptera, collected by William Bonney in the Great Forest of Central Africa while on the Emin Pasha relief expedition. The number of novelties is comparatively small, and the insect fauna shows very marked resemblances to that of the western coast of Africa.

Studies on Amphioxus.—F. E. Weiss has had the opportunity to study at Naples some points in the anatomy and physiology of Amphioxus which needed elucidation. The basis of his work was the paper by Professor Lankester,[4] in which many unsolved questions were pointed out. Weiss now settles[5] some of these. Feeding with carmine seems to show that there is not that intimate connection of cœlom with the vascular system that had been supposed. Many of the connections and relations of the circulatory tubes have been made out, while the most interesting discovery is that of excretory tubules, paired and branchiomeric, occurring at the upper part of the branchial apparatus, in connection with the secondary or tongue-bars. Each of these tubules is supplied with a comparatively large blood-vessel. It is bent in the shape of the letter S, and empties into the atrial cavity. Weiss was not certain whether it communicates with the cœlom or not, his sections failing to settle this point. These tubules are regarded as nephridial, but the author does not regard them as homologous with the pair of tubes described by Lankester. Another point of interest is that many points on the surface have also excretory functions.

The Amphibian Blastopore.—R. V. Erlanger has attacked this oft-studied problem, and concludes[6] that the anus is formed from the ventral, and the neurenteric canal and neuropore from the dorsal, margin of the blastopore. In the Anura the blastopore closes, and the anus later breaks through within its limits, while in the Urodeles there is no closing.

The Position of the Sun Grebes.—The systematic position of the Heliornithidæ has been very uncertain. Recently F. E. Beddard has had an opportunity of studying the anatomy of *Podica senegalensis*, and concludes[7] that if the muscles alone were concerned the sun grebes

[3] Proc. Zool. Soc. London, 1890.

[4] *Vide* AMERICAN NATURALIST, XXIII., p. 639, 1889.

[5] *Quart. Jour. Mic. Sci*., XXXI., p. 489, 1890.

[6] *Zool. Jarbuch*, Abth. Anat. und Ontogenie, IV., p. 239, 1890.

[7] Proc. Zool. Socy. London, 1890.

would be placed with the Pygopodes, but that osteology alone would refer them to the vicinity of the rails, though it differs from the latter in the sternum. The characters peculiar to the Heliornithidæ are the absence of an aftershaft, the form of the sternum, the shape and relations of the interclavicular, in the fusion of the pubes with the ischia, and the absence of post-acetabular ridges, in the arrangement of the intestinal coil, and in the form of the biceps crusis. On the whole, Beddard thinks it a distinct family, which has traversed for a certain distance the branch leading from the rails to the Colymbidæ, and has then diverged rather widely in a direction of its own.

Zoological Notes.—Cœlenterata.—The habits of the sea pens (Vergularia, etc.) have not been certainly known. Edgar Thurston says that near Madras *V. juncea* sticks straight up in the sand, and that as soon as touched they go down deeper and deeper, so that frequently a spade is necessary to secure them.

G. C. Bonme[8] gives a catalogue of 55 Hydroids growing at Plymouth, England. The only novelty is *Haloikema* (n.g.) *lankesterii*, a Halecium-like form with non-retractile polyps.

Molluscs.—The Opisthobranch molluscs of Plymouth, England, are catalogued[9] by Walter Garstang. Fifty-two species are enumerated, while very full notes are given of many species. The student of Nudibranchs on the New England coast cannot neglect this paper.

Vertebrates.—Some five years ago the discovery in Mauritius of a cave containing the body of the dodo was announced. It appears that this was probably a mistake, two recent letters[10] showing that the person making the announcement had been imposed upon. The caves of Mauritius are not such as to contain such remains, swept as they are by frequent floods.

Boulenger gives[11] a synopsis of the genus Arges, describing six species, two of which are new. They come from the Andes of Equador and Peru.

Howes believes that the proatlas is a normal feature in Hatteria, and regards it as a vestigial vertebra. He has found several specimens

[8] Jour. Marine Biol. Ass. United Kingdom, No. 4, p. 391, 1890.

[9] Jour. Marine Biol. Ass. United Kingdom, No. 4, p. 399, 1890.

[10] Proc. Zool. Socy. London, 1890, p. 402.

[11] Proc. Zool. Socy., 1890, p. 450.

of this form with the vomerine teeth, discovered by Baur, and refers to their relationship to similar teeth in Paleohatteria.

Dr. Emil Schoebel contributes[12] an account of the post-embryonic development of the eye of the Amphibia. The eye has almost all of its essential features at the beginning of larval life, and, contrary to the title of the paper, the author describes the features before as well as after hatching.

EMBRYOLOGY.[1]

A New Text-Book on the Embryology of Invertebrates.—Dr. E. Korshelt and Dr. K. Heider have recently published the first volume of a "Lehrbuch der Vergleichenden Entwicklungsgeschichte der Wirbellosen-Thiere" (Jena, 1890, Gustav Fishcher). Since the publication of Balfour's "Treatise on Comparative Embryology," written more than ten years ago, there have been published an immense number of papers dealing with the embryology of animals; and the authors believe there is a pressing need of bringing these together, and making a new inventory of the accumulated material. The present book is confined to the results on invertebrates, inasmuch as the papers on vertebrate embryology have been brought together, within the last few years, in well-known treatises on the subject. The first volume treats of the Sponges, Cnidaria, Ctenophora, Platyhelminthes, Nemertines, Nemathelminthes, Annelids, Echinoderms, and a few smaller groups. In the second volume the authors promise to treat of the Arthropods, Molluscs, Molluscoids, Tunicates, and Amphioxus; and the book will close with a general part.

The substance of the first volume is largely made up of reviews of the most important papers published since Balfour's time, and, so far as we can judge, these are admirably presented, and are noticeable for clearness as well as conciseness of statement. The authors believe fully in the evidence of embryology to solve most of the problems of phylogeny. They hold fast to the gastrula ancestry of the Metazoa, and each larval form is marshaled up to tell its tale of how the groups arose. This diagrammatic conception certainly admits of clearness of treatment; but whether it represents the high-water mark of morphological speculation may be open to doubt.

[12] *Zool. Jahrbuch*, Abth. Anat. Ont., IV., p. 297, 1890.

[1] Edited by Dr. T. H. Morgan, Johns Hopkins University, Baltimore, Md., to whom books and pamphlets for review should be sent.

Each of the sections ends with a general part, in which the authors bring together the essential points of the papers on the subject, and give their interpretation of the meaning of the facts.

The first section, on the Sponges, is admirable, and a much better-balanced presentation than that given by Balfour, who has unduly emphasized the amphiblastula larva. They believe the Sponge is a distinct phylum, only connected with the other Metazoa in its earliest history,—"nur an seiner Wurzel." The group has a true blastula and gastrula stage, but believing the polyp to represent the ancestral Cœlenterate, they do not think the Sponges have any affinity with the latter group. For the Cœlenterates they adhere to the old views that the fixed Hydroid represents the ancestral form, and the Medusæ a higher, more specialized, and later form; and they reject the free-swimming jelly-fish as an ancestral form, as held by Claus, Brooks, and Vogt. The authors are inclined to believe in the gastrula as the ancestral form of the Cnidaria, and think a secondary change has come into the ontogeny "because the typical larval form of the Cnidaria is the planula. It is probable that the transition of the free-swimming, gastrula-like ancestor was changed into the fixed polyp form through a creeping stage, which the creeping planulæ of many forms now repeat in their ontogeny."

The Ctenophors have many general points of agreement with other Cœlenterates, but recent work (Hertwig, Lang, Hatschek) goes to show that the Ctenophors have had an independent origin. They show no evidence of a polyp ancestry in the ontogeny, and the formation of organs shows they have no close relationship to the Medusæ. To sum it all up, the Ctenophors represent an independent phylum of the animal kingdom, and only at the base unite with the Cnidaria.

The Turbellarians show many common characteristics in segmentation and gastrulation with the Ctenophors, but if these two groups came from the same root, each has become so changed that only general resemblances are possible.

The Trematodes go back to Turbellarian-like flatworms which have assumed a parasitic life. The Nemertines, although more highly developed, are probably related to the flatworms, and it is not possible to separate Nemertines from the Turbellarians in order to place them among the segmented worms. Hubrecht's hypothesis as to the relationship between Vertebrates and Nemertines can have only an entirely speculative value. The embryology of the Nemathelminthes throws no light upon their ancestry, and we cannot determine whether they are related to the Nemertines on the one hand, or to the Annelids on the other. The Rotifers go back to the Trochophora, and Semper's Trochosphæra shows this relationship.

The Annelids include Chætopods, Echiuriden, Dinophilus, Myzostoma, Hirudinea, Branchiobdella.

The treatment of the group is interesting, and brings out clearly the tendency of the authors to overestimate, as I believe, the value of embryology as affording a solution to phylogeny. The Trochophore larva is the typical larval form of the Annelids. It is exceedingly probable that the Trochophore of Annelids is a recapitulated stage of an ancestral form of the group which was common to the Annelids, Mollusca, and Molluscoida, and from which these groups diverged. It is difficult to determine from what ancestors the Trochophore itself arose. The authors give their reasons for rejecting the Medusæ as the ancestors of the Trochophore. They conclude that the facts indicate that the Trochophore developed directly out of a ciliated gastrula-like forefather, and by a change in the method of progression. The transition of the Trochophore-like ancestor into the typical Annelid (Archiannelid) took place by an increase in the length of the body and a diminution of the head. At the same time a change from a free-swimming to a crawling animal took place, and this process is repeated in the ontogeny of living Annelids. The Sipunculids show resemblances to the Annelids, but cannot certainly be referred to that group; and their resemblance to Phoronis and Molluscoids is not sufficiently established. The Chætognatha are perhaps most nearly related to the Annelids.

The Tornaria of Balanoglossus shows certain resemblances to Echinoderm larvæ, but it appears to be only in external and non-essential characters, and the Tornaria comes nearer to the Trochophore. There is some uncertainty as to the relationship of Balanoglossus to the Chordata.

The radial structure of the Echinoderms is due to the ancestral form having been fixed and subsequently become a free-living animal. To what group of the Bilateralia these go back to is "in der Luft." (I cannot believe the authors have fairly treated the apparent relationship, as Metchnikoff has pointed out, between the Echinoderms and Balanoglossus, through perhaps a Holothurian form.) The larva of the Echinoderms, they think, comes nearest to the Trochophore.

Whether or not we agree with these more speculative parts of the volume, the general verdict seems to be that the authors have produced a useful book. An English translation would probably appeal to a larger audience and excite a wider interest in embryology.

Amphioxus.—Prof. E. Ray Lankester and Mr. Arthur Willey have a paper on "The Development of the Atrial Chamber of Amphioxus," in the *Quar. Jour.* for Aug., 1890. Mr. Willey made some observations in Sicily on the life of the adult and the embryo which are of interest. The adults will spawn in glasses, and this takes place about an hour after sundown. The eggs must be distributed into glasses containing clean, unfiltered water from the pantano in which the adults live. "If the water is filtered, or if sea-water [outside of the pantano] is employed," the eggs "will either die or develop abnormally." Most, if not all, of the ova were discharged through the atriopore, which contradicts the statement of Kowalevsky, who says they issue from the mouth.

The young larva rests habitually on one side, and does not bury itself in the sand. The larva shows for a time the most marked asymmetry, with the mouth on one side and a single row of gill-slits on the other.

The young Amphioxus, after regaining its symmetry, does not lie on its side, "but buries itself upright, tail downwards, with the oral hood alone projecting from the sand." The spawning occurs from April to September, inclusive.

The greater part of the paper is taken up with a description of the formation of the atrium and of the organs in the head region.

The Life-History of the Red Blood-Corpuscles.—Prof. W. H. Howell, of the University of Michigan, has a most important and interesting paper on the origin of the corpuscles of the blood. A rather full abstract of this paper is given below, as the subject is one of great interest to all students and teachers of physiology, and is either treated in a most meagre way, or, worse still, false statements are not infrequent in many of our text-books of physiology. Those who care for a fuller account will find Dr. Howell's paper instructive (*The Journal of Morphology*, Vol. IV., No. 1):

"Before 1869 it was quite generally believed that the red corpuscles are formed from the white corpuscles, most probably while in the circulation," but "the evidence is overwhelming against this view. In the very young embryo two forms of red corpuscles are found,—one large, oval, and always nucleated, resembling the corpuscles of the lower vertebrates; and one small, biconcave, circular in outline, and found both nucleated and non-nucleated. The latter are the true mammalian corpuscles; the former represent possibly ancestral corpuscles. The true mammalian corpuscles lose their nuclei by extrusion.

The nuclei of the nucleated red corpuscles of the *young* embryo (except of the larger variety) are lost while in the circulation. . . . As the embryo grows larger, and the production of new corpuscles becomes localized in different organs,—liver, spleen, marrow,—more and more of the early history of the corpuscles is passed over while still in the blood-forming organ, and more and more of the red corpuscles are sent into the blood in the non-nucleated stage. In the first part of embryonic life new red corpuscles are produced in the liver from groups of mesoblastic cells, outlining the position of future blood-vessels (veins). It is probable that new red corpuscles are formed in all parts of the body where blood-vessels are being developed." This view of the origin is essentially different from that of Klein and Balfour, as given in the "Embryology of the Chick," where it is asserted that the red corpuscles are endogenously *within* large mesoblastic cells. "In the second half of embryonic life red corpuscles are formed in the liver, the spleen, and the marrow of the bones, the function being most active first in the liver, then in the spleen, and, finally, in the red marrow of the bones, where it continues during adult life.

"The white corpuscles and blood-plates do not occur in the circulating blood of young embryos, but make their appearance in later embryonic life." Certain nucleated cells of the red marrow of the bones multiply by division, later loose their nuclei by extrusion, and getting into the blood become the red corpuscles, and the biconcavity of these corpuscles may be due to the extrusion of the nucleus.

The white blood corpuscles are derived from the lymph leucocytes. These enter the circulation, and are at first not amœboid. The nucleus increases in size as the leucocyte grows older; finally it fragments, and probably this is followed by disintegration of the whole cell. The fragments of the nuclei persist for a time as the blood-plates. See Minot in NATURALIST, November, 1890.

Appendages of the First Abdominal Segments of Embryo Insects.—Mr. Wheeler has made a comparative study of the larval appendages of the first abdominal segment of insects (Trans. Wisconsin Acad. Science, etc.) He concludes that the appendage—the pleuropodia—of this segment were at one time organs of considerable functional importance in the primitive Hexapods, but are not equally well represented in the larva of all existing groups. They are serially homologous with the appendages of the thorax and abdomen, and in the embryos of existing insects these rudimentary structures are found as evaginations or invaginations of thickened ectoderm. Rathke, Ayers, and Graber believe these rudimentary appendages represent embryonic gills. Wheeler objects to this interpretation, as the cells of the pleuropodia are large, swollen, vacuolated structures, and would prevent any great interchange of gases between the blood and the air. Nor could these pleuropodia be sense organs, as Patten and Cholodkovsky believed, for no one has discovered even the trace of a nervous system running into them. The author is led to the belief that the organs must be large ductless glands, which were functional in ancestral insects. It seems probable that the pleuropodia represent appendages homologous with the thoracic legs, and may have been, at a remote time, ambulatory appendages, and subsequently converted into functional glands in the ancestors immediately preceding living insects.

Are the Arthropods the Ancestors of the Vertebrates ?— Two papers of a speculative nature have appeared side by side in a recent number (Aug., 1890) of the *Quarterly Journal of Microscopical Science.* The contrast between these cannot be without its value. Dr. William Patten, of the University of North Dakota, Grand Forks, U. S. A., makes the first attempt to establish "the origin of vertebrates from Arachnids." The other production comes from Cambridge, England, and is advanced by W. H. Gaskell, M.D., F.R.S., to establish "the origin of vertebrates from a Crustacean-like ancestor." It is difficult to bring one's self into the proper mental condition to treat these matters seriously; but that the authors, especially Gaskell, are in dead earnest there can be no doubt.

Patten seems to have been led to his hypothesis in studying the anatomy and embryology of Scorpions and Limulus; while Gaskell, if we remember aright, was started towards his present goal by the resemblance between *tumors* in the spinal cord and in the digestive tract.

A detailed review of these papers is impossible here, and the barest outline must suffice. Briefly, then, Patten inverts a Limulus, or a scorpion, or anything similar, and proceeds to compare the principal organs of his up-side-down beast with a vertebrate right-side-up, proving the identity of the structures! The most important comparison is between the nervous systems of the two groups. The three brain vesicles of the vertebrate find their homologue in the supraœsophageal and fused thoracic ganglia of the scorpion. The cranial nerves of the vertebrate are the results of the first *thirteen* neuromeres of the Arachnid. (The fatal number *thirteen* seems unfortunate just at present—see Dohrn !) Then follows a lengthy comparison between the vagus of the vertebrate and a series of nerves from the posterior part of the thoracic cord, and a comparison between the eyes of the two groups. The cranial flexure of vertebrates is entirely explained in the relationship of the supraœsophageal ganglion (fore- and mid-brain) of the scorpion to the thoracic ganglia. The notochord finds its homologue in the "median furrow" of Arthropods, which comes from the *ectoderm*, and the support of this homology is found forthwith in our ignorance of the origin of the vertebrate cord ! "Only a strong faith in enteric diverticula, and in the red, white and blue gastrules of embryological treatises, can lead one to the belief in the entodermic origin of the notochord. On the other hand, its growth at both ends from superficial cells, and the manner in which it is frequently wedged in between the nerve cords, indicate its ectodermic origin." This is an excellent example of the author's scientific state of mind in treating so important a question as the origin of the vertebrates !

The gill-slits come from the rudimentary nephridia of the thorax, and somehow—it doesn't matter much, since they must—connect secondarily with the digestive tract.

The fossil fish Pterichthys probably shows the transitional form between Limulus and the vertebrates. The mouth of the latter group is a new affair, coming from a dorsal sucking organ of our ancestors, and our other Limulus-mouth has long since disappeared.

Our views of gastrula and blastopore must be rejected, and newer ideas received, which will show a wonderful similarity between Arachnids and vertebrates.

Gaskell, in a former paper, demonstrated how the nervous system is composed of nervous material grouped around a central tube, which tube was originally the alimentary canal of an invertebrate. The present paper shows, he thinks, that the lowest vertebrate nervous system (Ammocœtes) confirms his theory. The old invertebrate digestive tract is now the central canal of the nerve cord. Of course the vertebrate now turns over, and a new digestive tract arose from the *gill region* of the Crustacean (how the author includes Limulus in this process is not yet clear to us, for Limulus he includes in his Crustacea). Nor does the author, yet a while, explain how a new mouth arose ; perhaps he has not finally settled on a convenient Arthropod organ. The ventricles of the vertebrate brain and the canalis centralis of the cord is the invertebrate ancestor's digestive tract, and the infundibulum of Ammocœtes is the old œsophagus and mouth.

The pineal eye of the vertebrate may be reduced back to the three-layered Arthropod type. There is another more rudimentary pineal eye which belongs to the left side, while the previous one connects with the right ganglion habenulæ. The brain of Ammocœtes almost compels us to recognize the supraœsphageal ganglion of the Crustacean, etc.

If any one hopes to find a grain of truth in either of these two contradictory theories, which exhibit wonderful displays of mental gymnastics, starting from the Arthropods as from a spring-board, thence to take their aërial flight, let such a person read them side by side.

ENTOMOLOGY.[1]

A Review of Some Plum Curculio Literature.—A few years hence, when it is finally and definitely settled whether the Plum Curculio (*Conotrachelus nenuphar*) can be successfully fought on a commercial scale by spraying with the arsenites, there will be an opportunity to write a most curious and instructive chapter in the annals of economic entomology. This question has been under discussion by entomologists for more than twenty years, and to judge from the latest publications concerning it, the end is yet in the distant future. Nearly all our economic entomologists have taken part in the discussion, and the final record will show a curious mixture of assent and dissent on the part of those concerned.

Before attempting a brief analysis of this record, I desire to quote from a letter recently published in *Agricultural Science* (Vol. IV., p. 97), in which I made the following statements concerning the philosophy of spraying with the arsenites, and the conditions necessary for a fair test: "The remedy undoubtedly acts mainly by destroying the adult beetles that feed upon the poisoned surface of the fruit and foliage, thus preventing, to a greater or less extent, the deposition of the eggs. It need not necessarily act at all upon the beetles when engaged in oviposition, nor upon the larvæ after hatching. Consequently a fair test cannot be carried on with a half dozen trees close together, three of which are sprayed and the others not. Beetles from the unsprayed trees may oviposit in the fruit of those sprayed, and the beetles killed on the sprayed trees will lessen the injury to their checks. For the same reason a fair test cannot be carried on in an orchard in

[1] Edited by Dr. C. M. Weed, Experiment Station, Columbus, Ohio.

which every alternate tree is sprayed. A conclusive experiment necessitates an orchard of considerable size,—one half to be sprayed and the other half either to be jarred or left untreated,—or else two orchards near together, with a similar difference in treatment. Of course, by the every-other-tree method, results of some value may be obtained, but the conditions of the commercial orchard, where all the trees are sprayed, are far from being reached."

So far as entomologists are concerned, the discussion of this subject appears to have begun in 1870, when Dr. C. V. Riley wrote the following paragraph upon it:[2]

"Mr. G. M. Smith, of Berlin, Wisconsin, . . . recommends Paris green for the Plum Curculio. Even if the uniform application of such a poisonous drug on large trees were practicable, it would never succeed in killing one Curculio in a hundred. Paris green kills the leaf-eating beetles by being taken internally with the leaves; but the Curculio, with its snout, prefers to gouge under the skin of the fruit, and only exceptionally devours the leaves. Yet, notwithstanding the palpable absurdity of the remedy, it has very generally passed from one journal to another without comment."

Fifteen years later Dr. Riley delivered an address before the Mississippi Valley Horticultural Society, in which, "in giving his experience as to the feeding habits of the beetles, he urged experimentation with the arsenites in this direction as promising fair results, though in the very nature of the case not as satisfactory as in the case of the Codling Moth."[3]

In November, 1888, Dr. Riley, in reviewing a bulletin by Professor A. J. Cook, in which the latter reports successful results with the arsenites as Curculio destroyers, wrote:[4]

"We have long felt that they [the arsenites] might be used with benefit for this purpose, but from the nature of the case we have anticipated less good than in the case of the apple worm, and Professor Forbes's experiments, and some unpublished experiments which we have had made by Mr. Alwood, confirm this view."

Shortly after this Dr. Riley read an elaborate paper concerning the Plum Curculio before the American Pomological Society, at its meeting in February, 1889, in which the use of arsenical sprays was especially discussed. This article, in substantially the same form, was also incorporated in the memoir upon the Plum Curculio published by Riley

[2] Third Report State Entomologist Missouri, p. 18.

[3] Riley. Rept. Am. Pom. Soc., 1889, p. 31.

[4] *Insect Life*, November, 1888, Vol. I., p. 123.

and Howard in the Report of the U. S. Department of Agriculture for 1888. In this article the author summarized the experiments of Alwood, Cook, Osborn, Forbes, and Weed, and made the following concluding statement: [5]

"On the whole, the remedy is one which is a desirable addition to our list, although it will never become so great a success as the application of these poisons for the Codling Moth, and for two reasons: (1) The egg is deposited, and the beetle gnaws, preferably upon the smooth cheek of the fruit, where the poison does not so readily adhere, and from which it is more easily washed off; (2) the larva, eating directly from the flap, does not come in contact with the poison, as does the larva of the Codling Moth."

In the Department Report article already referred to Riley and Howard state that "there can be no doubt but [that] practical use has demonstrated that the jarring method is the most effective way yet proposed for destroying these insects." [6]

I have already called attention [7] to the fallacy of the arguments contained in the next to the last of these paragraphs; but as the periodical in which my letter was published seems not to be generally circulated among entomologists, and as there was also a printer's blunder which misrepresented my remarks, they may be quoted in this connection. Referring to the reasons given for the assertion that spraying for the Curculio "will never become as great a success" as in the case of the Codling Moth, I said: "The fallacy of these arguments lies in the assumption that the *modus operandi* of the method is the same for both insects,—an assumption that obviously is not justified by facts. In the case of the Codling Moth, the remedy acts by destroying *the larva after it has hatched from the egg*, while with the Curculio it acts by destroying *the beetle before the eggs are laid*. This throws the arguments concerning the place of oviposition and the food habits of the larva entirely out of court, leaving only that expressed in the phrase, 'The beetle gnaws preferably upon the smooth skin of the fruit, where the poison does not so readily adhere [as in the calyx of the apple?], and from which it is more easily washed off.' To what extent this is true, and what importance should be attached to it under the circumstances, are openquestions. The green fruit of many, at least of the so-called foreign plums, is covered with a fine pubescence, in which particles of London purple or Paris green readily lodge, and are not easily blown or washed away.

[5] Rept. Am. Pom. Soc., 1889, p. 34.

[6] Report U. S. Department Agriculture, 1888, p. 68.

[7] *Agricultural Science*, Vol. IV., p. 98.

"Clearly, if the question of comparative efficiency raised in the paragraph quoted above is to rest on a rational basis, it must be put in something like the following form: Is the deposition of Curculio eggs prevented (through the destruction of the parent beetles) by the application of arsenites to plum trees in as great a proportion as Codling Moth larvæ are destroyed by the same applications to apple trees? It is probable that each female Codling Moth and Plum Curculio deposits on an average about fifty eggs, so that, reduced to figures, this question resolves itself into the following: Is the application of the arsenites as likely to kill one adult female Curculio, feeding indiscriminately over a large amount of poisoned surface, before it has deposited eggs, as it is to kill fifty Codling Moth larvæ before they enter the apples.

"In order to get at field conditions, suppose that in an orchard of 1,000 apple trees there was a female Codling Moth to each tree, and that in an orchard of 1,000 plum trees there was a female Curculio to each tree. It is usually estimated that seventy-five per cent. of the fruit liable to injury by the Codling Moth is saved by spraying; so it becomes a question of whether spraying will be as likely to destroy the equivalent of 750 female Curculios before their eggs are laid, as it will to destroy 3,750 Codling Moth larvæ after they hatch. The answer to this question will be found along the experimental rather than the *a priori* road."

It will readily be granted, from the explanation already given, that if the case be restricted to a single tree, or a few trees in the midst of other trees liable to injury by the Curculio, the odds would be in favor the Codling Moth, at least for the first brood, but on a commercial scale the above reasoning must apply.

The writings of Professor A. J. Cook form an important part of the discussion upon this subject. During the first six or seven years of the last decade he frequently expressed the opinion that the Curculio could not be destroyed by the arsenites. For instance, in 1886 he is on record as saying:

"Paris green, kerosene emulsion, and other poisons are of no avail against the Curculio. He will not eat them."[8]

In 1887 Professor Cook took up the subject in an experimental way. The only record of the season's work is the following paragraph:[9]

"Paris green, in the proportion of one tablespoonful to six gallons of water, was very thoroughly sprayed upon four plum trees, May 18th. The petals had all fallen, but the dried calyces still clung to the fruit. On August 20th the trees were visited, when it was found that the two

[8] Report Mich. Board of Agriculture, 1886, p. 141.

[9] Report Mich. State Board of Agriculture, 1887, p. 40.

treated trees of the Wild Goose variety had dropped all their fruit, as had the untreated trees of the same kind. Another treated tree of a yellow variety was loaded with plums, of which only fifteen per cent. were stung, and those not badly. The fourth tree treated was a purple variety, and had not less than seventy-five per cent. of its fruit badly stung."

Professor Cook wisely refrains from drawing any conclusions from an experiment of such doubtful value. It is extremely probable that the Curculio had nothing to do with the dropping of the fruit on the Wild Goose trees, as this variety nearly always drops its fruit just after it sets, on account of the lack of fertilization of the ovule. The two remaining trees about offset each other, one having seventy-five per cent. of wormy fruit, and the other eighty-five per cent. of sound plums. The trees were sprayed but once, and a period of more than three months apparently elapsed during which no observations were made upon them.

In 1888 Professor Cook repeated the experiment, apparently on a slightly larger scale. An unrecorded number of cherry trees and three plum trees were sprayed with London purple, one pound to 100 gallons of water, June 6th, 12th, and 20th. The sprayed fruit of both kinds matured with little or no Curculio injury, while "cherry and apple trees near by not sprayed suffered seriously." The author gives the following conclusions: [10]

"From these experiments, and those of former years, I conclude that while one application will not save our plums and cherries, and prevent apples from being stung, two or three applications may be of signal advantage."

The experiments were repeated in 1889 "with no success. All the trees were severely attacked and all the plums lost." Nothing is said concerning cherries. Professor Cook thinks he is "warranted in the following conclusions:" [11]

"The arsenites will protect against the Plum Curculio if they can be kept on the tree or fruit. But in case of frequent rains the jarring method will not only be cheaper but much more effective."

Finally, in 1890 Professor Cook issued as Bulletin No. 66 of the Michigan Agricultural College, an article entitled "Fighting the Plum Curculio," in which spraying is entirely repudiated, and "the old reliable method" of jarring is fallen back upon as "the surest, cheapest, and best method to banish the Curculio and save our plums." As before, no details of experiments justifying such an entomological

[10] Bull. No. 39, Mich. Agr. College, p. 9.

[11] Proc. Tenth Meeting Soc. Prom. Agr. Science, 1889, p. 28.

stepping backward are vouchsafed, the entire record being embraced in the following paragraph:

"Trees were very thoroughly sprayed, at intervals of ten days, as many as five times, and after each rain, and yet in several cases every plum was stung and fell off. Some small trees, heavily loaded, were sprayed, and though no rain came to remove the poison, yet in less than a week all the plums were stung by the Curculio. Both last year and this, with the exception of one tree, nearly all the plums were stung. These fell from the tree, were all gatherd up and cut open, that we might be sure that the grubs were present."

This record is remarkable for the absence of any indication of details from which one might get an idea of the fairness of the experiment. We do not know the number, size, position or variety of the trees sprayed; nor whether they were surrounded by unsprayed trees; nor the dates of spraying; nor the amount of rainfall; nor the poison used; nor the proportion of poison and water; nor the method of spraying; nor whether the work was done under the author's personal supervision, or by untrained and inexperienced assistants. The present writer has learned from conversation with Professor Cook that ten trees only were included in the test.

These Michigan experiments for several years past, which are being quoted far and wide, are all open to the following objections:

(1) They have not been carried on with a proper understanding of the theory upon which the remedy rests. As a consequence, the every-other-tree method, or the method of a few trees treated among many untreated, has been employed,—methods by which no results of value to the commercial grower can be obtained.

(2) They have been conducted, so far at least as the record indicates, on too small a scale.

(3) The records of the experiments are incomplete and unsatisfactory. Nearly all of the details essential to a full knowledge of the force of the experiments are omitted.

Professor Herbert Osborn, in 1888, made some experiments on the grounds of the Iowa Agricultural College, which have been quoted by Riley and Howard in the Plum Curculio article already referred to. A few trees of native varieties were sprayed twice, among others not sprayed. Only a small proportion of the plums were injured in either case, and the experiment showed a small percentage in favor of the sprayed trees. But there were two insects engaged in the work,—the Curculio and the Plum Gouger (*Coccotorus prunicida*),—and the injuries of each were not separated. Careful observations made in the same region, and presumably in the same orchard, the next year, by Mr. C. P. Gillette, showed that ten times as much injury was done by the Gouger as by the Curculio. Consequently, so far as the Curculio is concerned, this experiment might well have been left out of the record.

In 1889 Mr. C. P. Gillette made some careful experiments on native varieties of plums at the Iowa Experiment Station, apparently on the same orchard that Professor Osborn had worked in the year before. Mr. Gillette recognized the dangers of the every-other-tree method, making a distinct statement of the principles involved, in the Bulletin of the Iowa Experiment Station for May, 1890 (pp. 383–384), shortly after the publication of my letter in *Agricultural Science*, which, however, he had probably not seen when his article was written. The percentage of Curculio injury on both sprayed and unsprayed trees was extremely small, though "the indicated saving of fruit that would have been injured in the absence of treatment was forty-four per cent." In this experiment only two sprayings were made, and, as the author states, both were too early to take most effect upon the Curculio.

The conclusions concerning the Curculio reached by Professor Forbes, in his admirable experiments in spraying apples for the Codling Moth, have frequently been quoted to show that the benefit to be derived from spraying for the insect is much less than in the case of the Codling Moth. But, aside from the fact that in these experiments the injuries of the Apple Curculio (*Anthonomus quadrigibbus*) and the Plum Curculio are not separated,—which alone would vitiate the conclusions so far as they relate to the latter insect,—a few trees were sprayed in the midst of others untreated, so that, from the principle already stated, results of little value, so far as the Plum Curculio is concerned, could be expected.

In 1887 Mr. W. B. Alwood made some experiments on the grounds of the Ohio Experiment Station, on the strength of which he has frequently claimed priority in demonstrating the usefulness of the arsenites as Curculio destroyers. No record of them was published until 1889, when they were incorporated in Dr. Riley's American Pomological Society article, and also in the Riley-Howard memoir in the Department of Agriculture Report for 1888 (pp. 70–71). Three plum trees of the Green Gage variety were treated in the midst of about twenty-five untreated trees of four other varieties. One Green Gage was left as a check. Paris green, at the rate of one pound to fifty gallons of water, was applied May 13th and 17th. Of course two such strong applications, only four days apart, greatly injured the foliage, so that "fully fifty per cent. fell off." Mr. Alwood continues:

"The trees were set very full of fruit, and much of this withered and fell. However, fully one-half of a crop was matured. There was one other tree in the orchard of this variety, and it matured more fruit than the other varieties, but not one-half as much as those which had been so thoroughly treated with the poison. This tree was set in spring as full as they were. It seems possible from this note that the gages are not so much injured by the Curculio as the other varieties. However, this is not at all certain."

It is needless to state that this part of Mr. Alwood's experiment proved nothing. He also sprayed some cherry trees, treating one row with Paris green once, and another with kerosene emulsion once. This experiment was even more fruitless than that on the plum, and was abandoned before final results were obtained. Some experiments of decided value, however, were made by Mr. Alwood upon feeding poisoned fruit and foliage to Curculios in confinement, which will be referred to later.

My own experiments upon this subject began in 1888, when seventy-five Early Richmond cherry trees, occupying a half-acre block, were chosen for this work. The west half of the orchard was sprayed, and the east half left as a check. London purple was applied three times, in the proportion of eight ounces to fifty gallons of water. At time of ripening, eight sprayed trees and seven check trees were selected, and 1,000 cherries from each were critically examined for Curculio injuries. It was found that 14.5 per cent. of the unsprayed fruit gave evidence of Curculio attack, while 3.5 per cent. of the sprayed fruit was injured. There was consequently a percentage of benefit of 75.8. The same year similar experiments were made upon plums and pears, but as stated in the record[12] the opportunities for a satisfactory test were not so good as with the cherries, so that, although the fruit was saved, less stress was laid upon the results.

In 1889 the cherry experiment was duplicated, the parts of the orchard being reversed to eliminate any possible effect upon the results that might be due to the situation. In 1888 the west half was sprayed, and the east half left as a check; in 1889 the east half was sprayed, and the west left as a check. London purple was applied three times, in the proportion of one pound to 160 gallons of water. At time of ripening, 1,000 cherries were picked from each of twenty-four trees in each half of the orchard—a total of 48,000 cherries—and examined for Curculio injuries. The percentage of injury on the untreated trees was 6.17, while on the treated trees it was 1.5. This gives a percentage

[12] Seventh Annual Rept. Ohio Agr. Exp. Station, pp. 134–150.

of benefit of 75.6,—just .2 per cent less than in 1888. Plums sprayed with a combination of London purple and the Bordeaux mixture matured a full crop, while unsprayed trees a few rods distant lost all their fruit. The record of this year's work will be found in the Bulletin of the Ohio Agricultural Experiment Station for September, 1889 (Vol. II., pp. 133–143).

While these experiments were made as complete and satisfactory as the circumstances would permit, and every essential detail was inserted in the records, they were open to three objections, namely: First, that while the remedy might work in a region like Central Ohio, where fruit-growing forms only a small proportion of the agricultural interests of the inhabitants, and where the Curculio, though abundant, is not so overwhelmingly present as in a region almost exclusively devoted to fruit production, it might be impracticable in the latter region; second, that the plum orchard was not sufficiently large to make a test under the conditions of the commercial orchardist; and third, that the cherries upon which some of these experiments were conducted ripened before the season of egg deposition of the Curculio was over. The force of these objections was fully appreciated while the experiments were in progress, but the work was done in the belief that results of value could be so obtained, and with the expectation of giving the method a thorough trial, from the standpoint of the commercial orchardist, if the preliminary tests were sufficiently encouraging.

The present season a plum orchard of 900 bearing trees in Ottawa county, Ohio, right in the heart of a great fruit-growing region, was selected for the experiment. In the north half of it the method of catching the Curculios by jarring on a sort of inverted umbrella mounted on wheels was employed, while the south half was sprayed four times with pure Paris green mixed with water, in the proportion of four ounces to fifty gallons.

The first application was made May 8th, just after the blossoms had fallen from the late-blooming varieties. There was a heavy rain the same night, and it rained almost continuously until May 15th, when there was a short cessation. The second spraying was done on that day. The third spraying was made May 26th, and the fourth and last, June 2d.

On the jarred portion of the orchard a great many Curculios were caught, showing that they were present in numbers. A careful examination of both parts of the orchard was made on June 3d. Between one and two per cent. of the fruit on the sprayed trees had been stung, while about three per cent. of the plums on the jarred trees were injured. No damage to the trees was then perceptible.

Early in July the orchard was again examined. Some of the sprayed trees showed that the foliage had been damaged by the spraying, but the injury was not very serious. Not over three per cent. of sprayed fruit was stung at that time, while about four per cent. of that on the jarred trees were injured. But on both the fruit was so thick that artificial thinning was necessary to prevent overbearing.

A large crop of fruit was ripened on both parts of the orchard, and so far as could be judged from one field experiment, it showed that spraying is as effective as jarring.[13]

Professor Cook, referring to this experiment, has asked: "Would the crop have been a failure had he not sprayed? And, if so, will he get equal results every season?"[14] To the first question I can only answer that in the jarred half of the orchard large numbers of Curculios were obtained,—enough to ruin the crop had they not been caught. It is fair to presume that they were equally abundant in the sprayed half. The second question is easily answered. If the crop would have been a failure without spraying, obviously the spraying saved it. And if the success was due to spraying alone—a condition involved by the query itself—future experience must conform to that of the past. I do not say that this is all demonstrated, but simply answer the question with the premise involved in it. Professor Cook continues: "Occasionally we secure a crop, with no effort to fight the Curculio. Does not this suggest an explanation why some who have given this remedy a limited trial speak so highly of it." If the "*limited* trial" refers to the Ohio experiments, which have been carried on for three successive seasons, and in which an aggregate of 1,200 fruit trees have been employed, I would venture to inquire what constitutes an *extended* trial? There is certainly nothing in the record of the Michigan experiments to indicate that half this number of trees have been employed.

I had intended briefly to summarize the records concerning the feeding habits of the Curculio, and the laboratory experiments in poisoning it, but the limits of space forbids so doing. Suffice it to say, that Dr. Riley in his earliest articles showed conclusively that the adult beetles feed freely upon the fruit and foliage, and that the subsequent observations of Forbes, Comstock, Cook, Gillette, Osborn, Alwood, and others abundantly confirm his account; while the feeding of poisoned fruit and foliage to beetles in confinement by

[13] This experiment is recorded in Bulletin Ohio Agr. Experiment Station, Vol. III., pp. 225–228; September, 1890.

[14] Bulletin No. 66, Mich. Agr. College, p. 6.

Forbes, Cook, and Alwood have rendered it certain, to use the words of the first-named experimenter, that "there can be no further question of the liability of the Curculio to poisoning by very moderate amounts of either London purple or Paris green while feeding on the leaves and fruit of peach and plum." [15]

It is sincerely to be hoped that future experiments upon this subject will be conducted with a proper understanding of the *rationale* of the method, and on a sufficiently extended scale to give results of value to the commercial orchardist. The experience of another season has strengthened my conviction of the force of the following statement (written nearly a year ago, and published in the *Agricultural Science* letter already referred to), with which this review may well be ended: "It seems to me that the evidence now in hand is sufficient to point to the conclusion that spraying with the arsenites is a complete and practical remedy for the Plum Curculio, at least in good-sized orchards of cherries, plums, and apples; and that the experiment stations can best serve horticulture by encouraging the practice among commercial orchardists, and carefully recording the results obtained, so that they may be collated in the future, and a definite conclusion be reached. If the simple process of spraying is effective, it is useless to complicate matters by advising jarring in wet seasons, planting plum trees in apple orchards, or various other modifications of the treatment that have been suggested."—CLARENCE M. WEED.

ARCHÆOLOGY AND ETHNOLOGY.

The Societe d'Anthropologie at Paris.—*A Sketch of Its Organization and Work.*—The year 1859 was one memorable in the science of anthropology. In this year was published Darwin's work on the "Origin of Species." Whatever may be the truth of the theory announced by him, whatever degree of opposition it may have received, its appearance in the world marked an era in science.

In 1859 was also discovered, or rather was acknowledged as true, the discovery by Monsieur Boucher de Perthes of the paleolithic implements in the gravels of the river Somme. He had made this discovery originally in the year 1836, and had published as a result thereof several brochures, but they were not generally accepted or received in the scientific world until 1859.

[15] Forbes. *Insect Life*, Vol. II., p. 7; July, 1889.

I cannot do better than to quote from some of those who were his contemporaries and assisted in that discovery a short sketch thereof.

In the year 1859, or rather in November of 1858, was organized the Societe d'Anthropologie at Paris. It did not get into working order until the beginning of the year 1859. There were six members at the first reunion; when it was completed and perfected there were nineteen. M. Philip Salmon, in his article on the Societe d'Anthropologie in the Dictonaire d'Anthropologie, gives their names: MM. Anthelme, Beclard, Bertillon, Broca, Brown-Sequard, de Castelneau, Dareste, Delasiauve, Fleury, Follin, Isidore-Geoffroy Saint-Hilaire, Godard, Gratiolet, Grimaux-de-Caux, Lemercier, Martin-Magron, Rambaud, Robin, Verneuil. They commenced their work much the same as our own society, and with much the same success. In 1862 they numbered 102 paying members. This society passed through much the same stages of growth as has our own. It limited its active members to its own neighborhood,—the city of Paris,—and made certain distinctions between active and associate members. In the year 1863 they did what we have just done,—abolished such distinctions,—and it was in that year that the society entered upon the successful course which has marked its history to the present time. Broca early conceived the idea of the establishment of a laboratory of anthropology in connection with the society. He had already organized such a laboratory, which was installed in the ancient church of the Cordeliers, in which was installed the Musèe Dupuytren. He had brilliant hopes for this society, and desired to attach to it a series of public scientific lectures. This he called the Ecole d'Anthropologie. Of this I will speak further on. There was such success in this establishment that the Societe d'Anthropologie transferred itself from the Faculty of Medicine, where it was first installed, to the Musèe Dupuytren, 15 Rue de l'Ecole de la Medicine, where it is now established. This change was made in the year 1876, and here were established the three organizations, the Society of Anthropology, the School of Anthropology, and the Laboratory of Anthropology, to which is now to be added, by reason of the legacy of Broca, the collection of his lifetime relating to anthropology, and called the Musèe Broca. These organizations were principally the work of Broca. He was the head and front, the organizer, the manager, the director; yet he never held any higher office than that of secretary. It was his hope, and afterwards his pride, to see these organizations established and united, and it was a part of his pleasure to call them the Institut d'Anthropologie. Broca died the 9th of July, 1880, after the society had been organized twenty-one years. He was universally regretted, and the society of which he was secretary received various testimonies from the anthropological societies of the world. Broca probably did more than any other man of his time to advance the science of anthropology. It was his life's labor. He was a profound student, an indefatigable worker, a close and accurate observer, reported his conditions with great detail, and was thoroughly enamored of his science. He had that aptitude for the management of men, for the harmonizing of those annoying differences of opinion which are sometimes unfortunately made public by scientific men. Broca harmonized these inharmonious elements, and was recognized as a friend of all parties. He was entitled to and received their confidence. If his influence in this regard was great, his wisdom and good sense were greater. The society determined to erect a monument to his memory. The funds were furnished by public subscription, and the monument was installed the 29th of July, 1887, and now stands at the triangle between the Boulevard St. Germain and the Rue de l'Ecole de la Medicine, in front of the Faculty of Medicine. It is of bronze, is of life size, and stands on a granite pedestal about ten or twelve feet from the ground. It represents the great master holding in his left hand a human skull, and in the other the instruments of anthropometric measurement.

It is only fair to the Senate of France to say that it recognized the claims of science to a share of the government; that it recognized the important part played by scientific men in elevating France to the high position which she has occupied among nations. In accordance with this idea, and having confidence in the great good sense and wisdom of Broca, they elected him a senator for life. He continued in this office, and performed its duties, without neglecting the demands of his science, until the day of his death. Not only was this appointment a proper recognition of science, but it was a compliment to Broca directly, and incidentally to the Societe d'Anthropologie,—one which its members and anthropologists generally in France always remember with pride.

The Societe d'Anthropologie early determined upon a practical course to make known to the world, in a permanent form, the results of the investigations of its members in the new science. This was by the publication, first of bulletins, and afterwards of memoirs. The bulletins were commenced on the 19th of May, 1859, and have continued until the present time. The memoirs commenced soon after, and have also continued until the present time. Both are published quarterly. The bulletins are divided into three series: the first is six volumes from 1859 to 1865, the second is twelve volumes from 1866 to 1877, the third is eleven volumes from 1877 to 1888. They comprise about 500 or 600 pages per volume, and are for sale for the price of $2.00 a volume.

The members of the society who pay their yearly dues, consisting of thirty francs, or $6.00, are entitled to receive the bulletins without further payment. The memoirs are published much the same as are the bulletins. The members are not entitled to them except on payment. They are divided into two series as are the bulletins. They average from 500 to 600 pages per volume, and are sold at sixteen francs each.

The *Revue d'Anthropologie* was published by Broca during his lifetime. He was succeeded by Dr. Topinard. But it has ceased as the *Revue*, and has been consolidated with the *Materiaux* and the *Revue d'Ethnographie*, and will have for its three editors, Topinard, Cartailhac, and Hamy.

The Musèe Broca contains all the objects gathered by Broca during his lifetime bearing upon the science of anthropology. It is installed in one of the rooms of the society. It possesses several hundred skeletons and about five thousand skulls. These belong to every country, and include those of every epoch from the prehistoric to the modern, and likewise every race of people.

The Societe d'Anthropologie also possesses a considerable library. It receives and exchanges with other societies and organizations, purchases, etc., the various books, and now numbers in its catalogue about 7,000 volumes relating to anthropology and its kindred sciences.

Prizes Offered by Various Members of the Society.—Dr. Godard was one of the original organizers of the Societe d'Anthropologie. He died in 1862. He provided by will for a prize of the value of 500 francs, to be given each two years to the author of the best memoir on the subject belonging to anthropology, and left the decision and management thereof to the society. Regulations were adopted governing the competition. Any one could compete except the members of the central committee. The jury of examination was to be composed of five members, who were to be elected four months in advance. The manuscript should belong to the society, and in case no prize was awarded at any competition, the sum should be added to the next.

In 1881, one year after the death of Broca, his widow founded another prize of 1,500 francs, to recompense the author of the best memoir on human anatomy, or that branch of physiology which related to anthropology. The rules governing this are much the same as those of the Godard prize.

In 1883 Monsieur Adolphe Bertillon, called Bertillon père to recognize him from his distinguished sons, also instituted a prize, which should be given for the best memoir concerning anthropology, and notably for demography. This prize was a value of 500 francs, and is given under much the same rules as the foregoing.

These prizes are all distributed under the direction of the society, and the days of competition are made gala days.

Laboratory of Anthropology.—After the establishment of the Society of Anthropology, which served as a common ground on which the various scientists could meet, read papers, argue, discuss, and elaborate and make known their theories, it was found that the needs of this great science required a laboratory or workshop, in which experiments could be instituted and methods practiced necessary for proper scientific investigations. Broca was the first to discover this, and he instituted such a one in his private apartment and for his own use; but it soon outgrew its environment. In 1876 he procured quarters in the Convent of the Cordeliers, which he maintained at his private expense. In 1868 Broca was gratified by receiving the recognition of his laboratory as one of those belonging to the École des Hautes Études. The state from that moment paid a portion of the expense, and gave small subsidies to Broca by which he was enabled to carry on his work. This was continued until the year 1876, when the School of Anthropology and the Laboratory were recognized by the government as a public utility, and received a place in the governmental budget.

Broca directed the laboratory until his death. His various assistants were MM. le Docteurs Topinard, Manouvrier. At his death, Mathias Duval was appointed as director.

The laboratory is organized so as to carry on the study of craniometry, anthropometry, comparative anatomy of the human race, and the primates. It has its halls for dissection, making casts or moulds for drawings and for study. Dr. Manouvrier is at present, and has been for several years, the principal officer in charge. There are also to be seen here, and used, the instruments of anthropometry which were largely invented by Broca, and also a collection of all the French and European instruments for a like purpose.

The extent to which this laboratory is employed shows in the number of students and the amount of work performed, which can be approximately understood by a list that might be given at great length, but a summary only can be here made.

The students who have occupied the laboratory, and profited by its existence to follow their various branches in the science of anthropology, aggregated from 1881 to 1888 a total of 293. This does not include the visitors nor those who did sporadic work, but only those who devoted themselves seriously to the study of some branch of anthropology. The following gentlemen have performed work in the laboratory and library, more as professors than as students, the principal results of which have been recorded in memoirs, some of which have been read before the society, and all have been published in the scientific journals, principally in those related to the Societe d'Anthropologie, to wit: the bulletins, memoirs, and *Revue*. The best of such published memoirs are as follows:

Broca (died in 1880), 8; Mathias Duval, 90; Manouvrier, 59; Topinard, 41; Chudzinski, 39; G. Hervè, 22; Deniker, 19; Goldstein, 7; Mahoudeau and Zuborowski, each 5; Kuff, Tenkate, Mereschowski, Bordier, and Mondeires, each 3; Blanchard, Real, Toroch, and Fère, each 2. The following gentlemen each produeed one: Drs. Dally, Rey, Renard Calmette, Ujfalvy, Pasteau, Bouvier, MM. Girarde, Rialle, Golstein, Drs. Weisgerber, Ducatte, Ribe, Debleme, Marcano, Bajenoff, Felix Regnault, Orchansky, Baron d'Hercourt, Danillo, Carriere, Neis, Chambellan, and Cauvin; making a total of 345 memoirs, theses, or notes, published as aforesaid.

M. Chudzinski is one of the most successful artists in Europe for the reproduction in plaster of objects belonging to anthropology. He has made, and they are now to be seen in the museum, 157 pieces of this work.

It would not be practicable to give any complete list of the publications of these gentlemen in connection with the Laboratory of Anthropology. I may, as a sample, and because he is a personal friend, give a list of the publications of Dr. Manouvrier, together with the journal of publication.

1. Measurements and Record of 1,500 Skulls from the Catacombs of Paris. In the *Public Register* of the Laboratory of Anthropology, 1880.

2. On the Cubic Index of the Skull. Association Française, Rheims, 1880.

3. Comparative Study of the Skull and the Skeleton. Congrès d'Algier, 1881.

4. Weight of the Skull. Bull. Soc. d'Anthropologie, 1881.

5. Craniology. *Revue Scientific*, 1881.

6. Torsion of the Humerus. *Revue d'Anthropologie*, 1881.

7. The Fuegians. Bull. Soc. d'Anthropologie, 7 Nov., 1881.

8. Weight of the Brain. Acad. des Sciences, 6 Jan., 1882.

9. Height and Weight of Body and Brain. Ibid., 2 Feb., 1882.

10. The Brain and the Skeleton. Soc. Zool., 1882.

11. Force of Muscles and Weight of Brain. Ibid., August, 1882.

12. Grand Regions of the Skull in the Two Sexes. Ibid., 1882.

13. Relation between Intelligence and Weight of Brain. *Revue Scientific*, June, 1882.

14. The Galibis. Bull. Soc. Anthrop., Oct., 1882.

15. Skulls of Some Assassins. Ibid., Feb., 1883.

16. Plagiocephaly. Ibid., June, 1883.

17. The Weight of the Cerebellum and the Bulb. Congrès de Rouen, 1883.

18. The Skull in Its Relation to Age and Height. Ibid.

19. The Cingalese and the Araucams. Bull. Soc. Anthrop., 1883.

20. The Relations between Domestic Animals. Bull. Soc. Zool., 1883.

21. Dynamometric Errors. Bull. Soc. Anthrop., 1884.

22. A Comparative Study of the Sexes. Progress Française, Jan. 6th, 1884.

23. The Function of the Psycho-Motor. *Rev. Philosoph.*, 1884.

24. The Profile of the Brain Compared with the Cavity of the Skull. Bull. Soc. Anthrop., Bordeaux, 1884.

25. Ethnology and Ethnography. *l'Homme*, March 25th, 1884.

26. Vitrified Fort of Puy de Gaudy. Bull. Soc. Anthrop., 1884.

27. Three Cases of Congenital Idiocy. Congrès Blois, 1884.

28. Idiots and Imbeciles of Hospital Blois. Ibid.

29. Character of the Skull and the Brain. Second paper. Interpretation of the Weight of the Brain, Memoirs Soc. d'Anthrop, 1885.

30. The Indian Tribe of Omahas. Bull. Soc. Anthrop., 1885.

31. Graphic Display of Anthropological Series. *l'Homme*, Feb., 1885.

32. Prehistoric Trepanations. Bull. Soc. Anthrop., 1885.

33. Physio-Pyschologic Dynamometry. Soc. Biology, 1885.

34. Prehistoric Skulls of Grenoble. Conggren Grenoble, 1885.

35. The Skeleton of Members of Man and of the Anthropoid. Ibid.

36. Dolichocephaly. Soc. Anthrop., Lyons, 1885.

37. Capacity of the Skull of Sixty Assassins. 1885.

38. Skull of an Imbecile. Bull. Soc. Anthrop., 1885.

39. New Variety of the Wormian Bones. Ibid., 1886.

40. Five Skulls of Senegambiens. Ibid.

41. Craniology of Three Lunatics. Ibid.

42. Consecutive Movements of Mental Images. *Rev. Philos.*, 1886.

43. Skulls of Executed Criminals. Archives of Anthrop., Criminal, 1886.

44. Importance of Craniology. 1886.

45. The Greek Profile. Congrès of Nancy, 1886.

46. A Micro-Cephalic Idiot. Bull. Soc. Anthrop., 1887.

47. Seance of Spiritism. *l'Homme*, 1887.

48. Neolithic Skull of Crecy-en-Brie. Bull. Soc. Anthrop., 1887.

49. The Brain of M. Bertillon. Ibid., 1887.

50. Prognathism and Its Measure. Congrès of Toulouse, 1887.

51. Platycnemy. Memoirs Soc. Anthrop., 1887.

52. Cerebral Comparisons. *Rev. Phil.*, 1887.

53. Vitrified Forts, Walls, and Tumuli, 1887.

54. Studies of a Rickity Dwarf. Congrès of Oran, 1888.

55. The Temporal Convolution of a Deaf Person. Bull. Soc. Anthrop., 1888.

56. The Flattening of the Sous-trochanter. Ibid.

57. Frontal Circonvolutions, *à masse du Corps.* Ibid.

58. Heights of the Parisians. Ibid.

School of Anthropology.—As I have already said, the School ot Anthropology, like the society and laboratory, was indebted to Broca for its establishment. From almost the beginning of his labors in behalf of this science, Broca was of the opinion that the people should be educated in it. He believed that, in addition to all other opportunities, there should be provided that which is so popular in France,—courses of lectures for the public. In 1870 he obtained from the Dean of the Faculty of Medicine permission to deliver a course of lectures on anthropology in the public hall of the chemical school. In connection therewith he carried on clinical conferences in the laboratory in the Musèe Dupuytren. This course was confined to a single lecturer, himself, and was far from realizing his hopes as desired in this direction. He had organized in his imagination the Institute of Anthropology, which combined the three,—the society, the laboratory, and the school; and that there should be a number of chairs and professorships to teach the principal branches of the science of anthropology. Broca expressed himself very clearly and at length upon this subject, and as his saying has the same application to the present time as when uttered, and to our country and our society as to France and the Parisian society, I am justified in quoting it:

"In a project for the reorganization of the Faculty of Sciences of Paris, presented to the National Assembly, Prof. Paul Bert proposed to institute at the Sorbonne a chair of anthropology. This thought is excellent, and I hope that it will sooner or later be realized. It is still possible that other chairs of the same nature will be established at the College of France and in certain faculties of the provinces. But no matter how many of such single or isolated chairs of anthropology we may have, they will never respond to the needs of education. Good to instruct and to interest the public auditor, and consequently of great utility, they will never serve the needs of the student. If the course is to be accomplished in one or two years, it will be superficial. If it should last for five or six years, like that at the museum, it can be complete and excellent; but then it will be necessary for students to consecrate to the study of anthropology more time than for law or for medicine. Anthropology is not yet a profession, it does not lead to any public or scientific career, it has no hopes for the future; it will be rare to find scholars or students who are sufficiently impressed with this science to persevere to the end. They must also be rich in money, that they may maintain so long an initiation. It is necessary to form a school of anthropology where each of the principal branches can have a chair and a professor, to the end that the entire science can be taught each year in a simultaneous course, by men specially trained therefor."

This was a vast programme, and presented enormous difficulties, but they did not daunt Broca. His indomitable will, seconded by his ardent love for his science, caused him to push his endeavors until he arrived at a happy result. If it was necessary to obtain authorization from the government, he obtained it; subscribers, he gathered them; money, he found it. Carried away by his convictions, he took as founders around him Bertillon, Chudzinski, Collineau, Mortillet, Topinard, Manouvrier, Hamy, etc. The government of France, the Department of the Seine, and the city of Paris combined to furnish each a part of the money needed for the establishment of this School of Anthropology. A generous scientist, Dr. Jourdanet, himself provided the expense of one of these chairs.

On the 30th of October, 1876, everything was completed, and the ministerial authorization received, The 15th of November following, the course of lectures and teaching commenced. Broca's pride was satisfied when he said, upon that occasion, "the foundation of a School of Anthropology at Paris enables us to state with pride that anthropology is a science altogether French."

Other countries might have established chairs of anthropology and aught it in their educational establishments before this, but this was the first successful attempt to establish a course of anthropology, with numerous lecturers and professors who should coöperate and endeavor to teach the entire science in a single series.

Broca, as director, charged himself with the course of anatomic anthropology, and delivered two lectures per week. Dr. Dally was professor of ethnology, Hovelacque of language, G. de Mortillet of prehistoric anthropology, and Dr. Topinard of biologic anthropology. In 1877–'78 Monsieur Bertillon took charge of the course of demography; in 1878–'79 Monsieur Bordier commenced a course of medical geography, which chair had been established and paid for by Dr. Jourdanet.

On the death of Broca, the 9th of July, 1880, Monsieur Mathias Duval was designated to succeed him in the chair of anatomic anthropology; and Monsieur Gavarret, a professor of the Faculty of Medicine and Inspector-General of Superior Education, was denominated director of the school.

At the death of M. Bertillon, the 28th of February, 1883, the chair of demography was suppressed. In 1884–'85 Monsieur Dally was taken sick, and Dr. Manouvrier supplied his place; and the same year MM. Blanchard and Hervè were designated to make supplementary courses.

In 1885–'86 the chair of the history of civilizations was created, and Dr. Letourneau was designated as professor. The 1st of January, 1888, Monsieur Dally being dead, Monsieurs Hervè and Manouvrier were called respectively to the chairs of zoologic anthropology and physiologic anthropology, and Monsieur Lefevre was charged to supplement Monsieur Hovelacque. Finally, in 1889, supplementary courses were added, of which MM. Chudzinski, Mahoudeau, and Adrien de Mortillet had charge.

The programme of the lectures for the year 1888–'89 will give an idea of the scope of the science of anthropology as thus taught. It is as follows:

Anthropogeny and Comparative Embryology—The Fecundation of the Egg; The Laws of Heredity. Prof. Mathias Duval.

Zoologic Anthropology—The Anatomy of Man Compared with the Vertebrates; The Members. Prof. M. Georges Hervè.

Anthropology General—Parallel between the Characters of Superiority and Inferiority of the Human; Genealogy of those Characters in the Animal Kingdom. Prof. Dr. Topinard.

Prehistoric Anthropology—Origin of Hunting, Fishing, and Agriculture. Monsieur Gabriel de Mortillet.

Physiologic Anthropology—The Evolution of Psychology; Parallel between the General Doctrines of Metaphysics and the Doctrines of Science. Prof. Dr. Manouvrier.

History of Civilizations—The Evolutions of Political Institutions in the Different Races of Human Kind,—Government, War, Justice. Prof. Dr. Letourneau.

Medical Geography—Comparative Pathology; Parasitic Maladies; These Among the Different Races. Prof. Dr. Bordier.

Ethnography and Language—Their Relations to Mythology. Prof. M. Hovelacque, with M. Andre Lefevre as assistant.

The supplementary course for the same year was:

The Cerebral Convolution. M. Chudzinski.

The Principal Phases of the Evolution of the Brain. M. Mahoudeau.

Paris and its Environs in Prehistoric Times. M. Adrien de Mortillet.

The programme of lectures before the School of Anthropology for the current year 1889–'90 is as follows:

Prehistoric Anthropology—The Origin, Development, and Constitution of the French People; Autochtones; Ligurians and Iberians; Celts or Gaulois; Bergundians and Franks; Divers Elements. Prof. Gabriel de Mortillet; Monday and Wednesday, 4 o'clock.

Anthropogeny and Comparative Embryology—The Blastoderm of the Vertebrates, and the Theory of the Gastrula. Prof. Dr. Mathias Duval; Monday, 5 o'clock.

Ethnography and Language—The Myths and Gods of the Atmosphere, of the Stars, and of the Heavens, from the Times of Antiquity Until the Present. Prof. Andre Lefevre; Tuesday, 4 o'clock.

Zoologic Anthropology—Anatomy of Man Compared with that of the Vertebrates; The Members (continuation). Prof. Georges Hervè; Tuesday, 5 o'clock.

Medical Geography—Action of the Environments; Transformism (Evolution); Effect of Climate on Man and upon Organized Beings. Prof. Dr. A. Bordier; Friday, 4 o'clock.

Physiologic Anthropology—Human Anatomy in Its Relation to Psychology. Prof. Dr. L. Manouvrier; Friday, 5 o'clock.

History of Civilization—The Evolution of Jurisprudence in the Different Human Races. Prof. Dr. C. Letourneau; Saturday, 4 o'clock.

Comparative Ethnography—The Industry of Modern Savages Compared with that of the Prehistoric People. Prof. Adrien de Mortillet; Saturday, 5 o'clock.

Histologic Anthropology—Histology of the Nervous System and Its Principal Relation with other Systems of Organism. Prof. Dr. P. G. Mahoudeau; Wednesday, 5 o'clock.

Anatomic Demonstrations—Done at the Musée and Laboratory. Prof. Chudzinski; Saturday, 3 o'clock.

The card on which the foregoing announcements are made has this note at the foot:

"A register for inscription is at the school for the auditors of the course who may desire a certificate of attendance."

Because of my greater interest in that branch of anthropology belonging to the prehistoric, the course of lectures which were given by Monsieur G. de Mortillet attracted me most. I give the divisions of his course during the two or three later years.

The Origin of Man: Man during the Tertiary Geologic Period.—A glance at the history of the theories of the origin of the earth and of man; geology, general notions; geologic revolutions and their causes; continued movements of the surfaces; theory of earthquakes; laws of paleontology; succession of living (or created) beings; precursor of man, fossil monkeys; indication of the existence of an intelligent being during the Tertiary period; incised bones from Mount Operto, Italy; depot of Thenay (Loir and Cher), flints, burnt or retouched; depot of Puy-Courny (Cantal), split flints, fauna; depot of Otta (Portugal), flints chipped, fauna and flora; human skull of Calaveras, California; skeletons of Brescia, Italy; jaw of Moulin-Quignon; subdivisions and climatology of the Quaternary period; Neanderthal skull and race; skulls of Engis (Belgium), of Olmo (Italy), Laugerie-Basse and Cro Magnon (Dordogne); transformation and filiation of man; date (approximate) of the appearance of man; chronometers; glaciers, a proof of the antiquity of man.

Origin of the Arts, Agriculture, and Industry.—Heat, fire, lighting; beaux arts—engraving, sculpture, painting, music, architecture; medicine, surgery, sculpture, and religion; arms—hatchets, *casse-tetes,* swords and poignards, bows and arrows, defensive arms; instruments—knives, scrapers, razors, saws, etc., etc.; hunting, fishing, navigation; agriculture, horticulture, domestication; dress and ornaments; metallurgy—gold and copper, bronze and tin, iron, silver, and lead; ceramics—pottery, glass, enamel.

This has lasted two years in the course, and will be published as a separate volume.

Some of these lectures were illustrated by means of lantern slides. Those of Prehistoric Anthropology and Archæology were as follows:

Silex tertiare otta	65
Cromlechs munergces	54
Roche Montonnees	14
Glaciers de forna	6
Portraits (P. Broca and others)	7
Quarternaire stratigraphie	48
Archæologic (bronze)	83
Paleothologic (stone)	91
Megalethiqus (dolmen)	19
Ethnographic (char.)	30
	417

In addition to the courses of lectures, which have now been continued for fourteen years past, and of which the foregoing are given as an example, there have been other lectures, either delivered by special lecturers or upon special subjects under the direction of the Society of Anthropology:

Eulogy of Dr. Paul Broca, by Monsieur Dally, 1884.

The Distinctive Characters of the Human Brain, by Monsieur Pozzi, 1885.

A Study of the Races of Mankind in the Lower Valley of the Nile, by Monsieur Hamy, 1886.

Aphasy Since the Time of Broca, by Monsieur Mathias Duval, 1887.

The Nervous Centers, by Monsieur Laborde, 1888.

(*To be continued.*)

MICROSCOPY.[1]

Medullated Nerve-Fibres.[2]—Prof. Kultschitzky offers the following methods designed to take the place of Weigert's hæmatoxylin method. Kultschitzky's method permits of washing the preparation after fixation, and so avoids, to a great extent, the precipitation of chromic salts in the tissues.

The material must lie in Erlicki's fluid 1–2 months, then be washed in water 1–2 days, and hardened in alcohol. Then follows imbed-

[1] Edited by C. O. Whitman, Clark University, Worcester, Mass.

[2] Kultschitzky. *Anat. Anz.*, September 12, 1890, No. 18, p. 519.

ding in celloidin, and sectioning with the microtome in the usual way. The sections thus obtained are stained in

ACID HÆMATOXYLIN.

Hæmatoxylin, 1 g., dissolved in a *small quantity* of absolute alcohol, added to acetic acid (two per cent.) 100 g.

One to three hours in the stain is generally sufficient. After staining, the sections are to be placed in a

LITHIUM SOLUTION.[3]

Lithium carbon. (saturated solution) . . . . 100 ccm.
Ferricyanide of potassium (one per cent. solution) . 10 ccm.

In this solution the sections generally remain from 2-3 hours. The time required for decoloration may be reduced by adding more ferricyanide of potassium. After decoloring, the sections are to be well washed in water, passed through alcohol, and mounted in balsam in the usual way.

Instead of the above hæmatoxylin solution, we may use with equal success

ACID CARMINE.

Carmine . . . . 2 g.
Acetic acid (10 per cent.) . . . . 100 ccm.

The powdered carmine is heated 2–4 hours in the acid, and the solution, after cooling, is then filtered. The time for staining is 24 hours. Decoloration is effected in the same manner as before. The process, however, is more rapid than with hæmatoxylin, and hence it must be closely watched.

Henneguy's Methods with Pelagic Fish-Eggs.[4]—The eggs may be killed in water strongly acidulated with acetic acid. In the course of a few minutes the embryo becomes quite distinct, and the eggs are then transferred to chromic acid, one per cent. At the end of three days they are placed in water, and the chorion removed. After 24 hours in water, they are placed in ninety per cent. alcohol, then in absolute alcohol. Such preparations are excellent for surface views, but difficult to section on account of the hardness of the yolk.

The isolation of the germ from the yolk may be accomplished in two ways:

1. The egg is placed in osmic acid, one per cent., for a few minutes, until it has acquired a light brown color, then transferred to Müller's fluid, and the chorion cut open with sharp scissors. In this fluid

[3] Dr. J. Schaffer (*Anat. Anz.*, V., 22, November 21, 1890, p. 643) employed Weigert's borax-ferricyanide of potassium in place of this lithion solution, and with perfect success.

[4] *Journ. d'Anat. et de Physiol.*, 1888, pp. 416-7.

the yolk dissolves, and the cortical layer with the germ can thus be easily isolated. After several days the preparation is to be carefully washed and passed through several grades of alcohol.

This process does very well for the earlier stages, but not so well for the later ones, as the osmic acid does not penetrate the more advanced embryos sufficiently.

2. The method that proved the best was as follows: The egg is immersed for ten minutes in Kleinenberg's fluid, to which has been added one-tenth its volume of glacial acetic acid; it is then opened in ten per cent. acetic acid, which dissolves the yolk, and thus enables one to isolate the germ. The germ is next placed in Kleinenberg's fluid for several hours, then in alcohol.

Bryozoa.[5]—In studying the process of budding in Pedicellina, Loxosoma, and other Bryozoa, Dr. Oswald Seeliger made use of corrosive sublimate (saturated solution in hot sea-water), usually in combination with one-fiftieth its volume of glacial acetic acid. This mixture was used cold, and allowed to act from five to eight minutes. The preparation was thoroughly washed and stained with borax-carmine. To this sublimate-acetic acid mixture was sometimes added chromic acid (one-tenth per cent.), with the result that the epithelial structure was well preserved but difficult to stain.

Caryokinesis in Paramæcium.[6]—In the study of Paramæcium Prof. R. Hertwig made use of picro-acetic acid, chromic acid, and chrom-osmic acid as hardening reagents. Picro-acetic acid followed by borax-carmine was the principal method. The staining process was aided by the heat of an incubator, and decoloration was effected by alcohol acidulated with hydrochloric acid. The preparation was mounted in glycerine or in clove oil. Clove oil is preferable to balsam, as it reveals more clearly the fibrous structure of the spindle, and allows of turning and pressing the object at any time.

Clove oil causes the cytoplasm to become brittle, so that the body of the infusorian may be broken up by pressure or blows on the cover-glass, and thus the nuclear spindles be set completely free. In this isolated condition they can be studied to the best advantage, as they are not obscured by overlying cytoplasm.

For the study of the achromatic figures clove oil is too strong a clarifying medium. Glycerine or water will serve better. Hertwig examined the preparation first in clove oil, then isolated the nuclear figures, washed in alcohol, and mounted in glycerine. He was thus able to study all parts of the figures under most favorable conditions.

[5] *Zeitschrift f. wiss. Zoologie*, XLIX., 1, 1889, pp. 168–9; and L., 4, 1890, p. 561.

[6] R. Hertwig. Conjugation d. Infusorien. Abhl. d. k. bayer. Akad. d. Wiss., II. Cl., XVII. Bd., I. Abth., 1889, pp. 4–5.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Biological Society of Washington, D. C.—November 29, 1890.—Dr. T. H. Bean read a paper upon "The Death of Salmon after Spawning." He called attention to the fact that the species of salmon upon the northwest coast belongs to a different genus from the salmon on the Atlantic coast, and one of the distinguishing features of the former was the dying of the fish after spawning. In the smallest species, known as the "little humpback," the mortality is excessive, for every individual seems to die after spawning. It is a very abundant and widely spread species. It ascends the smaller streams and deposits its spawn, often a rod or less, or even within ten feet, of salt water, and yet it does not live to reach it again. The reason for this is unknown, but the fact is of great practical importance, for if the species spawns but once in its lifetime, if it is not to become extinct the mouths of the streams must be kept free from obstructions. This is not the case, so that if the fish cannot spawn naturally, it remains only for the Fish Commission to take the matter in charge, and rear the fish artificially.

In the largest species on the coast, when the individuals ascend the streams only about 75 miles, some return to the ocean; but when, as is sometimes the case, they penetrate 500, 1,000, and even 1,500 miles inland, the evidence all goes to show that none ever return to the ocean alive. With the silver salmon a large proportion return to the sea, because they spawn in the small and unobstructed streams, and they are not especially pugnacious. With the dog salmon the mortality is also said to be very great, nearly all dying after spawning.

In the discussion of this paper numerous interesting facts were brought out. Dr. Gill referred to a species of fish which might be termed an annual fish, inasmuch as it matures in a single year, and the young hatched from the spawn at the end of the season are all that remain to continue the species. He also alluded to the peculiar elongation of the upper jaw of the salmon which took place when the fish entered fresh water, and suggested it might be this structural change that caused the mortality.

Dr. Merriam referred to a large specimen of red salmon caught by one of his party on one of the tributaries of the Columbia River, a thousand miles from the ocean, that was four feet long and two feet in girth.

Dr. Theobald Smith spoke of "Species among Bacteria." He stated it to be possible to separate and study the various forms in a nutrient fluid. The species or forms can be separated by both morphological and biological characters. Among the former were enumerated form, size, formation of spores, method of germination, flagella, and staining. The biological characters are the results of culture, both in liquid and upon solid media. The forms can be distinguished by habitat, by the formation of ferments which liquify gelatine, by fermentation, by affinity for oxygen, by coloring matter, and by their occurrence in disease.

As examples of these differences the bacillus of anthrax and of hay were compared. They were long supposed to be closely related, and under the microscope both look alike, both grow in the same way, and both have spores of the same kind. But when the two are cultivated in a liquid the hay bacillus will form a scum upon the top of the liquid in a short time; the liquid will then become cloudy throughout, and finally clear up. With the anthrax, on the contrary, the cloud makes its appearance at the bottom of the culture tube. In germination of the spores, the anthrax grows in the direction of the larger diameter, while the other grows at right angles to it. If the hay bacillus be placed under the skin of an animal, it is innocuous. But if the anthrax be injected, it will kill in twenty-four hours.

Again, in the typhoid fever and the hog cholera bacillus there is great similarity in morphological characters; but when cultivated they assume different colors. In the fermentation tube hog-cholera germ evolve gases, while the typhoid do not. One form of the comma bacillus cultivated on gelatine liquifies it; another similar form does not.

In the discussion Mr. True thought the morphological characters were those which characterized higher groups than species; they were rather family, perhaps ordinal, characters. Dr. Smith, in replying to this, stated that it was impossible to say what were family, what were generic, what were ordinal characters, but those he had mentioned were of use in distinguishing the various forms one from another.

[In the course of the discussion the fact that the organisms under consideration were of vegetable rather than animal nature was lost sight of. While, therefore, the morphological characters of form, size, spores, etc., referred to would not do to separate species of animals, they are exactly the characters used by botanists to separate species of plants. Dr. Smith, therefore, in stating that species could be separated upon the morphological characters of form, size, etc., gave characters which are of *specific* value in plants, though they may not be so in animals.—J. F. J.]

Geological Society of America.—Second annual meeting, Washington, D. C., Dec. 29, 30, and 31, 1890.—The following papers were read: On the Geology of Quebec and its Environs; Henry M. Ami. Antiquities from under Tuolumne Table Mountain, California; On the Early Cretaceous of California and Oregon; The Structure of a Portion of the Sierra Nevada of California; George F. Becker. The Nickel and Copper Deposits of Sudbury District, Canada; Robert Bell. The Chazy Formation in the Champlain Valley; Ezra Brainerd. Remarks on a Fallen Forest and Peat Layer Underlying Aqueous Deposits at Naaman's Creek, Del.; Hilborne T. Cresson. Mineral and Chemical Composition of Certain Igneous Rocks from the Mesozoic Area in Culpepper County, Virginia; H. D. Campbell and W. G. Brown. A Proposed System of Chronologic Cartography on a Physiographic Basis; T. C. Chamberlin. An Account of the Geology of the Washington Region; On a Jointed Earth-Auger for Geological Exploration in Soft Deposits; Nelson H. Darton. The Geological Date of the Origin of Certain Topographic Forms on the Atlantic Slope of the Eastern United States; W. M. Davis. Two Fossil-Bearing Belts in the Triassic Formation of Connecticut; W. M. Davis and S. W. Loper. Illustrations of the Structure of Glacial Sand-Plains; W. M. Davis and H. L. Rich. Note on the Geological Structure of the Selkirk Range, in the Vicinity of the Line of the Canadian Pacific Railway; George M. Dawson. Note on the Carboniferous Flora of Newfoundland; Sir William Dawson. The Triassic Sandstones in Massachusetts; B. K. Emerson. Glacial Grooves South of the Terminal Moraine; F. Max Foshay and Richard R. Hice. The Overthrust Faults of the Southern Appalachians; C. Willard Hayes. The Quatenary Formations of the Southwest; E. W. Hilgard. On the Probable Upper Jurassic and Basal Cretaceous Beds of the Texas-Arkansas Region, Coastward of the Present Paleozoic Areas, Together with Remarks on Preëxisting Conditions and Subsequent Erosion; R. T. Hill. The Phosphate Deposits of the Island of Navassa, W. I.; E. V. D'Invilliers. The Structure of the Blue Ridge Near Harper's Ferry; Arthur Keith and H. R. Geiger. A Geological Section Across Paris Ridge; The Detailed Stratigraphy of the Carbonic of Central Iowa; Charles R. Keyes. Exhibition of Some New Petrographical Microscopes; A. C. Lane. Notes on Variations in the Tertiary and Cretaceous Strata of Alabama; Daniel W. Langdon, Jr. On Tertiary and Post-Tertiary Changes in Physical Geography on the

Western as Compared with the Eastern Side of the American Continent; A Note on the Mutual Relations of Land Elevation and Ice Accumulation During the Quaternary Period; Joseph LeConte. Geology of the Environs of Quebec; Jules Marcou. The Coal Fields of Alabama; Henry McCalley. The Melting of the Northern Ice Sheet in Northeastern Iowa; W J McGee. Contribution to the Geology of Georgia; P. H. Mell. The Post-Archæan Age of the White Limestones of Sussex County, New Jersey; Frank L. Nason. Relations of Secular Rock Disintegration to Certain Crystalline Schists; Ralph Pumpelly. Glaciers of the St. Elias Region, Alaska; I. C. Russell. On the Geology of Little Falls, New York; N. S. Shaler and H. S. Williams. The Railroads and the Geology Classes in Alabama; Eugene A. Smith. Notes on Two Moraines in the Catskill Mountains, New York; J. C. Smock. Post-Pliocene Continental Subsidence; J. W. Spencer. Geological Notes on Mount Diablo, California; H. W. Turner. Glacial Lakes in Canada; Warren Upham. The Cinnabar and Bozeman Coal Fields of Montana; Walter H. Weed. A Last Word with the Huronians; Alexander Winchell. On the Structure and Petrography of the Piedmont Plateau in Maryland; George H. Williams. Graphic Field Notes for Areal Geology; Bailey Willis. On the Lower Cambrian Age of the Stockbridge Limestone at Rutland, Vermont; J. E. Wolff. Observations Upon the Lava Deposits of the Snake River Valley, Idaho; G. Frederick Wright. (*To be continued.*)

Industrial and Scientific Society of Alabama.—The Alabama Industrial and Scientific Society was organized at the University of Alabama, Thursday, December 11th, 1890, with 70 members. Its objects are the promotion of the industries of the State, and the furtherance of scientific investigations of the problems arising in civil and mining engineering, geology, smelting, and the manufacture of coke. The officers for 1891 are: President, C. Cadle, general manager, Cohaba Coal Mining Co., Biocton. Six vice presidents, viz., Thomas Sedcon, president Sloss Iron and Steel Co., Birmingham; C. P. Williamson, president Williamson Iron Co., Birmingham; W. E. Robertson, city engineer, Anniston; J. W. Burke, president, Tredegar Co., Jacksonville; M. C. Wilson, professor natural science, Normal School, Florence; Col. Horace Harding, U. S. engineer, Tuskaloosa; Treasurer, Henry McCalley, Alabama Geological Survey, University Alabama; Secretary, Wm. B. Phillips, professor Chem. and Met. University Alabama. The annual fee is $5.00. The society will meet three or four times a year at different places in the State for the reading and discussion of papers, which will afterwards be published. The next meeting will be held in Birmingham, January 28th, 1891.

The American Morphological Society.—A well-attended meeting for the inauguration of an American Morphological Society was held in the Massachusetts Institute of Technology, Boston, on December 29th and 30th, 1890. Officers for the meeting were elected as follows:

President, Professor E. B. Wilson; Secretary and Treasurer, Dr. J. Playfair McMurrich; Executive Committee: Professor E. L. Mark, Dr. C.-S. Minot, and Dr. E. A. Andrews.

After the details of meeting had been completed, the following papers were read and discussed: On the Development of the Scyphomedusæ; J. Playfair McMurrich. On the Intercalation of Vertebræ; G. Baur. The Heliotropism of Hydra: a Study in Natural Selection; E. B. Wilson. The Early Stages of the Development of the Lobster; H. C. Bumpus. Some Characteristics of the Primitive Vertebrate Brain; H. F. Osborn. The Development of Nereis and the Mesoblast Question; E. B. Wilson. The Præoral Organ of Xiphidium; W. H. Wheeler. A Review of the Cretaceous Mammalia; H. F. Osborn. Spermatophores as a Means of Indirect Impregnation; C. O. Whitman. The Phylogeny of the Actinozoa; J. Playfair McMurrich.

The following are the officers of the society for the ensuing year: President, C. O. Whitman; Vice President, Professor E. L. Mark; Secretary and Treasurer, Dr. J. Playfair McMurrich; Executive Committee: The Officers of the Society, Professor E. B. Wilson, and Professor H. F. Osborn.

Third Annual Meeting of the Association of American Anatomists.—Held at Boston, Mass., on December 29th, 30th, and 31st, 1890.—Monday, December 29th.—The Homology of the Cerebro-Spinal Arachnoid with the other Serous Membranes; F. W. Langdon, M.D., Cincinnati, Ohio. Something Additional About the Human Sternum; D. S. Lamb, Washington, D. C. The Merits and Defects of Owen's Account of the Cerebral Fissues; Burt G. Wilder, M.D., Ithaca, N. Y. On the Teeth of Cheiroptera; Harrison Allen, M.D., Philadelphia, Pa. Studies on the Spine; Thomas Dwight, M.D., Boston, Mass. Corrosive Preparations by Different Methods; S. F. Mixter, M.D., Boston, Mass. The Relations of the Olfactory to the Cerebral Portion of the Brain; Burt G. Wilder, Ithaca, N. Y. An Unusual Case of Platycnemy in the Negro; Frank Baker, M.D., Washington, D. C.

Tuesday, December 30th.—Subfrontal Gyri and Problems Connected with the Cerebral Fissures; Burt G. Wilder, M.D., Ithaca, N. Y. A Comparison of the Fibrine Filaments of Blood Lymph in Mammalia and Batrachia, with Methods of Preparation; Simon H. Gage, M.D., Ithaca, N. Y. The Semilunar Bone; Francis J. Shepard, M.D., Montreal, Canada. On the Structure of Protoplasm and Mitosis (Demonstration); Carl Heitzmann, M.D., New York City. A Specimen, George McClellan, M.D., Philadelphia. Corrections of the Article "Gross Anatomy of the Brain," in Wood's Reference Hand-Book of the Medical Sciences; Burt G. Wilder, M.D., Ithaca, N. Y.

The American Ornithologists' Union.—The Eighth Congress of the American Ornithologists' Union was held in the Lecture Hall of the United States National Museum, Washington, D. C., on November 18th, 19th, and 20th, 1890, and was attended by a large number of active and associate members from all parts of the country. The first day's session was devoted to business. Dr. J. A. Allen, of New York, who has been president of the Union since its foundation, declined reëlection, and Mr. D. G. Elliot was elected to succeed him in the presidency. The succeeding days were set apart for the reading of scientific papers, of which the following is a list:

November 19th.—1. The American Ornithologists' Union: A Seven Years' Retrospect; J. A. Allen. An interesting review of the work done in American ornithology since the founding of the Union. 2. Seed-Planting by Birds; Walter B. Barrows. A valuable contribution to economic ornithology based upon the system of stomach examinations now being conducted by the Department of Agriculture. 3. A Study of Bird Waves in the Delaware Valley during the Spring Migration of 1890; Witmer Stone. This paper gave a brief review of the work done by the Delaware Valley Ornithological Club, of Philadelphia, in the investigation of bird migration, and illustrated by a system of charts a new method for the graphic arrangement of migration data. 4. Our Present Knowledge of the Neotropical Avifauna; Frank M. Chapman. An excellent review of the work that has been done on the birds of the western tropics, up to the present time. 5. The Present Status of the Ivory-billed Woodpecker; E. M. Hasbrouck. By carefully-prepared maps Mr. Hasbrouck contrasted the former extensive distribution (nearly throughout the Austro-riparian fauna) of this elegant bird, and its present restricted range in Florida and the southernmost portions of some of the other Gulf States, and showed that in the near future this species will become a thing of the past. 6. Phalaropes at Swampscott, Mass; Wm. A. Jeffries—read by Mr. Chapman. 7. The Spring Migration of the Red Phalarope; Harry Gordon White—read by Dr. Allen. This paper gave the results of observations on this bird during a voyage from Massachusetts to the Gulf of St. Lawrence, and indicated that the birds, in the spring of 1890, after following the southern coast of Nova Scotia, passed through the Gut of Canso, instead of rounding Cape Breton Island. 8. Some Observations on the Breeding of *Dendrœca vigorsii* at Raleigh, N. C.; C. S. Brinley—read by Mr. Chapman.

November 20th.—9. The Trans-Appalachian Movement of Birds from the Interior to the South Atlantic States, Viewed Chiefly from the Standpoint of Chester Co., S. C.; Leverett M. Loomis. 10. The Birds of Andros Island, Bahamas; John I. Northrop. An interesting account of the birds of this (ornithologically) little-known island, where Mr. Northrop was fortunate enough to discover a fine new species of Icterus (*I. northropi* Allen.) Dr. Allen made some additional remarks upon the birds collected by Mr. Northrop, exhibiting a number of specimens. 11. Some Bird Skeletons from Guadalupe Island; Frederic A. Lucas. 12. On the Tongue of Humming-Birds; F. A. Lucas. 13. Remarks on the Primary Faunal Divisions of North America; C. Hart Merriam. In this able paper Dr. Merriam explained his recently-published Faunal Map of North America, and gave his grounds for abolishing the generally-adopted system of dividing the continent into three great provinces,—Eastern, Central, and Western,—and for deriving the various faunal districts from two primary regions—Boreal and Sonoran. The paper was illustrated by a large series of maps showing all the faunal divisions of the North American continent that have hitherto been proposed by authors.

After this paper, Mr. William Brewster exhibited a number of excellent lantern slides from photographs of wild birds taken in the field.

The following papers were presented, but were not read for lack of time: An Experimental Trial of a New Method for the Study of Bird Migration; Harry Gordon White. The Case of *Colaptes auratus* and *C. cafer*; J. A. Allen. Observations upon the Classification of the United States Accipetres—Based upon a Study of their Osteology; R. W. Shufeldt. Some Notes Concerning the Evening Grosbeak; Amos W. Butler. Owls of Illinois; W. S. Strode. Instinct, Intuition, and Intelligence; C. F. Amery. The Habits of the American Golden Plover in Massachusetts; Geo. H. Mackay. Correction to Revised Catalogue of the Birds of Kansas; N. S. Goss. Second Occurrence of the White-Faced Glossy Ibis in Kansas; N. S. Goss.—W. S.

Words; their Use and Abuse. By WM. MATHEWS, LL. D. Twentieth edition, 12mo., cloth, 504 pp. Regular price, $2.00; with the GEOLOGIST for 1891, $4.00.

Men, Places and Things. By WM. MATHEWS, LL. D. Third edition, 1 vol., 12mo., 394 pp. Regular price, $1.50; with the GEOLOGIST for 1891, $3.75.

Shall We Teach Geology? By ALEXANDER WINCHELL, LL. D. Should be read by all teachers and those interested in educational matters. 12mo., cloth. Regular price, $1.00; with the GEOLOGIST for 1891, $3.50.

Dickens' Works; complete set in twelve volumes; with the GEOLOGIST for 1891, $4.00.

Mammoth Cyclopædia, in four volumes, 2176 pp., 620 illustrations; with the GEOLOGIST for 1891, $4.00.

Gems and Precious Stones of North America. By GEORGE F. KUNZ. Large quarto, pp. 336, 8 colored plates and numerous minor engravings, cloth, gilt. Regular price, $10.00; with the GEOLOGIST for 1891, $11.00.

The Metallurgy of Steel. By HENRY M. HOWE. "A notable contribution to the literature of iron and steel metallurgy." Royal quarto, 425 pp., cloth, gilt, profusely illustrated. Regular price, $10.00; with the GEOLOGIST for 1891, $11.00.

Modern American Methods of Copper Smelting. By DR. E. D. PETERS. Second edition, large 8vo., 342 pp., illustrated. Regular price, $4.00; with the GEOLOGIST for 1891, $6.00.

Mining Accidents and their Prevention. By SIR FREDERICK A. ABEL. With the laws governing coal mining in every state and territory in the United States, and those of Great Britain and Prussia, never before collected in accessible form. Large 8vo., pp.420, cloth. Regular price, $4.00; with the GEOLOGIST for 1891, $6.00.

America Not Discovered by Columbus. A historical sketch of the discovery of America by the Norsemen in the tenth century. By R. B. ANDERSON, A. M. 3d edition enlarged, 12mo., cloth. Regular price, $1.00; with the GEOLOGIST for 1891, $3.75.

Geology, Chemical, Physical and Stratigraphical. By JOSEPH PRESTWICH, M. A., F. R. S., F. G. S. In two volumes, with illustrations, Vol. I, *Chemical and Physical.* Vol. II, *Stratigraphical and Physical.* Regular price for both volumes, $15.25. With the GEOLOGIST for 1891, $15.50. [See the advertisement of Macmillan & Co. in the GEOLOGIST.]

Bien's Atlas of the Metropolitan District and Adjacent Country. Unrivalled as a specimen of the map-maker's art. Just published. Scale, two inches to the mile. Sheets are 23 x 35 inches, the atlas being 17½ x 23 inches. Regular price, $20. With the GEOLOGIST for 1891, $20. [See advertisement of Julius Bien & Co., in the GEOLOGIST.]

For these premiums money must be sent in advance, and in all cases by postal order or note, or by express or draft on New York.

For public libraries this affords a rare opportunity to procure these standard works at reduced prices. We desire to extend the GEOLOGIST to all scientific libraries and laboratories. Our subscription list is steadily increasing, and with the year 1891, which will be memorable in the history of American geology, because of the American session of the International Congress of Geologists, we expect to see it doubled. We hope our old subscribers, to whom we acknowledge our obligation for numerous favors, will call attention to these offers for 1891.

THE AMERICAN GEOLOGIST,
MINNEAPOLIS, MINN.

SEPT. 18, 1890.

NOTICE TO CONTRIBUTORS
TO THE
AMERICAN NATURALIST

Send Contributions to the EDITORS ONLY.

Send to the PUBLISHERS ONLY:

All Orders for Extra (or Reprint) Copies.
All Proofs of Texts and Engravings.

NOTE.—All orders for reprint or extra copies must be given before the number containing the article goes to press; otherwise none will be furnished.

$4.00 per Year. 40 cts. per Copy.

THE AMERICAN NATURALIST.

A MONTHLY JOURNAL
DEVOTED TO THE NATURAL SCIENCES
IN THEIR WIDEST SENSE.

Vol. XXV. FEBRUARY, 1891. No. 290

CONTENTS.

PHILADELPHIA:
FERRIS BROS., PUBLISHERS
SIXTH AND ARCH STREETS

To Scientific Investigators.

ONE of the greatest needs of American science at the present time is a convenient medium in which brief preliminary notices of the results of investigation can be published. A considerable length of time of necessity elapses between the conclusion of any series of observations and their appearance in print, and it is of great advantage to the observer, and still more to his fellow-workers, to have the results made known as soon as possible, thus insuring priority of discovery to the one, and allowing the others to keep more perfectly posted with what is going on in the scientific world around them.

A preliminary notice should be published *at once* to be of value, and hitherto there has been no scientific periodical in this country, published at sufficiently brief intervals, and open to all investigators, which has specially opened its columns to the publication of such notices, and has undertaken to make them public with as little delay as possible. This the NATURALIST proposes to do, and invites the coöperation of all investigators in an attempt to inaugurate a department for the prompt and satisfactory publication of preliminary notices of the results of scientific investigations.

THE

AMERICAN NATURALIST

VOL. XXV. FEBRUARY, 1891. 291.

RECENT STUDIES OF THE VERTEBRATE HEAD.

BY H. W. NORRIS.

THE view that the vertebrate head is composed of several segments, comparable to those of the trunk, has of late years formed the basis of almost innumerable essays; but the problems connected therewith cannot yet be regarded as solved. It is, indeed, universally admitted that the head is composed of segments or metameres; but the number of segments and the limit of each segment are points upon which there is far from unanimity of opinion. A study of the skull, as was first pointed out by Goethe, leads to one conclusion, while a study of the muscle-plates or myotomes of the embryo gives greatly different results. Then the brain itself in its early stages shows marked evidence of metamerism, while the nerves arising from the brain can be more or less clearly divided into segmental groups which can be compared to the undoubtedly segmental spinal nerves.

In the following pages I have presented, in a very condensed form, the results of some recent studies in this direction. In these abstracts the nerves are referred to by Roman numerals, in accordance with the commonly received ideas of their sequence: I., olfactory; II., optic; III., oculomotor; IV., trochlearis; V., trigeminus; VI., abducens; VII., facial; VIII., auditory; IX., glossopharyngeal; X., vagus; XI., spinal accessory; XII., hypoglossal.

In the lizard, according to Hoffmann ('88–'89), the myotomes of the head agree very closely with the same in the chick and Selachians. But the fourth seems to be wanting, and corresponding in position to the third myotome are two small cellular masses, not connected with each other, out of which are developed the muscles externus rectus and retractor bulbi. Between the vagus nerve and the first cervical spinal nerve are four myotomes, the cephalic of which is rudimentary. The oculomotor, trochlear, and abducens nerves are not described in their earliest stages. The III. with a broad origin springs from the base of the midbrain, and innervates the muscles derived from the first head-cavity. The IV. arises as a large cellular outgrowth from the place where the roof of the midbrain passes into the hindbrain, and resembles in every respect the "Anlagen" of the dorsal cranial nerves, sending an extension to the epidermis. The absence of a trochlear ganglion in the serpent, bird, and Selachians, and its presence in the lizard, gives rise to the query whether the trochlear nerve may not primarily have been the motor nerve of the protective organs of the parietal eye. The VI. springs by 10–12 fine fibres from the base of the medulla oblongata, and innervates the muscles derived from the two cellular masses that appear to belong to the third head-cavity. The V., VII.–VIII., IX., and X. nerves take their origin from the neural ridge, in a manner similar to the dorsal roots of spinal nerves, and their respective ganglia unite with the epidermis above the branchial arches. Between the V. and VII.–VIII. the neural ridge early aborts. The ophthalmic ganglion of the V., from its development on a dorsal root and its anastomosing with the III. nerve, a ventral root, is regarded as homologous to a dorsal ganglion. The ganglion of the VII.–VIII. nerve divides into two portions, the anterior part being the proper ganglion of the facial nerve, the other forming the auditory ganglion. The accessorio-vagus nerve arises by a broad base extending from the IX. nerve to the second cervical spinal nerve. Later the neural ridge loses its connection with the brain, and becomes a commissure between the second cervical nerve and the caudal vagus root, so the X. nerve then arises by 5–6 roots. The hypoglossus originates by four roots, the caudal root being a branch of the first cervical spinal nerve. Anterior to the roots of the hypoglossus are two rudimentary somites, to the caudal of which apparently belongs a nerve of transitory duration. Froriep had already discovered four somites in the occipital region of the chick, but it will be seen that in the lizard there are five somites in this region. The two cephalic roots of the hypoglossus possess neither ganglia nor dorsal roots; the condition of the third root in this respect has not been determined; the first cervical nerve has a transient ganglion, and the second cervical a permanent ganglion. The hypoglossus thus seems to represent a complex of true spinal nerves, whose ganglia and dorsal roots have partially or completely degenerated. According to Hoffmann ('89), on the hinder portion of the lizard's brain appears an evident segmentation. Other authors had previously noticed this. Hoffmann finds in the hindbrain and medulla seven segments. From the caudal of these springs the X. nerve; from the next, or sixth, the IX.; opposite the fifth is the ear vescicle; from the fourth arises the VII.–VIII.; from the third none; from the second the V.; from the cephalic border of the first segment the trochlear nerve primarily takes its origin, though later shifting over to the midbrain.

Rabl ('89) considers the vertebrate head as consisting of two regions: a cephalic or proximal unsegmented, and a caudal or distal segmented region.[1] The ear vescicle forms the boundary between the two portions, but is to be reckoned with the proximal. The mesoderm of the proximal section may be divided into segments which neither in mode of origin nor in further development can be compared with protovertebræ. The five distal somites arise exactly as the protovertebræ. The first protovertebra to appear is the fifth head somite of Van Wijhe, or the first distal somite. The musculature and connective tissue of the distal somites develop in the same portions as in the protovertebræ of the body. Dorsal and ventral nerve roots occur in this region as in the body. In their origin the proximal somites show scarcely even a distant relationship with the structure of protovertebræ. The proximal somites cannot be called primary, for they appear later than the protovertebræ. The muscles of the proximal re-

[1] Kastschenko had observed in Pristiurus and Scyllium that at no period did the mesoderm of the anterior portion of the head appear segmented.

gion arise almost entirely in portions where in the protovertebræ connective tissue originates, and vice versa. There is no differentiation of myotomes and sclerotomes in the proximal somites. There are two primary nerves in the cephalic portion, the V. and VII.–VIII., but these do not arise from a continuous neural ridge. The cephalic border of the neural ridge forms a delicate strand uniting with the triangular part of the trigeminus Anlage, which becomes the ciliary ganglion. In later stages, answering to the direction of this delicate strand, extend the oculomotor and trochlear nerves. The oculomotor and trochlear nerves are thus to be considered as secondarily derived from the trigeminus, and the eye-muscles perhaps from the musculature of the first branchial arch innervated by the V. From researches on Selachians, birds, and mammals it is concluded that the III. and IV. nerves arise on the dorsal border of the midbrain. The primary nerves of the caudal region of the head are the IX., X., and hypoglossus, the latter consisting of the ventral roots of the region. The IX. and X. arise from a continuous neural ridge in a series with the dorsal roots of the true spinal nerves. The opinion of Beard, that the "Anlagen" of the dorsal cranial and spinal roots develop prior to and independent of the neural tube, is erroneous. The homology of the spinal ganglia to the parapodial ganglia of Annelids cannot be established till it is proved that the spinal ganglia grow out of the ectoderm independent of the neural tube. Rabl bases his observations on embryos of *Torpedo ocellata*. The unsegmented mesoderm of the head in the Craniota he compares with the unsegmented forward extension of the first primitive segment in Amphioxus. In the head region of Amphioxus are two stout nerves, which cannot be compared with spinal nerves. Rabl thinks they may be homologous with the V. and VII.–VII. of the Craniota.

In reply to Rabl, Dohrn ('90*a*) notes that the former repeats the mistake of Balfour in deriving the dorsal roots of the spinal nerves from the neural ridge. In all Selachians the dorsal roots of the spinal nerves grow out of the ganglia into the neural tube. The sensory fibres of the cranial nerves (V., VII.–VII., IX., and X.) grow out from the ganglia into the brain, while the motor fibres spring from the cells of the lateral columns and enter the ganglia.

The neural ridge arises as a cell-growth from the closing portion of the neural tube, as Rabl says. Neither His's "Zwischenstrang" nor Beard's ectodermal ganglion-anlage theory is tenable. The cells of the neural ridge, that do not form ganglia, atrophy. The neural ridge may thus be regarded as merely the forerunner of the ganglia. The gaps between the Anlagen of the V., VII.–VIII., and IX. nerves do not prove the absence of a continuous neural ridge in that region, but rather are points of atrophy. Rabl is correct in saying that a nerve-strand arises at the cephalic border of the neural ridge. The cell-mass from which this springs is anterior to the ciliary and gasserian ganglion Anlagen. In Torpedo a true ganglion is found derived from this cell-mass, but it later loses connection with the neural tube and neural ridge. After isolation nerve-fibres grow out from this ganglion, thus proving that sensory nerve-fibres and sensory root-fibres arise not from the neural tube, but from the cranial and spinal ganglia. The fibres of this isolated ganglion enter into such close relation with the trochlear nerve as to appear to belong to it. This ganglion and its outgrowth of fibres appear to represent the nerve ophthalmicus superficialis minor. The III. nerve arises by 3–7 roots from the base of the midbrain, and no medullary cells pass out with it. The ganglion, which seems to belong to this nerve, is really derived from the ciliary ganglion. The III. and IV. do not have their origin in the cephalic portion of the neural ridge. The VI., as well as the III., spring from the anterior column of the medulla oblongata. It arises by 4–6 roots. The hypoglossus is in no way connected with the vagus. It is to be regarded as formed from the ventral roots of one or more spinal nerves, as Balfour thought. Van Wijhe found extending over the eighth and ninth myotomes an outgrowth of the neural ridge, interpreted by him as representing rudimentary ganglia of the second and third hypoglossal roots. Froriep first established the existence of rudimentary ganglia of the hypoglossus. Ostroumoff finds in Pristiurus two spinal ganglia answering to the last two roots of the hypoglossus. Dohrn states that the hypoglossus has as many ganglio Anlagen as there are ventral roots, the first being merely a thickening of the neural ridge. It is impossible to classify the V. and VII.–VIII. nerves in contrast to the IX. and X. All four are connected with the organs of the lateral line, while the spinal nerves take no part in the latter structures. The motor roots of all four spring from the lateral column, and pass into the ganglia, while no motor fibres go into the spinal ganglia. In Selachians, at the time the sensory roots of the glossopharyngeus and vagus enter the medulla oblongata, there appears in this region a folding or furrowing of the walls of the neural tube, similar to that seen in the spinal cord. In this segmentation the roots of the IX. and X. nerves correspond in position to the furrows separating the metameres, just as the furrows in the metamerism of the spinal cord answer to the sensory nerve-roots. The probability that the vagus is a polymere whose components were originally similar to spinal nerves, the similarity of the V. and VII.–VIII. nerves to the IX. and X. in development and functional differentiation, and the fact that the neural ridge can be traced anteriorly into the VII.–VIII. anlage, render Rabl's hypothesis of unsegmented cranial mesoderm untenable.

Dohrn's recent contributions ('90*b*) to our knowledge of primitive cranial segmentation must be regarded as epoch-making. In embryos of *Torpedo marmorata*, stage F of Balfour, 12–15 myotomes are found anterior to the glossopharyngeal region. Rabl refused to refer any segmentation to this region. Van Wijhe found four somites. These 12–15 myotomes pass ventrally into the lateral plates, which form the cranial cœlom, and out of which come the "head-cavities." In stage G the myotomes are considerably coalesced, and the more the development goes on the more the obliteration of myotome boundaries. Van Wijhe's mandibular somite is made up of 3 myotomes, the hyoid of 3, and the fourth somite of 2–3. The segmentation recognized by Van Wijhe is thus apparently secondary. The myotomes of the head are throughout comparable to the myotomes of the body. The cranial motor nerves show a metamerism. The III. nerve arises by 4–7 separate fibres, and innervates the muscles of the premandibular head-cavity, which is a multiple of myotomes. The VI. originates also as a multiplex of fibres, and innervates the muscles of the third head-cavity, which is also composed of several myotomes. Both nerves spring from the anterior columns, and are homodynamous with motor spinal nerves. The IV. nerve emerges on the dorsal border of the brain, but whether it is homodynamous with the cranial ganglionic motor fibres, or with the motor spinal nerves, is uncertain. The ganglionic motor fibres, viz., those of the V., VII.–VIII., IX., and X., arise from the lateral columns. These fibres greatly converge in passing to the ganglion-anlagen of the respective nerves, and it may be assumed that at one time the fibres arose as separate nerves, each belonging to its myotome. Marshall believes the olfactory nerve to be an outgrowth from the anterior portion of the neural ridge. Beard advances the same view. His found that in human embryos the olfactory ganglionic cells and nerve-fibres originated from the epithelium of the nasal vescicle. Dohrn confirms the same in Selachians. Rudimentary ganglia are found in the anterior part of the V. Anlage, in the anterior part of the VII. Anlage, and in the anterior part of the IX. and X. We see indications of a centralizing process which has resulted in the reduction in number of the primitive ganglia. Displacement and suppression has taken place in the visceral mesoderm of the head. The premandibular, mandibular, and hyoid head-cavities are to be considered as multiples of original head-cavities, in which serial origin the lateral plates share. The fact that the embryonic vascular system is similar throughout would indicate that it originated at a time when the body was not yet differentiated into metameres. The difference in direction of the blood-currents in the aorta and the carotids can be explained by the hypothesis that the current in the latter has been reversed by the suppression of preoral arterial arches. By this hypothesis it may be assumed that at one time there was no separation between aorta and carotids. In consequence, the existing mouth is derived from the coalescence of one or more pairs of gill-clefts, and there must have been a time when the present mouth did not exist. Thyroid and hypophysis must have had a bilateral structure, so that a median passage could be left for the conus arteriosus. The aorta shares in two segmentations: one that of the branchial arches, the other that of the vertebral arteries; the one of the branchiomeres, the other of the myotomes. The existing branchiomeres do not appear to be secondary to the myotomes, but secondary to primary hypothetical branchiomeres. In the hyoid and mandibular arches, and in the region of the head-cavity supplied with the III. nerve, are to be assumed a greater number of primitive branchial clefts. Hyoid and spiracular clefts are to be considered as multiples of branchial clefts. The irregularity seen in the posterior branchial arches is connected with the changes that have caused the coalescing of branchial arches. Thyroid, mouth, hypophysis, and nose are evidently related to the branchial system. Gegenbaur holds that the branchial skeleton is secondarily derived from ribs. But the ribs are dorso-lateral structures, and the branchial arches ventral. If the latter are secondary articulations of the vertebral column, then traces of the apophyses should be found. But as this does not occur, the branchial skeleton is to be regarded as of independent origin. The hyoid and mandibular cartilages then represent multiples, and cartilaginous girdles, which have functioned as branchial arches, now enter into the composition of the skull.

LITERATURE.

'90*a*. DOHRN, A. Bemerkungen über den neuesten Versuch einer Lösung des Wirbeltierkopf-Problems. *Anat. Anz.*, V., Nos. 2 and 3, 1890.

'90*b*. DOHRN, A. Studien zur Urgeschichte des Wirbelthierkörpers. XV. Neue Grundlage zur Beurteilung der Metamerie des Kopfs. Mittheil. Zool. Station, Neapel, IX., Heft 3, 1890.

'89. HOFFMANN, C. K. Ueber die Metamerie des Nachhirns und Hinterhirns, und ihre Beziehung zu den segmentalen Kopfnerven bei Reptilien-Embryonen. *Zool. Anz.*, No. 310, 1889.

'88–'89. HOFFMANN. In Bronn's Klassen und Ordnungen des Thier-Reichs. Bd. VI., Abth. III., pp. 1907–1914, 1938–2000, 1888–'89.

'88. KASTSCHENKO, N. Zur Entwickelungsgeschichte des Selachierembryos. *Anat. Anz.* III., p. 445, 1888.

'89. RABL, C. Theorie des Mesoderms. *Morph. Jahrbuch*, XV., Heft 2, 1889.

'89. VON OSTROUMOFF, A. Ueber die Froriep'schen ganglien bei Selachiern. *Zool. Anz.*, No. 311, 1885.

(*To be continued.*)

SOME OF THE CAUSES AND RESULTS OF POLYGAMY AMONG THE PINNIPEDIA.[1]

BY C. C. NUTTING.

SEVERAL years ago the writer was much struck by the great sexual differences met with among the Gallinæ, and had noted the fact that there was a relation between sexual disparity in size and polygamy.

During the last summer an opportunity was afforded to carefully observe one species of the Pinnipedia, and these observations led to a perusal of all the available literature for facts concerning the relation between sexual disparity and polygamy in this order. The results of this study had already been outlined for a paper to be read before the Iowa Academy of Sciences, when an article appeared in the November number of the NATURALIST entitled "Probable Causes of Polygamy Among Birds," by Samuel N. Rhoads.

The above facts are mentioned to show that the conclusions as to the cause of polygamy among birds on the one hand, and Pinnipedia on the other, were the result of independent investigations, and hence will serve to strengthen each other in some important particulars.

True polygamy is something of a rarity among the Mammalia. It must not be confounded with mere promiscuous sexual intercourse, such as is often met with among the Herbivora. The term polygamy, in its strict sense, can properly apply only to those species in which a single male habitually copulates with several females, and jealously and persistently defends them from the approach of other males.

The most typical examples of this state of affairs are met with among the Pinnipedia, and ultra polygamy is exemplified by the northern fur seal (*Callorhinus ursinus*).

Two striking facts at once arrest the attention of even the most cursory observer of this species:

1st, The astonishing extent to which polygamy is carried.

[1] Paper read before the Iowa Academy of Sciences, Jan. 1st, 1890.

Mr. Elliott thinks " that it will be nearly correct to assign to each male from twelve to fifteen females, occupying the stations nearest the water, and those back in the rear from five to nine. I have counted forty-five cows all under one bull."[2]

2nd, The no less astonishing disparity in size between the sexes. The average length of the male is 7½ feet, while that of the female is 4 feet. The male weighs 450 lbs., while the female weighs only 85 lbs. It will thus be seen that the male weighs nearly *six times* as much as the female.

Two questions arise in view of the above facts :

1st, Is there any relation between polygamy and sexual disparity in size? 2nd, If so, what is that relation?

The Pinnipedia are fortunately sufficiently numerous in species and individuals to furnish an ample field for the study of both of the above questions. They are all eminently gregarious in habit, a condition favorable to polygamy. The order furnishes examples of both monogamous andpolygamous species, and almost every degree of sexual disparity in size to be found in the Mammalia. We can easily construct a series of species, ascending from those exhibiting the least sexual disparity to those exhibiting the greatest. We can then see what, if any, relation exists between sexual disparity and polygamy. We shall presently see that pugnacity on the part of the males plays a not unimportant *rôle* in our discussion, and for that reason the fighting proclivities of the males will also be noted.

The following arrangement, then, illustrates what might be termed the ascending series of sexual disparity. The relation of the sexes (monogamy, promiscuity, or polygamy) and the relative pugnacity of the males in relation to other males of the same species will also be noted in each case.

Odobænus rosmarus (Walrus).

(*a*) Sexes nearly equal in size, the female not being notably smaller than the male. (*b*) Monogamous, according to the only

[2] Quoted from " Monograph of North American Pinnipeds" (Allen). Nearly all the material used in the above article has been taken from that work.

information at the disposal of the writer.[3] (*c*) Disposition not at all quarrelsome, the animals of both sexes being singularly good-natured and peaceable, "huddling together like so many swine," although they will fight fiercely in defence of their young.

Cystophora cristata (Hooded Seal).

(*a*) Considerable sexual disparity. The male is eight feet long, and the female seven feet. Weight of male, 450 pounds; of female, 200 pounds. (*b*) Probably monogamous, although there is no direct evidence at hand. There is at least nothing to indicate that they are polygamous in the sense used in this paper. (*c*) The males fight fiercely for the possession of the females.

Erignathus barbatus (Bearded Seal).

(*a*) Considerable sexual disparity. Length of male, ten feet; length of females, seven feet four inches. Weight of males, two-and-one-half times that of females. (*b*) Strictly polygamous, according to the single authority found. (*c*) Males often have severe battles, the strongest males driving away the younger.

Macrorhinus angustirostris (Sea Elephant).

(*a*) Great sexual disparity. The weight of the male is three-and-one-half times that of the female. (*b*) Polygamous.[4] Elliott says that they "resemble the sea lions in their breeding habits." (*c*) The males "fight desperately for the females."

Eumetopias stelleri (Steller's Sea Lion).

(*a*) Great sexual disparity. Length of males, twelve feet; of females, eight-and-one-half feet. Weight of male, three times that of female. (*b*) Strictly polygamous. This species maintains a regular harem, but "does not maintain any such regular system in preparing for and attention to its harem as is illustrated on the breeding grounds of the fur seal" (Elliott). (*c*) "The bulls fight savagely among themselves, and turn off from the breeding ground all the younger and weak males."

[3] Monograph of North American Pinnipeds, p. 107.

[4] "The sea elephants appear to be exceptional among the Phocidæ in the great disparity of size between the sexes, in which, *as well as in their breeding habits*, they closely resemble the Otaries." Monograph of North American Pinnipeds (Allen), p. 755. The italics are mine.

Callorhinus ursinus (Northern Fur Seal).

(*a*) Extreme sexual disparity. The males weigh three times as much as the females. (*b*) Ultra polygamous, the males maintaining a large harem, and guarding the females with the greatest vigilance and courage. In fact, this animal is the most polygamous of all the Mammalia. (*c*) Males fight with greatest desperation and persistence for females.[5]

A consideration of the above series will disclose the fact that there is a close and constant relation between polygamy and disparity in size among the Pinnipedia. It also indicates that this relation is a *direct* one, the disparity increasing *pari passu* with the polygamy throughout the series. Another fact is rendered evident by this series, and that is that the combativeness of the males increases *pari passu* with sexual disparity and polygamy.

These facts having been reasonably well established, it is possible to construct a hypothetical history of events which will illustrate the successive stages by which a species might pass from a simply gregarious habit, in which monogamy, or at least promiscuity, prevails, to the extreme of polygamy practiced by the northern fur seal. Such a transition may be conceived to take place by the following steps or gradations:

1st, An eminently gregarious species would offer more favorable conditions for the introduction of polygamy than a non-gregarious species. Our point of departure in this part of the discussion would then be a gregarious, monogamous species. If the principles deduced from an examination of the series presented in the first part of this paper be correct, this species should also be one in which there is little sexual disparity, and little or no fighting among the males for the possession of the females. All of the above conditions seem to be fulfilled in the case of the walrus (*Odobænus rosmarus*). This species will then stand for our point of departure.

2nd, The gregarious habit of the walrus offers a constant opportunity for a departure from the path of monogamous rectitude. This fact is well illustrated in human affairs by the great

[5] Elliott says that he has seen one male fur seal fight fifty or sixty battles during a single season.

amount of social immorality found among the crowded tenements of our large cities. Constant opportunity offers the most powerful temptation to gratify desire, and this is doubtless as true among Pinnipedia as among men. The result of this is a departure from strict monogamy in the direction of promiscuity.[6] The harbor seal (*Phoca vitulina*) illustrates this stage in the process. So far as I can ascertain, this species is simply promiscuous in sexual affairs, but does not attain to polygamy in the sense used here. The sexual disparity is slight, the males being somewhat heavier, and but little, if any, longer than the females.

3d, The departure from monogamy in the direction of promiscuity results in constant rivalry on the part of the males to possess the most attractive, or the greatest number, of the females. Rivalry begets warfare, the world over. This purely individual and personal rivalry among the male Pinnipedia results in individual combats, in which courage, ferocity, and size are the controlling factors. We thus have instituted the most rigorous kind of sexual selection, by means of which the above desirable qualities are secured, propagated, and intensified on the part of the males. The females, on the contrary, seem to be practically passive. The writer has been unable to find any evidence that the female Pinnipedia exercise any choice in the matter of accepting or rejecting individual successful males. The sexual selection thus instituted is true sexual selection as defined by Darwin as follows: "This [sexual selection] depends on the advantage which certain individuals have over other individuals of the same sex or species, in *exclusive relation to reproduction*."[7] It differs, however, from a vast majority of instances of sexual selection in apparent absence of choice on the part of the female.

This stage in the development of polygamy is illustrated by the hooded seal (*Cystophora cristata*), which appears to be promiscuous in sexual matters, and in which the males fight fiercely for the possession of the females. The divergence in sex has become considerable, as already indicated, the males being more than twice as heavy as the females.

[6] This word, although questionable, is the only one known to the writer by which the meaning, indiscriminate intercourse, can be tersely expressed.

[7] The Descent of Man, p. 248. The italics are mine.

4th, The struggle for the possession of the females having become a fixed and intensified habit, and the sexual disparity continuing to grow more pronounced, the following results might be expected:

(*a*) The larger and lustier males would have their desire greatly intensified and their sexual powers appreciably increased.

(*b*) The smaller and weaker males would be crowded to the wall, and, in many instances, entirely deprived of all conjugal rights, which would be usurped by the larger and stronger animals.

As a result of these conditions, certain males would obtain possession of several females, and deprive all other males of access to them. This would be *polygamy* in the sense used in this paper. The whiskered seal (*Erignathus barbatus*), in which the male weighs two-and-one-half times as much as the female, and polygamy prevails, would illustrate this stage in the process.

5th, Polygamy having become a fixed habit, all the conditions would tend to accelerate the divergence in size between the sexes. The selection by which the bulkiest and most pugnacious males would succeed in obtaining the females would be as rigorous as could well be conceived, and would result in very great sexual disparity. The males would become remarkably fierce and aggressive. The females, on the contrary, would become less and less disposed to offer any resistance to the males, and hence a remarkable difference in temperament would eventually separate the sexes. The males would be intensely pugnacious, jealous, and aggressive, while the females would be gentle, indifferent, and passive.[8]

Polygamy having become established, the causes or conditions which aided in its establishment would tend to its intensification to such an extent that some males would have scores of females in their harems, while others, indeed the majority, would be entirely deprived of marital rights. Such, in brief, is the state of

[8] Curiously enough, Darwin quotes Captain Bryant to the effect that the females of the fur seal "appear desirous of returning to some particular male" (Descent of Man, p. 257). A careful perusal of the detailed accounts of the habits of this animal collated by Allen, in his Monograph of North American Pinnipeds, fails to discover any exercise of choice whatever on the part of the female. It may further be said that even if she had a choice there would be no chance to exercise it, as she is immediately pounced upon by the nearest male upon landing, and usually handed about by the scruff of the neck by several males before finding her ultimate resting place.

affairs among the sea lions, of which the fur seal (*Callorhinus ursinus*) is the best example.

The above hypothetical history of events will serve to convey the writer's opinion as to what may have been the stages by which polygamy has arisen and become intensified among the Pinnipedia. For the sake of the non-scientific reader, it may be well to say that there is no intention to convey the idea that the fur seal was first a walrus, then a seal, and finally evolved into a sea lion or fur seal.

Two other points deserve mention in connection with this highly interesting animal.

The question naturally arises, Why do not the females increase in size by inheriting the increased bulk of the male? There are few more interesting and perplexing laws than those of inheritance, and among these one of the most elusive is the inheritance of certain characteristics by one sex alone. Darwin attempts to explain these facts by the hypothesis of pangenesis,—a theory which seems to have few, if any, supporters at present. Whatever may be the cause of the transmission of certain characters to one sex only, there are two facts that may help us to understand the disparity between the sexes of the fur seals:

1st, The great size of the male is purely a *secondary sexual character*, and as such would not be expected to be inherited by the female, whatever may be the reason or an ultimately found to explain the fact.

2d, Small size is of direct advantage to the female in this case, and hence a *natural* selection[9] would tend to intensify this feature, or what is practically the same thing, to keep the females from sharing in the increased size of the males.

The advantage referred to arises from the manner in which the females are handled by the males upon the landing of the former, which is described as follows by Elliott:

"The little cows have a rough-and-tumble time of it when they

[9] The selection here spoken of can hardly be termed a *sexual* selection, as the advantage accrues directly to the mother, and does not have the direct and exclusive bearing upon the reproductive act which is the essence of sexual selection. It is, of course, true that one sex alone is affected; but this fact alone is not sufficient to stamp it as sexual selection as set forth by Darwin.

begin to arrive; for no sooner is the pretty animal fairly established on the station of bull number one, when bull number two, seeing bull number one off his guard, reaches out with his long, strong neck and picks the unhappy but passive creature up by the scruff of hers, just as a cat does a kitten, and deposits her on his seraglio ground; then bulls numbers three, four, etc., in the vicinity, seeing this high-handed operation, all assail one another, and especially bull number two, and have a tremendous fight, perhaps for half a minute or so, and during this commotion the cow generally is moved or moves farther back from the water, two or three stations more, where, when all gets quiet, she usually remains in peace."

Allen also quotes Captain Bryant as follows: "Frequently a struggle ensues between the two males for the possession of the same female, and, both seizing her at once, pull her in two or terribly lacerate her with their teeth."

It is evident that the more easily and quickly the females can be moved the better for them, as they are thus more likely to avoid being lacerated by the males, either in being stolen from one by another, or in being fought over as described in the last quotation. If this is true, the lighter females would be less likely to be injured by the savage males, and hence the heavier ones would be weeded out by a natural selection, which by its constant action would go far toward accounting for the great sexual disparity exhibited by these animals.

The remaining fact demanding explanation is the wonderful ability of the male sea lions to endure long-protracted fasts. On this point Mr. Elliott says that they "abstain entirely from food of any kind or water for three months at least, and a few of them stay four months before going into the water for the first time since hauling up in May."

"This alone is remarkable enough, but it is simply wonderful when we associate the condition with the increasing activity, restlessness, and duty devolving upon the bulls as heads and fathers of large families. They do not stagnate, like bears in caves."

It seems highly probable that this astonishing ability to endure protracted fasts is one of the results of the ultra polygamy practiced by these animals.

A marked intensification of desire seems to be one of the immediate concomitants of polygamy among animals. A writer in a recent number of the NATURALIST[10] says, in speaking of monogamous birds adopting a polygamous habit: "We may infer, therefore, that sexual power and high sexual characters go hand in hand, and that in proportion to the advance toward organic perfection virility increases."

The virility of the sea lion is probably more excessively developed than that of any other mammal. The sexual organization is of the most highly specialized type, and differs in some important particulars (*e.g.*, external scrotum) from most other Pinnipedia.[11]

This excessive virility might lead to the habit of abstaining from food in order to secure and then guard the females. This abstinence in its incipiency would not be of very great duration, but the period might be lengthened by almost imperceptible increments throughout hundreds of generations, until the surprising results noted above would be reached. The animals live on their own blubber during their long fast, and it is reasonable to suppose that the male progenitors of the sea lions which were the strongest and lustiest and possessed the most blubber would be able to outstay their rivals, and hence obtain possession of a greater number of females and beget a greater number of offspring than those having less strength and blubber. Thus a process of selection would be instituted whereby animals would eventually be produced possessed of sufficient blubber and endurance to survive the effects of even such phenomenal fasts as are endured by the fur seal of the present day.

In the preceding pages the writer has endeavored to account for the following peculiarities met with among the Pinnipedia:

1st, The relation between great sexual disparity in size and polygamy.

[10] AMERICAN NATURALIST, November, 1890, p. 1030.

[11] For further interesting particulars, see Monograph of North American Pinnepeds, pp. 382–405.

2d, The manner in which polygamy may have originated.

3d, The origin and effect of excessive pugnacity.

4th, The origin and advantage of great sexual disparity.

5th, The origin and advantage of the ability to endure long-protracted fasts.

The sexual disparity, excessive pugnacity, and ability to endure protracted fasts are all intimately related to polygamy, either as cause or effect.

Up to a certain point pugnacity and disparity seem to have acted as causes of polygamy. Beyond that point they seem to be effects of polygamy, or at least are accelerated or intensified by it.

The ability to endure long fasts would seem to be purely an effect of polygamy.

ON THE GENESIS OF THE CHROMATOPHORES IN FISHES.[1]

BY CARL H. EIGENMANN.

FOR several reasons pelagic eggs are more available for a study of the phenomena of color-formation than fixed eggs. Pigment is nearly always formed in pelagic eggs some time before hatching, and as the embryonic life is usually short and the eggs are transparent, the whole process from fertilization to hatching can be observed, without any great inconvenience, in the living egg.

In all pelagic ova with oil-globules observed by me pigment is deposited in certain cells before the time of hatching. In the eggs of three species of pelagic ova (Stolephorus) without oil-globules no pigment is formed several hours after hatching, while in *Fierasfer dubius* (?) without oil-globules, pigment is present at the time of hatching.

Only three colors have been observed in the eggs examined, viz., black, a brownish-yellow, and bright yellow. In the various species of Sebastodes (viviparous) only black pigment is formed, while in Atherinopsis black pigment alone is observed until near

[1] Notes from the San Diego Biological Laboratory, IV.

the time of hatching, when bright yellow pigment appears. In the pelagic ova observed, excepting Stolephorus, black pigment was always formed, but never in great quantity. In *Serranus nebulifer* (Fig. 34) only black pigment is formed before hatching, while in *Serranus maculofasciatus*, *Sciæna saturna*, and *Hypsopsetta guttulata* the few black cells are almost obscured by the great number of brownish-yellow cells. In those cases in which both black and yellow cells appear the black cells soon collect on the lower surface of the oil-globule and on the lower surface or back of the embryo, while the yellow cells are aggregated on top of the oil-sphere and on the ventral surface of the embryo,—a fact already observed by others.

Figs. 32 to 41 will give a fair idea of some of the various patterns the color-cells form in early stages. Figs. 33 to 40 represent nearly homologous stages of various embryos. The time required to reach these stages differs, however, vary greatly in the various species. Figs. 33, 34, and 40 represent larvæ between two and three days old, while Figs. 35 to 39 represent larvæ as many, or more, weeks old. The conditions of development also vary greatly in the larvæ selected for illustration. Figs. 33, 34, and 40 are all hatched from pelagic ova; Fig. 36 from ova which adhere together and are thus hatched in masses; Fig. 38 from ova with a mycropylar circlet of filaments; and Fig. 39 from ova with isolated filaments scattered over the entire zona; while Fig. 37 represents a viviparous fish just at the time of birth.

Viviparity does not affect the chromatophores immediately. In the rock cod (Sebastodes), Fig. 37, color is as well formed at the time of parturition as in some related viviparous species. In the Holconotidæ, on the other hand, color is not formed until quite late stages are reached, and the eyes are the first to be pigmented.

In all cases observed the chromatoblasts originate in the mesoblast surrounding the embryo. This condition was considerably modified in *Sciæna saturna*, in which they are formed along the entire margin of the embryonic ring; but the difference is one of degree only.

2d, The manner in which polygamy may have originated.

3d, The origin and effect of excessive pugnacity.

4th, The origin and advantage of great sexual disparity.

5th, The origin and advantage of the ability to endure long-protracted fasts.

The sexual disparity, excessive pugnacity, and ability to endure protracted fasts are all intimately related to polygamy, either as cause or effect.

Up to a certain point pugnacity and disparity seem to have acted as causes of polygamy. Beyond that point they seem to be effects of polygamy, or at least are accelerated or intensified by it.

The ability to endure long fasts would seem to be purely an effect of polygamy.

ON THE GENESIS OF THE CHROMATOPHORES IN FISHES.[1]

BY CARL H. EIGENMANN.

FOR several reasons pelagic eggs are more available for a study of the phenomena of color-formation than fixed eggs. Pigment is nearly always formed in pelagic eggs some time before hatching, and as the embryonic life is usually short and the eggs are transparent, the whole process from fertilization to hatching can be observed, without any great inconvenience, in the living egg.

In all pelagic ova with oil-globules observed by me pigment is deposited in certain cells before the time of hatching. In the eggs of three species of pelagic ova (Stolephorus) without oil-globules no pigment is formed several hours after hatching, while in *Fierasfer dubius* (?) without oil-globules, pigment is present at the time of hatching.

Only three colors have been observed in the eggs examined, viz., black, a brownish-yellow, and bright yellow. In the various species of Sebastodes (viviparous) only black pigment is formed, while in Atherinopsis black pigment alone is observed until near

[1] Notes from the San Diego Biological Laboratory, IV.

the time of hatching, when bright yellow pigment appears. In the pelagic ova observed, excepting Stolephorus, black pigment was always formed, but never in great quantity. In *Serranus nebulifer* (Fig. 34) only black pigment is formed before hatching, while in *Serranus maculofasciatus*, *Sciæna saturna*, and *Hypsopsetta guttulata* the few black cells are almost obscured by the great number of brownish-yellow cells. In those cases in which both black and yellow cells appear the black cells soon collect on the lower surface of the oil-globule and on the lower surface or back of the embryo, while the yellow cells are aggregated on top of the oil-sphere and on the ventral surface of the embryo,—a fact already observed by others.

Figs. 32 to 41 will give a fair idea of some of the various patterns the color-cells form in early stages. Figs. 33 to 40 represent nearly homologous stages of various embryos. The time required to reach these stages differs, however, vary greatly in the various species. Figs. 33, 34, and 40 represent larvæ between two and three days old, while Figs. 35 to 39 represent larvæ as many, or more, weeks old. The conditions of development also vary greatly in the larvæ selected for illustration. Figs. 33, 34, and 40 are all hatched from pelagic ova; Fig. 36 from ova which adhere together and are thus hatched in masses; Fig. 38 from ova with a mycropylar circlet of filaments; and Fig. 39 from ova with isolated filaments scattered over the entire zona; while Fig. 37 represents a viviparous fish just at the time of birth.

Viviparity does not affect the chromatophores immediately. In the rock cod (Sebastodes), Fig. 37, color is as well formed at the time of parturition as in some related viviparous species. In the Holconotidæ, on the other hand, color is not formed until quite late stages are reached, and the eyes are the first to be pigmented.

In all cases observed the chromatoblasts originate in the mesoblast surrounding the embryo. This condition was considerably modified in *Sciæna saturna*, in which they are formed along the entire margin of the embryonic ring; but the difference is one of degree only.

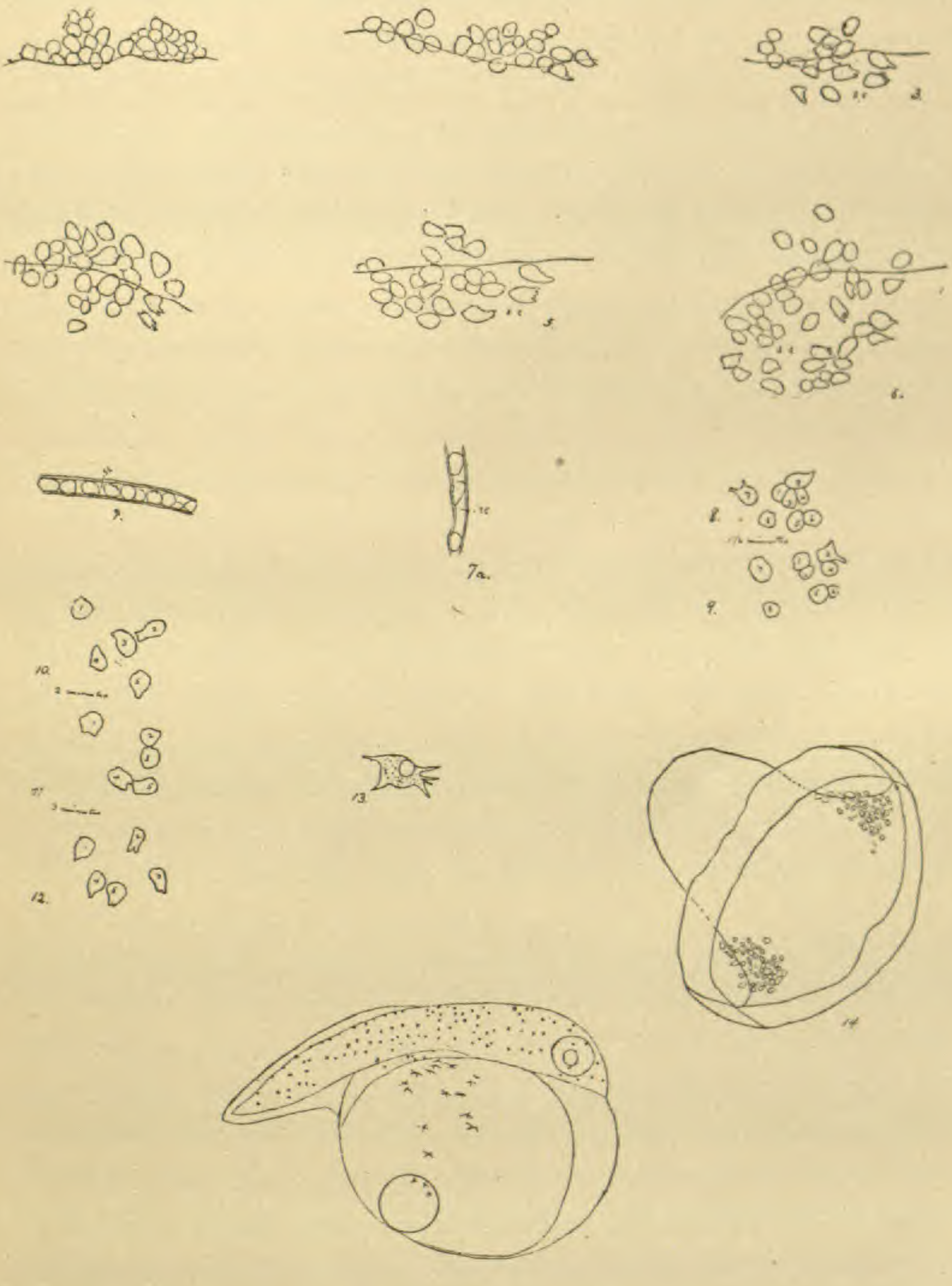
To follow the species observed separately:

In *Sciæna saturna* (Figs. 1–7) the chromatoblasts are first noticed when the gastrula covers about one-third of the yolk; that is, they appear quite early. They are formed along the entire margin of the embryonic ring. When first noticed they are slightly separated from the surrounding cells, and their outlines become well defined. They thus appear larger than the cells surrounding them, which are closely packed and whose outlines are not sharply defined. They either move toward the outer rim of the embryonic ring or remain stationary, while the embryonic ring moves over the yolk. At any rate, they soon come to lie entirely in the segmentation cavity, (see Figs. 1–7). At this time they are quite regular in outline, with probably one or two angular prolongations. Their depth is usually equal to that of the segmentation cavity, and much greater than the epiblast below them or the ectoderm above them. As soon as they have reached the segmentation cavity they migrate in it, most of them being intended for the embryo, while many remain on the yolk, and others cover the oil-globule.

While the individual cells undergo amœboid changes, their locomotion is not necessarily caused, as some observers supposed, by their amœboid changes. One cell, which was smaller than usual, was seen to move quite rapidly towards the oil-globule, with a motion not unlike that of ciliate Infusorians caught under a cover-glass; *i. e.*, it moved quite rapidly, and then seemed to be momentarily arrested by some invisible barrier, when it would again dart along. When the cells are first freed from the embryonic ring no color is seen in them; but before long fine granules are observed, resembling in most respects the minute oil-globules covering the yolk. Individually these are apparently colorless, but collectively they form yellow or black pigment. On the oil-globule and embryo, and later over the yolk also, the cells become flattened, more densely pigmented, and at the same time gain the power of contracting the pigment to a dot (Fig. 15), or expanding it to the dendritic form of the cell itself (Fig. 17).

I have not observed any other cells than the migratory ones in this species; if others exist, they were obscured by the large

PLATE III.



EMBRYOS OF FISHES.

quantities of migratory cells. I have not had an opportunity of reëxamining this species or Hypsopsetta since the species of *Serranus* were observed.

In *Hypsopsetta guttulata* the color-cells appear much later and not nearly in such large quantities as in Sciæna. They are first noticed when the gastrula covers only one-half or two-thirds of the yolk, and the migratory ones are formed only at or near the union of the embryonic shield and the embryonic ring (Fig. 14). Numerous cells are soon after seen along the entire embryo. I am not certain whether they originate *in situ* or whether they migrate to their position. Later, when the embryonic shield is contracted to form the embryo, these cells move toward it, and finally cover it. Later other cells again move out from the embryo to cover the yolk (see Figs. 15–17).

The observations on *Serranus nebulifer* (Fig. 34) were not very complete. Only black cells are formed, and very few cells become free from the embryo, all of which migrate to the oil-sphere.

In *Serranus maculofasciatus* (Figs. 18–28) the chromatoblasts were observed about sixteen hours after fertilization. There were at that time a few free ones on either side of the embryonic shields. In fifteen minutes the number of free ones on one side had increased from nine to fifteen (see Figs. 18–22). These cells moved rapidly away from their place of origin, and most of them finally, in about two hours and a half, were found on the oil-sphere. A few probably returned, and finally lodged in the region of the head. Besides these migratory cells, there is a broad band of mesoblastic cells along either side of the embryo in which color is soon formed. These cells never become nomadic in the segmentation cavity, but remain attached to the embryo, over which they are finally nearly evenly distributed. By far the greater portion are yellow cells, but a few being black. Before hatching these cells become collected into definite masses, and some time after hatching they assume the remarkable condition observed in Fig. 33.

So far as I am aware, nothing has been written concerning the origin of the color itself. As stated above, the color is not due to the color of the protoplasm of the chromatophores but to the aggregation of small granules, most probably oil-spherules. The protoplasm is colorless. The color-granules are not found in the nucleus of the cells. They are sometimes scattered through the whole of the remainder of the cell, but can be withdrawn from the pseudopods of the adult chromatophore and collected in a small spot. It is to the ability on the part of the chromatophores to thus distribute or collect the color-granules that the larva owes its power to rapidly change color.

The individual spherule of the chromatophores does not possess any definite color. It is only, as has been stated, when a number of them are aggregated that color is evident. These granules are either a secretion of the cell itself, or they are formed otherwise and appropriated by the cell. The process of the formation of the granules in the chromatophores would, of course, be difficult to follow if they were secreted by the cell. On examining the medium surrounding the migratory cells for a possible explanation of the color-spherules, it was found that the epiblast was full of granules or oil-spherules, similar in size and but slightly, if any, different in refractive index. Such spherules were especially abundant in Sciæna, in which there is also an unusual number of color-cells. Especially towards the closing of the blastopore, a large number are seen over the entire portion of the yolk not covered by the gastrula, and it seems as though the advancing embryonic ring were heaping them up at the entodermic pole of the egg.

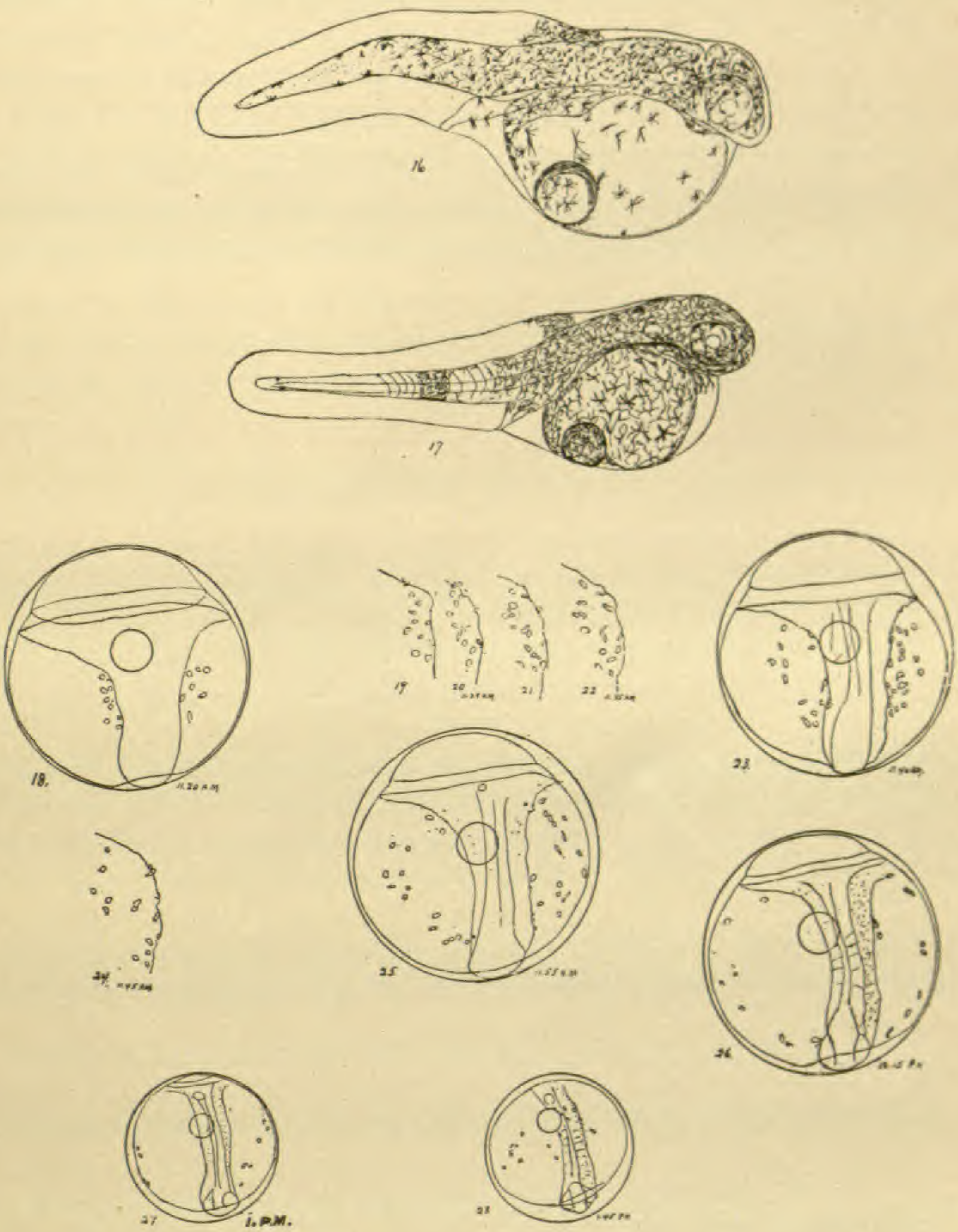
I have frequently observed individual chromatophores while in the segmentation cavity, and have seen them put forth pseudopods and withdraw them independently of their locomotion; but I have never seen them in the act of appropriating any of the spherules of the epiblast.

There is a difference between the spherules of the yellow and of the black cells. The granules of the black cells are smaller and less refringent.

When first freed from the embryonic ring the color-cells usually approach the typical cell in shape, but later they become flattened and assume the dendritic form so characteristic in the larvæ.

These observations were made while at a distance from all scientific libraries. After they had been prepared for the printer,

PLATE IV.



EMBRYOS OF FISHES.

I was enabled, through the courtesy of Dr. C. O. Whitman, to examine the records of previous observations during my stay at the Marine Biological Laboratory at Woods Holl. Although I then found that many of my observations were but verifications of those of others, it has seemed best to publish my account because I have examined new material, have worked out the matter in greater detail in several species, and do not agree with the previous observers in all points.

Aubert,[2] Kupffer,[3] Agassiz and Whitman,[4] Wenkebach,[5] and List [6] all seem to agree in deriving the chromatophores from the mesoblast; as to when and where they arise these authors naturally vary with the different species examined.

All the figures, excepting 37, were made from living eggs or larvæ, with a Zeiss microscope and Abbe camera. The letters A and D refer to the objectives, the 2 and 4 to the oculars, of Ziess.

EXPLANATION OF PLATES.

PLATE I.—*Sciæna saturna.* Figs. 1–6, a portion of the embryonic ring, showing the chromatophores. In Fig. 1 they are all still contained in the embryonic ring. In Fig. 2 a few are seen entering the segmentation cavity. Figs. 3 and 4 show a portion only of the region covered by Figs. 1 and 2, with more cells in the segmentation cavity, Fig. 4 being drawn five minutes later than Fig. 2. Figs. 5 and 7 show still later stages, in which a still larger number of cells have been freed; Zeiss, D and 4. Fig. 7, an optical section of the segmentation cavity (s. c.), near the embryonic ring, showing the large chromatophores, the thin ectoderm lying above them, and the parablast below them. Fig. 7*a*, the same at some distance from the embryonic ring, the chromatophores being much less numerous. Fig. 8, a series of eight free chromatophores of *Hypsopsetta guttulata;* D and 4. Fig. 9, the same cells 1½ minutes later. Fig. 10, a series of five chromatophores. Fig.

[2] Beiträge zur Entwickelungsgeschichte der Fische. *Zeitschr. f. wissensch. Zool.*, VII., 1856.

[3] Beobachtungen über die Entwickelung der Knochenfische. *Arch f. mikr. Anat.*, IV., 1868.

[4] The Pelagic Stages of Young Fishes. Mem. Mus. Comp. Zool., pp. 7 and 40, 1885.

[5] Beiträge zur Entwickelungsgeschichte der Knochenfische. *Arch. f. mikr. Anat.*, XXVIII., 1886.

[6] Zur Entwickelung der Knochenfischen (Labriden). *Zeitschr. f. wissensch. Zool.*, XVL., 1887.

11, the same two minutes later. Fig. 12, the same three minutes later than Fig 11. Fig. 13, a single chromatophore, more highly magnified after pigment has begun to be formed. Fig. 14, outline of embryonic shield and ring, with chromatophores beginning to be freed; A and 4. Fig. 15, a larva just freed from the membrane, 1.4 mm.; the chromatophores contracted.

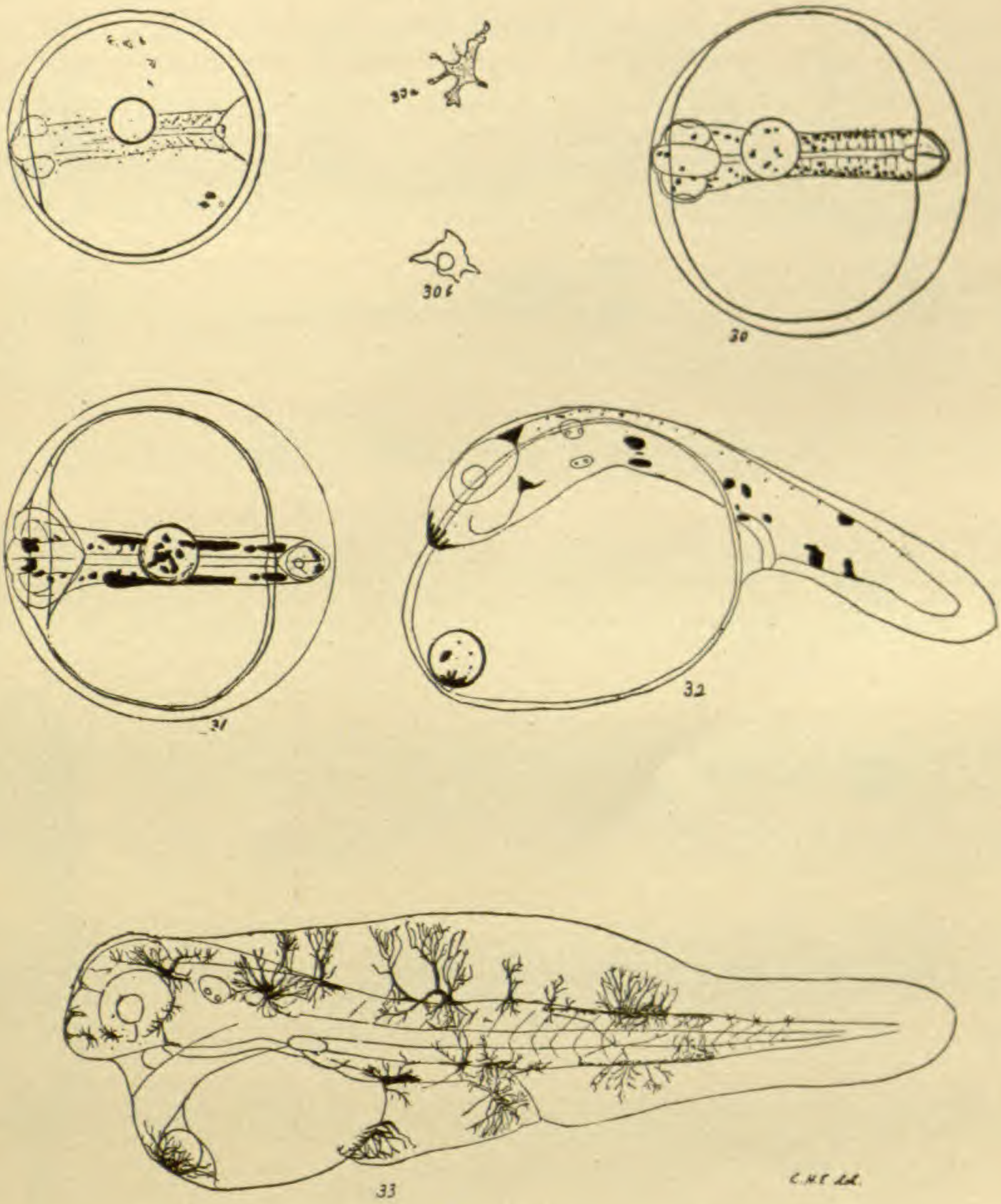
PLATE II.—The same larva (Fig. 15) twenty hours afterwards, 1.6 mm. Fig. 17, another more advanced larva, 1.7 mm. long.

Serranus maculofasciatus.—The aim being to show the chromatophores, the details of the embryo were not as well attended to as they otherwise would have been. Figs. 18–28 represent the successive positions of the free chromatophores from the time they become free till they have nearly reached the oil-sphere. The exact times when the drawings were made are indicated with the figures. The egg figured was probably fertilized at about 5 P.M. the day preceding the stages represented. Figs. 19–22 and 24 show merely one side of the embryonic shield. In Fig. 25 the lateral cells have begun to be pigmented Figs. 18–26, Zeiss, A and 4; Figs. 27, 28, A and 2.

PLATE III.—Fig. 29, slightly older egg than Fig. 28; A and 4. Fig. 30, the free chromatophores have reached the oil-sphere, the yellow cells lying on the upper surface, the black on the lower surface; the chromatophores of the body have become more densely pigmented; A and 4. Fig. 30*a*, a chromatophore (the nucleus is not seen), with the color-granules from the oil-sphere of Fig. 30; D and 4. Fig. 30*b*, another chromatophore, showing nucleus, also from oil-sphere of Fig. 30; D and 4. Fig. 31, a later stage, the yellow cells having aggregated in large masses; A and 4. Fig. 32, immediately after hatching, the yellow cells being large, the black cells small, all the cells contracted; A and 4. Fig. 33, twelve hours after hatching, the cells expanded to their utmost and constantly changing; A and 4, 2.2 mm.

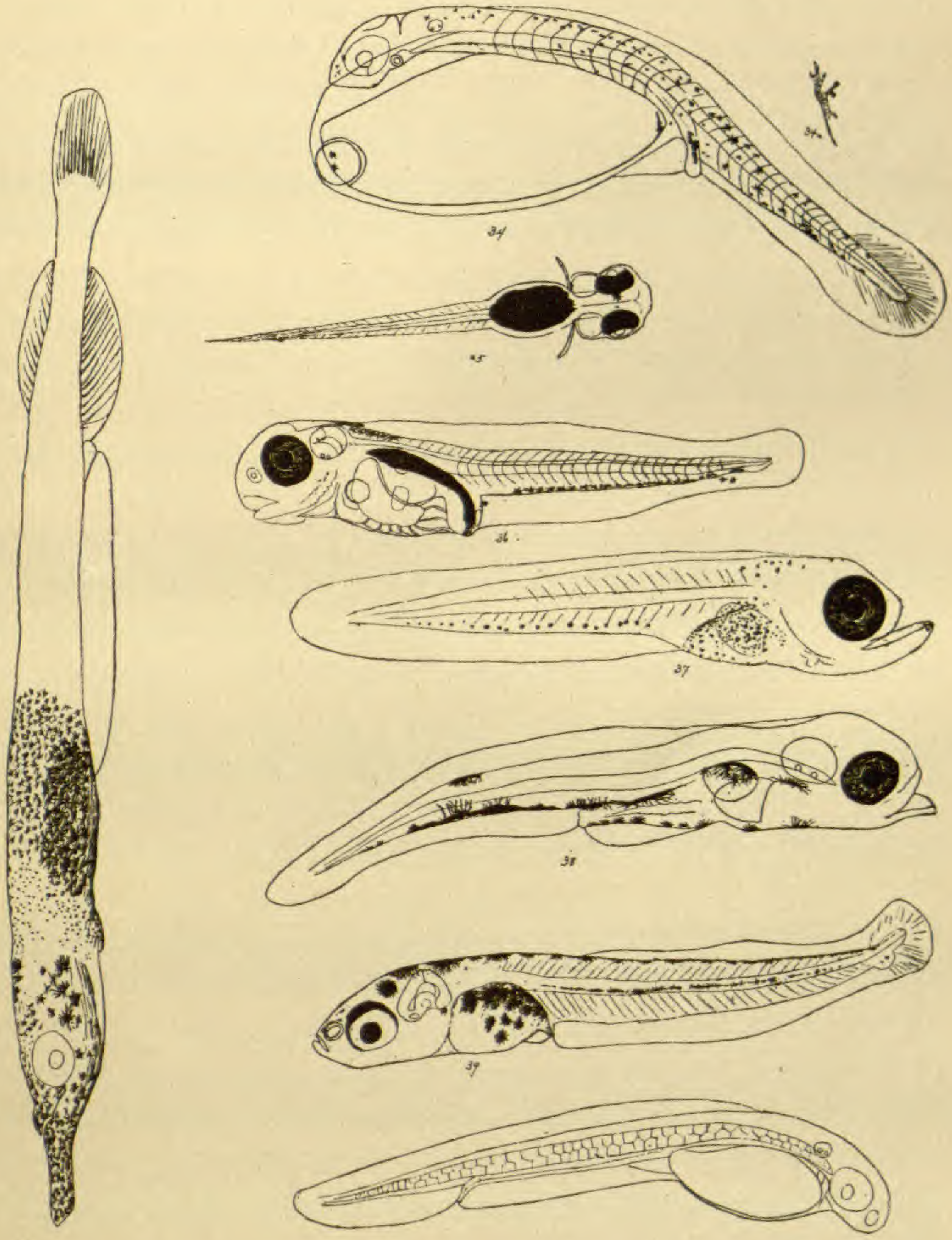
PLATE IV.—Fig. 34, a newly hatched larva of *Serranus nebulifer;* 2.67 mm. Fig. 34*a*, one of the chromatophores from the tail, more enlarged; D and 4. Fig. 35, *Oligocottus analis*, twelve hours after hatching; dorsal surface; X 25. Fig. 36, somewhat older *Oligocottus analis*, two days after hatching; lateral view; X 35. Fig. 37, *Sebastodes ruber*, at the time the larvæ are freed from the ovary. This is probably a pathological specimen; the tail is usually more elongate. Fig. 38, Lepidogobius sp., showing peculiar distribution of pigment; X 68. Fig. 39, *Atherinopsis californiensis*, after the yolk is all absorbed; Jan 9, 1889; X 12. Fig. 40, *Stolephorus ringens*, forty-eight hours after hatching; no color is formed in the latest stages observed. Fig. 41, *Hemisbamphus rosæ*, 12.5 mm. long, showing the distribution of the color cells; the cells of the posterior part of the body and of the tail are omitted.

PLATE V.



EMBRYOS OF FISHES.

PLATE VI.



EMBRYOS OF FISHES.

AN INDIAN GRAVE IN WESTERN NEW YORK.

BY A. L. BENEDICT, M.D.

SOUTH of Lake Ontario, between the Genesee River on the west and Canandaigua Lake and its outlet on the east, lies a fertile country, studded with knolls and hills from twenty to two-hundred-and-fifty feet in height. West of the Genesee River, as far as Buffalo and Lake Erie, the land is level, with only occasional elevations to relieve the monotony. East of Canandaigua Lake the hills enlarge into miniature mountain ranges, five to fifteen miles long, four or five miles from valley to valley, and five or six hundred feet in height.

Nearly the whole of this region west of Seneca Lake was inhabited by the Seneca nation of the Iroquois, but only in the middle portion was there much communication between the Europeans and the Indians until late in the eighteenth century, when the usurpation of the land by the white settlers was accomplished in a comparatively short time. Hence, as a rule, the Indian village sites and burial places of the western and eastern portions of the Seneca territory yield relics of genuine aboriginal workmanship, whereas in the central portion, in which the Indian population held its own against foreign encroachment for more than a century, European influence is indicated by an abundance of iron axes and knives, glass beads, copper ornaments, brass kettles, and a variety of other articles found in connection with flint arrow-heads, stone tomahawks, wampum, and unglazed pottery.

One of the largest and best-known sites of Indian occupancy in this region is on a large hill near the thriving village of Victor. Some idea of the importance of this Indian village may be derived from the following considerations: The hill is one of the most commanding localities in the whole middle territory, descending so abruptly on the west and north as to make it a vantage-point in case of war, sloping more gradually in other directions. At least ten acres of the hill-top were so densely populated that even at this late day, after half a century of cultivation and the visits of two generations of relic-hunters, it still yields ample recompense in the form of beads, pipe-stems, pottery, and other implements to any one who will take the pains to search for them. On and near this village site so many iron tomahawks were found by the early settlers that they were of commercial value as old iron, and were by no means an insignificant source from which the blacksmiths derived the material for horseshoes and other articles of farm use.

The writer had made several visits to this place, and had gathered from the surface a considerable number of relics. In the spring of 1885 a young man of the locality exhumed a skeleton with which were buried two or three silver rings, and in September following the writer opened a grave almost adjoining the first one, with such rich results that he has thought it worthy of a descriptive article.

The graves were situated at the extreme western edge of the hill, four or five rods beyond the field in which the relics were so plenty, and a few feet before the slope, already begun, became so steep that ascent was difficult.

The writer, availing himself of the work of excavation which had been done in the spring, dug into the side of the grave, reaching, after a short time, a woodchuck hole, which fortunately led him to another skeleton. This skeleton, whose immature bones and teeth showed that it had belonged to a person between sixteen and twenty years old, was in the crouching attitude, with elbows at the sides and knees drawn up to meet them, characteristic of Indian burial. Strange to say, however, the skeleton was turned head downwards, a circumstance which has never been duplicated in the writer's experience.

One of the first objects exhumed was a bone head-comb, evidently either of European manufacture, or an imitation by the Indians of some similar ornament which they had seen the white women use. Several of the teeth of the comb had become broken, but otherwise it was well preserved. At the top of the comb there is a rudely cut figure of a man standing and resting his hand on the shoulder of another person who is on horseback. Beside the skeleton was a partially overturned brass kettle, containing a hard discoid stone, presumably used to heat water, for only a few years previous to the time when this village was destroyed the Indians used clay kettles, which could not stand the heat of a fire, and they therefore heated water in them by throwing in hot stones. In and just outside the kettle was a quantity of large, red glass beads, of smaller glass beads, white, blue, green, and yellow, some spherical, some cylindrical in shape, and which, when strung, measured thirty feet. There was also a flat, white shell ornament in the shape of an isosceles triangle, with a hole near the apex. At the bottom of the kettle was a mass of decayed organic matter, which showed faint traces of interlacing fibres, and which was probably the remains of a basket or mat. The bail of the kettle was of iron, much corroded, for that metal is not nearly so enduring as copper or brass. The spongy fragments of a wooden handle were also found.

Seven slender bone or shell tubes were also found, some almost perfect, some worn and decayed so as to require the most careful handling. The longest of these measured four-and-one-eighth inches, the shortest unbroken one three-and-three-eighths inches. Nearer yet to the skeleton was genuine Indian wampum, both white and purple, showing in places, as it rolled out of the earth, the original arrangement into parallel rows of five or six beads. This when strung measured sixty feet, and when stitched on to cloth, in imitation of its arrangement at the time of burial, it would reach from one shoulder to the opposite hip, or several times around the waist of a small person.

Part of the upper rounded shell and most of the jointed under shell of a good-sized turtle were also exhumed. This turtle skeleton may have been part of a rattle, or it may have been a pet of the Indian girl, or, again, it may have been the symbol of the clan to which she belonged, for running through the six nations of the Iroquois were clans or brotherhoods taking their names from animals, and one of these clans was named from the turtle.

This grave was one of a number opened in the vicinity, and all, while differing in detail, agreed in presenting evidences of European civilization in conjunction with aboriginal customs.

Buffalo, N. Y.

EDITORIAL.

EDITORS, E. D. COPE AND J. S. KINGSLEY.

NOW that the first excitement regarding the new remedy for tuberculosis has subsided, the time seems opportune to glance back at the events of the past eighteen months, which have proved rich in scientific research in relation to the tubercle bacillus, and to place on record, not only for our own satisfaction, or even for those more immediately concerned, but especially for the benefit of succeeding generations, the announcements that have been made public from time to time in regard to that microbe, and the means that have been discovered for combating its ravages on the animal economy.

The endless and often embittered controversies which constantly occupy the literary world almost invariably arise from the fact that no plain contemporaneous record was made at the time, which would have placed the question beyond the range of argument. To cite a case in point, the circumstances surrounding the sale by Oliver Goldsmith of the "Vicar of Wakefield" have proved an inexhaustible field for conjecture and surmise, and gallons of ink have been wasted over the attempts to reconcile two apparently conflicting accounts of that transaction.

In almost all cases of discovery there are rival claimants,—in some instances, where the evidence seemed most conflicting, it has been afterwards proved beyond question that the same idea has come to two workers, hundreds of miles apart, at almost identical moments. A little consideration will show that there is nothing very surprising in this. In the case of two scientific men pursuing an investigation on similar lines and with an identical goal in view, it is perfectly possible for them to hit upon the same conclusion at nearly the same time, and for both of them to believe that the one has been pillaging from the other.

In the case of the discovery of vaccination, no serious question ever arose, and Jenner stands out alone without challenge or dispute. The same can be said with regard to the discoveries of

Pasteur; nor is there any doubt as to the claims of Professor Koch to the discovery of the tubercle bacillus.

In the month of March, 1882, Dr. Koch announced to the medical world that he had discovered the existence of a microbe hitherto unknown, and to which was given the name of the tubercle bacillus. He described how he had subjected diseased organs of numbers of men and animals to microscopic examination, and found, in all cases, the tubercles infested with a minute, rod-shaped parasite, which, by means of a special staining process, he differentiated from the surrounding tissue. He says: "It was in the highest degree impressive to observe in the center of the tubercle cell the minute organism which had created it."

Professor Klein differs from this view. He says: "I cannot agree with Koch, Watson Cheyne, and others, who maintain that each tubercle owes its origin to the immigration of the bacilli, for there is no difficulty in ascertaining that, in human tuberculosis, in tuberculosis of cattle, and in artificially induced tuberculosis of guinea-pigs and rabbits, there are met with tubercles in various stages, young and old, in which no trace of a bacillus is to be found, whereas in the same section caseous tubercle may be present containing numbers of tubercle bacilli."

Transferring directly by inoculation the tuberculous matter from diseased animals to healthy ones he in every instance reproduced the disease. To meet the objection that it was not the parasite itself, but some virus in which it was embedded, he cultivated his bacilli artificially for long periods of time and through many successive generations.

This was confirmed by reliable investigations, and thus was established the existence of the tubercle bacillus and its discovery by him, and up to this time everything is plain sailing.

From the date of this announcement (1882) by Professor Koch, up till October, 1889, nothing particularly new was heard on the subject, and as far as the literature on the tubercle bacillus goes, we have every reason to believe that the search for a toxic agent to combat the disease of tuberculosis and the ravages of the tubercle bacillus has been fruitless. Indeed, to all outside appearances, the tubercle bacillus, having been once discovered, was to be left unmolested to pursue its ravages on helpless humanity. But in reality it was being followed up by tireless and relentless foes.

On October 19th, 1889, was published in the *Medical News*, of Philadelphia, by Dr. Samuel G. Dixon, at that time Professor of Hygiene to the University of Pennsylvania, a monograph announcing his discovery of the hitherto-unknown forms of the tubercle bacillus.

In the previous summer, whilst investigating different methods of technique and manipulation abroad, Dr. Dixon was led to believe that the bacillus could be cultivated so as to show lower forms of virulent life; and following this idea up by a series of experiments, he was in a short time able to produce the hitherto-unnoticed forms of the bacilli, some club-shaped, others curved, and others again branched.

From the growths thus obtained he proceeded to make a series of tube inoculations, from which he grew bacilli corresponding in every respect to the ordinary rod-shaped tubercle bacillus.

Having obtained these results, he propounded two hypotheses: 1st, That by a thorough filtering out of bacilli from tuberculous material a filtrate might be obtained and attenuated, so that by systematic inoculations a change might be produced in living animal tissues that would enable them to resist virulent tubercle bacilli. 2d, To bring about a chemical change or physical change in living tissues that would resist tubercular phthisis, it is possible that inoculation with the bacillus would have to be made; yet, before this could be done, the power of the virulent bacilli would have to be diminished, otherwise the result would be most disastrous. He added further that he had reduced the tubercle bacillus to a condition that, when inoculated into the animal economy, caused a resistance to the disease.

To use a military metaphor, this was the first note proclaiming that an active campaign had been opened on the tubercle bacillus, and specifying in terms as definite as possible the means by which the war was carried into the enemy's country.

The announcement of this discovery was widely circulated and commented upon, and reprints of the article were forwarded to

Drs. Von Pettenkofer, Koch, Louder-Brunton, and other scientific investigators.

The International Medical Congress was appointed to meet in Berlin in August, 1890, and more than usual interest attached to its meeting, as it was generally rumored that some important papers on the subject of the tubercle bacillus would be read on that occasion.

Nor was this rumor falsified, and the interest of the meeting may be said to have culminated as Professor Koch rose to address the assembled physicians, and when he stated that he had hit upon a substance which had the power of preventing the growth of the tubercle bacillus, it was greeted with loud applause. It was then stated that the bacillus of tuberculosis in man and chickens was very similar, and he inferred that the latter is a special species of the organic matter supposed to lie at the root of pulmonary consumption. He also announced that the direct action of solar light on the tubercle bacillus destroys in a certain length of time, varying from a few minutes to several hours, the virulence of this microbe.

It will be convenient to quote verbatim from that portion of the paper proclaiming his discovery of a toxic agent: "In spite of this failure—to effect any result on tuberculous animals with chemical substances—I have not allowed myself to be discouraged from prosecuting the search for growth-hindering remedies, and I have at last hit upon a substance which has the power of preventing the growth of tubercle bacilli, not only in a test tube, but in the body of an animal. All experiments in tuberculosis are, as every one who has had experience of them has sufficiently discovered, of very long duration. My researches on this substance, therefore, although they have already occupied me for nearly a year, are not yet completed, and I can only say this much about them, that guinea-pigs, which, as is well known, are extraordinarily susceptible to tuberculosis, if exposed to the influence of this substance, cease to react to the inoculation of tuberculous virus, and that in guinea-pigs suffering from general tuberculosis, even to a high degree, the morbid process can be brought completely to a standstill without the body being in any way injuriously affected. From these researches I in the meantime do not draw any further conclusions than that the possibility of rendering pathogenic bacteria in the living body harmless without injury to the latter, which has hitherto been justly doubted, has been thereby established." (Address before the Medical Congress in Berlin, August, 1890.)

It will be observed that Professor Koch in his paper makes two points: 1st, The action of solar light and a high degree of heat in destroying the virulence of the microbe; 2d, The fact that he had produced a substance the effect of which was to prevent the growth of the tubercle bacilli in the body of an animal, and that he produced a condition in that animal that was immune to the virulent tubercle bacilli; also that he by the same process could overcome tuberculosis already established.

There are also two facts that cannot fail to strike the observer. The first is, that a period of over seven years had elapsed from the date of his first publication on the tubercle bacillus and that announcing his discovery of the toxic agent; and the second, that his researches after the substance must have commenced about the period of Dr. Dixon's publication of October, 1889, of which, however, no mention is made in his address. It does not seem unfair to infer that Professor Koch had been unsuccessful during the preceding years in arriving at any satisfactory results. His own words, "My researches on this substance, therefore, although they have occupied me for nearly a year," etc., seems conclusive on this point. We do not, however, propose to do more than call attention to the coincidence of his researches after the toxic agent and the publication of Dr. Dixon's, October, 1889, the importance of which would be obvious to any bacteriologist, and the unfruitful nature of the former's investigations previous to that date.

There was, perhaps, a feeling prevalent in the medical world of incompleteness in the terms of Professor Koch's announcement, and it seems as if he had only stimulated curiosity in order to deny it satisfaction. Nor was this allayed when the news arrived from Berlin that the scientist, having brought his researches to a point sufficiently advanced to justify the use of his remedy in corpore vili, was prepared to inoculate the human subject. But the nature of his remedy and the method of its composition were to be kept a profound secret.

The first inoculation into the human economy took place on September 22d, in a case of lupus, but it was not until the first week in November that it was given out that Professor Koch was ready to make inoculations on a general scale It is not germane, however, to our purpose to do more than refer in passing to these events, or the exodus to Berlin, which is fresh in the public mind.

On November 15th Dr. Dixon, in the Philadelphia *Times and Register* (medical), clearly explained his position, as well as the result of his experiments up to that date. He wrote: "The hypothesis advanced in my terse article in the *Medical News* of October, 1889, have given the most brilliant results; yet I have never felt that the time had arrived for me to experiment on the human subject. Nor do I mean to be tempted to take any risks until the act would be purely an unselfish one. Even with the results that have been obtained in my laboratory, I would be sorry to have the general public stimulated with the idea that inoculation for tubercular phthisis had been perfected.

"Owing to the rumored report that Professor Koch has been, and is, inoculating human beings, it behooves me to await his results and understand his methods. If, however, it should appear that he is working on different lines, and that his plan is less dangerous than my own, it will be welcomed and adopted by me."

On November 18th Dr. Dixon laid before the Academy of Natural Sciences a report summarizing in more detail his work of investigation on the tubercle bacillus. After alluding to the capability of the bacillus of changing from its commonly recognized rod-form to that of a more compound one, club-shaped, curved, or branched, which he believed to be either involution or degenerate forms, he went on to say: "There would appear to be in this homogeneous mass something other than the bodies of the micro-organisms. This may be the residue of the pabulum remaining after the bacilli have selected what was necessary for their existence, or a digestive secretion, or again it may be an excretion of the live organism. Let this be as it may, I hoped to find a changed functional action in the organism, in secretion or its excretion, that would combat tuberculosis in animal life, either by stimulating the cells or by causing a chemical reaction in the tissues that were susceptible to the digestive secretion of the tubercle bacillus.

An attempt to explain its probable action appears in an article I wrote for the *Medical News* of October 19th, 1889, and also in the *Medical and Surgical Reporter* and the *Times and Register* of this year. The views expressed are, however, purely hypothetical.

When the mass that I have already spoken of as being found on the pabulum was subjected for a considerable length of time to various degrees of heat, and injected into the guinea-pig, the animal seemed to sicken, yet only for a short time. The animals so treated appear to resist injections of virulent bacilli. Whether this would produce immunity for any length of time, provided we discontinue the administration of the remedy, I am not sure. Some animals injected with the virulent matter after the treatment with the changed mass had been discontinued appear to be immune, and experiments on animals suffering with tuberculosis have resulted most satisfactorily.

It is evident from this report that Dr. Dixon had pushed his ideas advanced on October 19th, 1889, to a stage promising to confirm in a remarkable degree the hypotheses laid down in his monograph, and that inoculation by the toxic agent had yielded most satisfactory results.

It cannot fail also to be remarked that there is a definiteness of statement, as far as the circumstances will admit, in Dr. Dixon's announcements which are lacking in those of his German colleague.

It soon became evident to Professor Koch that the attempt to withhold the composition of his remedy after it had been supplied to the profession was likely to defeat its own object. He therefore published on January 15th, 1891, a statement disclosing the nature of the remedy.

In this communication, after speaking of the preventive and curative effects of inoculating by living tubercle bacilli, he says:

"*This effect is not exclusively produced with living tubercular bacilli, but is also observed with the dead bacilli, the result being the same whether, as I discovered by experiments at the outset, the bacilli are killed by a somewhat prolonged application of a low temperature or boiling heat, or by means of certain chemicals. This peculiar fact I followed up in all directions, and this further result was obtained—that killed pure cultivations of tubercular bacilli, after rinsing in water, might be injected in great quantities under healthy guinea-pigs' skin without anything occurring beyond local suppuration.* If the injections are continued at intervals of from one to two days, the ulcerating inoculation wound becomes smaller and finally scars over, which otherwise it never does; the size of the swollen lymphatic glands is reduced, the body becomes better nourished, and the morbid process ceases, unless it has gone too far, in which case the animal perishes from exhaustion. *By this means the basis of a curative process against tuberculosis was established.*"

We have italicized these words in order to call the reader's attention in connection with their identical nature with the following statement by Dr. Dixon, published months before: "That by submitting a mass of growing bacilli to different degrees of heat, etc., and injecting the mass into animals, he not only prevented tuberculosis, but also cured the same."

Compare this with Koch's just-published claim, that by injecting tubercle bacilli that had been submitted to solar light, heat, etc., he had produced in guinea-pigs immunity, and also cure, and moreover that by this the curative process against tuberculosis was established, and if there is any difference between the two, we have not been able to detect it.

With this last utterance of Prof. Koch the literature on the subject of the cure for tuberculosis for the present ceases.

We have endeavored to lay before our readers a succinct and chronological account of the history of this great discovery.

The important question as to whom belongs the credit for it, and to whom should be awarded the priority, may well be left to them. We venture to think that the material is present here before them to enable them to form a correct judgment.

That the use of the remedy has not yielded the results expected from it by Prof. Koch is very probable, and it is difficult to avoid the reflection that a more conservative policy, such as that persistently advocated and followed by Dr. Dixon, would have been wiser, and moreover kinder to those whose hope of cure had been unduly raised. There is abundant work to be done yet in the laboratories before definite conclusions can be reached, and the inoculation into the human system is therefore to be deprecated as premature. That the main principle has been arrived at seems beyond doubt, but much yet remains before the discovery can become of permanent benefit to suffering humanity.

—IN these days of object teaching, science made easy, and German taught by the lightning method, it is not surprising to find that there are philanthropic men who will undertake to see a college graduate through commencement day—for a consideration.

That this long felt want has been filled is due to the enterprise of two Ohio men. Their circular announces that "the student of the present day finds that in doing justice to the physical man he has little time for literary work." There are those of us who had a lingering fancy that colleges were endowed and professors engaged to stimulate young men to mental labor. We are glad to be corrected, and shall, after this, adopt the more advanced views upon the subject.

These philanthropists admit "there *may* be students in every college who enjoy literary work," but their sympathies go out to "those who are obliged by a tyrannical college faculty to waste both mortal time and parental money in gorging a brain with a material that is as essentially foreign to that particular intellect as is sawdust to the human system." With a consideration born, perhaps, of experience, they agree to furnish to the possessors of these overworked brains already digested food, so that in the end they may put to shame the tyrannical faculty who are such fossils that they think a man goes to college to study.

The price of show brains is quite reasonable. Orations, essays, debates, eulogies, invectives, sermons, political speeches, and lectures range from \$3 to \$50,—a graduated scale of prices to suit the parental pocket,—and all written by "two of the most prolific writers of the age," who will write anything and everything, on any and all subjects. These two men must belong to that misguided, behind-the-age set who enjoyed literary work at college. However, the point of it all is just this, now that the public know there is learning in the land to be had at so much per foot or yard of foolscap, it will no longer submit to the imposition of stupid, prosy essays on commencement days.

Do men gather grapes of thorns, or figs of thistles? Yea, verily, if they can pay for them.

—PROFESSOR J. W. SPENCER has had the usual difficulty experienced by all scientific men who hold political positions. The Treasurer of the State of Georgia forced a geological ignoramus on him as a subordinate, who calls quartz magnetite, silicified wood as lignite, slabs of feldspar as quartz, etc. The assistant's brother is a representative, and has been trying to groom the young man for State Geologist. He defeated the geological bill which abolished the political board. His testimonials were obtained under false pretences. But these are now exposed. The Governor is at Professor Spencer's back. What the Legislature will do in July is not yet known, but if it knows the true interest of the State it will permit Dr. Spencer to select his own assistants.

RECENT BOOKS AND PAMPHLETS.

ALBRECHT, DR.—Über den Stammbaum der Nagethiere. Sitzungsbericht der Physikalisch-ökonomischen Gesellschaft zu Königsberg, June, 1880. From the author.

ALLEN, J. A.—On Seasonal Variations in Color in *Sciurus hudsonius*.—A Review of Some of the North American Ground Squirrels of the Genus Tamais. Exts. Bull. Am. Mus. Nat. Hist., Vol. III., 1890. From the author.

Annual Report of the Kansas Experiment Station State Agri. College, 1888.

Atlas of Northern Anthracite Coal Field; Atlas to Reports HH and HHH. From the Penna. Geol. Survey.

BARCENA, M.—Informe sobre el Estado Actual del Volcan de Colima. From the author.

BAUR, G.—Neue Beiträge zur Morphologie des Carpus dur Säugetiere. Sonder-Abdruck aus *Anatomischer Anzeiger*, IV. Jahrgang (1889), No. 2.

——Bemerkungen über den Carpus der Proboscidier und der Ungulaten im Allgemeinen. Separat-Abdruck aus *Morpholog. f. Jahrbuch*, XV. Bd., 3 Heft.

——Die Systematische Stellung von Dermochelys Blainv. Sonder-Abdruck aus dem *Biologischen Centralblatt*, March, 1889.

——Ueber den Ursprung der Extremitäten der Ichthyopterygia. Oberrheinischen. Geologischen Vereins zu Metzingen in Würtemberg, April, 1887. From the author.

BAXTER, S.—Berlin: A Study of Municipal Government in Germany. Bull. Essex Institute, April, May, June, 1889. From the author.

BEAN, T. H.—New Fishes Collected off the Coast of Alaska and the Adjacent Region Northward. Ext. Proc. U. S. Nat. Mus., Vol. XIII., pp. 37-45. From the author.

BECKER, G. F.—The Washoe Rocks. Ext. Bull. No. 6, Cal. Acad. Sci. From the author.

BEECHER, C. E.—On the Development of the Shell in the Genus Tonoceras Hyatt.

BOULENGER, G. A.—Remarks on C. W. De Vis's Recent Contributions to the Herpetology of Australia. Ext. *Ann. and Mag. Nat. Hist.*, Nov., 1885.

——On the Varieties of *Chalcides ocellatus* Forsk. Ext. *Ann. and Mag. Nat. Hist.*, June, 1890.

——An Account of the Batrachians Obtained in Burma by M. L. Fea, of the Genoa Civic Museum. Ext. Annali del Museo Civico, 1887.

——A Reply to M. De Betta's Remarks on *Rana temporaria*. Ext. *Ann. and Mag. Nat. Hist.*, March, 1886.

——Fourth Contribution to the Herpetology of the Solomon Islands.—First Report on Additions to the Lizard Collection in the British Museum (Nat. Hist.).—List of the Reptiles, Batrachians, and Fresh-Water Fishes Collected by Prof. Moesch and Mr. Iversen in the District of Deli, Sumatra. Exts. Proc. London Zool. Soc., 1890. From the author.

BRITTON, N. L.—On an Archean Plant from the White Crystalline Limestone of Sussex Co., N. J. Ext. Ann. N. Y. Acad. Sci., Vol. IV.—On Recent Field Work in the Archean Areas of Northern New Jersey and Southeastern New York. Proc. A. A. A. S., 1887. From the author.

Bulletin No. 7, Penna. State College Agri. Station.

Bulletin de l'Academie Royale des Sciences des Lettres et des Beaux Arts de Belgique, 1890.

CARLSSON, A.—Untersuschungen ueber Gleidmassen-Reste Bei Schlangen. Bihang Till K. Svenska Vet. Aked. Handlingar. Band II., No. 11.

CROSS, W., and L. G. EAKINS.—On Ptilolite, a New Mineral. Ext. *Am. Jour Sci.*, Aug., 1886. From Whitman Cross.

DANA, J. D.—Volcanic Action. Ext. *Am Jour. Sci.*, Feb., 1887.—A Dissected Volcanic Mountain; Some of its Revelations. Ext. *Am. Jour. Sci.*, Oct., 1886. From the author.

DAWSON, W. J., and G. J. HINDE.—New Species of Fossil Sponges. Ext. *Canadian Record of Science*, 1888. From the authors.

DOLLO, L.—Troisième Note sur les Dinosauriens de Bernissart. Extrait du Bull. du Musée Royal de Belgique, 1883.

——Notes sur les Vertébrés Fossiles, Récemment Efferts au Musée de Bruxelles par M. Lemmonier. Extrait du Bull. de la Société Belge de Geol., 1889. From the author.

EIGENMANN, C. H., and R. S. EIGENMANN.—A Revision of the South American Nematognathi, or Cat-Fishes. Proc. Cal. Acad. Sci., July, 1890. From the authors.

EUDES-DESLONGCHAMPS, E.—Notes Paleontologiques. Rapport sur les Fossiles Oxfordiens de la Collection Jarry. From the author.

FARLOW, W. G.—The Task of American Botanists. Ext. *Popular Sci.*, July, 1887.

FRAZER, P.—The Horizon of the South Valley Hill Rocks in Pennsylvania. Read before the Am. Philos. Soc., Dec. 15, 1882.

——The Philadelphia Meeting of the International Congress of Geologists. Ext. *Am. Geol.*, June, 1890. From the author.

GARMAN, S.—Reptiles and Batrachians from the Caymans and from the Bahamas. Bull. Essex Institute, July to Dec., 1888. From the author.

GAGE, S. P.—Form, Endings, and Relations of Striated Muscular Fibres in the Muscles of Minute Animals (Mouse, Shrew, Bat, and English Sparrow). Ext. from *The Microscope*, Aug., 1888. From the authoress.

GEINITZ, H. B.—Ueber die rothen und bunten Mergel der oberen Dyas bei Manchester. Ges. Isis in Dresden, 1889. From the author.

GILL, T.—On the Psychrolutidæ of Günther. Ext. Proc. U. S. Nat. Mus., 1888. From the author.

HALSTEAD, B. D.—Notes upon Stamens of Solanaceæ. Ext. *Bot. Gaz.*, May, 1890.—Rusts, Smuts, Ergots, and Rots. Address before N. J. Board of Agriculture, Jan. 31, 1890. From the author.

HANSTEIN, J.—Christian Gottfried Ehrenberg, ein Tagework, auf dem Felde der Naturforschung des Neunzehuten Jahrhundertz.

HEILPRIN, A.—The Animal Life of Our Seashore. From J. B. Lippincott & Co.

HEINRICH, C. F.—Death from Electrical Currents. From the author.

JAMES, J. F.—A Cave in the Clinton Formation of Ohio. Ext. *Jour. Cin. Soc. Nat. Hist.*, May, 1890.

——On the Maquoketa Shales, and their Correlation with the Cincinnati Group of Southwestern Ohio. Postscript to above Article. Exts. *Am. Geol.*, 1890. From the author.

KINGSLEY, J. S.—The Development of *Crangon vulgaris*. Third Paper. Bull. Essex Institute, Jan., Feb., March, 1889. From the author.

LAWSON, A. C.—Note on the Pre-Palezoic Surface of the Archean Terranes of Canada. Ext. Bull. Geol. Soc. America, March, 1890. From the author.

LECHE, W.—Über einige Entwicklungsstadien der Hypophysis cerebri. Ext. Proc. Biol. Soc. Stockholm, Dec., 1888. From the author.

LÉVY, A. M.—Sur un Gisement Furançaise de Mélaphyres à Enstatite. Ext. Comtes rendues des Séances de l'Académie des Sciences, Mars., 1889.

——Structures et Classifications des Roches Eruptives. From the author.

LEWIS, T. H.—The Silver Find in Kentucky. *Am. Antiquary*, July, 1887.

——Ancient Fireplaces on the Ohio. Ext. *Am. Antiquary*, May, 1889.

——Stone Monuments in Northwestern Iowa and Southwestern Minnesota. Ext. *Am. Anthrop.*, July, 1890. From the author.

MARTIN, L. J.—Preliminary Analysis of the Leaves of *Juglans nigra*. Ext. *Am. Jour. Phar.*, Oct., 1886. From the author.

MERRILL, G. P.—Notes on the Composition of Certain " Pliocene Sandstones " from Montana and Idaho. Ext. *Am. Jour. Sci.*, Sep., 1886. From the author.

MONACO, ALBERT, PRINCE DE.—Sur un Appareil Nouveau pour la Recherche des Organismes Pelagiques a des Prolon dems Déterminées. Extrait des Comptes rendus des Séances de la Société de Biologie, Juin, 1889.

Museum Catalogue of Pennsylvania Geological Survey.

NADAILLAC, LE MIS DE.—Les Premières Populations de l' Europe. From the author.

Ninth Report of the Committee on the Metric System of Weights and Measures. Ext. Jour. Ass. of Engineering Societies, Nov., 1884.

Report of the New Jersey State Geologist, 1889.

RICE, W. N.—Science-Teaching in the Schools. From the author.

RYDER, J. A.—The Origin of Sex through Cumulative Integration, and the Relations of Sexuality to the Genesis of Species. Ext. Proc. Amer. Philos. Soc., May, 1890. From the author.

SPENCER, J. W.—Ancient Shores, Boulder Pavements, and High-Level Gravel Deposits in the Region of the Great Lakes. Ext. Bull. Geol. Soc. Am., Vol. I., 1889. From the author.

STEPHENSON, F. B.—A Summary of Holsti's Views on Anterio-Capillary Sclerosis. Ext. *New York Medical Jour.*, Nov., 1886.

——Arabic and Hebrew in Anatomy. Ext. *New York Medical Jour.*, July, 1886.

STOWELL, T. B.—The Glosso-pharyngeal, the Accessory, and the Hypoglossal Nerves in the Domestic Cat. Read before the Am. Philos. Soc., March 2, 1888.

——The Soft Palate in the Domestic Cat. Ext. Proc. Am. Soc. Microscopists, Vol. X., 1888. From the author.

Transactions of the Brooklyn Pathological Society.

TROUESSART, E.—Revue de Paléontologie pour l'Année, 1887. Vertébrés. From the author.

WATSON, J.—Caird's Philosophy of Kant. Ext. *The Week*, Jan. 24th, 1890.

WHITEAVES, J. F.—On Some Fossils from the Hamilton Formation of Ontario.—The Fossils of the Triassic Rocks of British Columbia.—On some Cretaceous Fossils from British Columbia, the Northwest Territory, and Manitoba. Geol. and Nat. Hist. Survey of Canada. From the author.

WIEDERSHEIM, R. VON.—Weitere Mltteilungen über die Entwicklungsgeschichte des Schulter und Beckengürtels. Sonder-Abdruck aus *Anatomischer Anzeiger*, V., Jahrgang (1890), No. 1. From the author.

WILDER, B. G.—Address before the Section of Biology. Am. Assoc. Adv. Sci., 1885. From the author.

WINCHELL, A.—Conglomerates Enclosed in Gneissic Terranes.—Views on Pre-Nebular Conditions.—Douglass Houghton.—Exts. *Am Geol.*, 1889. From the author.

WOODWARD, A. S.—On the Paleontology of Sturgeons. Ext. Proc. Geol. Assoc., Vol. XI. From the author.

WOOLMAN, L.—Geology of Artesian Wells at Atlantic City, New Jersey. Ext. Proc. Phila. Acad. Nat. Sci., March, 1890. From the author.

RECENT LITERATURE.

Justus Roth's "Allgemeine Geologie"[1] treats of the original crust of the earth and of the theory of metamorphism. In that part of the volume now before us the author maintains his position as one of the most indefatigable investigators of geological literature. As the result of his labors he has produced a book which at the same time is almost a complete index of the literature of metamorphism and a cyclopedia of the facts learned or surmised with respect to the phenomenon. To the plutonist it serves as a very welcome antidote to the great mass of neptunistic doctrine now penetrating the body of geological thought. In it is denied *in toto* the possibility of the alteration of a sediment into a crystalline-schist. The origin of those crystalline-schists that are not members of the original crust is ascribed in all cases to the dynamo-metamorphism of plutonic rocks. At the same time it is denied that pressure without attendant chemical action is able to produce such changes as are necessary in a rock to transform it from a granite or gabbro into a gneiss or a hornblende-schist. The necessary chemical action is thought to be sometimes the direct consequence of the pressure, and sometimes to be merely the ordinary processes of complicated weathering. No reliance is placed in the conclusion that the granulites of Saxony are regularly metamorphosed granites, or that the hornblende-schists are (as is supposed to be the case by Rosenbusch) "metamorphic facies of gabbro."

After discussing briefly the constitution of the original crust, of which the crystalline-schist formation is supposed to be the survival, the author plunges at once into the subject of metamorphism, which he takes up and treats with the same thoroughness as is evinced in the first two volumes of his work. The principal topic of the portion of the volume before us is the description of metamorphic phenomena, under which are described the action of lightning on rocks, the products of the action of coal burning underground (Erdbrände), and the changes produced in rocks by the intrusion through them of eruptives (contact-action). Under contact-action are treated the effect of igneous rocks upon coals, their effect upon inclusions caught up in them during their progress to the surface, and the result of their action upon eruptive and sedimentary rocks through which they break.

[1] Allgemeine und Chemische Geologie. 3 B. 1 Abt. Hertz (Besser'sche Buchhandlung), Berlin, 1890, 210 pp.

The effects upon inclusions of various kinds are discussed in detail, first coming quartz inclusions, then following in order inclusions of old eruptive rocks and crystalline-schists, inclusions of younger eruptives, inclusions of clastic rocks, of sandstone, of quartzite, of basalt-jasper, and of contact-rocks. Contact-action proper is treated under three heads: first, the action upon intruded eruptives; second, upon crystalline-schists; and third, upon sedimentaries. Endomorphous contact-action is next described, and the articles relative to it are briefly extracted. The action of pressure upon rocks is next taken up, and the discussion of the changes produced in them by gaseous emanatious concludes the portion of the volume under review. Practically all the results bear-upon metamorphism that have been reached by investigators in their study of rocks are incorporated in the book, so that for this reason, if for no other, it becomes indispensable to the working lithologist as well as to the geologists. Many students will be unwilling to share with Dr. Roth his skepticism with regard to the conclusions reached by careful observers in all parts of the world, but none of them can afford to be without the volume on their book-shelves for consultation.

W. S. B.

General Notes.

GEOLOGY AND PALEONTOLOGY.

Discovery of Fish Remains in Ordovician Rocks.—At a meeting of the Biological Society of Washington on February 7th, 1891, Mr. Charles D. Walcott, of the U. S. Geological Survey, announced the discovery of vertebrate life in the Lower Silurian (Ordovician) strata. He stated that " the remains were found in a sandstone resting on the prepaleozoic rocks of the eastern front of the Rocky Mountains, near Cañon City, Colorado. They consist of an immense number of separate plates of placoganoid fishes and many fragments of the calcified covering of the notochord, of a form provisionally referred to the Elasmobranchii. The accompanying invertebrate fauna has the facies of the Trenton fauna of New York and the Mississippi valley. It extends upward into the superjacent limestone, and at an horizon 180 feet above the fish beds. Seventeen out of thirty-three species that have been distinguished are identical with species occurring in the Trenton limestone of Wisconsin and New York.

"Great interest centers about this discovery from the fact that we now have some of the ancestors of the great group of placoderm fishes which appear so suddenly at the close of the Upper Silurian and in the lower portion of the Devonian group. It also carries the vertebrate fauna far back into the Silurian, and indicates that the differentiation between the invertebrate and vertebrate types probably occurred in Cambrian time."

Mr. Walcott is preparing a full description of the stratigraphic section, mode of occurrence and character of the invertebrate and vertebrate faunas, for presentation at the meeting of the Geological Society of America, in August, 1891.

MINERALOGY AND PETROGRAPHY.[1]

Petrographical News.—Among the several brochures lately published explanatory of the new map of France, one by Lacroix[2] contains two articles. The first is descriptive of the metamorphic and eruptive rocks of Ariège, and the second is on the acid inclusions in the volcanic rocks of the Auvergne. In the former the marbles of Mercus and Arignac are carefully described. In them occur two varieties of humite, brucite, amphibole, phlogopite, scapolite, spinel, corundum, sphene, rutile, zircon, and many other less common minerals. One variety of the humite occurs in rounded crystals of a clear yellow color, that become colorless in thin section. The other variety is light orange, becoming golden yellow in the section. Both possess the same optical properties, except that the orange crystals are pleochroic in pale yellow and light golden-yellow tints. They are classed by the author with the clino-humites. Their alteration products are interesting. The most usual alteration is into brucite, found either in little plates, often several millimeters in length, or in fibres forming aureoles around unaltered cores of humite. Another alteration is into chrysotile. This is rare, and the change is usually incomplete. A third method of decomposition is into a granular mixture of secondary calcite, dolomite, and small grains of the original mineral. The amphibole in the rocks is pargasite. Two varieties of spinel were observed, one a violet and often transparent variety, and the other green pleonast. The violet spinel often accompanies the pargasite and humite. Both spinels are almost always surrounded by a circle of colorless chlorite in thin plates, and this in turn by a zone of secondary calcite and an outer rim of brucite. The rutile merits special attention, because what appears to be the ordinary black variety is found in thin section to be sometimes this, and sometimes like the violet rutile of the amphibole and pyroxene gneisses of Norway. The pyroxene and amphibole gneisses of this region and the wernerite gneisses present few peculiarities. The marbles, pyroxene gneisses, and granulites of St. Barthélemy are all marked by interesting features. The accessory components of the marbles are almost exclusively graphite, scapolite, pyroxene, and occasionally oligoclase, the last three forming rounded grains rarely surpassing a millimeter and a half in diameter.

[1] Edited by Dr. W. S. Bayley, Colby University, Waterville, Me.

[2] Bull. des Serv. d. l. Carte. géol. d. France, No. 11, T. II.

The peridotite contains hypersthene and amphibole. Its olivine is perfectly fresh, and is in irregular grains imbedded in the amphiboloids. Some of the granulites contain corroded crystals of bright red andalusite, and also black tourmaline, sphene, muscovite, and garnet disseminated in a ground-mass of feldspar and quartz. Other granulites are very rich in cordierite, and these are in general less rich in quartz than are those bearing andalusite. Micaceous and quartzitic schists from the neighborhood of Ax embrace zircon, apatite, sphene, magnetite, and numerous other materials, thought to be due to the action of the granulite on the schists. On the granulite side of the contact this rock is found to be charged with andalusite, and often with cordierite. Pyroxenites consist of a colorless diopside, zoisite, garnet, calcite, occasionally quartz, and frequently vesuvianite, of which latter it is possible to isolate beautiful amber-yellow crystals of the variety egeran. In the second article by the same author is a discussion of the changes effected in acid inclusions by the basaltic and acid rocks of Auvergne. Two classes of these inclusions are recognized, viz., those found in lava streams, and those occurring in volcanic necks. Both classes include granites and gneisses rich in quartz, and frequently containing cordierite, sillimanite, garnet, corundum, diaspore, and zircon. The changes effected in them by the basic lavas varies in intensity, but not materially in kind. In extreme cases the inclusion has been entirely dissolved, with the exception of the insoluble substances, such as sillimanite, zircon, and diaspore, which remain as grains in the volcanic glass. The cleavages of the original feldspars have been accentuated, many liquid and gaseous inclosures have been developed in them, and the optical properties of the orthoclase have been changed. Quartz fragments in the altered forms have been surrounded by aureoles of augite. The new minerals developed in the surrounding rock by the solution of the inclusion are spinel, hypersthene, and sometimes labradorite, sometimes forming holocrystalline aggregates, and at other times occurring as individual grains bathed in a vitreous paste. In each case the minerals are met with only in the lava that has been injected between the components of the inclusions. They are not present in the magma enclosing them. The inclusions in the andesites and trachytes of the region are gneisses and kersantites. In most respects the changes that have been produced in them are analogous to those produced by the basalts. Much new feldspar has been generated in them, and this is usually optically continuous with the original feldspar to which it is attached. Tridymite is also an abundant new product, as are also spinel and hypersthene. All these minerals are produced in the inclusion; whereas in the case of the basaltic alteration the last two are found in the metamorphosed rock. In a later article Lacroix[3] summarizes the results of his study of inclusions, with reference especially to those of the Haute-Loire. When the inclusions are of the same composition as the enclosing rock, the former have in general been well preserved. If, on the contrary, the inclusion differs in its silica content from the surrounding rock, it is easily destroyed, merely traces of it remaining to mark its former presence.——Graywacke in contact with granite in the Lausitz, Saxony, is changed to knotty (Knoten) graywackes, in which muscovite, biotite, quartz, feldspar, and tourmaline occur as new products, and finally into a quartz-mica rock with cordierite, tourmaline, and some other new products. On the granitic side the rock has assumed a gneissic aspect, thought by Herrimann and Weber[4] to be the result of flowage.——The micro structure of several calcareous oölites from Iowa, and of siliceous oölites from Pennsylvania, is represented by Messrs. Barbour and Torrey[5] as concretionary in most cases, while in others the spherules have a brecciated or mosaic appearance. Analyses of several kinds ot oölites are given in the paper.

New Minerals.—*Castanite*, associated with barite occurs on a copiapite specimen from Sierra Gordo, Chili, in the form of large, brown, prismatic crystals, without well-developed faces. According to Darapsky[6] their streak is orange, hardness 3, and density 2.18. They are but slightly soluble in water or in cold hydrochloric acid, but easily dissolve in hot acid. Their composition ($SO_3 = 33.80$; $Fe_2O_3 = 33.92$; $H_2O = 30.76$; barite $= 1.15$) corresponds to $Fe(FeO)(SO_4)_2 + 8H_2O$. The crystallization is probably monoclinic.——*Manganopectolite* is associated with ozarkite and other decomposition products of elæolite-syenite at Magnet Cove, Ark.[7] On a fresh fracture the mineral is light gray and transparent. On its exterior it is covered with an opaque coating of brown manganese oxide. The crystals are bounded by oP, $\infty\bar{P}\infty$, $+ 2\bar{P}\infty$ and $\infty\bar{P}\infty$, and their axial ratio is $a : b : c =$ 1.0731 : 1 : 4840. Their habit is thick tabular. Cleavage is perfect, parallel to oP and $\infty\bar{P}\infty$. Hardness $= 5$, and density 2.845. Composition:

SiO_2	Fe_2O_3	CaO	MnO	Na_2O	H_2O	CO_2
53.03	.10	30.28	4.25	8.99	2.43	.82

[3] Bull. Soc. Franç. d. Min., XIII., 1890, p. 100.
[4] *Neues Jahrb. f. Min.*, etc., 1890, II., p. 187.
[5] *Amer. Jour. Sci.*, Sept., 1890, p. 246.
[6] *Neues Jahrb. f. Min.*, etc., 1890, II., p. 267.
[7] J. F. Williams. *Zeits. f. Kryst.*, XVII., 1890, p. 386.

Correcting for the small amount of calcite present, the analysis corresponds with the formula $(\frac{9}{10}\ Ca, \frac{1}{10}\ Mn)_2\ Na\ H\ (SiO_3)_3$—a pectolite with a tenth of its calcium replaced by manganese. In its optical properties the new mineral agrees well with the view that it is closely allied to pectolite. Its axial plane is $\infty\bar{P}\infty$, with b the acute bisectrix. The double refraction is positive, and the dispersion is strong $\varsigma > \rho$.——*Pinakiolite* and *trimerite* are both new minerals from the Manganese Mines in Sweden. The name of the first refers to its occurrence in small, tabular crystals. It was found by Flink[8] in granular dolomite at Langbanshyttan, associated with hausmannite. The density of the new mineral is 3.881, and its hardness is 6. It is soluble in strong hydrochloric acid with evolution of chlorine, and before the blowpipe it fuses with difficulty to a black bead. An analysis of the hydrochloric acid solution yielded :

B_2O_3	MgO	Mn_3O_4	Fe_3O_4	CaO	PbO	SiO_2	H_2O
15.65	28.58	49.39	2.07	1.09	.76	1.21	.47

Correcting for silica and water, the formula becomes R_3BMnO_5, or a manganese *ludwigite*. The black, lustrous crystals are usually orthorhombic, rectangular tables, in which the brachypinacoid is most developed. In addition to this there is present in the mineral only $\infty\bar{P}3$. A definite termination of the c axis is lacking, but since twins with a brachydome as a twinning plane are common, the axial ratio was calculated with this as the unit form, and the following result obtained : $a : b : c = .83385 : 1 : .58807$. Cleavage is parallel to $\infty\breve{P}\infty$. The optical axial plane is oP, with b the negative acute bisectrix. The absorption is $B > A > C$, with $B = c =$ opaque ; $A = b =$ reddish-brown, and $C = a =$ reddish-yellow. *Trimerite* (τριμερής = three-fold) was found at the Harstigsgrube associated with friedelite implanted on a fine-grained aggregate of magnetite, pyroxene, garnet, etc. The density = 3.474, and hardness = 6–7. The pulverized mineral dissolves in hot hydrochloric acid, with the separation of gelatinous silica. Its composition :

SiO_2	BeO	MnO	FeO	CaO	MgO
39.77	17.08	26.86	3.87	12.44	.61

corresponds to $(MnBe)SiO_4$, a manganese *phenacite*. The transparent bright red crystals have an hexagonal habit, due to twinning of triclinic individuals, whose triclinic nature is discoverable only by optical methods. In order to show their relations to the Willemite

[8] *Zeits. f. Kryst.*, XVIII., 1890, p. 361.

group the author describes the crystals in terms of the hexagonal system with $a : c = 1 : .7233$. They are thick, tabular forms, bounded by oP, $_\infty P2$, $_\infty P$, $\frac{3}{2}$ P2, $\frac{3}{4}$ P2 and $\frac{15}{8}$ P $\frac{5}{4}$, and other pyramids with complicated symbols. Brögger finds that sections parallel to $_\infty P2$ extinguish at about 4° from c. $2V = 83° 29'$, with a very slight dispersion. The angles α, β and γ are all nearly 90°, so that the combination is somewhat similar to the combination of orthorhombic aragonites to produce an apparently hexagonal form. The axial ratio on the assumption of triclinic symmetry becomes $a : b : c = .5744 : 1 : .5425$, and the forms oP, $\infty \bar{P} \infty$, ∞P^1, $\infty {}^1P$, P^1, ${}^1P$, P_1, ${}_1P$, $\frac{3}{2} \bar{P}^1 3$, $\frac{3}{2} \bar{P}_1 3$.

Mineral Syntheses.—Boracite has been produced by Gramont[9] in the wet way. One part of borax and two of magnesium chloride were moistened with water and heated to 275°–280° in a sealed tube. Little crystals of the mineral thus obtained are bounded by tetrahedrons, octahedrons, and other forms apparently belonging to the regular system. Each tetrahedral face, however, is observed, upon examination, to be composed of small sectors, indicating a grouping of individuals of lower symmetry to produce a pseudo-regular form. When the mixture was heated at a temperature below 265° (the temperature at which natural boracite becomes isotropic) no boracite was obtained, but in its stead there resulted elongated hexagonal crystals of some substance not yet investigated.——One part of alumina and two of silica, according to Vernadsky,[10] unite at a white heat to form a glass which, under the microscope, is seen to be filled with little needles of sillimanite, with the composition : $SiO_2 = 37.31$; $Al_2O_3 = 63.65$. Porcelaine consists essentially of the same substances, viz., a glass holding acicular crystals of sillimanite.——Many of the most important zeolites have been manufactured by Doelter,[11] who at the same time has solved some of the problems as to their composition. His method of procedure was to dissolve suitable substances at moderately high temperatures under pressure, and allow them to cool gradually and crystallize. In this way he succeeded in making apophyllite, chabazite, heulandite, natrolite, and skolecite. The author next proceeded to investigate the composition of the minerals formed by heating some specimens to a temperature beyond which they lose water, occasionally examining them chemically and optically, and by fusing others and studying their decomposition products. At 260° apophyllite loses 19 per cent. of its

[9] Bull. Soc. Franç. d. Min., XIII., 1890, p. 252.

[10] Ib., p. 256.

[11] *Neues Jahrb. f. Min.*, etc., I., 1890, p. 118.

water, and above this temperature is decomposed. Just below 260° the hydrate is biaxial, while above this temperature the anhydrous residue is uniaxial. Other zeolites yield similar results. These lead to the conclusion that they all consist of a nepheline, pyroxene, or feldspar-like silicate, combined with meta- or orthosilicic acid, and also an amount of water varying with the temperature. The crystal water may be driven off at high temperature, and taken up again at a lower one, and the various hydrates obtained by the successive steps may possess different crystallographic properties. After a certain amount of loss the minerals refuse to part with more water, which is regarded as chemically combined with silica in the silicic-acid portion of the combination. The author determines incidentally the solubility of several of the zeolites in different solvents, and concludes his paper with a table giving the supposed composition of the members of the group. Heulandite is represented as $CaAl_2Si_4O_{12}+2H_2SiO_3+3Aq$; natrolite as $Na_2Al_2Si_2O_8+H_4SiO_4$, etc.——Messrs. C. and G. Friedel,[12] by the action of lime on mica in the presence of calcium chloride, obtained small crystals of anorthite, and by the action of soda and sodium sulphate on the same mineral produced little prismatic crystals of a substance differing from nosean in the addition of two molecules of water.[13]

Physical Mineralogy.—The discussion as to the cause of optical anomalies in uniaxial crystals has received another addition in a late article contributed by Martin,[14] in which the writer attempts to show that the Mallard theory with respect to these phenomena is faulty. Mallard believes that the crystals are pseudo-uniaxial; that they consist of several twinned individuals, which by their combination build up a form possessing a geometrical symmetry of higher grade than that belonging to its individual constituents. Martin has examined several organic compounds, and is thereby led to the conclusion that in these the anomalies are due to strain or pressure exerted on some parts of the crystal by the more rapid growth of other parts. It is well known that in many crystals a skeleton is formed first in the act of crystallization, and that this skeleton is subsequently filled in by the deposition of material within its arms. The skeleton thus grows faster than the interstitial substance, and exerts in this latter a strain whose effect is exhibited in the anomalies. Other important thoughts are brought out in the investigation, which appears to have been conducted in a

[12] Bull. Soc. Franc. d. Min., XIII., 1890, p. 233.
[13] Ib., p. 238.
[14] *Neues Jahrb. f. Min.*, etc., B.B. VII., p. 1.

careful and conscientious manner.——Wyrouboff,[15] in a reply to Martin's article, states that the latter's results differ but little from his own, and that the conclusions reached by him comprehend no new notions. ——The writer last referred to (W.) has recently[16] completed a series of experiments on circularly polarizing substances, by which he seems to have shown that the peculiar property of these bodies is due to their structure, which is described by Mallard as an irregular piling of very small biaxial plates. In this way a high grade of symmetry is imitated, while the plates are really of a low grade. He also adds a nineteenth substance to the list of rotatory polarizing bodies, viz., $(NH_4)LiSO_4$, which is apparently biaxial and positive.——The effect of temperature upon the optical and crystallographic constants of prismatic sulphur has been thorougly investigated by Schrauf,[17] who records his results in an excellent paper of fifty-nine pages. The first part discusses the values of the interfacial angles at different temperatures. The second is confined to refractive phenomena, such as the refractive index for different wave lengths. The third and fourth contain calculations of the values of the optical constants, and the fifth contains a discussion of the relations existing between the refractive indices and the wave length of the transmitted light, temperature, and other factors, and concludes with remarks on the constancy of the refractive and dispersive power, and upon the crystal form of prismatic sulphur.——A paper by Becke[18] on the etching of fluorite is a remarkable exhibit of careful and painstaking work in this branch of physical mineralogy. The author has subjected both natural and prepared faces of crystals from various localities to the action of acids and alkalies of various strengths and at different temperatures, and has studied the results produced. The symmetry of the figures obtained indicate a tetragonal symmetry for the mineral. Anomalous figures on some crystals, found only on planes that show double refraction, are explained as due to the manner of growth. Many new ideas are gathered from the study, one of the most important of which is embodied in a restatement of the law of symmetry of etched figures. These possess the symmetry of the face on which they occur only when this is a natural one free from striations, vicinal planes, etc. Experiments on the solubility of the mineral in different directions lead to the expression of a law of solubility as follows: The rapidity of solubility is equal along equivalent crystallo-

[15] Bull. Soc. Franc. d. Min., XIII., 1890, p. 94.

[16] Ib., p. 215.

[17] *Zeits. f. Kryst.*, XVIII., 1890, p. 114.

[18] *Miner. u. Petrog. Mitth.*, XI., 1890, p. 349

graphic directions, and different along unequivalent directions. Further, the author finds that elevations due to etching (aetzhügel) occur on faces least capable of resisting solution, while depressions (aetzgrübchen) are produced in the least soluble faces. Etching zones, he defines as those containing the planes with the greatest capacity for resisting solution. Many more results of interest are contained in the paper, the character of which is sufficiently indicated by the conclusions above referred to.——The natural etched figures on the topaz of San Louis Potosi, Mexico, correspond in symmetry with the faces on which they occur, with the exception of those on the brachypinacoid $2P\breve{\infty}$, which are unsymmetrical. According to Pelikan[19] they resemble the figures produced by Baumhauer upon treating the mineral with molten potassa.——Dufet[20] obtains 1.54421 as the value of the refractive index of quartz, based on the examination of seventeen different specimens of the mineral.

Miscellaneous.—The cosmic dust (kryokonite) collected by Nordenskjöld in Greenland, in 1883, has been submitted to Wülfing[21] for investigation, by whom it has been found to consist in greater part of feldspar, quartz, mica, and hornblende. There are present in it also garnet, zircon, magnetite, augite, and sillimanite, and with them is mixed a nitrogenous organic substance. The most interesting constituents of the dust are little chondri of opaque, isotropic transparent, and double refractive material. The larger part of the dust is thought to be a sediment from the air, and to have been obtained by it from a region of crystalline schists. The chondri, on the other hand, are thought to be of cosmic origin, since they are similar to the chondri obtained in deep-sea soundings. If the amount of the dust collected from the snow in Greenland represents the fall of one year, the total amount falling upon the entire surface of the earth in this time is 125 million kilograms, equivalent to a cube of thirty-one yards on a side.——A new crystal refractometer has been devised by Czapski.[22] Its construction and use is carefully described by the inventor in a recent paper in the *Neues Jahrbuch.*——That a definite relation exists between the habits of crystals of certain minerals and their mode of formation has long been recognized, but it has been left for Arzruni[23] to undertake a systematic study of this relation. In a

[19] Ib., XI., 1890, p. 331.
[20] Bull. Soc. Franc. d. Min., XIII., 1890, p. 271.
[21] *Neues Jahrb. f. Min.*, etc., B. B., VII., p. 152.
[22] *Neues Jahrb. f. Min.*, etc., B. B., VII., p. 175.
[23] *Zeits. f. Kryst.*, XVIII., 1890, p. 44.

late paper this writer communicates the results of the examination of crystals of hematite produced by sublimation in smelting furnaces and those from San Sebastiano, Italy, that are supposed to have been formed in an analogous manner. In all of these the habit is the same, although different combinations of nearly related forms occur on them. Sublimed valentinite and senarmontite are likewise studied. Cuprite produced by slow oxidation at a low temperature has an octahedral or dodecahedral habit, while that produced at a high temperature is probably hexahedral. Struvite obtained from a solution of Koch's peptone differs materially from the natural mineral, but the differences have not yet been carefully enough studied to warrant any general conclusion being drawn from the observations. Further articles from Prof. Arzruni will be looked for with interest.

BOTANY.

The Relative Altitudes of the Rocky and Appalachian Mountain Systems as Influencing the Distribution of Northern Plants.—In the study of the geographical distribution of North American plants certain difficulties have been apparent since the adoption of three "regions," extending north and south, and denominated respectively the eastern, central, and western. A much better division of the continent is that proposed by Britton,[1] who recognizes a northern region, including British America, the Sierras, the Rockies, and the Alleghenies; and a southern region, including the Atlantic coast, Mississippi valley, and a part of California. Not only does such an arrangement of regions make it possible to group more correctly the known facts of spermaphytic distribution, but, to a certain extent, it corresponds more exactly with the probable method of original distribution of all plants over the continental area of North America. Since the glacial period the great drift-covered tracts have been covered with vegetation, spreading slowly from Siberia and Scandinavia on the north, and from Mexico and South America on the south. The flora of North America, then, exclusive of Mexico, is, for the most part, a resultant of the greater or less commingling of these two currents of vegetation, the one flowing constantly to the south, the other as constantly flowing northward.

[1] The General Distribution of North American Plants; by N. S. Britton. Meeting of the American Association for the Advancement of Science. 1890.

That a group of plants developed most abundantly in high northern latitudes should extend southward along north and south mountain ranges is precisely what one would expect, for in such localities conditions resembling the normal would be obtained. Consequently a large number of distinctively boreal plants may be found on the tops of high tropical mountains. With this well-known fact of distribution in mind, it will be plain that one should expect a high mountain range to bring south a greater number of northern plants than could be brought by a low mountain range. Such a hypothesis would find some support, at least, if one considers the distribution of Canadian spermaphytic genera in the southwestern United States, and then in the southeastern. Of the two great mountain systems of North America, the western is much higher and extends farther to the south. Throughout Colorado the elevation of Rocky Mountain peaks is somewhat over 13,000 feet, while the highest peak of the Alleghenies is barely 8,000 feet, above sea-level. The Rocky Mountain range from Montana to New Mexico averages about twice the height of the Appalachian chain from New York to the Carolinas.

The accompanying table is compiled to exhibit what seems to be the clearly preponderant massing of typically northern plants southwest rather than southeast. In the compilation only the more compendious lists have been employed. These are those of Macoun, Watson, Coulter, Chapman, Gray, and Porter. The table shows the number of species and varieties of several distinctively northern and south-bound genera in Canada, in the southern Colorado and New Mexico regions, and in the southern Appalachian regions, respectively. For the most part, genera which have their greatest North American development in British America are the ones which have been selected. In the majority of cases, too, the genera chosen are those of wide range, east and west, in the Canadian region. It is possible that the figures are not exactly accurate for many of the entries, since only a little critical work on the nomenclature has been attempted, and some synonyms may have crept into the totals. Again, especially in the southwestern region, some entries should doubtless be made from the smaller plant lists, not given by the larger lists, which alone were employed. This source of error, as will be seen, would not at all tend to vitiate the general results.

A Table Showing the Relative Distribution Southwestward and Southeastward of Certain Distinctively Boreal Genera of North American Spermaphytes:

	Canada.	Southern Rocky Mts.	Southern Alleghenies.		Canada.	Southern Rocky Mts.	Southern Alleghenies.
Anemone,	14	5–6	3	Potentilla,	45	28	3
Ranunculus,	41	24	14	Rosa,	19	6	4
Caltha,	5	1	1	Saxifraga,	38	17	5
Aquilegia,	5	7	1	Mitella,	5	2	1
Delphinium,	5	5	3	Huchera,	7	6	5
Nymphæa L.,	4	2	2	Parnassia,	5	3	2
Cardamine,	10	5	3	Epilobium,	17	8	3
Draba,	26	14	5.	Peucedanum,	9	4	0
Arabis,	15	8	6	Lonicera,	12	3	3
Lepidium,	7	4	1	Galium,	17	8	7
Sisymbrium,	12	4	3	Valeriana,	6	3	2
Nasturtium,	8	5	3	Campanula,	10	4	4
Viola,	31	11	16	Vaccinium,	22	5	10
Silene,	11	6	6	Bryanthus,	5	1	0
Lychnis,	11	3	0	Kalmia,	4	1	4
Arenaria,	20	17	2	Ledum,	4	0	0
Stellaria,	18	8	4	Pyrola,	14	7	1
Cerastium,	12	4	4	Primula,	9	3	0
Sagina,	5	3	1	Gentiana,	29	15	7
Claytonia,	13	5	2	Veronica,	15	5	4
Geranium,	9	7	2	Castilleja,	6	9	1
Oxalis,	4	3	3	Plantago,	17	6	4-5
Lupinus,	16	11	3	Betula,	9	2	3
Trifolium,	20	10	6	Alnus,	5	3	2
Vicia,	8–9	5	4	Salix,	62	18–19	6–8
Spiræa,	8	3	2	Populus,	7	4	3
Dalibarda L.	22	6	6	Habenaria,	22	4	2
Geum,	11	6	3	Cypripedium,	8	2	4
Fragaria,	4	3	1	Unifolium,	7	3	2

In glancing over this table it will be seen that such larger and more widely distributed genera as Ranunculus, Draba, Stellaria, Lupinus, Potentilla, Saxifraga, Epilobium, Pyrola, Plantago, and Salix are very clearly extended southwestward much more abundantly than southeastward. The same is true, less noticeably, of the smaller genera. Marked exceptions, however, will be noted in the genera Viola, Vaccinium, and Kalmia. These are all northern genera, and their anomalous distribution demands explanation. Of Viola it might be said with reason that many of the species have entered from the east rather than from the west. It is a cosmopolitan genus at the present day, and may have entered the continent by other paths than the ordinary passage across Bering Strait. In Europe, according to Nyman,[1] there are fifty-six species of Viola, while in the Russian Empire, according to Ledebour[2] there are but forty. This would indicate an eastern expansion in North America, corresponding with the westward expansion in the old world. At any rate, the present diffused condition of Viola species makes the problem of the general distribution much more complicated than it might at first appear. The genus Viola, then, although probably northern in point of origin, has been redistributed from southern stations, it may be, and the position of species over continental areas is due to a more complicated interaction of causes than the present writer is able to explain. With reference to Vaccinium and Kalmia, however, no such argument can be employed. Of Vaccinium there are but ten species in the Russian Empire and but three in Europe. The genus is seen, therefore, to center in North America. Kalmia is a North American genus, one species ranging to Cuba, but none found native in the Eastern Hemisphere. Both of these genera, then, are somewhat differently situated from Pyrola, which, although centering in British America, has five species in Europe and five in the Russian Empire. Kalmia and Vaccinium, being typically North American, may have originated far eastward on the continent, and this would give an explanation of the greater distribution southeastward than southwestward. It is a fact that even the Canadian species of these two genera are principally in the eastern provinces. Only one species and one variety of Kalmia range west of Hudson Bay, and fifteen of the twenty-two species and varieties of Vaccinium range in the eastern provinces. A similar state of affairs on the west may be noted in the genera Arenaria and Peucedanum. Both of these are massed upon the western plateau-regions of the continent.

By adding up the column which shows the southeastern extension it will be found that the total is just about half of that obtained by adding up the column which shows the southwestward extension ; that is, twice as many species of northern genera come south along the Rocky

[1] Conspectus Floræ Europeæ.

[2] Flora Rossica.

Mountains as along the Appalachians. This would seem to indicate very strongly a law of distribution such as noted above. It is quite probable that an exactly similar line of tabulation would be offered by the southern and northbound genera, notably those of the Compositæ, if traced up a slow-flowing river like the Mississippi on the one hand, and a more rapid river like the Rio Grande or Colorado on the other. We should expect to find at similar degrees of latitude a preponderance of southern species along the slower river. At any rate, it is comparatively clear that some sort of a proportion may be assumed between the heights of two north-and-south mountain systems, and the number of species of northern genera in the more southern extensions of each range.—CONWAY MACMILLAN.

An Important Work on the Fungi.—North American botanists already owe much to J. B. Ellis and B. M. Everhart for the excellent work they have done in the preparation of the great collection of specimens, the "North American Fungi." They are now about to deepen this obligation by the publication of a volume to be devoted to the systematic description of the North American Pyrenomycetes. The volume will be illustrated by many full-page plates, giving the external or gross anatomy, together with the internal microscopical structure. A personal inspection of many of these plates warrants us in saying that this feature of the work will prove of inestimable value to the student of the fungi. Winter's system of classification will be followed in the text. The volume will contain about five hundred pages, and may be expected some time during the year.

Ringing Trees.—Hartig gives the following account of his experiments in ringing the bark from trees. Trees from which a ring of bark has been taken are affected differently, according to the kind of tree and the thickness of the trunks. Some die rapidly, while others remain alive a long time. The author has already expressed his opinion that most likely root-structure has considerable influence on plants submitted to this operation, and any prognostications as to the probable effects must be guided by the fusions or inosculations which may have taken place between the roots of the tree under treatment and those of the untouched trees around. If the roots, after the cessation of nourishment and of growth, and the formation of new rootlets, soon lose the faculty of absorbing water and the mineral substances from the soil, the death of the plant must be the direct consequence of the operation, unless there are underground unions with the roots of neighboring trees by which life is sustained until the dead part of the trunk becomes impermeable to water. But if the roots do not entirely lose the power of absorbing water, even in their oldest parts, as in the case of maples, lime trees, etc., the trees continue to thrive without underground union, so long as the denuded trunk is in a fit state to allow of the passage of water. The following interesting example will therefore be easily understood: A spruce fir tree, a hundred years old, divided at a height of about twenty-three feet from the ground into two almost equal trunks. In 1871 a complete ring of bark was removed from one of these trunks. The tree was cut down in the winter of 1888–'89; the two crowns were quite green, that of the ringed side being rather less abundantly provided with leaves. The roots of the injured side had ceased to grow; but in spite of that the ringed branch continued to grow for seventeen years, nourished by the roots of the uninjured side.—*Gard. Chron., from Ann. Agronomiques.*

Botanical News.—The "Index to North American Mycological Literature," in the *Journal of Mycology*, will prove a most valuable aid to students of the fungi. In the last number no less than ninety-eight titles are given for the three months of May, June, and July. Although many of these papers were of slight importance, yet their number indicates a good deal of activity among the workers in this country.——Hereafter the *Journal of Mycology* will appear at least four times a year, but not at regular intervals, the intention being to issue it whenever there is sufficient material for a number.——The elevation of the section of Vegetable Pathology to the rank of a division, thereby placing it on an equal footing with the other branches of the department, is a most gratifying indication of progress in botanical science in the National Capital.——The November number of the *Torrey Bulletin* enumerates sixty-two papers in the excellent "Index to Recent American Literature." At this rate (which is not unusual) the whole number of papers on botany published in America in a year must now be somewhat more than seven hundred! Surely "of making many books (botanical ones) there is no end," and the "much study" required by them will most assuredly prove "a weariness of the flesh."——Dr. Britton's "List of State and Local Floras of the United States and British America" contains nearly eight hundred entries. Every state and territory has had one or more catalogues made of some portion of its plants. Naturally the older states have more such lists than the newer ones; but some new states have been more favored than some old ones. Thus, while Minnesota has 21, Kansas 30, and Colorado 15, Virginia, Georgia, and Alabama have but four each, and some others have still fewer.——Theodore Holm, of the United States

National Museum, publishes in the proceedings of that institution a suggestive paper on the leaves of Liriodendron, being a study of the leaf-forms observed on individual trees. Thirty-eight figures make it plain that there is very much variation in form in the leaves of this species, and suggest that many of the so-called species based upon the forms of fossil leaves may have little real foundation. Certainly there are as marked differences between some of the leaf-forms figured by Mr. Holm as there are between those often regardad as species by paleobotanists——Two "garden scholarships" will be awarded by the director of the Missouri Botanical Garden prior to the first of April next. These are open to young men not more than twenty years of age, and will entitle the recipients to instruction in practical horticulture and the allied subjects, as well as a sum of money sufficient to cover all expenses of living. The conditions under which these may be obtained may be learned by addressing the Director at St. Louis. ——The October *Botanical Gazette* contains a portrait of J. B. Ellis, the well-known mycologist.——In the October number of the *Revue Generale de Botanique*, Henri Jumelle publishes an interesting paper on the influence of anesthetics on the transpiration of plants. By an ingenious apparatus plants were subjected to the fumes of ether, when it was found that although assimilation was stopped, the transpiration of water was greatly increased.——Part V. of Macoun's Catalogue of Canadian Plants has just come to hand. It is devoted to the Acrogens, and a long list of "additions and corrections" to the preceding parts. Thirteen species of Equisetum are enumerated, sixty-four species of ferns and adder-tongues, and twenty-two Lycopods and their allies. This part completes volume II. of the catalogue. In part VI., which will begin a new volume, we are promised the Characeæ, Musci, and Hepaticæ.——In a recent number (January, 1891) of the *Pharmaceutische Rundschau* Dr. Power and Mr. Cambier give the results of their chemical examination of two "Loco-Weeds," viz.: *Astragalus mollissimus* Torrey, and *Crotalaria sagittalis* L.——A recent number of the *Gardeners' Chronicle* contains figures of the fungus *Glœosporium læticolor* which causes the "Spot" on grapes in England.

ZOOLOGY.

New California Fishes.—PERKINSIA (genus nov.,) CLUPEIDÆ. Type: *Perkinsia othonops.*—Like Etrumeus, except that the pectoral and ventral fins are shielded, the scales of the breast adherent forming a ventral buckler, which covers the closed pectoral fins, leaving only the dorsal edge and the extreme tip of the fins visible. The closed ventral fins likewise slip under a posterior buckler. The capillary scales are large, that of the pectoral extending very nearly to its tip, while the ventral axillary scale reaches slightly farther than its fin. Caudal deeply forked, the lateral scales extending continuously upon the center of the fin almost to margin of central rays. Adipose eyelid covering the eye wholly, without a pupillary slit.

Perkinsia othonops; one specimen, 320 mm. long. The single specimen known was caught November 20th, 1890, off Point Loma, by fishermen taking mackerel. It belongs to the British Museum.

Form of *Clupea sagax*, or of a mackerel with a stout tail.

Head 4 ($4\frac{4}{5}$); depth 5 (6); D. 17; A. 10; P. 15; V. 8.; Scales 50.

Head compressed forward, eye longer than snout, 3 in head. Interorbital a little less than snout, 4½ in head, the frontals narrowing forward. Occiput with ridges forming a W, the top of the head with a long, lanceolate depressed area anteriorly, with a median ridge, and a triangular area between anterior part of the W. This region filled with adipose tissue in life. Maxillary 3 in head, not reaching the pupil, the supplemental bone very narrow, the maxillary sublinear, deeply ground. Cheeks opercle, preopercle, lateral portions of occiput and an enlarged humeral scale with multifurcate mucous canals, which, especially upon the cheeks, form conspicuous dendritic markings, the canals being unpigmented against closely dotted interspaces.

Isthmus triangular, the gill covers not emarginate below. Scales large, deciduous. Teeth as in Etrumeus. Pseudobranchia large, exposed. Gill rakers long and slender. Form of dorsal fin similar to that of *Clupea sagax*. The insertion of the fin equidistant between tip of snout and end of the anal. Anal small. Caudal with minute scales. Ventrals entirely posterior to the dorsal fin, short, 3½ in the head. Pectoral fins placed very low, $1\frac{2}{5}$ in head.

Silvery below, steel-blue above, checks golden. Dorsal and caudal fins dusky. Ventral fins with a median blackisk blotch anteriorly. Inner surface of pectoral fins chiefly black, the ends of the posterior rays hyaline. Adipose eyelid transparent in life, preorbital regions translucent; the adipose tissue becoming opaque in spirits.

SEBASTODES GILLII, sp. nov.

Types: Two specimens, 555 and 580 mm. long, taken off Point Loma, November 19th, 1890. Collection of the British Museum.

Related to *S. cos*, *chlorostictus*, and *rhodochloris*.

Head, 3 (3½ to lip of caudal); depth, 3 (3½); D. XIII., 13½; A. III., 7½. Lateral line (pores), 44–45.

Lower jaw projecting and entering the profile without symphyseal knob. Profile nearly straight to origin of dorsal fin, not steep, Snout very broad, blunt. Maxillary reaching posterior edge of pupil, 2 in the head. Mouth very oblique, the premaxillary on a level with superior edge of the pupil. Orbit 1 in snout, 4⅓–4½, in head, a little greater than interorbital. Interorbital concave.

Pre-, supra-, and postocular, occipital, and nuchal spines sharp; the first four very short and broad, the supraocular spine about 2½ in the interorbital. Occipital spines very high and stout; the nuchal spines almost continuous with the occipital.

Opercular and preopercular spines long and strong, the 3 superior preopercular conical, directed backward, the other 2 flat, triangular, downward and backward. Preorbital with a sharp, subconical anterior spine, and terminating posteriorly in a similar but larger spine. Maxillary with a few scales superiorly on its median third. Snout either naked or with a few scattered patches of scales. Mandible naked.

Scales strongly ctenoid; accessory scales very numerous everywhere, especially so on cheeks. Membranes of soft dorsal, and anal with minute scales on basal half of fins. A few scales basally on spinous dorsal.

Vomerine teeth in a V-shaped patch; palatine teeth in short ovate patches. Gill rakers very short, ¼–⅕. Orbital diameter, 9+17–18.

Spinous dorsal low, the highest spine 2⅗–2½ in head; the fin deeply notched, the highest ray about equal to highest spine.

Caudal truncate. Second anal stouter and about as long as third.

Buccal and opercular cavities and peritoneum white, sparsely dotted with black.

Ventral surface light geranium red, shading into scarlet on the tail. Dorsal surface rather closely covered with small bronze, roundish spots, which extend upon the membrane of soft dorsal fins and a few on the first dorsal. Series of confluent bronze spots form radiating streaks or bands on sides of head; one extends from eye to upper angle of gill-opening, one to tip of lower opercular spine which is continued upon the shoulder as a conspicuous blotch, one to lower angle of opercle, one downward and slightly backward across cheeks; lower lip and anterior part of maxillary dusky. A few conspicuous spots on base of pectoral.

All the dark markings becoming blackish and persisting in spirits, the radiating streaks of the head especially conspicuous in the alcoholic specimen. A light spot under last dorsal spine; one on opercular flap.

S. cos.	*S. gilli.*
Mandible, maxillary, and snout, except a median triangular spot, scaly.	Mandible entirely naked; maxillary with a few scales medially.
Preorbital with a single, flat, downward-directed spine at its posterior angle.	Preorbital with an anterior and a posterior spine.
Interorbital deeply concave, grooved medially.	Interorbital nearly evenly concave, the median groove shallow.
Second preopercular spine directed downward.	Upper three preopercular spines directed backward.
Second anal spine 2⅔ in head.	Second anal spine 3½ in head.
	Peritoneum nearly white.
Color-markings having a washed or faded appearance.	Color-markings conspicuous.
A prominent symphyseal knob.	No symphyseal knob.
Intermaxillary band of teeth very deep in front, 3 in orbit, projecting beyond the mandible.	Intermaxillary band of teeth shallow in front, 5 in orbit, the lower jaw projecting.
Scales of head strongly ciliate, with upturned edges, the breast scales similar.	Scales of head slightly ciliate, depressed.
Palatine band of teeth long, 1⅓ in orbit.	Palatine band of teeth short, 4 in orbit.

GERRES CINEREUS, var. nov.—One specimen, 185 mm. San Diego, California, summer of 1890. Probably taken in the bay. The single specimen collected for us by Mr. Medina, at San Diego, is intermediate between *G. californiensis* and *G. cinereus*.

The caudal fin is slightly longer than the head, while the second anal spine is short, about 3½ in the head.

Ventral fins 1½ in head. Dark punctulations everywhere, except on the ventral surface. No dark lateral bars. Upper portion of spinous dorsal fin blackish. All the fins finely punctate, the pectorals least so. A dark-blue axillary spot.

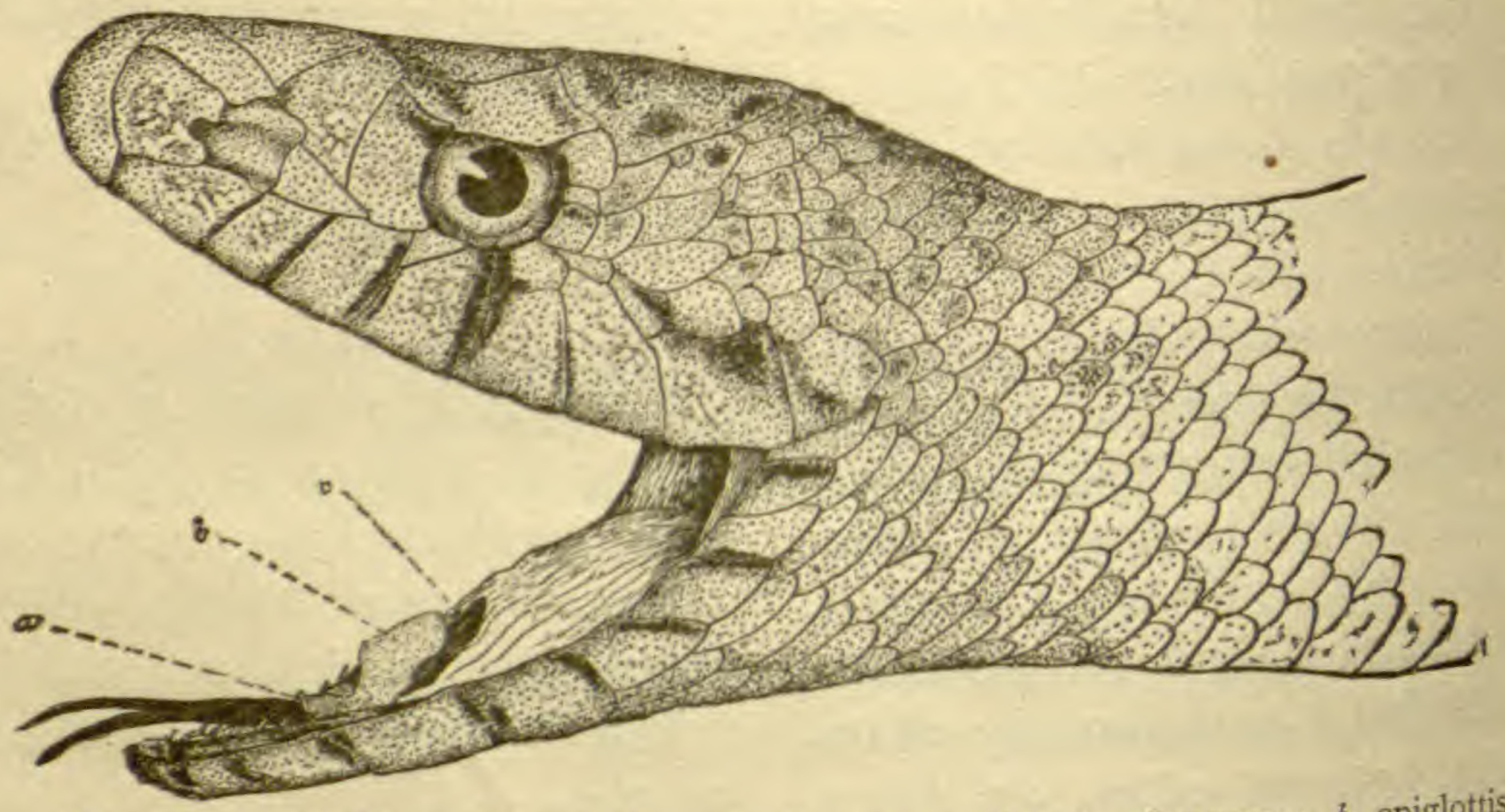
Head, $3\frac{2}{5}$; depth, $2\frac{2}{3}$; scales 6–45–10.

Eye equal to interorbital space, 5 in head. Maxillary just reaching front of eye. Predorsal distance $2\frac{1}{2}$ in the length.

SCOMBRESOX BREVIROSTRIS Peters.—One specimen of this rare species was also collected for us by Mr. Medina in the vicinity of San Diego.

ALOPIAS VULPES (Gmel.).—This shark is also to be added to the fauna of San Diego.—R. S. EIGENMANN, *San Francisco, Cal., Jan. 8th, 1891.*

The Epiglottis in Colubrine Snakes.—In the AMERICAN NATURALIST for January, 1884 (p. 19), Dr. Chas. A. White describes the epiglottis of the pine-snakes (Pityóphis), and figures it as it appears in the *P. sayi bellona* B. and G. He shows that instead of having the horizontal form found in the higher Vertebrata, it is a vertical lamina standing erect in front of the *rima glottidis*. He states



Pityophis sayi bellona, B and G, natural size; *a*, sheath of tongue; *b*, epiglottis; *c*, glottis. From Dr. Shufelot.

that he has found it in all of the species of Pityophis, but that it is wanting in all other serpents which he has examined. As Dr. White does not specify which these species are, I have made an examination of many genera found in all parts of the world, with the view of ascertaining its presence in any of them other than in Pityophis.

The result of my examinations is that it is either distinctly present or absent, and that no intermediate conditions occur. In a few instances an insignificant tubercle occupies its position and represents it as remarked by Dr. White, but this scarcely assumes the importance of a rudiment. I have found it well developed in the four species of Pityophis, and in the two Mexcan snakes which I have enumerated under Spilotes: the *S. deppei* D. and B., and the *S. lineaticollis* Cope

(Bulletin U. S. Nat. Museum, 32, 1887, p. 72). It is, however, wanting in Spilotes proper, and curiously enough in the *Rhinechis elegans*, which is otherwise a good deal like Pityophis. It is not present in any other American snakes, harmless or venomous. It appears to me to be a character of generic importance, so I propose to separate the two Mexican snakes referred to from Spilotes on account of its presence under the name of Epiglottophis, with *E. deppei* as the type.

Among old-world snakes it is wanting in all types, both venomous and harmless. The rudiment in the form of a small tubercle is present in the *Spilotes helenae*, *S. melanurus* and *S. samarensis*; also in the *Rhinechis scalaris*.—E. D. Cope.

Notes on the Classification of the Pigeons.—Quite recently the writer has very thoroughly compared the characters presented on the part of the skeletons of specimens of nearly all the genera of the United States Columbidæ. There appears to be a difference of opinion as to how these birds should be classified. Coues, in his "Key" (second edition), states it as his opinion that "the order Columbæ may be separated into three groups or suborders: Didi, Pterocletes, and Peristeræ,—the first two certainly, the last probably, of a single family. The Peristeræ alone are American. These he divides in the following way:

Suborder.	Family.	Subfamilies.
Peristeræ.	Columbidæ.	1. Columbinæ. 2. Zenaidinæ. 3. Starnœnadinæ.

In the Columbinæ he includes the genera Columba and Ectopistes; in the Zenaidinæ, the genera Engyptila, Zenaidura, Zenaida, Melopelia, Columbigallina, Scardafella, and Geotrygon; and finally, in the Starnœnadinæ, the genus Starnœnas.

The American Ornithologists' Union, in its official check-list, presents the order Columbæ to contain the family Columbidæ, and creates no subfamilies for the genera just named above.

Mr. Ridgway, in his "Manual," adopts the same scheme of classification.

Coues primarily bases his division of the Columbidæ into subfamilies upon the following characters:

Tarsi scutellate, feathered	Columbinæ.
Tarsi scutellate, naked	Zenaidinæ.
Tarsi reticulate, naked	Starnœnadinæ.

The remaining characters, in so far as we have any knowledge of them at present, except in the case of the Starnœnadinæ, do not go to support this division, and it breaks down utterly when we come to take into consideration the osteology of the various species.

The skeleton of Geotrygon has not been examined by me; but I am of the opinion that it will not militate against the classification suggested below, judging as I do from its external anatomy.

My studies of the osteology of the group convince me that our United States pigeons naturally make a very good suborder, containing the family Columbidæ. Now, if we take the characters presented on the part of the skeleton of such a species as *Ectopistes migratorius*, we find that they are essentially repeated by all the other genera save Starnœnas. When we come to osteologically compare Starnœnas we find that it differs very materially and in a number of points, as in the general pattern of its sternum, the number and arrangement of its vertebræ and ribs, some of its cranial characters, and in the characters of its pelvic limbs.

From osteological premises, then, our family Columbidæ divides naturally into two subfamilies: the Columbinæ, containing the genera Columba, Ectopistes, Engyptila, Zenaidura, Zenaida, Melopelia, Columbigallina, Scardafella, and Geotrygon; and the subfamily Starnœnadinæ, containing the genus Starnœnas.

In another connection it is my intention to present these osteological characters of the Columbidæ in detail.—R. W. SHUFELDT, *Smithsonian Institution, January 22d, 1891.*

Description of Two New Species of Rodents from Mexico.—While recently classifying and arranging the collections of mammals belonging to the Natural History Section of the Comision Geografica-Exploradora of Mexico, I found two species apparently new, whose characters I now give:

SPERMOPHILUS SONORIENSIS, sp. nov.—Apparently quite similar to Dr. Merriam's recently described *S. cryptospilotus*, which I know only from the description. Above, head and body fawn color, with no indications of spots. Individual hairs with extreme bases black, followed by a narrow ring of straw-yellow, subterminally broadly ringed with walnut-brown (which color occupies more than twice the space covered by the two preceding colors), and tipped with cream-buff. Something like one per cent. of the hairs have the walnut-brown replaced by black; but these are so relatively few in number as not to sensibly affect the general tone. Color gradually shading lighter to sides, where it meets, in a sharp line, the white of under parts. A bar of decidedly lighter fawn color, 3 mm. in width, commencing a little back of the nose, passes between the darker shade of the crown and a superorbital white area, terminating at the ear.

The upper border of the white of under parts is defined by a line drawn from the nostrils, passing over the eyes and through centers of ear openings, across shoulders and along sides of body to the groins. The white area also includes the inner surfaces of legs and dorsal surfaces of hind feet, which latter are slightly washed with rufous. Hairs of under parts entirely white, but so thin in the specimen before me that the color of the skin shows through, giving a plumbeous cast to most of this surface.

Outer surface of fore limb, from elbow to bases of toes, white, more or less washed with rufous. Outer surfaces of hind legs concolor with dorsum.

First third of upper surface of tail the same as back; thence the center is fawn color, bordered by a black zone that, in turn, is bordered by a whitish rufous. On its under surface the black line is scarcely perceptible, the whole of this surface being pale rufous.

Ears, in dried skin, a mere rim.

Lower surfaces of pes densely haired; of manus, naked.

Claws medium sized, black, with white tips; of thumb, as well developed as in *S. mexicanus*.

Mystacial hairs mostly black; a few white ones interspersed.

Measurements of dried skin, in millimeters: Total length, 220; head and body, 155; tail vertebræ, 65; hairs beyond vertebræ, 20; hind foot, 33; fore foot, 21; longest mystacial hairs, 32.

Measurements of skull: Length from point of nasals to upper edge of foramen magnum, 38; greatest width at auditory bullæ, 18; least interorbital width, 9; length of molar series, 8.5; transverse diameter of first premolar, 1.25; the same of second, 2; of first molar, 2.5.

The zygomæ and hinder edge of palate are broken, so as to allow of no measurements being taken from them.

The only noticeable differences between this skull and that of *S. cryptospilotus* (*vide North American Fauna*, No. 3, Pl. IX., Figs. 1, 2, and 3) is that in this the hamular processes of the pterygoids abut against the auditory bullæ posterior to the suture of the basisphenoidum with the basioccipitale, instead of in front of it, as in *cryptospilotus;* and in that the transverse diameter of the first premolar is fully equal to its longitudinal diameter.

Type: No. 517 ♂ ad., Museum of the Comision Geografica-Exploradora de México. Taken by Zenòn Córdova, at Hermosillo, Sonora, November, 1887.

This species belongs to the Spilosoma group, and in all probability finds its closest affinity in *S. cryptospilotus*, from which it appears separable by some slight differences in size, color, and the cranial characters noted.

NEOTOMA TORQUATA, sp. nov.—Above, head and body light Vandyke-brown, washed with black; more intensely in the mesaldorsal line, insensibly becoming entirely obliterated before reaching the white of lower parts. Hairs of all parts, except ears, feet, tail, and a small patch on chin, slate-gray for the greater part of their length. Above ringed for about 3 mm. with Vandyke-brown, followed by a slight tipping of black. In the dorsal line are interspersed longer hairs nearly or completely lacking the rufous ringing, whose place being occupied by the greater extension of the black tips, gives to this part its darker tone, which may be described as hair-brown. Belly nearly pure white, slightly tinged with yellow, and in parts soiled by the slate-gray of roots showing through the white tips of hairs. Breast occupied by a well-defined collar, 20 mm. in width, of same color as sides of body. Under surface of neck grayish-white, gradually shading forward to slate-gray to form an ill-defined band, about 4 mm. in width, that covers the upper lips, excepting a narrow line of white encircling the mouth parts. A small, circular area on chin of pure white, including roots of hairs. Upper third of circumference of tail clove-brown, sharply separated from the dirty white of its sides and under parts. The tail is closely covered with short, stiffish hairs, through which only upon very close scrutiny can the annuli be seen on sides and beneath. Feet white, slightly washed with drab a trifle below carpus and tarsus. Outer surfaces of legs and arms shading from Vandyke-brown above to drab below. Inner surfaces as belly. Ears seal-brown, nearly naked on posterior external surfaces, rather scantily covered with short seal-brown hairs on internal and anterior external surfaces. Mystacial hairs black for half or two-thirds of their length, terminating in white; the longest being 65 mm. Soles of fore feet entirely naked, with five warts; of hind feet, well covered with hair for posterior half, having six warts. Eyes blue-black, very large and exserted. Their diameter in the dried skin is about 8 mm.

Measurements, taken in flesh: Length from tip of nose to end of tail vertebræ, 338 mm. (13.33″); tail vertebræ, 160 (6.37″); manus, 16 (.69″); pes, 35 (1.41″); ear, 21 (.84″).

The skull shows no peculiarities of note. Length, 45; greatest width of zygomæ, 23; length of both upper and lower molar series, 9; length of inferior mandibula from arthral bead to anterior edge of alveola of incisor, 25. The skull and teeth are nearly precisely as figured by Baird for *Neotoma mexicana* (U. S. Mex. Boundary Survey, Mammals, Pl. XXIV., Figs. 1 *a* to *g*.)

Type specimen : No. 380, Museum of Comision Geografica-Exploradora ; adult female, taken between Tetela del Volcan and Zacualpan Amilpas, State of Morelos, Oct. 26, 1890. Collector, H. L. Ward. Found in dark tunnel of an abandoned mine.

According to Coues (Mon. N. A. Rod.), Neotoma is a genus in which cranial and dental characters count for little or nothing (!), but in which color appears to be quite constant. We will therefore disregard the almost exact conformity of the skull and teeth of this species with those figured by Prof. Baird for *mexicana*, and will call attention only to external characters. *N. torquata* is at once distinguished from all known species of Neotoma by its collar ; also from *floridana* by the more rufous color of upper parts, and by roots of hairs of belly being gray instead of white ; from *fuscipes* and *ferruginea* by this latter distinction and the tail being bicolor, instead of unicolor ; from *cinerea* in general coloration and in not having the tail bushily haired.—HENRY L. WARD, *Tacubaya, D. F. Mex., Jan. 22, 1891.*

The Entepicondylar Bridge in Man.—M. S. Nicholas, has observed and recorded (*Revue Biologique du Nord de la, France,* 1891, p. 121), six cases of the presence of a rudiment of the superior part of the entepicondylar bridge of the humerus in man. They all occurred in insane persons who died in the Asylum of Maréville. This anomaly is interesting as constituting a lemuroid reversion. Struthers has observed this anomaly in 2 p. c. of skeletons he has examined, and Gruber in 2.7 p. c. Testut gives 1 p. c. as the proportion of cases, which Nicholas thinks is the most probably correct figure.

EMBRYOLOGY.[1]

Development of Mammals.—In so thoroughly worked over and so narrowly bounded a field as vertebrate embryology we should hope to find a singleness of plan running through the series, accompanied by an agreement amongst workers and theorists as to the interpretation of the known phenomena. In fact, however, the greatest possible divergence is found. This is especially marked in the recent attempts of embryologists to explain the process of gastrulation in the groups of vertebrates. Of course the problem of the mesoblast is here, as everywhere, a challenge for battle; but this is not all, for even the origin of endoderm and ectoderm have their various interpreters.

An illustration of this is furnished by the three (and more) hypotheses which are advanced to account for the early stages of development of the mammals. Two of these may be taken here as an example, and a third will be mentioned below in a review of Hubrecht's recent paper. The two which we shall now consider are those of Haddon[2] and Minot.[3] These two theories, advanced about the same time, are said by Haddon to be "somewhat similar hypotheses," and Minot says that his own is "the most satisfactory, and preferable to the similar explanation advanced . . . by Haddon." To an outsider the two theories seem to contradict each other in all that is essential and new to each.

Balfour prophesied that the ancestral mammal had a large ovum filled with yolk, and this, by Caldwell's discovery of the eggs of Monotremes, has been practically demonstrated. Both Haddon and Minot accept this as their starting point, but immediately diverge in opposite directions in their "somewhat similar explanations."

The two accompanying diagrams have been copied to illustrate their views:

Diagram *A* gives Haddon's idea of the meaning of the germ-layers of the mammalian embryo. The central cavity (*y.s.*) is the yolk-sac of the ancestral vertebrate, which has been covered over *precociously* by ectoderm (*e.c.*); ancestrally this was accomplished by epibole. At the upper pole the blastoderm, owing to the loss of yolk, has fallen into the yolk-cavity, leaving a small opening (*B b*) at the

[1] Edited by T. H. Morgan, Johns Hopkins University, Baltimore.

[2] Elements of Embryology.

[3] AMERICAN NATURALIST, April, 1889.

surface, which Van Beneden mistook for the blastopore. The blastoderm proper consists of ectoderm, several cells in thickness, and below scattered endoderm cells. The mesoderm is formed later between the

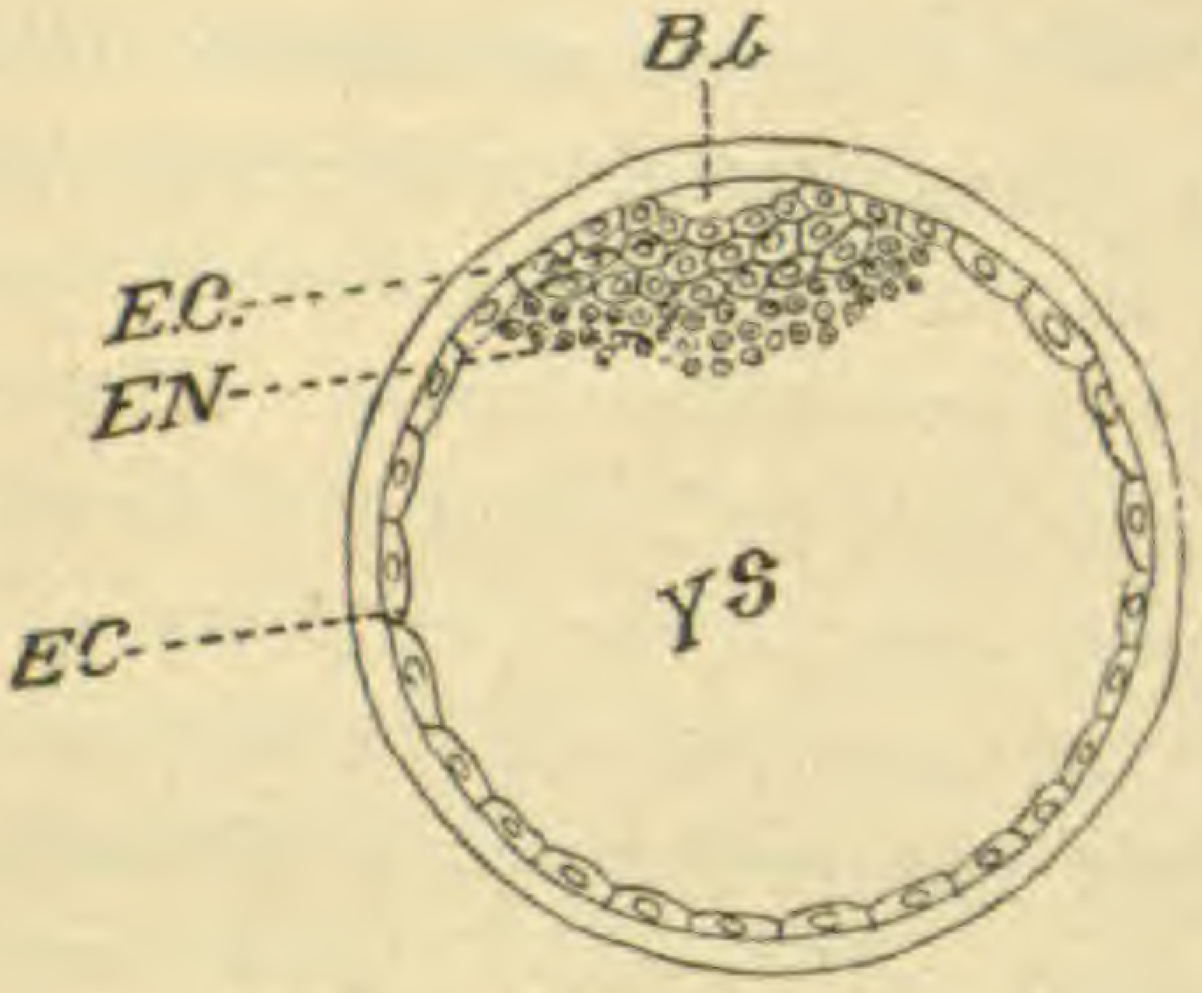


FIG. 1.—(Diagram A.)

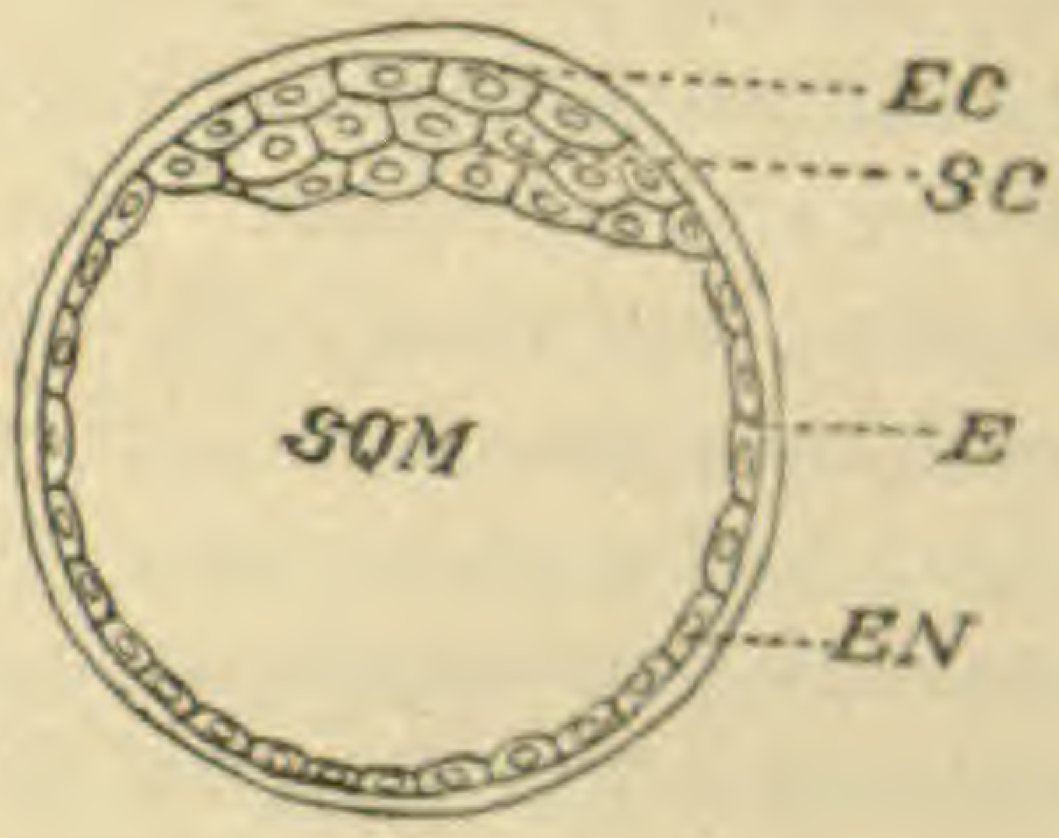


FIG. 2.—(Diagram B.)

two. The strong point of this explanation is that it seems to refer the germ-layers back to a condition found in the reptilian embryo, and the weak point, it seems to me, is that it does not clearly illustrate the method by which the yolk has been lost, and what cells originally contained it.

Minot gives the following hypothetical stage to explain the homologies of the mammalian germ-layers (see Diagram *B*). The large central cavity, which he calls the segmentation cavity (the yolk-cavity of Haddon), is surrounded by *endodermal* cells, which formerly contained yolk. (Hence they do not represent epibolic ectoderm, as believed by Haddon.) The walled blastoderm (embryonic knob) at the upper pole of the figure is composed probably *entirely* of *ectoderm cells*. (Again a contradiction to Haddon's view.) The endoderm which later appears under the blastoderm comes from the sides where the endoderm cells around the segmentation cavity pass into the ectodermal blastoderm. Here, it seems to me, is the weakest part of the hypothesis, and Dr. Minot seems to have expected to find the same formation of endoderm as in the teleost. This is flatly contradicted by well-supported statements. (See Hubrecht below.) The author has jumped from the frog's gastrula to that of the mammal, not giving, I believe, due weight to the intermediate reptilian stage, assuming that with the loss of yolk in the ancestral mammal there was a return to the more primitive condition of the amphibian stage; but it seems this is hardly a fair assumption as a basis for further hypotheses.

Prof. Hubrecht gives a second paper[4] in his studies in mammalian embryology, entitled "The Development of the Germinal Layers of

[4] *Quar. Jour. Micro. Science.*

Sorex vulgaris." The paper is a detailed description of the origin of the germ-layers. The earliest stage obtained had a single layer of flattened cells (ectoderm) lying beneath the zona and bounding a central cavity filled with fluid. These ectodermal cells he calls the trophoblast. At one point in the periphery there is an accumulation of cells —the embryonic knob—which contains the material for the embryonic ectoderm and endoderm. The cavity in the center surrounded by the trophoblast and filled with fluid is the *segmentation cavity*. The embryonic knob gives rise to the early endoderm cells from its more central part, and some of these then migrate around the periphery of the central cavity and apply themselves to the inner side of the trophoblast (ectoderm). See Diagram *C.* (This contradicts part of Minot's hypothesis given above.) The trophoblast cells seem to grow over the embryonic knob, causing an "inversion" of the embryo. After the differentiation of the endoderm from the embryonic knob the remaining ectoderm is spoken of as the embryonic shield (*emb.sh.*) The endoderm first forms part of the notochord and mesoblastic plates. Thus under the anterior end of the embryonic shield the endoderm is spoken of as the protochordal plate (*no.ch'.*) The rest of the notochord differentiates later and in a different way. The mesoderm has not yet appeared, but is now inaugurated by the appearance of the primitive streak. The mesoderm originates from three different points: 1st, from the sides of the protochordal plate (see above); 2nd, from the primitive streak, from which it advances forward between ecto- and endoderm; and 3d, from an annular zone of endoderm lying around and under the periphery of the embryonic shield. The details of this process are shown in a large number of figures.

We may now pass to the theoretical considerations of the gastrulation of mammals. (The process of inversion, or the sinking of the embryo into the cavity of the vesicle, may be left out of account, as it produces no important changes in the germ-layers of the embryo, and may in a general way be compared with the later formation of the amnion.) We have seen in the early differentiation of the endoderm from the embryonic knob that part of the endoderm is formed before the actual process of gastrulation has set in,—that is, before the appearance of the primitive streak. This the author calls precocious segregation, and is an *ontogenetic* phenomenon. Later, when the primitive streak is formed (the coalescing of the lips of the blastopore), new endoderm arises in this region and is added to that already present, and this latter is the phylogenetic endoderm, and alone is to be compared to the Sauropsidan type. The remaining part of the notochord (also the lateral wings of the mesoderm) is formed from the phylogenetic endoderm, and may be compared to the formation of notochord and mesoblast of Batrachia.

We have sufficient evidence to believe that between the Batrachia and the Mammalia a " phylogenetic link has once existed, in which the actual food-yolk formed a very considerable addition to the early blastocyst. The case of the Ornithodelphia is most important in this respect. . . . When the nutritive contents of the yolk-sac were no longer of primary importance, . . . a reduction in size of the blastocyst was not effectuated because *another factor came into play.* The vascular area which heredity called forth on the surface of the yolk-sac . . . must have rendered eminent service for the establishment of a different mode of nutrition, as soon as the embryo underwent a considerable part of its development inside the maternal generative ducts." Hence the large size of the blastocyst of the mammal has been *retained not because it once contained yolk*, but because it was an essential function to perform in the nutrition of the embryo.

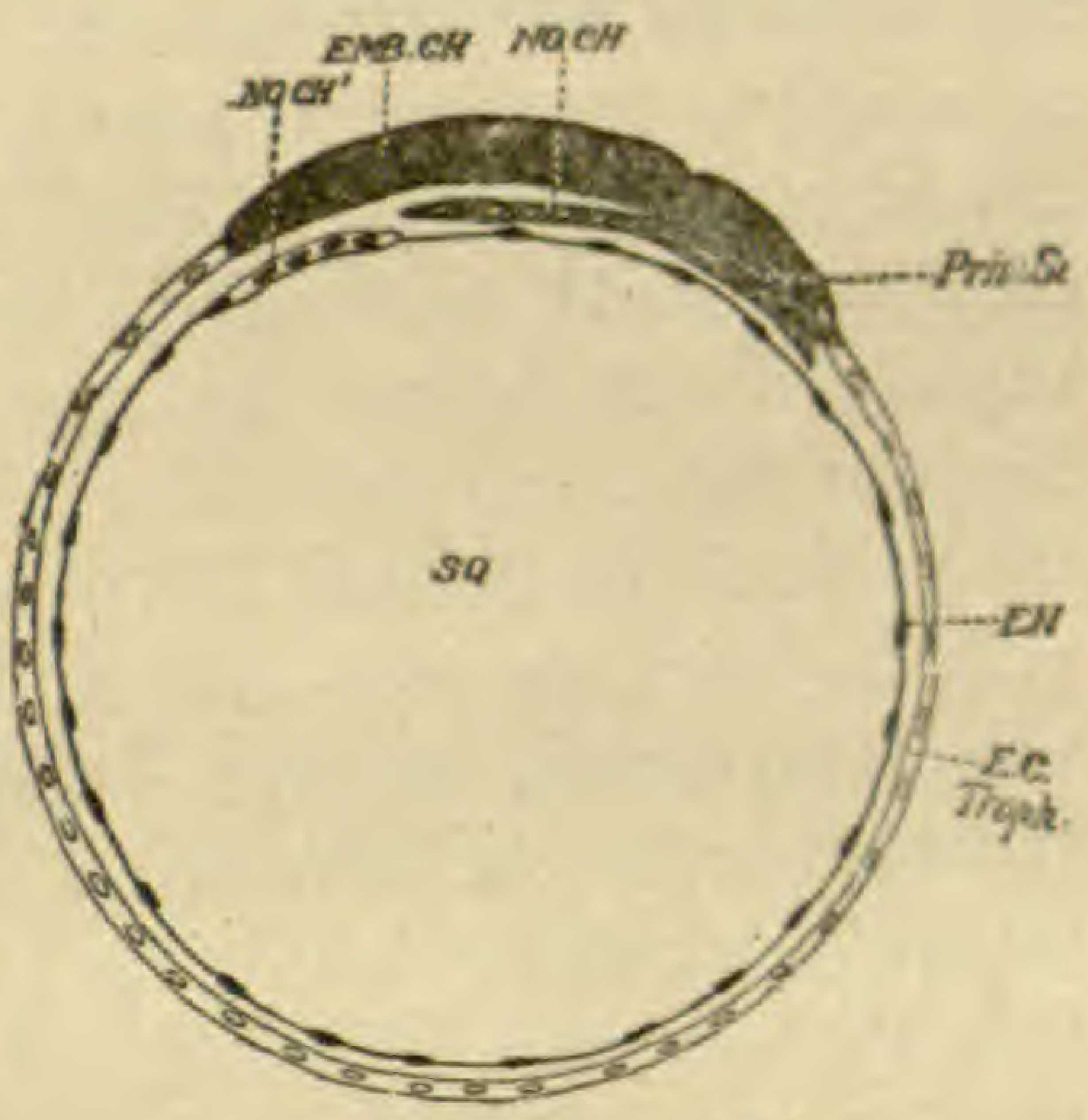


FIG. 3.—(Diagram C.)

The accompanying diagram (Fig. 3) represents (somewhat modified) the author's figure to show the relationship to each other of the mammalian germ-layers. The greater part of the central (fluid) cavity is surrounded by two layers,—the outer of ectoderm, the trophoblast, and within the ontogentic endoderm. The upper part of the figure shows the embryonic layers. The endoderm passes under the ectodermal embryonic shield (black). The posterior part of the latter (with white streaks) shows the area of the primitive streak, and from this runs forward under the embryonic shield a prolongation (*no.ch.*, black with white dots), forming the posterior part of the notochord, and laterally, though not shown in the figure, the wings of mesoblast. In front of this is seen a thickened part of the ontogenetic endoderm, which forms precociously the anterior end of the notochord (*no.ch.*) and to the sides some of the mesoderm. For further details see the author's excellent figures.

The essential difference between this hypothesis and that of Minot is at once seen. What the latter speaks of as endoderm cells are the trophoblast cells of Hubrecht, which are ectodermal. Hubrecht shows conclusively that the endoderm originates from the embryonic knob, and not at its sides as is demanded by Minot's recent hypothesis. Hubrecht is more in accordance with Haddon, both as to the origin of the endodern from the under side of the embryonic shield, and in the ectodermal covering of the the early blastocyst.—T. H. M.

The Embryology of Gecko.—Dr. Ludwig Will gives, in the *Biologisches Centralblatt,* November 15, 1890, a short paper on the method of gastrulation of this lizard. At the posterior end of the embryonic shield is a mass of cells, called the primitive plate. The cells at this point are several rows deep, while over the embryonic shield the ectoderm is composed of a single layer of columnar cells, but with a few yolk-cells scattered beneath it. At a later stage the anterior end of the primitive plate forms a distinct invagination, the walls formed of a single row of cells. This sac pushes forward under the embryonic shield, between the ectoderm and the yolk-cells. The invagination cells spread out into a broad sac. There follows next an irregular fusion and absorbtion between the invaginated endoderm and the yolk-cells (endoderm also), so that the general cavity above the yolk, in which the yolk-cells were scattered, communicates with the invagination cavity, and hence with the outer world by means of the proximal end of the latter cavity, or blastopore. The upper walls of the invaginated cells go to form the notochord, and the rest of them go to form the mesoderm at the sides of the latter. The author believes that the Gecko furnishes grounds for comparing the reptilian with the amphibian gastrulation. The blastopore—or the open mouth of the invagination—extends backwards, and the two lips coming in contact fuse to form a primitive streak, so that what was previously only a theory—namely, that the primitive streak was formed by the fusion of the lips of the blastopore in Sauropsida, and whose opening in these was only represented by the neurenteric canal—is now shown to be a fact from the development of the Gecko.

Theory of the Mesoderm.[5]—Prof. C. Rabl has a long paper on the origin of the mesoderm of vertebrates. The paper is largely devoted to theoretical discussions, although based upon observations on the germ-layers of Selachians, birds, and mammals. The first part of the paper deals with the formation of the mesoderm in the above types, the second with the later differentiations of the mesoderm. It is unnecessary to give a full review of the paper here,[9] and we may confine

[5] *Morphologisches Jahrbuch*, No. 15, 1889.

See *Journ. Royal. Micro. Soc.*, Feb., 1890.

our attention to that part of it dealing with the gastrulation of the vertebrates. The Selachian gastrulation arose by the accumulation of yolk in the cyclostome egg, while the Amniote (reptiles, birds, mammals) gastrula arose from accumulated yolk to the amphibian egg. The resulting gastrulæ of Selachians and Amniota, the author attempts to show, are therefore fundamentally different. The Selachian (and Teleost) gastrulæ resulted from the addition of yolk to the endoderm cells of the cyclostome before the ectoderm had grown over the endoderm, and since the epibolic endoderm does not cover in the yolk, the blastopore in this group is represented by the whole margin of the embryonic shield. The blastopore mouth then is very large, and the (morphological) posterior end of the blastopore lies just in front of the embryonic shield, and the anterior or upper end of the blastopore lies at its usual position at the posterior end of the shield. This is, of course, the general conception. But for the Amniota the author believes the gastrula to be different in that it is not here represented by the whole border of the embryonic shield, but has a more limited extent. Rabl believes that the accumulation of yolk in the amphibian egg has been also in the endoderm cells, but, so far as he explains it, this must have taken place after (ancestrally) the epiblast had covered the (endoderm) yolk-mass so that the gastrula becomes reduced to the region of the primitive streak alone. Therefore it follows that one end of the primitive groove (just behind the embryonic shield) represents the anterior (upper) end of the amphibian blastopore, and the other end of the groove the posterior (lower of the amphibian). The anterior end of the primitive shield would not seem here to represent anything in particular! Rabl supports his conclusion by arguments drawn from the formation of the mesoderm.

The author does not account for the large exposure of yolk outside of the blastopore in the Amniota gastrula as we find it in the bird and lizard; unless indeed he supposed it to have actually broken through the ectoderm covering. Further, that the author's view is probably erroneous is shown in the occasional presence of a lengthened primitive streak running posteriorly through the area opaca, as seen and figured by Whitman. It has also, I believe, been seen since by others.

ENTOMOLOGY.[1]

Insects in Iowa.—Bulletin No. 11 (issued November, 1890) of the Iowa Agricultural Experiment Station contains four articles by Mr. C. P. Gillette, of considerable entomological interest. The first discusses the injuries and life-history of the Potato Stalk Weevil (*Trichobaris trinotata* Say), which has been unusually destructive in Iowa the past season. Mr. Gillette thinks that "half a million of dollars would fall far short of making good the loss that it has occasioned the state this year. In gardens where potatoes have grown year after year I have seldom found less than seventy-five per cent. of the stalks infested, and from this to ninety-three per cent. In field patches at a distance from where potatoes were grown last year I have found as few as twenty per cent. of the stalks infested, but in no case have I found the injuries less abundant than this." The next article discusses the Apple Curculio (*Anthonomus quadrigibbus* Say), and contains the first extended description of the method of oviposition of this insect. The two remaining articles discuss the currant-stem boring habits of *Hyperplatys aspersus* Say, commonly known as the Cottonwood Borer, and kerosene emulsion as a sheep dip and destroyer of parasites upon domestic animals. The experiments reported under this last heading are of great practical value. The author concludes with this paragraph: "I must say that after repeated experiments with kerosene emulsion, along with other substances commonly recommended for the destruction of vermin upon domestic animals, I feel certain that it is far ahead of anything I have tried when cheapness, effectiveness, ease of application, and freedom from possible bad effects are taken into account."

Indiana Insect Notes.—Bulletin No. 33 of the Purdue University Agricultural Experiment Station contains ten pages of entomological notes by Mr. F. M. Webster. The sub-titles are as follows: Experiments with the Plum Curculio; Notes on Strawberry Insects (*Tyloderma fragariæ*, *Haltica ignita*, and the Field Cricket); Some Hitherto Unrecorded Enemies of Raspberries and Blackberries (*Solenopsis fugax*, *Limonus auripilis*, *Carpophilus brachypterus*, *Iulus impressus*, and *Cosmopepla carnifex*). Most of these notes are republished from *Insect Life*. The Plum Curculio experiments were made chiefly to determine to what extent the insect develops in native varieties of plums, and they showed that the insects do breed freely in them. The eco-

[1] Edited by Dr. C. M. Weed, Columbus, Ohio.

nomic points are summarized as follows: "(1) The variety of plum or apple whose blooming season covers the greatest period of time will best withstand the work of the curculio; (2) the planting of plum trees in the apple orchard will not protect the latter, and vice versa; (3) if anything is to be gained by using another fruit to draw off the curculio and protect the plum, the nectarine will probably serve as well as the apple; (4) adult curculio beetles eat the pulp of apples; (5) curculios will deposit their eggs in fruit hanging over the water; (6) the indications are that the Strawberry Crown Borer lays its eggs during March and April in the plants near the surface of the ground; (7) burning strawberry plants after fruit-picking may destroy the Crown Borer; (8) the common field cricket will eat strawberries."

Oviposition of the Apple Curculio.—Mr. C. P. Gillette has lately described the process by which the eggs of *Anthonomus quadrigibbus* are deposited. The description was originally read before the Iowa Academy of Science, September, 1890, and has since been published in Bulletin No. 11 of the Iowa Experiment Station (pp. 492–493). Mr. Gillette says: "I am not aware that any one has published actual

FIG. 1, *a*, apple infested by the Apple Curculio; *b*, egg-cavity, natural size; *c*, egg very much enlarged. Redrawn from Gillette.

observations on the method of oviposition of this insect. On the 13th of last June I was fortunate enough to see a female perform the entire operation, which was done as follows: First, a cavity (Fig. 1, *b*) was eaten in the apple as deep as the beak was long, the bottom being much enlarged and subtriangular in outline. The walls of the cavity converge to the opening, which is only large enough to admit the slender beak. When first noticed the beetle had begun her work and it was 30 minutes before the egg-cavity was completed. The beetle, almost immediately after withdrawing her beak, turned about and applied the tip of her abdomen to the small opening into the egg-cavity. After remaining in this position for about five minutes she walked away without turning about to inspect the work she had done.

I at once plucked the apple, and examined closely the identical spot where the beetle had been at work, and was surprised to find that there was no puncture to be seen in the skin of the apple, but only a minute brown speck. I found that the beetle had plugged the little opening with what appeared to be a bit of pomace, probably excrement, and she had done the work so nicely that I think no one would have suspected that this little speck marked the place of oviposition of this insect, unless he had seen such specks before, and knew what they signify. With a sharp knife a section was made through this egg-chamber, which I have endeavored to represent natural size, at Fig. 1, *b*, with the egg at the bottom.

Although it is almost impossible to distinguish newly stung fruit from external appearances, it becomes very easy after a few days when the infested apples become gnarly and ill-shapen, as shown in Fig. 1, *a*.

PSYCHOLOGY.

Professor Moll on Hypnotism.[1]—This work is a general résumé of what is known of hypnotism. The exposition by Prof. Moll covers most of the ground in an adequate manner, and is therefore well adapted for the instruction of the general reader. The author holds that suggestion is the efficient cause of the phenomena, and therefore regards the subject primarily as a branch of psychology, rather than of physiology. He states that most persons of healthy mental organization can be hypnotized, and that susceptibility, except in extreme cases, is not a mark of mental weakness. Persons of the nervous temperament are most susceptible, and idiots and insane persons can be hypnotized in a small proportion of cases only. Susceptibility is not confined to any race or nation, so far as known. The statements of the numerous investigators are subjected to rigid and rational criticism, and nothing is accepted or rejected without adequate evidence. The author pursues a judicial course in this respect, and refuses his assent to wholesale and uncritical scepticism, as well as to excessive credulity. Physiological explanations are frequently held in reserve as not proven, whatever degree of probability may attach to them.

The abundance of well-established facts now recorded in the literature of hypnotism has placed the subject within the domain of exact

[1] Hypnotism; by Albert Moll. The Contemporary Science Series. London: Walter Scott. New York: Scribner and Welford. 8vo. Edited by Havelock Ellis, 1890.

psychology, and its practical value to both mental and bodily therapeutics is admitted. Less attention is given to its importance to psychological science, and hence to philosophy. No support is given to the rather uncritical assertions frequently made as to the evidence offered by hypnotism for the existence of double or multiple personality of a single human individual. Not much space is given to the remarkable structural changes seen in the formation of red or necrobiotic figures on the skin, as the result of suggestion, although the reality of the phenomena is not challenged. The experiments of Jendrássik and Krafft-Ebing seem to place the facts beyond doubt.

Suggestibility is regarded as the principal characteristic of hypnosis as distinguished from somnambulism; hence most of the book is occupied with an elucidation of its mental and physical implications. Post-hypnotic suggestion receives a large share of attention. As an expert the author does not occupy so much space with the detailed accounts of experiments as with explanations of them in relation to other and normal mental states. The work is well adapted to enlighten the reader as to the essential significance of hypnotism. The citation of authorities is very full.—C.

Was it Hallucination?—I had a strange experience about nine o'clock this morning, which I hasten to put on record while all its details are fresh in my mind. My wife being quite seriously ill, I went for our family physician, about three blocks distant. I met him in an apothecary's shop, and asked him to come to our residence. He had one call to make near by, but promised to be with us very soon. I returned in a few minutes, coming into our cross-street at the east end of the block. As I came across a vacant lot just east of our house I happened to look out to the westward, when I saw our doctor just leaving the cross-walk and turning in as if to come straight to our place. It occurred to me that he was a little ahead of the time I expected him; but I hurried on to apprise my wife of his coming. I then went out to meet him. But *no one was in sight;* and at the moment I believed I saw him he was actually in a distant part of the town, at least several blocks away. He was detained, and did not reach us for a couple of hours, and was much surprised at my statement of having seen him. He said it was some sort of "hallucination,"—whatever that might be! He asked: "Was I not thinking about him?" Possibly I was, but with no idea of seeing him there and then. As to the man, I could not be mistaken. His dress, his long, flowing, almost white beard—every detail of his personal appearance—were just as clear to my vision as when he really called, a little later. It was clear daylight; I was as wide awake as I am now while writing this item. Fifty years ago I listened to just such a story, and the narrator declared she "had seen a ghost." I am not in the least superstitious, and even had this been a "ghost," and I had known it, I should have felt no alarm, for I never knew those intangible folk to harm a living mortal,—even in the days when ghosts were so generally "believed in." Thinking the matter over immediately afterwards, I tried to recall any feature of this "second sight" which was in any sense abnormal. The only fact I could remember was that the doctor seemed to walk rather faster than usual, but I thought he only wished to overtake me before I entered the house. I thought he kept his eye on me, and continued to look at me in a very interested manner. I only wish I had kept my gaze upon him, and noted the spot and how he so completely vanished. I was never more thoroughly taken aback than when I went out to meet him, not more than thirty seconds after I saw him, *and no one was in sight!*—CHARLES ALDRICH, *Webster City, Iowa, December 15th, 1890.*

ARCHÆOLOGY AND ETHNOLOGY.

The Societe d'Anthropologie at Paris.—*A Sketch of Its Organization and Work.*[1]—The theory of evolution, and so the origin of species, which has been credited by many people to Charles Darwin, is in France credited, or attempted to be credited, to the naturalist Lamarck, and there was organized in 1884, under the protection, or at least the shadow, of the Society of Anthropology, an organization called the "Réunion Lamarck."

Born of the same idea as was the School of Anthropology, the Society of Anthropology, on the proposition of Monsieur Mathias Duval, inaugurated a course of lectures, which, under the name of "Conferences Transformiste," were intended to popularize the doctrine of evolution and the mutability of species, and so the origin of man.

In this course have been delivered the following lectures:

"The Development of the Eye," by Monsieur Mathias Duval, 1883.

"The Evolution of Morality," by M. Letourneau, 1884.

"Evolution of Language," by Monsieur Hovelacque, 1885.

"The Paleontologic Evolution of Animals," by M. G. de Mortillet, 1886.

[1] Continued from page 85.

"The Mental Evolution in the Organic Series," by Madame Clemence Royer, 1887.

"Microbes and Transformism," by M. Bordier, 1888.

"Transformism Français, Lamarck," by M. Mathias Duval, 1889.

The regular lectures are given usually at four o'clock in the afternoon, from November to May inclusive, in the audience hall of the Societe d'Anthropologie at the Musèe Dupuytren, 15 Rue de Ecole de la Medicine. While the lectures are open to the public and any one can attend, yet it is usual that those who propose attending regularly shall inscribe themselves, and obtain cards of admission. They can then be assigned to a particular seat, which they can have without disturbance during the course. Thus there is obtained a record of the number of regular attendants. These are shown in the following table:

Number of attendants at the regular courses of lectures given by the School of Anthropology from 1877 to 1889 inclusive:

1877–'78	8,384
1878–'79	9,294
1879–'80	10,289
1880–'81	9,719
1881–'82	7,611
1882–'83	8,343
1883–'84	8,315
1884–'85	9,019
1885–'86	8,742
1886–'87	8,709
1887–'88	7,075
1888–'89	11,786

The members of the Societe d'Anthropologie were actuated by a desire that their fellow-men should reap as much benefit as possible from their efforts, and so devoted whatever opportunities they might have, with whatever amount of labor it might be, to spread the news of their science, and to give such information to the people and education to the students as they could. So they have organized within themselves various societies, and have armed themselves in various ways for the accomplishment of their much-desired project. I can do no more with these than simply to mention their names and give a list of the works published.

There was organized a library called "Contemporaneous Science." A committee of direction and editing was appointed, and M. Reinwald, 15 Rue des Saint-Peres was chosen editor. The plan agreed upon was to request or obtain from each professor or person having the requisite knowledge a manual, which should be small, compact, complete, clear, easily read. The manual was to be devoted to the science or specialty for which each professor was best qualified. There have been completed of this series the following:

Biology, by Dr. Letourneau, 3d edition, 1 vol., 518 pages and 112 engravings.

Language, by Hovelacque, 5th edition, 1 vol., 454 pages.

Anthropology, by Dr. Topinard, 5th edition, 1 vol., 576 pages with 52 engravings.

Esthetics, by Eugene Veron, director of the *Journal of Art*, 2d edition, 1 vol., 524 pages.

Philosophy, by M. Andre Lefevre, 2d edition, 1 vol., 640 pages.

Sociology in Its Relation to Ethnography, by Dr. Letourneau, 2d edition, 1 vol., 624 pages.

Economic Science, by Yves Guyot, 2d edition, 1 vol., 600 pages and 67 engravings.

Prehistoric Antiquities of Man, by G. de Mortillet, 2d edition, 1 vol., 678 pages and 64 figures.

Botany, by de Lanessan, 1 vol., 570 pages, 132 figures.

Medical Geography, by Dr. Bordier, 1 vol., 688 pages, with figures.

Ethics (la Morale), by Eugene Voren, 1 vol., 516 pages.

Experimental Politics, by Leon Donnat, 1 vol., 504 pages.

Problems of History, by Paul Mougeolle, 1 vol., 498 pages.

Pedagogy, by Issaurat, 1 vol., 512 pages.

Agriculture and Agronomic Science, by Albert Larbaletrier, 1 vol., 568 pages.

Physical Chemistry, and its Role in Natural Phenomena in Astronomy, Geology, and Biology, by Dr. Fauvelle, 1 vol., 512 pages.

Anthropological Library.—An organization much the same, and for the same purpose, but divided for convenience, is the one carrying the foregoing title. It is directed by another committee, much the same as the former, of which Mathias Duval, Hervè, Hovelacque, Letourneau, de Mortillet are respectively members. Their publishers are Lecrosnier & Babè, Place de Ecole de Medicine, Paris. The volumes which have been published by this organization are eleven:

I. Sociologic Physiology. Thulie, Femme.

II. Darwinism. Duval.

III. Moral Evolution. Letourneau.

IV. Precis d'Anthropologie, Hovelacque and Hervè.

V. Religions. Vison.

VI. Evolution of Marriage and the Family. Letourneau.

VII. The Family in the Roman Society. Lacombe.

VIII. Evolution of Property. Letourneau.

IX. The Negro of Africa. Hovelacque.

X. Comparative Pathology. Bordier.

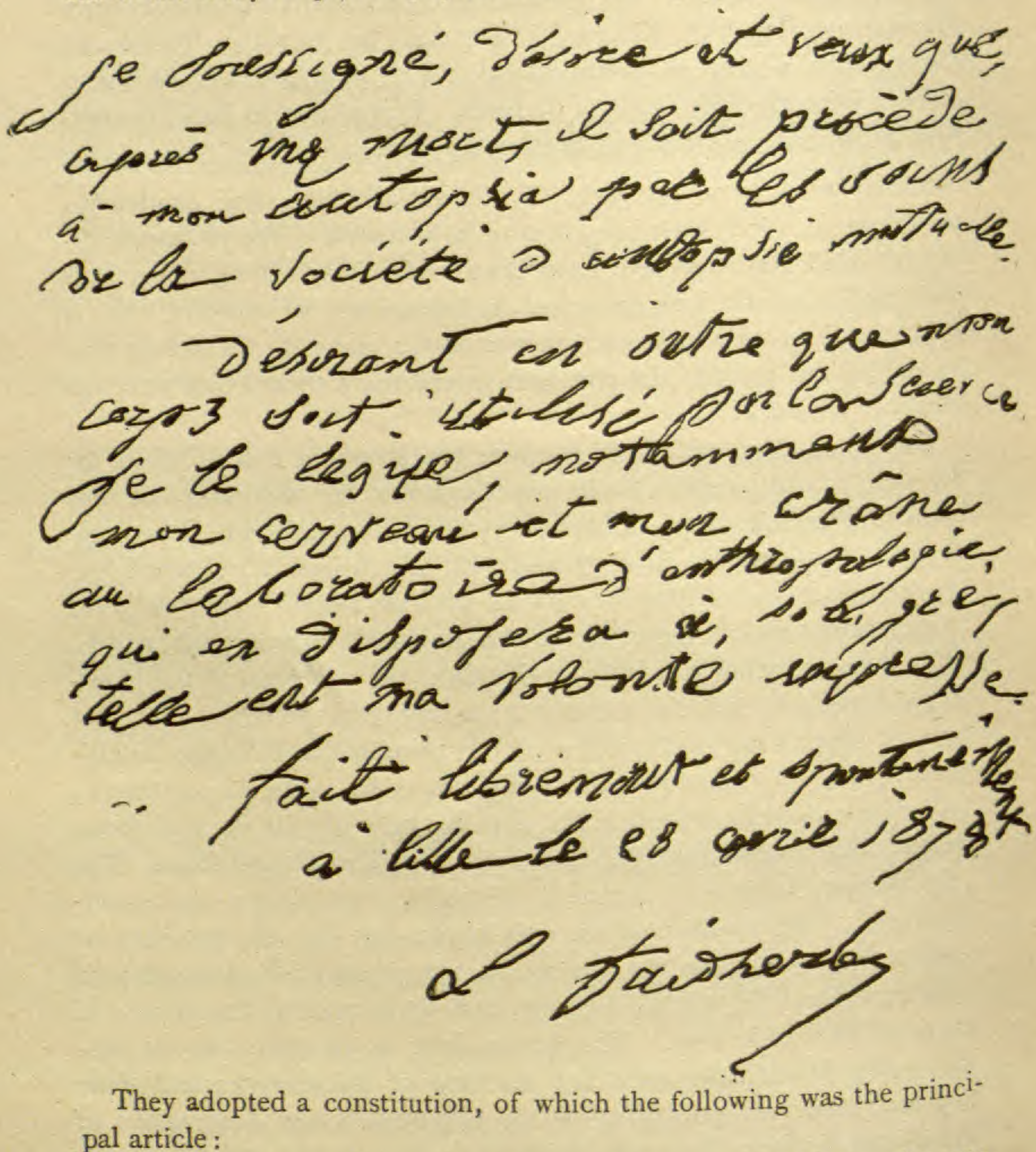
XI. Prehistoric France. Cartailhac.

A similar organization was made for bringing out a dictionary of anthropologic science. The committee of publication or editors were Hovelacque, Issaurat, Lefevre, Letourneau, de Mortillet, Thulié and Veron, with a host of collaborators. The publisher was Monsieur Octav Doin, Place de l'Odeon 8, Paris. It appeared in parts, twenty-four in number, and has just been completed.

Society of Autopsy.—A party of substantially the same gentlemen, published, in 1876, their intention to form a society, the principal object of which was to receive members who should be willing to bequeath their bodies to the Laboratory of Anthropology for autopsy, that it might be dissected and studied in a scientific manner. Whatever may be said of the project, the aim and intention of these gentlemen was certainly unselfish.

The declaration published by these gentlemen as a foundation for the society, and a reason for its existence, was the importance of that branch of the science of anthropology which they called the physiology of psychology (psycho-physics), and with this their want of knowledge, say ignorance, concerning it, coupled with the lack of opportunity for its successful study. Experiments had been made upon animals, which, while they contributed largely to elucidate the problems of the physiologic functions, like the sensations, movements, secretions, etc., had been of slight avail in the study of the phenomena of human intelligence. They declared that this study was to be made only or first by investigation of the human brain, and this not only in its size, form, weight, and composition, but also in its convolutions and folds. The existing opportunities by means of dissection were meagre and unsatisfactory. They mentioned the well-known fact that the professor or student who now made the dissection was proverbially unacquainted with the subject during his lifetime, and consequently the powers of his mind were unknown. The persons best acquainted with the subject during his lifetime were last to know of the autopsy; and there appeared to be no possibility of, or opportunity for, comparison of knowledge between those who knew the subject in life and those who made the dissection. There was, said they, no chance for the living descendants or relatives ofthe deceased, either through their own knowledge or the scientific knowledge of their own medical attendants, profiting from the discoveries which might be made by the dissection of the body of their ancestor.

They argued that public health and the interest of science has for a long period of time recognized the need for autopsy and dissection in the general education of the medical profession, while, they declared the study of psycho-physics had been largely ignored.


Je soussigné, désire et veux que, après ma mort, il soit procédé à mon autopsie par les soins de la Société d'autopsie mutuelle.

Désirant en outre que mon corps soit utilisé par la science de la ligue, notamment mon cerveau et mon crâne au laboratoire d'anthropologie, qui en disposera à son gré, telle est ma volonté expresse.

Fait librement et spontanément à Lille le 28 avril 1878

L Faidherbe

They adopted a constitution, of which the following was the principal article:

"Each member, in pursuance of the end of science and humanity, announces herein the procedure which shall govern his autopsy. In order to avoid every obstacle to the execution of his will he will leave at his death his testament declaring in general terms as follows: I will that after my death there shall be an autopsy practiced upon my body, that there may be discovered any malformation or hereditary malady, by means of which there can be employed the proper means to prevent their development among my descendants. I will that my body shall be utilized to the profit of the scientific idea which I have followed during my life, and to that end I bequeath my body, and notably my skull and brains, to the Laboratory of Anthropology, where it can be utilized in such mode as is believed to be best; and this is my wish spontaneously expressed. The portions of my body which are needed, after being used as aforesaid, are to be buried according to the usual method (or any other method may be indicated)."

A tracing is given on the opposite page of the oleograph testament of General Faidherbe, who died lately.

There are about 150 members of the Society of Autopsy. It has received the ministerial and legal authorization, and is now established upon a firm basis. The fees for membership are one dollar per year.

The importance was early recognized by these gentlemen of knowing everything concerning the physical and mental habits; and life of the subject, and therefore he was requested to make as full a description of himself and his physical and mental peculiarities as possible. His senses, sight, hearing, his understanding, his memory, was he a *visuaire* or an *auditaire*,—that is, could he understand and comprehend the meaning of words best through the eye or through the ear. So also, any peculiarities of his sensations, of the powers of his mind, and any observations upon his temperament or character.

The Laboratory of Anthropology has received several of the members of the Society of Autopsy, of which they have made dissection and investigation:

1. Jules Assezat, literateur, died June 24th, 1876, of heart disease, aged forty-five years.

2. Louis Asseline, literateur, died April, 1878, of rupture of the heart, aged forty-nine years.

3. Dr. Coudereau, died July 19th, 1882, of wounds of the intestines, aged fifty years.

4. Leon Gambetta, politician and statesman, died December 31st, 1884, aged forty-three years.

5. Dr. Adolphe Bertillon, professor, died March 1st, 1883, aged sixty-two years.

6. Gillet-Vital, civil engineer, died 1887, aged sixty-three years.

7. Sculptor Sauzel.

8. General Faidherbe.

The brains of the first five have been studied with care, and all their peculiarities described and written out. The brain of each has been accurately drawn, and by means of the stereograph they have been superposed, and drawings made comparing them.

I do not know whether it is by law or only by regulation, but the Laboratory of Anthropology has within the last few years received the bodies of all criminals executed in Paris, and there are to be now seen suspended from the usual ring in the top of the skull the articulated skeletons of these individuals, with their moulded brains laid upon the shelf beside them.

There were displayed either the brain, the skulls, or the busts of the following assassins who have been executed :

Lemaire, Menesclou, Prevost, Gagny, Marchandon, Rey, called Pas de Chance, Rivière, Pranzini, Barre, and two others, names unknown, one executed at Macon, the other at Montpellier.

I do not pursue this subject, for it will take me immediately into a catalogue and description of the 5,000 skulls and the numberless casts and studies, with all their numerous examples of anatomy, osteology, craniology, anthropogeny, which served to form the Musèe Broca.

The Institute of Anthropology at the Paris Exposition.—At the Paris Exposition of 1867 the science of anthropology was unrepresented.

In that of 1878 the Minister of Agriculture and Commerce, on the proposition of the Commissioner-General of the Exposition, decided upon a representation of anthropology, and confided its organization to the Society of Anthropology. It made a creditable, and for that time an important and instructive exhibit, but nothing to be compared with that in the Exposition of 1889.

In the Exposition of 1889 the Minister of Public Instruction requested the Society of Anthropology to make such display as was possible. A commission was organized, which made its appeal to its members in every part of the world, and to all kindred societies in France. I remember well in Paris, in the autumn of 1885, four years before the Exposition opened, the preparations which were being made. A family of bushmen from South Africa were being exhibited at a meeting of the society, under the management of Dr. Topinard. They were afterwards taken to the room for making plaster casts, and a cast of them made natural size. This was done in preparation for the Exposition, and when I visited it I saw the plaster casts of this family.

The members and societies appealed to for assistance in the Exposition of 1889 responded with alacrity, and, while the representation was not the equal of that of the l'Histoire du Travail Retrospectif, under the direction of the Minister of Commerce and Agriculture, with Drs. Hamy, Topinard, and Cartailhac for managers, yet it was an important display, and coming as it did in the Department of Public Instruction, it showed opportunities to teachers to educate the people in this science of anthropology, especially the prehistoric, which might be productive of greater good and more far-seeing in its benefits to the general public than the finer and more extensive display in the other section.

Any one who has any knowledge of the subject of this paper can scarcely fail to have remarked the absence of all note of some of the most celebrated writers and workers in France on anthropology. The reason of this can easily be made plain. This paper has been devoted to the Society of Anthropology and the organization and laborers connected therewith. These other gentlemen, notable by their absence, while members of the Society of Anthropology and affiliating therewith, belong or are attached to other institutions of the same or kindred sciences, and their work is done in connection with their own organizations, and so does not appear with the Society of Anthropology.

Monsieur de Quatrefages is the Nestor of the science,—first in time, first in years, and first in wisdom. He is professor at the Museum of Natural History at the Jardin de Plantes. He delivers three lectures a week. His publications upon this subject are numerous, profound, and of great value.

There are other gentlemen eminent in science: Dr. E. Hamy, Consevateur of the Musèe of Ethnography at the Palace of the Trocadero; Monsieur Alexander Bertrand, Member of the Institute and Director of the Musèe St. Germain; M. Solomon Rainach, his assistant; M. le Doctor Emile Riviere; Marquis Nadaillac; M. Emile Cartailhac.[1]

A few words as to the members of the Society of Anthropology at Paris, and their domicil and professors, may not be uninteresting.

The honorary members number ten; the titular members are four hundred and twenty-six, of which two hundred and ninety-nine reside in Paris, and one hundred and twenty-four elsewhere; the national correspondents are sixty-three, while correspondents and associate foreigners number one hundred and eighty-three; making a total of six-hundred and seventy eight members. One-third of the regular members reside outside the city of Paris.

[1] M. Cartailhac, though a resident of Toulouse, spends so much of time, and does so much of his work in Paris as to be fairly entitled to be classed with the Parisian scientists.

The interest in anthropology on the part of the medical profession is shown by the fact that of the regular members no less than forty-eight per cent. are doctors.

The Society of Anthropology of Paris pays no rent. It has a subvention from the government of one thousand francs. Its annual dues for members are thirty francs. Its receipts amount annually to between eighteen and twenty thousand francs; its expenditures from one to three thousand francs less. It has invested in the *rentes d'Etat* the sum of forty-three thousand, five hundred and ninety-three francs, and had enough on hand before it commenced its present work in the Exposition to increase the amount of its cash capital to fifty-four thousand francs.

Permit me a few observations in confidence,—delivered as it were in executive session. There is no satisfactory reason why the Society of Anthropology at Washington, should not equal that of Paris. I know it will be said that Washington is not so large a city as Paris; but that is no sufficient reason. If you will but look over the names of the members who have attended their meetings, will but see the amount of work which they have done, the seriousness of their study, the profundity and detail of their investigations, the value to science of their contributions, and, finally, the zeal and fidelity of their members as exhibited in their work, you will conclude that if the Society at Washington should equal in these regards the Society at Paris it will deserve a higher rank and greater success than it possesses at present. If you had or would or could take in the ladies as members, that alone would make considerable increase in your membership, and also in your income. If you would have your meetings open to the public, and the needed conveniences provided for its reception and accommodation, this would also increase your membership. No person will join a society of anthropology until after he shall become interested in the science. All those who have had an original interest have already joined, and we must now recruit our membership from those in whom an interest has to be created. This can now be done only by private solicitation. If the public could be invited and attend the meetings of the society, we would soon see revived interest; and I have every faith that it would result in considerable increase of the membership roll. We have sufficient evidence to justify the conclusion that the attendance of the public upon the regular meetings would be large enough to be called successful. I think it deplorable that papers of the value and importance of those prepared by our members should be read before so insignificant a number. Those papers will compare in scientific value and in public interest with the average lecture delivered at the National Museum, and the attendance thereof from 600 to 1000 at each lecture is to my mind proof that if the opportunity were offered the public would attend in large, if not in equal, numbers the meetings of this society, to hear the papers and discussions of its members. I think this fact illustrates the possibility of success in throwing open our meetings to the public. That it did not attend the meetings at Columbia College may have been due to the failure of detail in announcement, advertisement, etc.

I decline to stand as an apologist for our society; I do not excuse it in any comparison with that of Paris or London, on account of our youth as a nation or sparseness of our population. I would not plead the baby act as a reason for our poverty. We are located at the capital, and we possess all the advantages to be derived therefrom. We are a nation of sixty millions of people. We are as numerous, as rich, as capable, and have in every way equal opportunities with either the French, English, or any other nation to study the science of anthropology, whether prehistoric or otherwise, to do serious work which shall be of equal value; and, repeating what I said at the commencement of this chapter, I know no satisfactory reason why the Society of Anthropology at Washington should not be the equal in any and every respect with that at Paris, or with those in any other part of the world.

It has been an aspiration of mine that our society should be strong and powerful; that it should be at the head of kindred societies, and be the acknowledged authority of our science, not only in our own country, but that it should be its representative in foreign countries. I have hoped that every discovery of importance made within our country should be reported to it; that every question arising therefrom should be sent to it for resolution; that disputed points should be submitted to it for its opinion. I desire to see it conservative, dignified, learned, wise, and that it should occupy such acknowledged rank and speak with such acknowledged authority as that no anthropologist o prominence but would feel himself flattered by the use of its means to make known his opinions to the world, nor would one venture to publish to the world any new or untried theory in regard to the science except he had first sought to obtain our approval and the weight of our authority. I confess to a feeling of annoyance when the Hon. Charles Francis Adams, president of the Pacific Railroad, made or received from another the discovery of the statuette, said to be of human origin, and which came from the artesian well in Idaho, he should have sent the object to the scientists of Boston for their opinion, and should have ignored this society or its kindred organizations in Washington. This would not have been so in either England, France, Belgium, Germany, Denmark, Sweden, Portugal, Spain, or Italy.

On a Certain Gesture of the Mouth Among the American Indians.—It commonly happens that the Zuñi and Navajo Indians make use of a gesture which has come to have an interest to me. In indicating that a person, or thing is far away, or where an event has happened or a person is at the time of speaking, these Indians, instead of turning the head that way or pointing with the finger, raise the head and project the lower jaw in the direction which they wish to indicate. As I am not familiar with the mode of gesticulation of other Indian tribes, I do not know how widely spread among our aborigines this habit is, but certainly it is very different from that of any of the white races.

When I first observed this peculiar gesture, aside from its unusual nature it made but little impression on my mind. It seemed quite too insignificant to be of any use in the study of Indian habits, and would probably never have occurred to me again but for an interesting experience among our New England Indians. On my return from the southwest last summer I went directly to Calais, Maine, to witness a snake dance, which I had hoped, but in vain, to see celebrated at the election of the "Governor" of the tribe. In talking with an old man of the tribe, I observed him use the same gesture several times for identically the same purpose as it is used among the Zuñians. The resemblance was so close that one could not imitate it. I was immediately reminded of my former experiences in the southwest. In both instances the gesture was very different from what would naturally be made by a white man for the same purpose.

The resemblance may seem too insignificant to mention, for it may have been a simple coincidence; but to me it had an ethnographical interest, and may not be without the same to others.

I have not studied Indian tribes enough to say how universal this gesture is among them. It may be characteristic of all our aborigines, and it may not be confined to them; but I am confident that the gesture was identical in the two instances mentioned, and it has not been my experience to see the same among white people.

This note is a plea for information. Is the gesture with the lower jaw to indicate distance or direction a characteristic Indian habit? Those whom I have consulted tell me that it is. If it is, we may well wonder why such an insignificant habit should be so tenacious in a tribe so long in contact with the whites and so much affected by their civilization in much more important particulars as the Passamaquoddies.

It is conceivable that gestures like this certainly, spontaneous and in some respects involuntary, may furnish data of ethnological value.—J. WALTER FEWKES, *Boston, January 10th, 1891.*

MICROSCROPY.[1]

Methods for the Preservation of Pelagic Organisms.—The publication of the methods for the preservation of marine animals employed at the Naples Station[2] has called forth another contribution on the subject from Benedict Friedländer.[3]

Kleinenberg discovered some time since that picrosulphuric acid gave the best results with marine larvæ when it contained about 2 per cent. of common salt. Friedländer experimented on Hydromedusæ and Ctenophores with regard to this point, by placing some individuals in 1 per cent chromic acid, and others, of the same species, in an equal volume of the same solution, to which 2–3 per cent. of salt had been added; the results declared unmistakably in favor of the latter reagent. Still better results were obtained by fixing the specimens in a solution prepared by adding sea-water to a 30–40 per cent. solution of chromic acid until it was reduced to a ½–1 per cent. solution, the animals being exposed to its action for about an hour. An objection to the method lies in the fact that there is a danger of crystals of calcium sulphate separating out in the tissues when the specimens are transferred to alcohol. If the salts contained in the tissues are thoroughly washed out before the transfer, there will, on the other hand, be a shrinkage.

Friedländer obtained his best results by the prolonged action (5–10 hours) of an abundant quantity of 30 per cent. alcohol, followed by 50 per cent., 60 per cent., and 70 per cent. He concludes that a neither too rapid nor too slow extraction of the salts contained in gelatinous animals is more important for the prevention of shrinkage than the use of any fixatives. From many Medusæ, Salpæ, Siphonophores, etc., the salts can be more or less extracted before treatment with

[1] Edited by C. O. Whitman, Clark University. Worcester, Mass.

[2] See AMERICAN NATURALIST for September, 1890.

[3] *Biolog. Centralblatt.* Bd. X., Nos. 15–16.

alcohol by the action of fresh water, or a solution of chromic acid in distilled water. A trace of hydrochloric or nitric acid added to the alcohol dissolves some crystal deposits, but not those produced by calcium sulphate.

The greatest obstacle in the way of obtaining satisfactory preparations of Siphonophores is the tendency to split up into fragments which many of them, especially those with nectocalyces, show. Friedländer experimented with various salts in an attempt to discover a reagent which would kill without producing fragmentation, and obtained the best results with ammonia, zinc sulphate, and copper sulphate. The first of these reagents is, however, unsatisfactory for other reasons.

An interesting observation in connection with the use of these reagents is, that to obtain good results the reagent must have a certain minimal concentration; below this fragmentation occurs, increasing in intensity with the weakness of the reagent. This does not seem to depend on the rapid killing or fixation of the tissues by the strongest solutions, since such reagents as concentrated corrosive sublimate and strong nitric or acetic acids are much more rapid in their action than 15 per cent. copper or zinc sulphate, and yet produce excessive fragmentation.

The following method of preservation is recommended for the Siphonophores. The vessel which contains the animal in sea-water is held in a tilted position, so that the water is almost at the brim on one side. A solution composed of

Fresh water	1000 parts.
Zinc sulphate	125 "
Copper sulphate	125 "

is then poured in somewhat gradually, so that it may mix equally with the sea-water. The amount of the reagent to be used varies with the species under treatment. For instance, with Physophora it should be of about equal volume with the sea-water; but for Forskalia, which has numerous nectocalyces, it should be at least double that volume.

After the animal is completely dead, it should be placed in a fixing solution, for which Friedländer recommends 1 per cent. chromic acid in sea-water, with the addition for more delicate forms of strong osmic acid, or else $\frac{1}{5}$ per cent. osmic acid alone may be used.

Before transferring to alcohol the animal should be allowed to slip (the nectocalyces going first) into a glass tube, open only at one end. This opening should be plugged with cotton, and the tube suspended, the open end downwards, in 50 per cent. alcohol. In about 12 hours the chromic acid will have been extracted, and the tube is then transferred for another 12 hours to 80–90 per cent. alcohol.

Finally, to get rid of the air-bubbles which sometimes form in the cavities of the nectocalyces, it is recommended that the specimen, before being placed in alcohol, should be transferred for a time to well-boiled sea-water, so that the air contained in the tissues may, to a certain extent, be dissolved out.—J. PLAYFAIR MCMURRICH.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

The Western Society of Naturalists held its annual meeting Nov. 12th and 13th, 1890, in the Physical Laboratory of Purdue University, Lafayette, Ind. In the absence of the president, Prof. C. R. Barnes occupied the chair. The report of the treasurer showed a balance on hand of $36.70. The presidential address by Chancellor C. E. Bessey dealt with "General Culture as an Object in Teaching Science." The society then discussed, "What science, and how much science, shall be required for entrance to college classes?" The general conclusion was that it did not much matter what science was required so long as it was well taught in the preparatory schools, but that none was better than that which is usually offered. Dr. D. H. Campbell gave an account of "Some Histological Methods in Botany." He usually killed and hardened vegetable tissues by immersion for from four to twenty-four hours in 1 per cent. chromic acid, stained *in toto* with some nuclear stain, cut by the paraffin method, and then stained again on the slide with Bismarck brown in 70 per cent. alcohol. This brings out the nucleus and the cell-wall in a beautiful manner. Turpentine is better for plant-tissues than chloroform, while a solution of Bismarck brown in turpentine stains too diffusely. Professor Hargitt exhibited a warm stage of his own construction, and described his method o making permanent mounts of Infusoria. He killed the specimens with Lang's fluid and stained with borax carmine. Dr. Kingsley described a new method of making serial sections with celloidin. Many of the same points are contained in a paper by A. C. Eycleshelmer in the *Botanical Gazette*, Vol. XV., p. 291, 1890. Prof. O. P. Jenkins described a lens support and directed attention to the Urodeles as affording excellent material for the demonstration of muscle growth. He also recommended the beetle Dytiscus for exhibiting the phenomena of living muscle, using the blood of the beetles for a medium. Dr. Kingsley described a number of methods for killing marine invertebrates for histological purposes and for display. The following officers were elected for the ensuing year: Pres., J. M. Coulter; Vice Pres., S. Calvin, E. A. Birge, C. W. Hargitt; Treas., B P. Colton; Sec., J. S. Kingsley. The next meeting will be held next November, at St. Louis, Mo. Four states were represented at the meeting.

Indiana Academy of Science.—Indianapolis, Dec. 30th and 31st, 1890. T. C. Mendenhall, president.—Eighty-two papers were read, the following being those relating to the natural sciences: A recent find of Musk Ox remains in Indiana, Joseph Moore. A review of the Niagara Group in Bartholomew Co., Ind. (by title), J. F. Newsom. Shelby County "Earthquake," J. F. Newsom. Some new Crustacean Fossils, C. E. Newlin. Geological Section at Vincennes, W. J. Spillman. Sections of Drift in Vigo Co., Ind., J. T. Scovell. The highest old Shoreline on Mackinac Island, F. B. Taylor. The effect ot the Great Lakes on the ice sheet, F. B. Taylor. Preliminary notes on Genus Polygonum, Stanley Coulter. Aberrant fruit of *Juglans nigra*, Stanley Coulter. Aberrant forms of *Juglans nigra*—structural changes, D. T. McDougal. Value of minute anatomy in plant classification, Stanley Coulter. Notes on the apical growth of Liverworts, David M. Mottier. Notes on the germination of spores of Notothylus (by title), David M. Mottier. A remarkable oscillating movement of protoplasm in a Mucor, J. C. Arthur. Accelerating germination by previous immersion of the seed in hot water, J. C. Arthur. Notes on Guatemalan Compositæ, Henry E. Seaton. Parasitic Fungi of Indiana, E. M. Fisher. Circulation of sap, John Morgan. Distribution of Peucedanum in North America, J. N. Rose. Plants collected by Dr. Palmer in Arizona in 1890, J. N. Rose. Comparative structure of the roots of Osmunda and Botrychium, D. H. Campbell. Notes on the prothallium of the Osmundaceæ, D. H. Campbell. Notes on new Puccineæ, Henry L. Bolley. On the manufacture of plant infusions for the culture of Bacteria, Henry L. Bolley. The occurrence of *Veratrum woodii* in Decatur, Ind., W. P. Shannon. Some features of the occurrence of *Viola pedata* var. *bicolor*, Joseph H. Tudor. Preliminary list of Knox County plants, W. J. Spillman. Introduction of noxious weeds, W. J. Spillman. Biological surveys, John M. Coulter. The flora of Texas, John M. Coulter. Weight of the seed in relation to production, Katherine E. Golden. The identification of Ghost-fishes, Charles H. Gilbert. The deep-water fishes of the Pacific, Charles H.

Gilbert. The fishes of the interior of Kentucky (by title), A. J. Woolman. Notes on Indiana Reptiles, Amos W. Butler. Observations on the habits of *Synaptomys cooperii*, Amos W. Butler. Chætodontidæ of the Sandwich Islands, O. P. Jenkins. Notes on structure of muscle cells in Salamanders, O. P. Jenkins. Geophili in Jefferson County, Ind. (by title), Geo. C. Hubbard. Notes on some Actinia, W. F. Glick. Some notes on Indiana birds, B. W. Evermann. Contribution to the distribution of the fishes of the West Coast of North America, O. P. Jenkins and B. W. Evermann. Sailor Spiders on Lake Maxinkuckee, O. P. Jenkins. The Butterflies of Indiana, W. S. Blatchley. The Batrachians and Reptiles of Vigo Co., Ind., W. S. Blatchley. The death of Salmon after spawning, D. S. Jordan. The fishes of the upper Columbia and the Shoshone Falls, D. S. Jordan. Eels of America and Europe (by title), D. S. Jordan and B. M. Davis. Food habits of the Blue Jay, C. W. Hargitt. Notes on *Hydra fusca*, C. W. Hargitt. Acridiidæ of Vigo Co., Ind., W. S. Blatchley. On a bird new to the State fauna, W. S. Blatchley. On *Cnicus discolor* as an insect trap, W. S. Blatchley. Relation of the number of vertebræ in fishes to the temperature of water, D. S. Jordan. Notes on Indiana Mammals, B. W. Evermann and A. W. Butler. Audubon's old mill at Henderson, Ky., B. W. Evermann. The range of the Evening Grosbeak in the winter of 1889–'90, Amos W. Butler. Carolina Parakeet in Indiana, Amos W. Butler. The colors of sounds, Gustaf Karsten. The colors of letters, D. S. Jordan. A list of the Orthoptera of Illinois, with descriptions of new species and observations on the songs and habits of little-known species (by title), Jerome McNeill. Description of a new æsthesiometer, William Bryan. Researches on the tactual perception of distance, William Bryan. Researches on reaction time, William Bryan. Fishes of the Wabash Basin, B. W. Evermann and O. P. Jenkins. Hypnotism, W. B. Clarke. The presidential address, "The Work of the U. S. Coast and Geodetic Survey," was given on the evening of the 30th.

The Nebraska Academy of Sciences was organized at Lincoln, Neb., Jan. 1st, 1891, with seventy-three members. A short constitution was adopted, and the following officers were elected: President, Dr. J. S. Kingsley; Vice President, Prof. G. D. Swezey; Secretary and Treasurer, Prof. W. E. Taylor; Custodian, Lawrence Bruner; Directors, Mrs. E. O. Nettleton, W. H. Skinner. The Academy will hold its annual meeting in Lincoln, the week following Christmas, and will hold a field meeting each spring at some interesting point in the state.

SCIENTIFIC NEWS.

Dr. Clarence M. Weed, editor of the entomological department of the AMERICAN NATURALIST, and present entomologist to the Ohio Experiment Station, has been elected professor of zoology and entomology at the New Hampshire College of Agriculture and Mechanic Arts, located at Hanover, N. H., in connection with Dartmouth College. He will move to Hanover during the coming spring.

Alexander Winchell, Professor of Geology and Paleontology in Ann Arbor University, Michigan, died on February 20th at Ann Arbor. Professor Winchell was one of the best-known geologists, and was a distinguished author of works of original research, as well as educational books. He was long State Geologist of Michigan, and during his incumbency he published some important monographs of the Paleozoic geology and paleontology of his State. He subsequently assumed the Professorship of Geology in Vanderbilt College, Tennessee, from which school he was retired because of his belief in the doctrine of organic evolution. He was afterwards Chancellor of the University at Syracuse, New York, from which place he returned to Ann Arbor. At the time of his death he was President of the Geological Society of America. His latest work has been in the Archean and Huronian regions about Lake Superior.

Professor Winchell produced a number of works of a popular character, which have greatly stimulated the taste for geological science in this and other English-speaking countries. He was a pleasant lecturer, who instructed his classes, and aroused their interest in his favorite science. His treatment of the subject was within the reach of popular audiences, as it was not his specialty to deal with the finest subtleties of thought. His method was rather bold and comprehensive.

Professor Winchell was a handsome man of strong physical build, and of a quiet and somewhat phlegmatic temperament. He was honest and amiable, and personally attractive to many people. He has left many friends. He was born in the State of New York in 1824.

Professor Felipe Poey, the most famous naturalist yet produced in any Spanish country, died at Havana, Cuba, Jan. 28th, 1891, in the ninety-second year of his age. Poey was born in Havana, of French-Spanish parentage, in the year 1799. He was educated for the profession of law in the University of Havana, but his tastes for the natural sciences were very strong, and in 1826 he went to Paris, where he spent five years in the study of zoology. Here he was a friend of Cuvier, and one of the founders of the Entomological Society of France. After his return to Havana, Poey devoted his life to the study of the rich fauna of his native island, and especially to making known its fishes. Of the many new species of Cuban fishes described by Poey, one hundred and ninety-one are recognized as valid in the latest catalogues. The writer was told by a fish-dealer in Havana that "for twenty years Don Felipe was in the markets every day when at noon the fishes came in from the boats, and that he knew more about the fishes of Cuba than the fishermen themselves."

In 1842 Poey was appointed to the Chair of Comparative Anatomy and Zoology in the University of Havana, a position which as active and emeritus professor he held until his death. His publications were numerous, in Spanish and French, and occasionally in English. The most important are "Memorias Sobre la Historia Natural de la Isla de Cuba," "Repertorio Fisico-Natural de la Isla de Cuba," and "Enumeratio Piscium Cubensium."

The great work of his life, "Ictiologia Cubana," is still unpublished. This book contains detailed descriptions and life-size figures of seven hundred and fifty-eight species of Cuban fishes. A duplicate of its manuscripts has been purchased by the Spanish government at a cost of $5,000, and has been exhibited at several European expositions, but the prospect of its publication is still remote.

Poey has long been recognized as one of the most intelligent and faithful workers in faunal zoology. His writings are characterized by an entire lack of prejudice, his sole purpose being to place on record the facts which come before him. His interest was maintained up to the time of his death, a fact the more remarkable as outside of his own family not a person in Cuba had any real knowledge or appreciation of his work. His long life has been a very happy one, and few naturalists of our day have better deserved the good will and respect of their fellow-workers than the genial and cheery Professor Poey.—D. S. JORDAN.

Dyspepsia

Horsford's Acid Phosphate

In dyspepsia the stomach fails to assimilate the food. The Acid Phosphate assists the weakened stomach, making the process of digestion natural and easy.

Dr. R. S. McComb, Philadelphia, says: "Used it in nervous dyspepsia, with success."

Dr. W. S. Leonard, Hinsdale, N. H., says:
"The best remedy for dyspepsia that has come under my notice."

Dr. T. H. Andrews, Jefferson Medical College, Philadelphia, says:
"A wonderful remedy which gave me most gratifying results in the worst forms of dyspepsia."

Descriptive pamphlet free.

Rumford Chemical Works, Providence, R. I.

BEWARE OF SUBSTITUTES AND IMITATIONS.

CAUTION:—Be sure the word "Horsford's" is printed on the label. All others are spurious. Never sold in bulk.

ROOFING.

Gum-Elastic Roofing Felt costs only **$2** per **100** square feet. Makes a good roof for years, and any one can put it on. Send stamp for sample and full particulars. Gum-Elastic Roofing Co.,
39 and 41 West Broadway. New York.

Local Agents Wanted.

WANTED.—Professors of Science. The School and College Bureau of Elmhurst (Chicago), Ill., has an established patronage among leading universities and schools. A few of the well-known institutions that have recently secured Professors of Science through this Bureau, we may name the State University of Vermont, the State University of Colorado, Illinois Wesleyan University, South Dakota School of Mines, Pritchett School Institute, Leche's Graded School Institute, Searcy College, Mount Morris College, and others. Send for circulars and full information. Address

C. J. ALBERT, Manager,
Elmhurst, Illinois.

NORTH AMERICAN

LICHENS

For sale in sets, my new discoveries (some dozen species) among them.

W. W. CALKINS,

130 Dearborn St., Chicago.

A NEW BOOK

FROM COVER TO COVER.
FULLY ABREAST WITH THE TIMES.

WEBSTER'S INTERNATIONAL DICTIONARY

The Authentic "Unabridged," comprising the issues of 1864, '79 and '84, copyrighted property of the undersigned, is now **Thoroughly Revised** and **Enlarged**, and bears the name of

Webster's International Dictionary.

Editorial work upon this revision has been in progress for over **10 Years.**

Not less than One Hundred paid editorial laborers have been engaged upon it.

Over **$300,000** expended in its preparation before the first copy was printed.

Critical comparison with any other Dictionary is invited. **GET THE BEST.**

G. & C. MERRIAM & CO., Publishers, Springfield, Mass. U. S. A.

Sold by all Booksellers. Illustrated pamphlet free.

NOTICES.

Notices for scientific societies and private individuals inserted under this head free of charge. For business houses, two cents per word.

MINERALOGY. — Course conducted by correspondence. First collection and book $1. Postage 25 cents. Address
GUSTAVE GUTTENBERG,
Central High School, Pittsburgh, Pa.

WANTED—To correspond with conchologists in America, especially in California, with a view to exchange. Many British land, fresh-water, and marine duplicates; some foreign. Address Mrs. Falloon, Long Ashton Vicarage, Bristol, England.

WANTED—Position in Academy, Normal or High School, as teacher of the Natural Sciences and Modern Languages. Latin taught in addition, if necessary. Address G., box 441, Hanover, N. H.

A COLLEGE PROFESSOR of Natural Sciences and German, of four years experience and special Biological training received at the Universities of Leipzig and Bonn, Germany, is open for a position in a college. Good references.
Address, C., Box 136, New Berlin, Pa.

FOR EXCHANGE.—14 Volumes (1883–1889) AMERICAN JOURNAL OF SCIENCE; 10 volumes (1880–1889) AMERICAN NATURALIST; 21 volumes (1879–1890) ENGLISH MECHANIC; all in good condition for binding; also, Morris Typewriter. If you have a good Microscope, Camera, or anything else to offer, please send full description.
E. R. CHADBOURN, LEWISTON, ME.

FOR SALE.—Beautiful sets of Fossil Plants from the Dakota Group Cretaceous. On receipt of $3.00 I will forward, prepaid, to any address in Europe or America, 20 different species and varieties of Dakota Plants. Send 5 cents for plate illustrating the set. The specimens will equal the figures. CHAS. H. STERNBERG,
P. O. Box 60, Lawrence, Kans.

WANTED—Hall's works on Palæontology, and other works giving plates which show fossils of the Niagara Epoch. Address M. D. Sullivan, St. Ignatius College, Chicago, Ill.

VOLUMES I., II., III., and IV., of THE AMERICAN NATURALIST, in first-class condition, bound in half Morocco, for sale. Price $16.00. Address GEO. W. MACKAY,
25 Congress St., Boston, Mass.

WANTED—For dissection and microscopic work, Polyps, Jelly-fish, or other Hydrozoa, Actinozoa, and Ctenophora; also Echinodermata and Mollusca. Cash or exchange given. J. A. Leighton, Trinity College, Toronto, Can.

I HAVE FOR EXCHANGE for other shells from sea or land, very fine specimens of *Unios trigon, occidens, coccineus, lacrymosus, lævissimus, rectus, alatus, gracilis, turberculata, ventricasus; Margaritania confrogosis, complanata, rugosa, gibbosus,* and others; *Anadonta corpulenta* and *suborbiculata.* Will send six of the beautiful *Anadonta suborbiculata* by mail for one dollar.
DR. W. S. STRODE, BERNADOTTE, ILL.

$4.00 per Year. 40 cts. per Copy.

THE AMERICAN NATURALIST.

A MONTHLY JOURNAL
DEVOTED TO THE NATURAL SCIENCES
IN THEIR WIDEST SENSE.

Vol. XXV. MARCH, 1891. No. 291

CONTENTS.

PHILADELPHIA:
FERRIS BROS., PUBLISHERS
SIXTH AND ARCH STREETS

Entered at the Philadelphia Post Office as second-class matter.

To Scientific Investigators.

ONE of the greatest needs of American science at the present time is a convenient medium in which brief preliminary notices of the results of investigation can be published. A considerable length of time of necessity elapses between the conclusion of any series of observations and their appearance in print, and it is of great advantage to the observer, and still more to his fellow-workers, to have the results made known as soon as possible, thus insuring priority of discovery to the one, and allowing the others to keep more perfectly posted with what is going on in the scientific world around them.

A preliminary notice should be published *at once* to be of value, and hitherto there has been no scientific periodical in this country, published at sufficiently brief intervals, and open to all investigators, which has specially opened its columns to the publication of such notices, and has undertaken to make them public with as little delay as possible. This the NATURALIST proposes to do, and invites the coöperation of all investigators in an attempt to inaugurate a department for the prompt and satisfactory publication of preliminary notices of the results of scientific investigations.

THE

AMERICAN NATURALIST

VOL. XXV. MARCH, 1891. 291.

ARE ACQUIRED VARIATIONS INHERITED?

BY HENRY FAIRFIELD OSBORN.

Opening of a Discussion upon the Lamarckian Principle in Evolution; American Society of Naturalists, Boston, December 31st, 1891.

ARE acquired characteristics inherited? We admit that individuals inherit a certain constitution, and that definite variations from this constitution are acquired during life-time, according to well-known laws. The question is: Are these definite acquired variations in any degree transmitted, or are the congenital variations in the constitution of the offspring independent of those which have been acquired by the parents?

PRESENT STATE OF THE QUESTION.

Before opening this discussion let us draw up a balance sheet in biological philosophy for 1890, and determine exactly where we stand in point of knowledge of natural causation. Fortunately Professor Huxley balanced the Evolution account in 1871[1] in his usual accurate and candid manner, enabling us to institute a comparison:

"If I affirm that 'species have been evolved by variation[2] (a natural process, the laws of which are for the most part unknown), aided by the subordinate action of natural selection,' it seems to me that I enunciate a proposition which constitutes the very pith

[1] "Critiques and Addresses," p. 299. *Contemporary Review*, 1871. This passage is practically a résumé of the article entitled "Mr. Darwin's Critics," in which it occurs

[2] Including under this head hereditary transmission.

To Scientific Investigators.

ONE of the greatest needs of American science at the present time is a convenient medium in which brief preliminary notices of the results of investigation can be published. A considerable length of time of necessity elapses between the conclusion of any series of observations and their appearance in print, and it is of great advantage to the observer, and still more to his fellow-workers, to have the results made known as soon as possible, thus insuring priority of discovery to the one, and allowing the others to keep more perfectly posted with what is going on in the scientific world around them.

A preliminary notice should be published *at once* to be of value, and hitherto there has been no scientific periodical in this country, published at sufficiently brief intervals, and open to all investigators, which has specially opened its columns to the publication of such notices, and has undertaken to make them public with as little delay as possible. This the NATURALIST proposes to do, and invites the coöperation of all investigators in an attempt to inaugurate a department for the prompt and satisfactory publication of preliminary notices of the results of scientific investigations.

THE

AMERICAN NATURALIST

VOL. XXV. MARCH, 1891. 291.

ARE ACQUIRED VARIATIONS INHERITED?

BY HENRY FAIRFIELD OSBORN.

Opening of a Discussion upon the Lamarckian Principle in Evolution; American Society of Naturalists, Boston, December 31st, 1891.

ARE acquired characteristics inherited? We admit that individuals inherit a certain constitution, and that definite variations from this constitution are acquired during life-time, according to well-known laws. The question is: Are these definite acquired variations in any degree transmitted, or are the congenital variations in the constitution of the offspring independent of those which have been acquired by the parents?

PRESENT STATE OF THE QUESTION.

Before opening this discussion let us draw up a balance sheet in biological philosophy for 1890, and determine exactly where we stand in point of knowledge of natural causation. Fortunately Professor Huxley balanced the Evolution account in 1871[1] in his usual accurate and candid manner, enabling us to institute a comparison:

"If I affirm that 'species have been evolved by variation[2] (a natural process, the laws of which are for the most part unknown), aided by the subordinate action of natural selection,' it seems to me that I enunciate a proposition which constitutes the very pith

[1] "Critiques and Addresses," p. 299. *Contemporary Review*, 1871. This passage is practically a résumé of the article entitled "Mr. Darwin's Critics," in which it occurs

[2] Including under this head hereditary transmission.

and marrow of the first edition of the 'Origin of Species.' And what the evolutionist stands in need of just now is not an iteration of the fundamental principles of Darwinism, but some light upon the questions, What are the limits of variation? and, If a variety has arisen, can that variety be perpetuated, or even intensified, when selective conditions are indifferent, or perhaps unfavorable, to its existence?"[3]

Thus, twenty years ago, Huxley declared Evolution well established, with the Law of Natural Selection as one of its well-determined factors, while he found that we were merely upon the threshold of knowledge of the laws of Variation. Some sanguine biologists of to-day believe we have crossed this threshold in the patient researches of the two intervening decades; but others are represented by Professor Lankester, who has now taken the rank of leading English critic, and has recently summed up our knowledge in an article,[4] presumably written with the greatest care and deliberation, as follows:

"Their causes (*i. e.*, the causes of variations) are extremely difficult to trace in detail, but it appears that they are largely due to a "shaking up" of the living matter which constitutes the fertilized germ or embryo-cell, by the process of mixture in it of the substance of two cells—the germ-cell and the sperm-cell—derived from two different individuals. Other mechanical disturbances may assist in this production of congenital variation. Whatever its causes, Darwin showed that it is all-important. . . . . Hence there is no *necessity* for an assumption of the perpetuation of direct adaptations.[5] The selection of the fortuitously (fortuitously, that is to say, so far as the conditions of survival are concerned) produced varieties is sufficient, since it is ascertained that they will tend to transmit those characters with which they themselves were born, although it is *not* ascertained that they could transmit characters *acquired* on the way through life."

[3] He then observes that Mr. Darwin formerly inclined to answer these questions in the negative, but latterly in the affirmative.

[4] "The History and Scope of Zoology." Enc. Brit. Vol. XXIV. Also "Advancement of Science," pp. 372-73.

[5] *i. e.*, of acquired characters.

The emphasis here is upon the contrast between our knowledge of the *fact* of variation (op. cit. p. 373) and our indefinite knowledge of the *causes* of variation.[6] In other words, we have been accumulating facts, and our present induction from them is that the variations which have formed the main basis of evolution are fortuitous; there may be, indeed, definite causes, but the effects are largely indefinite. Now if all, or even the great majority, of naturalists were in agreement with Lankester, we might claim to have made a distinct advance since 1870, even in having reached such a negative conclusion—that is, on the principle that we progress when we recognize that no further progress is possible.

But fortunately, or otherwise, this is not the case, for in opposition to those who share Lankester's opinions are an equally large number who would balance the account differently, and claim that the distinctive feature of the past twenty years of study is that we have reached some of the fundamental principles of variation which Huxley presented as the goal of research.

But this difference in the accounts does not stop here. We biologists are obliged to frankly confess to our fellow-scientists in chemistry and physics, and to the world generally, that after studying Evolution for a century we are in a perfect chaos of opinion as to its factors. There is actually no consensus as to the powers of the natural selection principle, none as to the laws of inheritance, none as to the influences of environment! In the very heart of this disturbance is the problem we have come together to discuss. It is the medium which refracts our judgment upon every one of the factors of evolution. We may continue to accumulate facts, but no actual advance can be made in the study of natural causation until this problem is absolutely settled one way or the other. This being the case, Weismann has done a monumental service in forcing this question to an issue. It is true a very large number of naturalists consider the question no longer *sub judice*; but as half this number hold one opinion, and the other half an opinion directly opposed, we are forced to the criticism that neither side can at present offer such a clear and full

[6] I am very desirous to give a perfectly fair representation of the views of all authors here quoted, and am aware that a single passage is often misleading. On the present subject compare other recent essays and reviews of Prof. Lankester, principally those in *Nature*.

demonstration of how evolution works upon their basis as to be conclusive; nor will either side admit the value of the evidence furnished by the other. Contrast two of our most vigorous writers on this point:[7]

"This is all the more necessary, in that this author (Weismann) and his followers repudiate the evidence upon which the claim is made that acquired characters, taken in the widest Lamarckian sense, can be transmitted. During a period extending over fifteen years, the present writer has devoted himself to a study of the genesis of adaptations, and with the lapse of time the conviction has grown only the clearer that these authors are laboring under a delusion. The way in which they have placed themselves upon record shows that they have not reckoned with the consequences of their reckless speculations."

A few months later Lankester, echoing Weismann,[8] writes to *Nature*:[9]

"Naturalists are at pressnt interested in the attempt to decide whether Lamarck was justified in his statement that acquired characters are transmitted from the parents so changed to their offspring. Many of us hold that he was not; since, however plausible his laws above quoted may appear, it has not been possible to bring forward a single case in which the acquisition of a character as described by Lamarck and its subsequent transmission to offspring have been conclusively observed. We consider that, until such cases can be adduced, it is not legitimate to assume the truth of Lamarck's second law."

Nature of the Discussion.—Before taking up the question of evidence as to this factor in evolution, let us clearly understand what we are *not* discussing at the present time. First, the law of natural selection is well established and no longer under discussion; it furnishes by far the best, in fact the only, explanation which can be offered for many adaptations,—the question before us

[7] Ryder. "A Physiological Hypothesis of Heredity and Variation." AM. NATURALIST, Jan., 1890, p. 85.

[8] "There are no observations which prove the transmission of functional atrophy or hypertrophy, and it is hardly to be expected that we shall obtain such proofs in the future." Biol. Memoirs, 1889, p. 429.

[9] March 6th, 1890, p. 415.

is only as to the extent of its action. Second, we need not discuss the inheritance of mutilations, for mutilations are not part of the regular order of nature, and while they might have strong positive, they have little negative, value; the elaborate arguments which have been recently directed against them, remind us, therefore, of Don Quixote's excursions against the windmills, as if Lamarckism mainly depended upon such evidence. Nor is it in dispute whether the effects of general atrophy or hypertrophy of the body are transmitted, for it is self-evident that an ill-fed organism will not bear as perfect offspring as a well-fed organism. As to pathological atrophy or hypertrophy, it is, I believe, admitted on both sides that in cases where it arises from certain bacilli it is possible that it may be transmitted with the bacilli. What we *are* discussing is whether the special and local variations in function and structure induced by environment and habit in the life of the parent tend in any degree to reappear in the offspring.

This is the modern or modified form of Lamarck's law. His followers admit that he overestimated the rate of inheritance of the effects of use and disuse in stating that *all* that is acquired is transmitted.[10] The element of rate or time is a secondary one, as it is with the law of Selection; the main point is whether such effects are transmitted at all. Of course there are Lamarckians of all degrees of fervor. The following statement probably reflects the average opinion:

1. In the life of the individual, adaptation is increased by local and general metatrophic changes, of necessity correlated, which take place most rapidly in the regions of least perfect adaptation, since here the reactions are greatest. 2. The main trend of variation is determined not by the transmission of the full adaptive modifications themselves, as Lamarck supposed, but of the disposition to adaptive atrophy or hypertrophy at certain points.[11]

[10] "Quatrième loi: Tout ce qui a été acquis, tracé ou changé, dans l'organization des individus, pendent le cours de leur vie, est conservé par la génération et transmis aux nouveux individus qui proviennent de ceux qui ont éprouvé ces changements."

[11] Osborn. "The Paleontological Evidence for the Transmission of Acquired Characters." Brit. Assoc. Reports; Proc. Am. Assoc. Adv. Science; 1889.

Dr. W. H. Dall has given a very full and carefully considered statement in his paper on "Dynamic Influences in Evolution," May 8th, 1890.

At all events, this involves the Lamarckian principle, with all its necessary bearings upon our opinions as to Environment, Variation, Selection, and Inheritance. If we adopt it, we must accept its full consequences. Taking Spencer's definition of Life as the continuous adjustment of internal relations to external relations, we must regard the race as in part the summation of these individual adjustments, in part as the summation, by Selection, of favorable fortuitous variations. Environment must act directly in producing variations in the organism as a whole; directly also it must produce special variations wherever it induces changes of function. As these variations are in a degree transmitted, we will discover some of the laws of variation in the study of individual adaptation; variations of this kind will be found in definite lines; indefinite variations will also arise from the fortuitous combination of individual characters; the proximate causes of variation must be changing environment as well as the combination of diverse individual characters. Selection, so far as it is here involved, will be found to act mainly upon the *ensemble* of characters which have their origin in individual variation by the extinction of unadapted individuals and races, but its action upon fortuitous variations will be concomitant. Inheritance must bear the burden not only of ancestral and race characters, but must accumulate the modifications of these characters which occur in individuals.

Let us associate the opposite principle, that special individual variations are not transmitted, with the name of Weismann, for at a time when Lamarck's principle was rising in favor[12] he boldly opposed it *in toto*. His doctrine of the continuity of the germ-plasma, and especially of the isolation of the germ-cells from influences which are exerted upon the body-cells, is a perfect and necessary complement of the doctrine that Evolution has advanced by pure Natural Selection; he carries these twin doctrines out to their legitimate conclusions. Recalling Spencer's definition and applying Weismann's principle, we must regard the race not as the summation of individual adjustments, but as the summation of the best adjusted germ-plasmata. Environment may act

[12] In 1883, when Weismann published his first essay on Heredity, the only English or American naturalist of note who was not subscribing to some form of the Lamarckian principle was Alfred Wallace.

directly in causing the organism to vary as a whole, but none of the special individual variations which it also produces indirectly and directly can be inherited ; its influences upon the germ-plasma are gradual and indefinite. The lines of variation are definite so far as they are limited by the specific nature of the organism; within these limits variations must be indefinite and numerous ;[13] the proximate cause of variation is the combination of the diverse individual characters of the parents. Selection must accumulate minute existing variations in the required direction, and thus create new characters ;[14] it must act upon minute variations in single characters, as well as upon the *ensemble* of characters. Inheritance is the unbroken transmission of race and ancestral characters by subdivision of the germ-plasma; only changes which affect the body as a whole can be added to the characteristics of the germ-plasma.

This is a mere abstract of the diverse positions upon every problem to which these principles of Lamarck and Weismann lead us. No half-way ground is tenable; the result of this inquiry will be a complete rout to one side or the other. By the former we diminish the powers of Natural Selection, and increase the powers of Environment; at the same time we greatly simplify the problem of Variation, and render far more complex the problem of Inheritance. By the latter we throw the entire burden of Evolution upon Natural Selection, and eliminate the direct action of Environment; we admit definite laws or causes of general Variability, but no definite laws governing the variations of single characters ; we greatly simplify the problem of Inheritance. In short, the vulnerable point with the Lamarckians is in solving the problem of Heredity, while their opponents are weakest in solving the problem of variation. From the purely theoretical standpoint both sides can offer a good working explanation of the process of Evolution, provided we grant all their premises; our duty as professed scientific men should be, therefore, to dispassion-

[13] Biological Memoirs, p. 288. "It is the specific nature of an organism which causes it to respond to external influences along certain definite lines, although these may be very numerous."

[14] Biological Memoirs, p. 275.

ately examine how far these premises accord with *all* the phenomena which we can actually observe in Nature, and then espouse the side which is most favored by probabilities. Now I have no hesitation in saying that neither side is showing the disposition to test their premises by all the observed phenomena, and this is one of the most hopeless features of the present situation.

Variation, Repetition, Regression.—All the factors of Evolution interact. Variation and Repetition[15] in inheritance are in constant relation with every other factor. Thus we can accumulate facts as to variations *per se*, but if our observation and induction enable us to formulate certain laws, these will always involve at least two factors,—*i. e.*, Variation as related to Environment, Variation as related to the life-history of individual organisms, Variation as related to Inheritance, Variation as related to Natural Selection.

Variability is, of course, exhibited in organisms as a whole, and in groups of characters as well as in single characters. All would be diversely affected by the two diverse principles of inheritance under discussion, but we are to examine the variable tendency as exhibited in single characters. Repetition is the conservative or static condition wherein a character in the new individual most closely resembles the average development presented by the fraternity,[16] co-fraternity, race, variety, and species to which it belongs; let us adopt Galton's term "mediocrity" for this state of average development. Variation is the unstable or fluctuating condition in which a character deviates to either side of mediocrity, either in the plus or minus direction,—*i. e.*, to greater or less development. Regression is the tendency[17] to revert to "mediocrity"; and according to Galton's statistics we can imagine this law of regression as acting like gravitation upon the pendulum of variation : when the pendulum swings in one direction it may repre-

[15] Weismann, or his translators, uses the terms Variability and Heredity, as tendencies equivalent to these. But it seems to me clearer to use Heredity in the larger sense, so as to include Variation = the act of Varying, and Repetition = the act of repeating, ancestral characters. Variability = the tendency to vary.

[16] Galton. "Natural Inheritance," p. 94. All the offsrpring of the same mid-parne (= male and female) form a fraternity. All the offsping of a fraternity of mid-parentst form a co-fraternity.

[17] Op. cit., p. 95.

sent a plus-variation, in the other direction a minus-variation; mediocrity is the state of rest or balance. When we examine any species in course of evolution in time and space we find, however, that a mediocre character is a shifting quantity. An organ, for example, which is rapidly degenerating presents a certain "mediocrity" at one time and locality, and another "mediocrity" at a later time or another locality. There is, therefore, a clear distinction between the above terms and the more general terms "degeneration," "balance," and "development," which apply to characters which are either continuously static or in a downward or upward direction, not only in individuals but in whole species and larger divisions. Of course where regression ceases to exert its full gravitating force upon plus- or minus-variations, through a series of generations, development or degeneration respectively set in.

Another source of confusion, which is inevitable in observation but not in theory, is the difficulty of distinguishing between "congenital" and "individual variations." Weismann has marked the distinction by the useful terms "blastogenic" and "somatogenic."[18] Theoretically these congenital and acquired variations are quite distinct; but as some blastogenic variations do not manifest themselves until advanced life, it is extremely difficult in many cases to decide how far certain variations are really blastogenic and how far somatogenic in origin; in other words, how far they are due to inherited predispositions and how far due to life habits.[19]

A war of words has recently been waging as to the meaning to be attached to such adjectives as "fortuitous," "chance," "kaleidoscopic," or "indefinite." My understanding of these terms is that when we see characters fluctuating from mediocrity, in either the plus or minus direction, according to the ordinary laws of chance, we may describe them as in a state of indefinite variability; whereas, when they exhibit a tendency to fluctuate principally in one direction, we describe them as in a state of

[18] *i. e.*, as arising from the germ-plasma and body respectively.

[19] In his review of Wallace's "Darwinism" Lankester has pointed out this defect in some of Wallace's observations. *Nature*, 1889, p. 567.

definite variability. This is the only sense in which the terms "definite variations" and "indefinite variations" can be fairly used in this discussion.

In two of his most recent essays Weismann says:[20]

"My theory might be disproved in two ways,—either by actually proving that acquired characters are transmitted, or by showing that certain classes of phenomena admit of absolutely no explanation unless such characters can be transmitted. Only if it could be shown that we cannot now or ever dispense with the Lamarckian principle would we be justified in accepting it."[21]

We may gather evidence from the data of Embryogeny, or of Ontogeny and Phylogeny. It is neither possible nor desirable to separate these data; but as previous writers have dealt extensively upon the evidence of embryogeny, I will emphasize the ontological and paleontological evidence, with which I am, in fact, much more familiar. I shall endeavor principally to concentrate attention upon the phenomena to which future observation must be especially directed. We already have a number of valuable essays and criticisms in this line,[22] but none, so far as I have seen, examine the question in view of all the difficulties which the adoption of either principle involves us.

I believe we are far from understanding all the phenomena of variation, and put the question, therefore, in the following form: Does our present knowledge of variation in living and fossil forms lend greater support to Lamarck's or to Weismann's principle?

1. *What is the Origin of Variability?*—According to Weismann, the *ultimate* or primordial origin of variability is somatogenic,[23]—that is, we must trace variability back to the unicellular organisms in which the environment acts directly upon the whole

[20] Biol. Mem., p. 388.

[21] *Nature*, Feb. 6th, 1890, p. 322.

[22] Especially those of Ryder, Cope, Eimer, and Cunningham. A very valuable review of the whole subject is found in C. V. Riley's paper, "On the Causes of Variation in Organic Forms." Proc. Am. Assoc. Adv. Sci., 1888.

[23] Biol. Memoirs, p. 277. "The origin of hereditary individual variability cannot be found in the higher organisms, but it must be sought for in the lowest,—the unicellular organisms. . . . As such organisms reproduce by division, individual acquired characters will be transmitted to the offspring."

organism; in the multicellular organisms the source of variability becomes restricted to the germ-cells, and the proximate or secondary origin of variations is in the union of the diverse characteristics contained in the germ-plasms of the two sexes. This view as to the primordial origin of variations does not seem to me to enter directly into the problem we are discussing, although it is one of the legitimate conclusions from his premises. But I would like to call attention to one important point, viz., that it involves the operation of Lamarck's principle of the transmission of adaptive reactions to environment [24] in the unicellular, and therefore to some degree in the lower multicellular, organisms. I think it can be shown that Lamarck's principle would be highly advantageous to every organism by transmitting direct adaptations (see Query 4); if this be the case, every step in the gradual loss of this principle by the isolation of the germ-plasma would have been disadvantageous. Therefore, if Selection was constantly acting, as Weismann supposes, it would have preserved this very principle. This is, of course, in the nature of pure speculation; but turning this supposed enormous power of Selection to the service of Lamarckism, we can conceive how the extremely complex correlation between functional changes in the somatic and germ-cells, which is an essential part of the Lamarckian theory, may have had its beginnings in these transitional organisms.

The question of the *present* or proximate origin of variations does, however, bear directly upon these diverse principles:

(*a*) All observers must agree that sexual reproduction is one of the endless sources of indefinite variations.[25] Weismann's theory offers a beautiful idea of the *modus operandi*, and accords thoroughly with Galton's researches. Such variations originate in the germ-cells; there is no reason why we should trace them to the somatic cells.

[24] This is, of course, no new idea. It was most fully elaborated in Spencer's "Principles of Biology." The mode of transmission in the former is by simple cell division; the principle of the continuity of original and acquired characters is the same.

[25] Weismann's latest view is that sexual reproduction is the most important, but not the *only* factor which maintains Metaphyta and Metazoa in a state of variability. *Nature*, Feb. 6th, 1890, p. 322. (In answer to Prof. Vines.)

(*b*) Some plus- or minus-variations must also originate from the union of germ-cells. If the same character is strongly developed in both parents, it may appear still more strongly developed in the offspring; the same rule applies conversely to weakly developed characters. But this simply puts the question one stage back, for variations which are indifferently plus, minus, or mediocre are certainly not definite, although the union of two similar variations produces a definite result.

Before considering the possible origin of definite variations we must consider whether there are such variations.

2. *What Variations are Definite and What Indefinite?*[26]—This is really the most important and central question. Its solution has a vital bearing upon Weismann's principle as well as Lamarck's. Following Huxley,[27] Geddes[28] has most clearly stated these bearings:

"In the absence of any theory of definite and progressive change,[29] and in the presence of multitudinous variations under domestication and in nature which we can neither analyze, rationalize, nor hardly even classify, we are not only justified but logically compelled to regard variation as spontaneous or indefinite,—*i. e.*, practically indeterminate in direction, and 'therefore unimportant, except as the groundwork for Selection to act on.' Conversely, variation must be indefinite, else the paramount importance of natural selection must be proportionally impaired as this becomes definite. . . . It would exchange its former supremacy as the supposed determinant among the indefinite possibilities of structure and function for that of simply accelerating, retarding, or terminating the process of otherwise determined change."

We cannot emphasize too strongly these cardinal factors of indefinite Variation (so far as adaptation is concerned) and paramount Selection as two of the foundation stones of Weis-

[26] "Natural Selection trusts to the chapter of accidents in the matter of variation." Lankester.

[27] Article "Evolution," Enc. Brit., Vol. VIII.

[28] Article "Variation," Enc. Brit., Vol. XXIV.

[29] Such as has been postulated by Gray, Nägeli, and Mivart, or based upon the Lamarckian principle by Spencer, Cope, and others.

mann's theory of Evolution. This must be kept in mind in analyzing every argument advanced by his school. (The idea is that variations are definite only so far as they are limited by the specific nature of the organism, by special phenomena of nutrition, or in some cases by environment acting directly upon the germ-cells.[30] See Query 3. They are indefinite so far as they arise from the fortuitous union of diverse germ-plasmata.)[31]

I have made it clear in the introduction that this is no longer a matter of ignorance, as it was professedly with Darwin:

"I have hitherto sometimes spoken as if the variations, so common and multiform with organic beings under domestication, and in a lesser degree with those under nature, were due to chance. This, of course, is a wholly incorrect expression, but it serves to acknowledge plainly our ignorance of the cause of each particular variation."[32]

I have already quoted Lankester upon this principle, and refer below to a passage in which he reiterates it and carefully defines the sense in which "indefinite" is employed by him.[33] Prof. Thiselton Dyer, a leading English botanist, has supported this position:[34]

"If with Prof. Lankester we say that the combinations are kaleidoscopic, I do not see that we go beyond the facts. . . . The area of fortuity is narrowed down to the variable constitution of the ovum. . . . And this is quite in accord with the remark of Weismann that variation is not something independent of, and in some way added to, the organism, but is a mere expression for the fluctuations in its type."

[30] See Biol. Mem., p. 410.

[31] See Biol. Mem., p. 275. "Natural Selection must be able to do infinitely more than this: it must be able to accumulate minute existing differences (arising by these fortuitous combinations) in the required direction."

[32] "Origin of Species," 6th edition, p. 106.

[33] The latest is in *Nature*, March 6th, 1890. "This disturbance of the parental body (I compared it to the shaking up of a kaleidoscope), and with it of the germs which it carries, resulting in "sporting" or "variation" in the offspring, is, it should hardly be needful to state, a totally different thing to the definite acquirement of a structural character by a parent, . . . and the transmission to offspring of that particular acquired structural character."

[34] See Osborn. "Paleontol. Evidence," etc.

One reason why I have endeavered to emphasize the unanimity of opinion upon this point among those who deny Lamarck's principle in this: If there are definite lines in blastogenic variation which cannot be explained by Selection, or by Environment acting upon germ-cells, we must find some other causes or laws governing them. Therefore the Lamarckians must first establish their claim that there are definite lines of variation; second, that these lines have not been directed by Selection (see Query 6). The opinions of Lamarckians on this point is that "there are variations which follow from their incipient stages a certain definite direction towards adaptation, independent of Selection in their origin."[34] This, it will be observed, does not exclude the existence of variations of the class accounted for by Weismann, but it constitutes substantially a distinct class of variations which Weismann, Lankester, and others do not account for, because, upon their hypothesis, we have no evidence that there is such a class."[35]

This opinion has frequently been asserted without adequate support from observation, otherwise we should not find such candid writers as those quoted above dismissing it so summarily. The fact is, it is very difficult, if not impossible, to prove that there are definite lines of variation (which cannot be explained by Selection) from the examination of zoological and botanical collections, for we are, from the nature of the material, principally examining variations by divergence in space. In such complete fossil series as are now available paleontologists enjoy the distinct advantage of following divergence both in space and time. They are thus in a better position to study lines of variation than ever before, because they are in at the birth, so to speak, of many useful and adaptive characters, and can follow the gradual rise from the minute infinitesimal stages to the advanced condition in which are constituted what we call specific and generic characters. Not only so, but it is possible to observe pedigrees, since the condition of surrounding parts prior to their appearance is known.

The history of the teeth of the Mammalia affords the most

[35] That is, no class of variations which conform to direct individual adaptations.

direct evidence, since these structures furnish not only the most interesting correlations and readjustments (quantitative variation), but also the successive addition of new elements (qualitative variation). I believe the unanimous opinion of all those who have examined such series is that such variations follow definite lines from their incipient stages. This is a positive form of evidence, unless the observers are at fault, but cannot be considered as proof if it can be shown that these infinitesimal stages arise indefinitely, for if the advanced condition is useful the incipient condition must possess some degree of utility, and would *ex hypothesi* be selected. This objection is met, however, by the additional fact that the first appearance of such structures is also not indefinite,—*i. e.*, at definite adaptive points. In other words, the birth is as definite as the growth.[36]

To sum up, the opinions of the two sides as to the nature of blastogenic variations are as follows:

Both will admit:

I. That there are general fortuitous variations, which may be best explained as due to the spontaneous variability of the germ-cells, especially seen in their union.

II. That there is also a class of variations, also springing from the germ-cells, which are in one sense definite,—*i. e.*, in certain directions,—but not necessarily adaptive.

One side denies, the other affirms:

III. That there is also a large class of blastogenic variations which follow definite lines of adaptation.

What are the relations of these three classes of variations to environment?

3. *What are the Direct and Indirect Relations between Environment and Variability?*—How far does environment affect the germ-cells directly, and how far through changes in the somatic cells? It is well known that a change of environment, especially to more favorable conditions, as in domestication, increases Varia-

[36] Some idea of the enormous mass of material available may be gained from the recent generalization that the teeth of all the Mammalia have sprung from a similar type and passed through similar stages. See the papers of Cope, Wortman, and the writer.

bility,[37]—*i. e.*, variations of Class I. In the analysis of such effects effects we should carefully examine:

(*a*) Whether this variability in all the characters of the organism is an effect of the action of Environment directly upon the germ-cells, through the general channels of increased or diminished nutrition; or, whether the environment produces a general disturbance of the functions of the organism, and this acquired disposition to altered functions is transmitted to the germ-cells.[38]

(*b*) Whether changed environment produces variability in any special characters or in all characters alike? Here again the question as to the mediate action of the somatic cells comes up, and is not only much more pertinent than in (*a*), but probably more capable of solution.

On these points Weismann holds that luxuriance of growth results from the better nutrition of the germ-cells during development,[39] while poverty of growth, or general degeneration, conversely results from deficient nutrition of the germ-cells, as in the case of Falkland ponies.[40] The effects of these influences he thinks may be more specialized; they may act only upon certain parts of the germ-plasma.[41] Weismann discusses such cases as follows (p. 433). Observe that the modifications referred to are not necessarily adaptive:

"The wild pansy does not change at once when planted in garden soil; at first it remains apparently unchanged, but sooner or later in the course of generations, variations, chiefly in the color and size of the flowers, begin to appear; these are propagated by

[37] This we can attribute to the greater molecular activity of the cells. Darwin believed (*a*) that exposure to new conditions must be long continued to set up any new variation. (*b*) Excess of food increases variability. (*c*) Changed conditions may affect the whole organism, or certain parts alone, or merely the reproductive system. (*d*) Indefinite variability is the commonest result of changed conditions.

[38] The point raised by Mivart (*Nature*, Nov. 14th, 1889, p. 41) is not fairly taken. Of course nutrition must pass through some *somatic* cells of the digestive system on its way to the germ-cells; this is a different matter from its first passing to the peripheral somatic cells in certain organs and then conveying their modifications to the germ-cells.

[39] Biol. Mem., p. 98.

[40] Op. cit., p. 99.

[41] Op. cit., p. 104. Or as discussed upon p. 408, in the criticism of Hoffman's experiments upon flowers.

seed, and are therefore the consequences of variations in the germ. The fact that such variations *never* occur in the first generation proves that they must be prepared for by a gradual transformation of the germ-plasm. . . It is therefore possible that the modifying effects of external influences upon the germ-plasm may be gradual, and may increase in the course of generations so that visible changes in the body (*soma*) are not reached until the effects have reached a certain intensity."

The best-attested instances of the action of Environment in producing special characters are those seen in its action upon the reproductive organs. A slight change of conditions sometimes produces sterility, as seen in the cases of "isolation" and "divergence" advanced by Gulick and Romanes. Here the best explanation seems to be that the environment has acted directly upon the germ-cells. This could only be proved, however, by experiments in artificial impregnation, for it is possible that the cause of sterility might lie in some of the somatic functions accessory to impregnation or intercourse. A second instance of this kind is the effect of nutrition in the determination of sex, as proved by the experiments of Yung and Giron,[42] and employed as one of the main principles in the two theories of Heredity advanced respectively by Ryder and Geddes.

It is not necessary to enumerate the many well-known cases of rapid response to new environment by modifications, which we must analyze somewhat differently. Among the best recorded are those of Saturnia (imported to Switzerland from Texas),[43] and Artemia.[44] Now it is a very important fact that the modifications observed in such cases are in the main adaptive,—that is, in course of a very few generations not only are the organisms thoroughly acclimated, but they develop substantially new adaptive characters.

We can readily understand how the germ-plasm might respond

[42] Yung raised the percentage of females among tadpoles by high nutrition from 56 per cent. to 92 per cent. Giron found that sheep, when well fed, bred 60 per cent. males; when poorly fed, only 40 per cent. See Geddes and Thompson, "Evolution of Sex," Chap. IV.

[43] Recorded by Wagner. See "Die Entstehung der Arten durch Räumliche Sonderung." Basel, 1889.

[44] Schmankewitsch.

directly to new environment by general variability, and even by such special variations as above cited by Weismann; but, keeping in mind the fortuitous principle, why do we also discover variations, not merely in size and efflorescence,[45] but in the nature of direct adaptations? This point has recently been raised by Mivart, with his usual acuteness in destructive criticism.

I do not consider that it has been demonstrated that Environment does act directly upon the germ-cells. In the case of animals we certainly cannot determine how far the nervous and other somatic cells are mediate, besides the somatic cells of the nutritive system. Yet in the acceleration of variability, and in the direct production of variations of Class II., we have examples of such rapid response to changed environment that the presumption is somewhat in favor of Weismann's view. In either case, such mediate action of certain somatic cells cannot be advanced in support of Lamarck's principle that the effects of environment on special groups of somatic cells make themselves felt in, or transmitted to the germ-cells in such a manner as to reappear in some degree in the same special groups of somatic cells in the new individual. Let us therefore concentrate our attention upon the evidence as to the possible modes of origin and transmission of variations in definite adaptive lines (Class III.). Three explanations are open to us: 1. That these adaptations have been selected from a number of variations of the fortuitous class; 2. That the germ-cells respond to environment by adaptive variations; 3. That the variations originate in adaptive reactions of the somatic cells, under environment, which have been transmitted to the germ-cells. Let us first consider the question of individual variations.

4. *Are Individual Variations Adaptive?*—I should hardly have thought it necessary to consider this question but for the fact that a recent writer, who claims the sanction of Mr. Romanes and Mr. Poulton, has advanced the proposition that the inheritance of

[45] Huxley has thus analyzed Environment on the pure Selection hypothesis: "Environment does not cause a variation in any particular direction, but favors and permits a tendency in that direction which already exists. . . Conditions are not actively productive, but passively permissive." "Critiques and Addresses," p. 309.

individual variations would be an actual evil.[46] This is tantamount to saying that adults are less adapted to their environment than young individuals, and that the most perfect individual adaptation will be secured by inertia. This would, as Mr. Ball maintains, be a severe blow to the Lamarckian principle, but it would be a still more severe blow to the Natural Selection principle, for, to give a single instance, it can be shown conclusively that the skeleton of the limbs of all the Mammalia has mainly been evolved upon the broad lines of use and disuse, and Selection would thus be eliminated entirely. To express this idea of the utility of the greater part of individual variation, Semper applies the term "adaptations," and his work[47] abundantly illustrates and demonstrates this law. It is based, of course, upon the general physiological principle that the tissues react and their structure diversifies proportionally with their functions.[48] Life is the continuous adjustment of internal relations to external relations, in which the general adaptation of the organism to its surroundings is, upon the whole, steadily increasing up to the period of general decline.

This principle of individual adaptation is strikingly illustrated in recent studies upon the feet of the Mammalia, in connection with instantaneous photographs of animal motion.[49] These studies show, for example, in the extremely complex readjustments of the carpal bones, necessitated by the simultaneous reduction of one of the bones of the fore-arm and of the lateral toes, that the very redistribution of the lines of pressure is constantly tending to perfect the adaptation by the natural reactions of growth in the bone tissue. Some of these adaptations are in the nature of plus- or minus-variations from the original constitu-

[46] W. P. Ball. "Are the Effects of Use and Disuse Inherited?" Nature Series, 1890, p. 128.

[47] "Animal Life," 1877.

[48] Lamarck is still ridiculed for his idea that the wants or desires of animals produce new parts, but the only ridiculous points are in some of his illustrations of this idea. Every vertebrate is literally made up of "wish-bones" in one sense, since all parts are developed by the voluntary efforts of the animal to obtain its food, etc.

[49] See the papers of Cope and Ryder, and the writer's "Evolution of the Ungulate Foot." Memoir upon the Uinta Mammalia.

tion of the limb; other elements remain *in statu quo*,[50] or in a state of balance where their adjustments are perfect.

There is also a large class of adaptive, characters, both in animals and plants, upon which the law of individual adaptive variation operates very obscurely if at all,—*e. g.*, protective coloration

How Far Does Race Variation Follow Individual Variation?—The study of individual variations led Spencer to the conclusion that all higher forms (of vertebrates) have arisen by the superposing of adaptations upon adaptations.[51] The students of vertebrate paleontology observe that race adaptations conform so closely to the laws of progressive individual variation that they are impelled to seek the explanation of the origin of various structures in the reactions occurring in individuals. Here are the definite lines of variations spoken of above.

But if they jump to the conclusion that individual variations are the *cause* of these race variations, may they not fall into the old fallacy of *post hoc ergo propter hoc?* For every genetic line will be found to exhibit variations in definite lines of adaptation and many of these lines of variation occur in characters in which no individual adaptation can be observed.[52] Now there is no theoretical difficulty in supposing that the three classes of variations have different modes of origin, but in order to demonstrate the probability of a causal relation between individual and race variations of Class III. it is further necessary to show: 1. That in this special class of characters, in which obvious mechanical or dynamical principles are operative, race variations invariably conform to individual variations; for if some of these characters do not conform, other principles must be in operation. That is, if we once invoke the Lamarckian principle, we must apply it consistently to every case. 2. That no definite lines of variation arise in characters of this class without the antecedent operation of these individual reactions. These first tests of invariable antecedence and consequence would lend a high degree of probability

[50] A beautiful example of the effects of use in producing joints in the tail fins of fishes has been given by Ryder. Proc. Am. Phil. Soc., Nov. 21, 1889.

[51] As quoted by Ryder from *British and Foreign Medico-Chirurgical Review*, Oct., 1858.

[52] Such as are seen in the adaptations of mimicry and protective coloration.

to the existence of causal relationship ; this probability would be increased if it could be shown that no other explanation of this class of variations will stand the same test.

First, as to sequence. The overwhelming majority of variations as observed in the fossil series [53] occur along the lines of use and disuse. Weismann has urged that all variations in this class are substantially quantitative, that where an organ becomes stronger by exercise it must possess a certain degree of importance, and when this is the case it becomes subject to improvement by natural selection.[54] It follows from embryological development and the laws of growth by cell division that all new characters are in one sense quantitative, but in tooth evolution we have examples of the rise of structures which are qualitative,—*i. e.*, essentially new, and not simple modifications of preëxisting forms. I refer to the successive addition of new cusps. As already observed, there is absolutely no evidence for indefinite variation in these characters. The new cusps do not rise spontaneously at random points and then disappear, to be replaced by the gradual development of those which happen to rise at adaptive points.[55] One of the most surprising recent discoveries is that one after another these successive cusps are added to the simple conical crown at the point of maximum wear ; that is, the most-worn points in an earlier series of generations are those at which the new cusps appear in the later series.

Paleontologists cannot, however, claim that this sequence is universal. Among the rare exceptions there are, first, some secondary cusps[56] which arise from the base of the crown,—*i. e.*, entirely out of the region of use and disuse and pursue the same steady development until they reach a stage in which they are obviously useful and subserve attrition. Second, upon the principle that the action and reaction of two opposing surfaces must be equal, it is difficult to explain some cases in which we observe a

[53] See the exact studies of Kowalevsky, Cope, and Ryder among the vertebrates, and of Hyatt, Dall, and others among the invertebrates.

[54] Biol. Memoirs, p. 84.

[55] See "The Evolution of Mammalian Molars to and from the Tritubercular Type," AMERICAN NATURALIST, December, 1888.

[56] Such as appear in some molars of the later Tertiary ungulates.

cusp in one jaw developing, while the cusp in the other jaw, opposing it and presumably stimulating its development, is degenerating.[57] The force of these exceptions will weigh seriously against the Lamarckian principle, unless they also can be proved by subsequent research to conform to the laws of individual adaptation. I consider that the strongest line of attack which can in futute be taken against Lamarckism will be in showing that certain characters (such as the above), in which it is supposed to operate, could not be produced on principles of direct adaptation.

But if we reject the Lamarckian principles we must assign Selection as the cause of these definite lines in variation, for no one would urge the third alternative.

6. What is the Relation between Variation and Selection ?—The question of Utility is the first which arises when we attempt to explain the origin of such variations as we are here considering by the selection principle. In the recent animated discussion which has taken place between Romanes,[58] Mivart, and others on the one side, and Wallace[59] and Dyer on the other, great difference of opinion has been shown as to Utility. So far as the question bears upon the substitution of pure natural selection for Lamarck's principle, we may, in this argument, avoid the broader question by admitting that all characters possess, or have once possessed, some degree of utility, or the reverse. This is as necessary for Lamarck's as for Weismann's principle. The essential question here is whether the plus- or minus-variations in advanced stages, or the variations in initial stages, or still more the variations which constitute the initial stages themselves, are of such importance as to weigh sufficiently in the scale of survival, to accumulate definite lines of adaptive variations.[60] Let us assume that they can be, what further assumptions are necessary ?

We start with the proposition that all these variations have their origin under the laws which we have seen govern variations of Classes I. and II., for upon Weismann's principle we cannot admit

[57] I refer to the paraconid and hypocone.

[58] " The majority of specific differences are inutile (non-adaptive)." *Nature*, '89, p. 8.

[59] " There is no proof that specific characters are frequently useless."

[60] Darwin distinctly abandoned the utility principle in the case of Saturnia. See letter to Moritz Wagner, " Life and Letters," Vol. III.

any other modes of origin. They must start, therefore, indefinitely, but secure a definite direction by the selection of those in favorable, and elimination of those in unfavorable, directions. This direction must be continuously plus where the characters are developed by direct Selection,[61] or neutralized where the characters are under the sustaining power of Selection, or minus where the characters are degenerating under the influence of Panmixia (free intercrossing), or even of reversed Selection.[62] Every union of new individuals, according to Galton's law of regression, however, will tend to draw back all the plus- and minus-variations to mediocrity, even where both parents show a tendency in the same direction. This regressive tendency to mediocrity, seen in the union of a single pair, will be further hastened by Panmixia.[63] We have assumed the continuous operation of Selection and abundant favorable variations to draw from, but we have seen, under Query 3, that variability is generally greatest when external conditions are most favorable; at the same time Selection must be least active, for the struggle for existence is least severe,—that is, Selection is least rapid when its materials are most abundant. So much for the probabilities of the production of definite lines of variation in single characters of this class. Evolution is not, however, a "log-rolling" process, in which some parts lag behind while others are improved by selection; in the fossil series, as all parts of the skeletal organism are observed in course of evolution at the same time, we must assume indefinite variability in every part, and admit the probability that, especially in uncorrelated parts, the sum of favorable variations, will be equal to the sum of unfavorable variations, and thus neutralize each other, so far as Selection is concerned. We must, therefore, add the assumption that these definite lines will be selected in correlation with those observed to occur in all the surrounding parts, and granting that groups of correlated parts may

[61] See Biol. Memoirs, pp. 264, 85, 101, 275.

[62] Romanes has endeavored to show that where a character becomes detrimental Selection will tend actively to eliminate it.

[63] Galton has shown that in the union of two individuals showing exceptional characteristics only a few of the offspring would be likely to differ from mediocrity so widely as the mid-parent. "Natural Inheritance," p. 106.

vary simultaneously[64] (*e. g.*, fore and hind limbs, or a series of vertebræ), we have still further to assume that these variations are selected with coördinate variations in parts which are not in the remotest degree correlated, viz., the teeth.[65] We must still further assume that Selection acts at the same rate to produce simultaneously exactly parallel lines of adaptive variations in related species over widely distributed areas, as in the American and European species leading to the horse series. If it is maintained that this parallelism has been sustained by interbreeding, then the arguments based upon Divergence and Isolation lose their force. If it be said that combinations of favorable variations occur in nature, not only in correlated but in uncorrelated parts, and Selection acts upon these combinations, then those who support Weismann's principle must further assume that there are definite lines of blastogenic variation. This *argumentum in circulo* would bring us back to the original question, What is the cause of definite lines of variation?

Can Acquired Variations be Inherited?—It must be admitted by every one that, as the germ-cells are usually differentiated and set apart from the somatic cells at an early age, it is very difficult to conceive how definite changes in certain peripheral somatic cells occurring in the higher adult Metazoa can produce such changes in the germ-cells as to be reproduced in the offspring, even if we allow a very long time for the process. If, however, such a process does take place, it rests with the embryologists to work out a theory for it, so we are not concerned with the process, but the evidence. All the evidence above considered belongs properly to Evolution; we must now consider the bearings of some of the classes of evidence from Inheritance.

The evidence from mutilations is somewhat conflicting. It has been fully discussed recently by Weismann, Eimer, and others. It involves two elements which are not observed in the ordinary course of evolution: 1. Immediate transmission of the full characters. 2. Transmission of characters impressed upon the organism,

[64] The fact that they do so may be used as an indirect argument for the Lamarckian principle.

[65] Or adaptive characters for protection, mimicry, sexual ornamentation, etc.

and not self-acquired. I believe that no indisputable evidence for the inheritance of acquired characters has been produced under this head.

Another class of evidence consists in what are believed to be cases of the inheritance of maternal influences upon offspring *in utero*. It is an axiom among breeders that an ill-bred sire may affect all future strains. One of the most striking cases is that of Lord Morton's Arabian mare, which was sired by a Quagga, and later by a pure Arab, the foal of the latter showing zebra-like markings. Professor Turner says of this case: "I believe that the mother had acquired during her long gestation with the hybrid the power of transmitting quagga-like markings. The ova must have been modified while still in the ovary." [66]

I refer to papers of Vines [67] and Turner [68] as bearing especially upon the supposed isolation of the germ-cells, and showing that in the lower Metazoa and some of the higher Metaphyta the germ-plasm is diffused through the organism, and thus related to the *soma*.

We should find in these transitional organisms, as I have suggested under Query 1, that the relation between the somatic and germ-cells was established, if it exists. It is a necessary deduction from Weismann's theory that if this relation was advantageous it must have been preserved by Selection. If Selection can bear the burden of Evolution, it certainly can account for the origin of the Lamarckian principle in inheritance.

Conclusions.—The conclusions we reach in this discussion must finally turn upon the existence of definite lines of blastogenic variation. If there are no such lines, the Lamarckian principle falls *ipso facto;* if there are, we have still to estimate the probabilities between Weismann's and Lamarck's principles as affording the most adequate explanation for them, keeping in mind the problem of Inheritance as affecting these probabilities.

The Weismann principle depends upon Selection as the source

66 See *Nature*, 1889, p. 532.

67 "An Examination of Some Points in Prof. Weismann's Theory of Heredity." *Nature*, October 24th, 1889, p. 62.

68 "The Cell Theory, Past and Present." *Nature*, November 6th and 13th, 1890.

of definite lines of Variation. What evidence has been advanced for the initial but all essential assumption that, for example, a tiny adaptive cusp is a factor in survival, while its tiny inadaptive fellow is a factor in extinction? not to mention the succeeding assumptions which overwhelm us when we seek to derive definite adaptation from indefinite variations.

The Lamarckian principle furnishes us with an explanation of the observed phenomena of simultaneous progressive adaptation in most of those parts which it affects, including Correlation and Parallelism. It cannot be said at present to explain *all* the phenomena within its sphere; we must explain these phenomena, or abandon the principle.

It follows as an unprejudiced conclusion from our present evidence that upon Weismann's principle we can explain Inheritance, but not Evolution, while with Lamarck's principle and Darwin's Selection principle we can explain Evolution, but not, at present, Inheritance. Disprovê Lamarck's principle, and we must assume that there is some third factor in Evolution of which we are now ignorant.

ON THE ORIGIN OF THE GALAPAGOS ISLANDS.

BY G. BAUR.

ALL islands can be divided into two principal groups. 1. Islands developed from continents or larger bodies of land through isolation or subsidence: *continental islands.* 2. Islands not developed from continents, but from submarine portions of the earth: *oceanic islands.* The flora and fauna of the first group will be more or less *harmonic*,—that is to say, the islands will be like satellites of the continent from which they developed, and the whole group comparable to a planetary system. The flora and fauna of the second group will be *disharmonic*,—that is to say, it will be composed of a mixture of forms which have been introduced accidentally from other places. It is evident that the first group of islands will be affected in the same way; there will be immigrants from other localities besides the original inhabitants.

Continental islands, therefore, may be composed of two floral and faunal elements: first, an original (endogenous) one; and second a secondary (exogenous) one. Oceanic islands, however, will only contain a secondary (or exogenous) floral and faunal element.

We will now proceed to examine whether the Galapagos belong to the first or second group of islands; whether they are detached portions of a continent, or of new origin emerged from the sea. These islands, better than any other group, afford a splendid opportunity for the examination of this question. They had never been inhabited before their discovery by the Spaniards in the sixteenth century. Buccaneers and whalers made the islands a place of frequent resort; but it was not before 1832 that a small colony was established on Charles Island, which, however, was soon abandoned again. To-day a small settlement is found on Chatham Island only, under the management of Señor Manuel Cobos. The only animals which seem to have been seriously affected by these intruders are the tortoises, which had once been so very numerous on all the islands. On some of them at least—Charles Island, for instance—they are extirpated; but it is probable that a few specimens still exist on some other islands on which they are now considered to be exterminated. All the islands, with the probable exception of Charles and Chatham, show with little doubt nearly the original condition.

The Galapagos are situated on the equator, about 600 miles west from the coast of Ecuador, to which state they politically belong. They are placed between the 89th and 92d degree west of Greenwich, covering about three degrees of longitude, and extending on each side of the equator one-and-a-half degrees north and south. (The best map published is No. 1375 of the British Admiralty, based principally on the researches of Captain Fitzroy, of the historical "Beagle.") There are five principal islands, eleven smaller ones, and a great number of islets and rocks. The five principal ones are situated between the equator and the 1° south. They are Narborough, Albemarle, James, Indefatigable, Chatham. Of the eleven smaller islands three are in the same region, Jervis, Duncan, Barrington; three are between the 1° and 2° south, Brattle, Charles, Hood; and five north between the equator and the 2° north, Tower, Bindloe, Abingdon, Wenman, Culpepper. Hood is the most southern, 1° 27′ south; Culpepper the most northern and also the most western island, 1° 39′ north, 92° west; Chatham is the most eastern, 89° 17′ west. Albemarle is by far the largest; it is the only one cut by the equator, and is about 140 km. long. Then follow Indefatigable, Narborough, James, Chatham, Charles, Bindloe, Abingdon, Barrington, Tower, Duncan, Jervis, Brattle; the last only about 1½ km. long and 1 km. broad. As is well known, the whole group is volcanic. The highest mountain, on the southwest end of Albemarle, is 1570 m. high. The elevation of the other islands varies from 70 m. (Tower) to 1270 m. (Narborough). Albemarle, and especially Narborough, the most western island of the larger ones, have frequently been in a state of eruption. Delano speaks of one on Albemarle in 1797 and 1800, Porter in 1813, and Morrell witnessed a most terrific outbreak on Narborough in 1825. Fitzroy saw smoke on a southeastern volcano on Albemarle in 1835. Since that time these volcanoes seem to have been in a state of inactivity. Wolf, who visited the islands in

1875, states that Narborough still has an active central crater of enormous size. Most of the islands consist of basaltic rocks and masses of scoriæ and lava, but besides we find, according to Wolf, remains of an older volcanic formation on Charles Island and the small islands Gardner, Caldwell, and Enderby, which surround it. Dr. Th. Wolf, the state geologist of Ecuador, visited the islands twice, according to a letter received from him. He spent in all six months on the group,—more time than any other visitor, Dr. Habel excepted. He published a small pamphlet about the islands in 1879 (Ein Besuch der Galapagos-Inseln. Heidelberg, 1879, 44 pp., 3 maps). The following account about the climate is taken principally from him and from "The South American Pilot."

The climate, considering that these islands are directly on the equator, is far from being excessively hot, a circumstance which is chiefly owing to the singularly low temperature of the surrounding sea, which is 23° C. On Charles Island at an elevation of 140 m. the thermometer was 19–21° (about 68° F.), and at about 300 m. 18–19°. Darwin observed a heat of 34° C. (93° F.) in his tent when the thermometer stood at 29° C. in the wind and sun, but which, when plunged in the soil, rose at once to 58° C., and would probably have risen higher had the tube been longer.

The rainy season is between February and June, but is very irregular, generally very short, and often it stops entirely for one or two years. In the higher portions of the islands, about 270 m., there is often rain all the year, but very little. In August and October Wolf observed such squalls, so-called "garruas," very often. They repeated each other often five or six times in a day, but never lasted more than half an hour. They are confined to the high plateau. The whole broad lower zone up to 170 m. is nearly without any rain; therefore the upper region remains always green, the lower one arid and barren. On the southeastern parts of the islands, on the side of the southern trade-winds, the damp region extends nearly 70 m. more down than on the northern side. It is evident that the conditions of the vegetation are dependent upon this different distribution of humidity. Near the border of the sea we find different maritime plants; in some of the bays mangroves and avicenias. In ascending the hills from the shore the whole ground in all directions is covered with apparently withered brushes; but on a closer examination it is found that these plants are mostly in bloom. The most common brush in this region is a Lantana, one of the Verbenaceæ, and members of the Euphorbiaceæ, Croton for instance. This brushwood grows up to a height of 5 feet or 6 feet, rarely 10 feet, and here and there are found Algoraba trees about 20 feet high, and also sporadic Palo Santos (Guaiacum). The latter is the largest tree in the lower region; it reaches a height of 30 feet, and 3 feet in circumference. On places which do not allow the growth of any other plant, the grotesque, tree-like Opuntias and gigantic Cereus are found.

The Cereus is generally seen in the most barren spots. These forms give a very characteristic appearance to this region. The Opuntia reaches a height of 20 feet, and a thickness of two feet; the Cereus the same proportions. Besides these characteristic plants are found Gramineæ, Cyperaceæ, Euphorbiaceæ, Labiatæ, Compositæ, and so on (about fifty to sixty species according to Wolf). There are only a few Cryptogamia, the most important of which is the Orchilla (*Rocella tinctoria*), which is found not higher than 100 m. This is the condition of the vegetation up to 200 m. Now other shrubbery, especially Compositæ, appears; the Algoraba and Palo Santo are of stronger growth; the Lantanas and Cactaceæ disappear. The ground is still more covered with brushwood of the withered aspect. A white Usnea, which hangs in long strings from the trees, alone indicates a little more humidity. This plant is characteristic of a zone between 200 m. to 270 m., separating the dry and humid region. It is easily distinguished from a far distance by its white color.

When the high plateau between 270 m. to 300 m. is reached, the whole scenery changes. A refreshing, moist breeze comes from the coast; the traveler is surrounded by green woods and stands on meadows. These woods are principally composed of about thirty-feet-high trees, of the Sanguisorbaceæ and Compositæ, of an Andean type. Herr Wolf remarks: Everybody who knows the flora of Ecuador must be reminded of the mountains of the

Andes, and he appears to be on an elevation of about 3,000 m.; but in fact he is only 300 m. high. Wolf found great resemblance with the small Paramo forests of the Andes, not only in the habitus of the trees, but also in the small plants which cover the ground and in the mosses and lichens which cover the trees. The woods are free, without creeping plants, making a passage easy. They are interrupted by small meadows, consisting nearly entirely of small Gramineæ and Cyperaceæ. Above this woody region another one could be distinguished, which is free from trees, and only covered with short grass.

The description of these different zones is based on the condition found on Charles Island; but it is the same, according to Wolf, on the others of high elevation. From this it is evident that different islands which do not reach to the humid region, like Hood, Barrington, Tower, and so on, show only the arid state.

After this description of the climatological condition of the islands, I have to make some remarks on the topography of the whole group. The deepest sounding on record is 671 fathoms, between Tower and Indefatigable Islands; between the median islands the greatest depth does not surpass 300 fathoms; but a complete series of soundings between the different islands may bring to light quite different results. There is little doubt, however, that all the islands, Culpepper and Wenman perhaps excepted, are placed within the 1000-fathoms line. Northeast of Chatham, 0° 24′ south, 80° 6′ west, 812 fathoms are recorded by the "Albatross." It is probable that an elevation of 300 fathoms or 550 m. would bring all the central islands together.[1]

I give now the approximate distances between some of the islands: Hood to Culpepper, 430 km.; Chatham to Narborough, 262 km.; Hood to Chatham, 50 km.; Hood to Charles, 64 km.; Chatham to Indefatigable, 65 km.; Albemarle to Abingdon, 77 km.; Abingdon to Bindloe, 23 km.; Bindloe to Tower, 50 km.; Abingdon to Wenman, 141 km.; Wenman to Culpepper,

[1] The soundings of the "Albatross" have shown that the Galapagos are connected through Cocos and Malpelo Islands with Central America by the 4000-m. line. This is an important fact; all the older maps showed the Galapagos separated from Central America.

36 km.; Duncan to Indefatigable, 10 km.; Jervis to James, 8 km.; Barrington to Indefatigable, 18 km.; Indefatigable to James, 19 km.; James to Albemarle, 18 km.; Charles to Indefatigable, 50 km.

Currents.—From the "South American Pilot" I record: "The currents about these islands are remarkable, for, in addition to their velocity, which is from one to two-and-a-half miles an hour, and usually towards the west and northwest, there is a surprising difference in temperature of the bodies of water moving within a few miles from each other. These striking differences are owing to the cool current coming from the southward along the coasts of Chili and Peru, which at the Galapagos encounters a far warmer body of water coming from the Bay of Panama. Heavy rollers occasionally break upon the northern shores during the rainy season, though no wind of any consequence accompanies them. They are probably caused by the northers from Tehuantepec, and the Papagayos or northeast winds, which are so well known on the coast between Panama and Acapulco." In the vicinity of the islands calms prevail from January to April; from the middle of April to the end of December the trade-wind blows with regularity, and gales are unknown.

After these necessary remarks we can proceed to examine the fauna and flora.

1. *The Fauna.*—I shall restrict myself to the higher vertebrates, of which I shall give what is known. The only mammals which have been recorded are a mouse, two species of seals, and bats. The mouse is of the American genus Hesperomys. Darwin found it on Chatham, and Wolf saw a skin of it on Barrington Island. Further researches must decide whether this form is introduced or not. The fact that Wolf found it on the deserted Barrington speaks for its being indigenous. The seals found on the islands are *Otaria jubata* and *Arctocephalus australis*. They are still numerous, but in former times must have been exceedingly abundant, as I conclude from the work of Morrell. These two seals belong to Antarctic forms, and show in the Galapagos their most northern extension. It is quite probable that they represent species distinct from the more southern forms. So far as I know,

only the skeletons have been studied (Allen, "Pinnipedia"). Bats have been seen by Habel, and are also mentioned by Wolf; but no specimens have been collected so far.

Before speaking about the birds, I shall treat the reptiles, which are represented by tortoises, lizards, and snakes. The gigantic land tortoises always have attracted attention. The Spaniards gave the name Galapagos to these islands, which means tortoise. I may mention here that the etymology of the word Galapago is not known; the regular Spanish word for tortoise is tortuga, as in the Portuguese. The Portuguese also have the word cacado, which is of South American origin. It is probable that the word Galapago is of Central or South American origin also. I have treated on the tortoises in a paper published lately in the AMERICAN NATURALIST, and I shall give my results here in brief.

It was David Porter, the well-known American commodore of the "Essex," who pointed out for the first time the important fact that the different islands contain different races of the tortoise. Darwin has fully supported this view. He states that the inhabitants of Charles Island could tell from the aspect of the tortoise from which particular island it came. Tortoises have been recorded from Hood, Charles, Chatham, Indefatigable, Duncan, James, Albemarle, Abingdon. Nothing is known in this regard about Barrington, Brattle, Jervis, Bindloe, Tower, and the others. So far we know, there are six races of land tortoises from these islands: 1. *T. elephantopus* Harlan = *T. vicina*, Guenther; from South Albemarle. 2. *T. galapagoënsis* Baur = *T. elephantopus* Jackson; from Charles Island. The only complete specimen is in the Museum of the Boston Society of Natural History. 3. *T. abingdonii* Guenther = *T. ephippium* Guenther; Abingdon Island. 4. *T. microphyes* Guenth.; North Albemarle. 5. *T. guentheri* Baur = *T. elephantopus* Guenther; locality unknown. 6. *T. nigrita* Dum. and Bib.; locality unknown.

It is impossible yet to determine to which island the two last tortoises belong; but the important fact remains that the tortoises are different on the different islands. The species from Abingdon Island, for instance, is not found on any other one; the Charles Island form is only found there, and so on.

The genus Tropidurus of the Iguanidæ shows better than any other form the peculiar specialization on the different islands. I have already in a former paper spoken about the variation of this lizard. I reached the following result:

1. *Each island has only a single variety or species of Tropidurus.*
2. *Nearly every island has a peculiar variety or species of Tropidurus.*

These results were based on 128 specimens of Tropidurus collected by the "Albatross" on eight islands, namely: Chatham, Hood, Gardner (a little islet northeast of Hood), North Albemarle (Tagus Cove), James, Duncan, Indefatigable, Abingdon.

The first species of Tropidurus described from the Galapagos was *T. grayii* Bell, the type specimens of which had been collected by Darwin on Charles and Chatham Islands. I have taken the form from Charles Island, of which the "Albatross" did not get any specimens as the type of *Tropidurus grayii*, because Chatham Island is inhabited by a distinct form, which has been described as *T. lemniscatus* by Prof. Cope. Specimens from Indefatigable and James Islands are very much alike, and probably different from the specimens from Charles Island. I named these *T. indefatigabilis.* The peculiar form from Duncan Island was called *T. duncanensis;* that from Hood and Gardner Islands *T. delanonis;* the Albemarle form *T. albemarlensis;* that from Abingdon *T. abingdonii;* the Bindloe forms were considered as typical for *T. pacificus* Steind. No conclusion could be reached in regard to *T. bivittatus* Peters and *T. pacificus* (var. *habeli*) Steind., the localities of these forms not being known.

The following table shows the number of scales round the middle of the body in the different forms: *Tropidurus indefatigabilis* Baur, 55–59; *Tropidurus lemniscatus* Cope, 55–61; *Tropidurus albemarlensis* Baur, 57–63; *Tropidurus grayii* Bell, 55–65; *Tropidurus duncanensis* Baur, 72–79; *Tropidurus delanonis* Baur, 82-85; *Tropidurus pacificus* Steind., 85-90; *Tropidurus abingdonii* Baur, 95–101.

The specimens from Jervis figured by Steindachner as *T. grayii* are probably identical or closely related to *T. indefatigabilis.* Nothing is known of these lizards from Brattle, Barrington, Tower, Wenman, Culpepper, Narborough. I do not doubt that on most of these islands we will find other species of Tropidurus. It would be of special interest to know whether any of them are found on Narborough, since we have to suppose that probably every organism was killed by that great eruption mentioned by Morrell. No other animal or plant shows the specialization of a single genus in the different islands so well as Tropidurus. On every or nearly every island it has developed into a different race or species. Let us now, for instance, compare the forms from Gardner and Duncan Islands with those from the nearest islands. On Gardner Island we find the same species as on Hood Island. Gardner is only one kilometer distant from Hood. The water between the two is not deep, not exceeding five fathoms. Between these islands are placed four smaller islets and the Magicienne Rock (Brit. Adm. Chart, 1376).

The species from Duncan Island is totally different from that of Indefatigable. The islands are only ten km. distant from each other. The deepest sounding taken between the two is, however, 60 fathoms. No specimen of *T. duncanensis* occurs on the very near Indefatigable, and none of *T. indefatigabilis* on Duncan. The races from the distant Abingdon and Bindloe and the low Hood Islands are more different from the central forms than those among each other.

Besides the genus Tropidurus, which is only found in South America, we have two other genera of Iguanidæ which are peculiar to the islands: the land and sea guanas, as called since the times of Dampier: Conolophus and Amblyrhynchus, the latter reaching a length of nearly four feet.

Amblyrhynchus is the only "oceanic" form of the Iguanidæ. It lives upon sea-weeds, and to get them it goes out to the sea, but never far from the shore. It is probably found on all islands. The "Albatross" collected specimens on Abingdon, Duncan, Hood, Gardner, James, Chatham, and it has been recorded from other islands, Charles, Barrington, Jervis, Albemarle, by Darwin, Steindachner, Wolf, and others. The individuals of the different islands have never been studied carefully; but I do not doubt that even here we find modifications according to islands. Perhaps the thirteen specimens brought back by the "Albatross" could give some light when closely examined. Darwin already mentions differences. According to Steindachner, only small specimens are found on Jervis Island. Wolf found the specimens from Barrington different from those from Charles; they were all smaller and the dorsal spines were not so much developed. There is, therefore, evidence that even these semi-aquatic animals show some modification on the different islands.

Conolophus.—This large land form, no specimens of which were collected by the "Albatross," is so far only recorded from Albemarle, Indefatigable, Barrington, and James. Porter already states that it is absent from Charles. Nothing is known about the variation of this lizard, few specimens only having been collected. The Geckonidæ are represented by the genus Phyllodactylus. Charles Island contains a peculiar form, *Ph. galapagoënsis* Peters, of which the "Albatross" got one specimen. Two other species are recorded by Prof. Cope from Chatham, *Ph. tuberculosus* Wiegm., and *Phyllodactylus leei* Cope. *Ph. tuberculosus* would represent the only lizard not peculiar to the group, and Chatham would be the only island containing two species of the same genus. These specimens need reëxamination.

Snakes.—Snakes are much more widely spread over the islands than is generally believed. They were first mentioned by Dampier. Delano found snakes on Hood; Porter saw "a few small snakes much resembling the common American striped snake" on James, and "a small gray snake" on Albemarle; Steindachner, who distinguishes two varieties, *Dromicus chamissonis dorsalis*, and *D. habeli* records snakes from Indefatigable, Hood, Charles, and Jervis. The "Albatross" collected two snakes, one on James and one on Gardner Island. According to Dr. Habel, snakes are absent from Bindloe and Abingdon. We have, therefore, not less than seven islands on which snakes have been seen. How far the variation in the different islands goes is not yet known.

The Birds.—With the birds we are somewhat better acquainted, due to the collections of Dr. Habel and the "Albatross." The first collection forms the material of Mr. Salvin's extensive memoir on the Avifauna of the Galapagos. The material brought together by the "Albatross" has been very thoroughly worked up by Mr. Robert Ridgway. Collections have been made by Darwin, Kinberg, Dr. Habel, and the "Albatross." A few specimens have also been collected by Dr. W. H. Jones, Kellett and Wood, Dr. Neboux, Cookson and Markham. I give a list of islands with the names of the collectors:

Chatham: Darwin, Kinberg, Jones, Kellett and Wood, "Albatross." Charles: Darwin, Neboux, Kinberg, Jones, Cookson, Markham, "Albatross." Indefatigable: Darwin, Kinberg, Habel. "Albatross." James: Darwin, Kinberg, "Albatross." Bindloe: Habel. Albemarle: Darwin, Cookson, "Albatross." Abingdon: Habel, "Albatross." Duncan: "Albatross." Hood: "Albatross."

We have, therefore, collections from nine islands. So far 69 species of birds have been described, besides the albatross, which is recorded by Delano and Wolf from Hood Island, Thirty-two are found on Indefatigable, 28 on Chatham, 27 on James, 23 on Charles, 18 on Abingdon, 14 on Bindloe, 12 on Hood, 5 on Duncan, and 4 on Albemarle. The great number of Indefatigable is due to the collection of Dr. Habel, who brought not less than 267 skins from this island. Albemarle has hardly been touched. Darwin collected one bird. The "Albatross" remained only five hours at Tagus Cove, and collected four species. There can be no doubt whatever that a very much greater number of birds exist on Albemarle. We know from Wolf that some parts of Albemarle, especially the southern ones, have a well-developed flora (fifty to sixty species of Phanerogams in the lower regions) and there must be also birds.

No collections have been made on Brattle, Barrington, Narborough, Jervis, Tower, Wenman, and Culpepper. The number of genera collected is 40; of these 6 are peculiar to the islands, 8 are found in continental America, and 27 have a wide distribution. Of the 69 species 49 are peculiar to the islands, or 71 per cent. The six peculiar genera are Nesomimus, Certhidea, Geospiza, Cactornis, Camarhynchus, and Creagrus. Nesomimus belongs to the Mimidae; Certhidea to the Cœrebidæ or Honey Creepers; Creagrus to the Laridæ; and the three others to the Fringillidæ or finches.

Creagrus contains a single species, and all the specimens the history of which is absolutely known were taken on Dalrymple Rock, near Chatham Island, a rock 65 feet high,—a most peculiar example of distribution of a single genus.

The genus Nesomimus is represented by five species; one is peculiar to Charles, one to Hood, one to Albemarle, and one to Abingdon; the fifth, *N. melanotis*, is found on the central islands, Charles, Chatham, James, Indefatigable.

Certhidea contains three species; one is peculiar to Hood, one to Abingdon and Bindloe, and the third is again found in the central islands, Chatham, James, Indefatigable.

Geospiza is represented by eleven species, two of which, *G. dubia* and *nebulosa*, are doubtful. Hood has a peculiar species, *G. conirostis* Rigw. *G. magnirostis* has been found on Charles and Chatham; *G. media*, based on a single specimen, comes from Hood; *G. strenua* has been found on the central and northern islands; *G. fortis*, also *G. fulginosa*, are typical for the central islands; *G. parvula* and *dentirostris* seem to be the original inhabitants of Abingdon and Bindloe.

Cactornis shows five species; *C. brevirostis* is only found on Chatham; *C. assimilis* is typical for Bindloe; *C. abingdonii* for Abingdon; *C scandens* and *pallida* spread over the central islands; no form has so far been found on Hood Island.

Camarhynchus is represented by six species; none is known from Hood; two, *C. prosthemelas* and *C. habeli*, are characteristic of the northern Abingdon and Bindloe; *C. townsendi* has only been found on Charles; the other species occur on the central islands.

As a whole we find in the birds the same distribution as in the reptiles, notwithstanding flight could enable them to reach the different islands. The northern islands, Abingdon and Albemarle, show different forms from the central islands. The same is the case with Hood, so far as it has been examined. Some species of the genus Geospiza, which contains the greatest members, have perhaps only lately spread over a greater number of islands than the others. This genus needs further examination. It seems that in the time when Darwin visited the islands the birds were more restricted in distribution. I think it possible to trace the "original" locality of each species of this genus.

If we now compare the results we have reached about the distribution and variation of birds and reptiles, we must admit that we have found absolute harmony.

We find exactly the same in regard to the flora, but unfortunately only five islands of the central group have been examined, and that but little,—Chatham, Charles, James, Indefatigable, and Albemarle. All that we know of the flora of Indefatigable, for instance, was collected in a few hours by Andersson. All these islands reach into the humid region. Great results doubtless will be found when the northern and southern islands have been studied, and also the lower ones of the central group, like Barrington and Duncan, for instance. The peculiar genera found in the Galapagos are representcd by peculiar species on the different islands; and the same is true for the non-endemic genera.

(*To be continued.*)

THE BIOLOGICAL WORK OF AMERICAN EXPERIMENT STATIONS.[1]

BY CLARENCE M. WEED.

As was to be expected, nearly all of the published work of the biological departments of American experiment stations (and for the present purpose I mean, by these, the departments of zoology and botany, including entomology, ornithology, and mycology), up to the present time, has been of a purely practical nature, usually having an immediate application to agricultural procedure. This is perfectly right and exactly what has been needed. There has been, and is yet, a great demand for this sort of work, and it must be satisfied so far as possible if the enterprise is to continue to receive encouragement and support. The problems of spraying, of remedies for the great crop pests, whether insect or fungous in nature, of the effects of rotation and fertilization upon the increase of insects and fungi, and many similar subjects, furnish opportunities for a vast amount of useful work, which must on no account be neglected. But, nevertheless, is there not a tendency to confine ourselves too strictly to these purely practical problems, when very often a somewhat wider study would not only shed light upon the case in hand, but add much useful knowledge besides? Should not our work be organized and conducted on so broad and comprehensive a basis that our results will be cumulative, and in the years to come aid in the formulation of general biological laws?

We are so used to hearing about economic entomology, economic botany, and economic ornithology, that I fear even some of us have an idea that the main field of entomology, or botany, or ornithology, is not economic, but belongs to that department of pure science possessing, in the words recently quoted by Dr.

[1] This paper, in substantially its present form, was prepared for the Entomological Section of the Association of American Agricultural Colleges and Experiment Stations at its recent Champaign meeting, but was not read on account of the limited time at the disposal of the section.

Mendenhall, "the inestimable value of being of no practical utility whatever." But surely this is an error. I believe that every addition to our knowledge of the biology, classification, or distribution of an animal or plant will sooner or later be found useful. The organisms about us are so intimately related to each other and to their environment that we cannot say to one or a few of them: "Thou art of practical account; thee alone will we study." For when we come to investigate even the smallest insect thoroughly, we find that it is simply a part of a vast and complex organism, and that it is vitally related to other creatures in a thousand ways. It is preyed upon by "the fowl of the air and the fish of the sea"; frogs are ever ready to lick it up with their viscid tongues, and toads are lying in wait to send it in search of the mystic jewel within their bodies; quadrupeds in great variety esteem it a delicate morsel, and other insects devour it bodily, or suck out its life-blood, or gnaw away its vitals; bacterial germs are ever ready to destroy it, and the spores of Cordyceps and Empusa are but waiting an opportunity to develop within its body; its alimentary canal may contain a rich and varied fauna and flora, revealed only by the microscope, and the plant upon which it feeds is subject to a thousand agencies that make for its weal or woe. In short, it is engaged in an intense struggle for existence, and an adequate knowledge of the insect itself necessarily involves a consideration of the forces engaged in the struggle.

In the same way, if we would learn the economic status of a bird, we must study its food, its habits, its enemies. To do this properly involves an acquaintance with a large portion of the flora and fauna where the bird occurs,—not a mere knowledge of species, but an acquaintance with their habits and histories. And an adequate knowledge of a plant involves a study of a vast number of organisms,—a study of the insects that attack its roots; those that burrow in its stems; that feed upon its leaves, within or without; that visit its blossoms; that mine its fruit; of those that find in its foliage or flowers concealment from prey or protection from enemies; of the birds that devour its fruit and scatter its seed; of the quadrupeds that browse upon its foliage or gnaw its bark ; and of numerous other agencies to which it sustains vital relations.

In view of this intimate relation between the organisms with which we have to deal, it seems to me that one of the first needs of our work is the organization of biological surveys of our respective states ; and to this point I invite your special attention.

In that masterly essay published just ten years ago this month, entitled "On Some Interactions of Organisms," Dr. S. A. Forbes stated that "the principal general problem of economical biology is that of the discovery of the laws of oscillation in plants and animals, and of the methods of nature for its prevention and control." This is as true to-day as it was then, and so also is this paragraph that immediately follows it :

"For all this, evidently, the first, indispensable requisite is a *thorough knowledge of the natural order,—an intelligently conducted natural history survey.* Without the general knowledge which such a survey would give us all our measures must be empirical, temporary, uncertain, and often dangerous."

At various times in the history of many of the United States provision has been made for more or less complete natural history surveys. As a rule they have been combined with geological surveys, but this has been by no means universal. In Illinois the work has very appropriately been given to the State Laboratory of Natural History, the first of the series of final reports—an elaborate monograph of Illinois birds by Robert Ridgway—having lately been issued. In Kansas such a survey has been undertaken by the scientific staff of Washburn College, and in other western states scientific associations are at work upon it.

It must be confessed that the results of these surveys on the whole are incomplete and unsatisfactory. In no state can there be found a series of volumes containing an adequate account of its flora and fauna. The reason is not far to seek. The provision made for their support has been meagre and insufficient ; to one man has been given the work of ten, and he has often also been compelled to compass in a single season investigations requiring a decade for their proper completion. As a rule the work has also been of a transient nature, and very rarely has it rested on a fairly permanent basis. A knowledge of the flora and fauna of a state is not to be gained in a day nor a year, nor even, under ordinary circumstances, in a decade. It requires the coöperation of several specialists, with facilities for field and laboratory investigations, rooms for the storage of large numbers of duplicate specimens, a library of American and foreign natural history literature, extensive reference collections, means of producing illustrations, and opportunities for the publication of results,—in short, the methods and equipment of a permanent institution of investigation.

So far as I am aware, Illinois is the only state, unless perhaps we except New York, that has supplied these conditions in a fairly respectable manner. For fifteen years it has maintained a State Laboratory of Natural History, one of the main objects of which has been to make a systematic natural history survey of the state. The work of this laboratory, as published in its series of bulletins, has obtained the most gratifying recognition from the scientific world; and the initial volume of the final reports gives promise of a series of great value and importance. The director is now engaged upon the second volume concerning birds, treating of the food habits and economic relations of the various species, for the Illinois survey is not to be a mere catalogue of forms, but is to include the investigation and discussion of the relations of the organisms to each other and to agriculture.

It is scarcely probable that, for the present, at least, other states will follow to any great extent the example thus set by Illinois. Even there, where the work of Kennicott, Walsh, LeBaron, Riley, Ridgway, Thomas, French, and Forbes has given natural history a prominence and popularity enjoyed by no other western state, it has often been difficult to get the meagre appropriations furnished for the work. But it seems to me that the organization of an experiment station in each state furnishes an opportunity for the conducting of such surveys upon a permanent and well-established basis. Nearly all of them include departments of botany and entomology, with specialists in charge, and in many the college biological departments are closely connected. A knowledge of the flora and fauna of the states would furnish exactly the foundation needed for the prosecution of the distinctively economic work; and the two lines of investigation could very well be carried on together. To illustrate this point let me again quote from a recent report by Professor Forbes, in which the relations of the Illinois State Laboratory of Natural History to the Illinois Station are discussed. He says:

"The recent organization, at the university, of the State Agricultural Experiment Station has raised the question of the relations of the work thus instituted to that of the Natural History Laboratory and the State Entomologist's Office, with the effect to bring about an adjustment of the two at their points of contact in crytogamic botany and economic entomology. The purpose of the State Laboratory being essentially scientific and educational, its results are only incidentally economic; while the purposes of the Experiment Station are essentially economic, and its scientific work must naturally be regulated with close reference to practical results. In cryptogamic botany, for example, the Laboratory is engaged in a general survey of the state, intended to give us the species, the classification, and the life-history of all our flowerless plants, whether economically important or not, and the relations of these to agriculture will come in as a purely secondary matter; while in Experiment Station work, on the other hand, little attention will probably be paid to any species except those having economic relations. *All practical botanists are agreed, however, that the economic species and those of no economic importance are so intimately related in classification, habit, and life-history, that a full and exhaustive knowledge of the whole subject is very helpful, and often indispensable, for the solution of merely economical problems.* The more, in short, the State Laboratory is able to do in technical and biological botany, the easier and more fruitful will be the economic work of the botanical department of the Station. The former should, in fact, supply a broad and strong foundation on which the latter may build elaborately.

"As much of the work in the two directions requires substantially the same facilities, methods, skill, and knowledge, the two may be easily combined in a way to economize labor and expense and to increase results, the only requisite being a common scheme of subdivision and adjustment of proper subjects of research, and a proper arrangement with respect to assistance, separate and conjoint, in the two departments. Substantially the same may be said of the entomological work."

The Illinois station is fortunate, indeed, to have available the results of the long years of exhaustive work of the laboratory force, but for most of us there is no such reserve fund of knowledge upon which to draw, and if the foundation is obtained we must build it ourselves.

There are other advantages to accrue from such an undertaking besides those to be gained in the direct prosecution of the economic work. One of the greatest of these will be found in the stimulus given to natural history studies. A well-known botanist recently stated that nothing so stimulates the study of a group of plants as a good monograph. In the same way monographs or descriptive catalogues of the organisms of a locality or state are a great help to local naturalists; and there can be no doubt that the existence of volumes similar in plan to that of Ridgway's Illinois birds, treating of the mammals, birds, shells, insects, and plants, would greatly increase the number of students of natural history. We can all remember how eagerly, in our boyhood days, we attempted to get help from books in determining the species, as well as the habits and histories, of the organisms about us. A large proportion of farmers' boys are born naturalists, and it is only because they receive no encouragement and help that so many of them grow away from their early love. It is needless to say that by so increasing the number of nature students the stations would be doing a great service, not only to the agricultural community, but also to themselves,—to the former by adding to the enjoyment of rural life, to the intelligence of the farming community, to the mastery of the farmer's profession; and to the latter by increasing the number of trained observers, to whom experiments and observations may safely be trusted.

Of the methods to be employed in such surveys little need be said at this time. They will necessarily vary with the circumstances and the organizing skill of the individual in charge. But an indispensable requisite in all cases will be that a system of record and arrangement be adopted that is permanent, expansible, and easily applied, and by means of which the data obtained will be readily available at any time. Much aid also can nearly always be obtained by the judicious use of student assistants and local naturalists, both in making collections and working out results.

I am well aware that this idea will not meet with favor in the eyes of many critics of station work, especially those who are crying for a deluge of immediate practical results, and who often can see nothing "practical" in any result which does not carry with it as a passport the odor of the barnyard, the aroma of the onion bed, or the subtle flavor of insecticides like whale-oil soap. But criticisms from such sources should not prevent the undertaking of the work. The history of all the sciences related to agriculture shows that the investigations of greatest value have been those having to do with the discovery of general laws, and on the surface such investigations have often seemed of the most theoretical and impractical nature.

THE EVOLUTION OF THE CIRCULATORY ORGANS.

BY W. C. CAHALL.

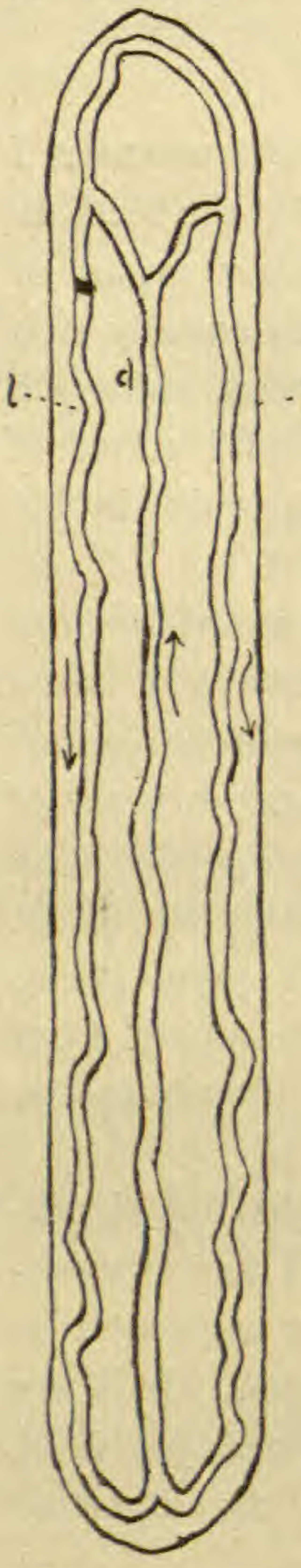
IN the March (1890) number of the AMERICAN NATURALIST I attempted to marshal the evidences furnished by the teeth in support of the hypothesis of evolution. Any other organ or group of organs could have been selected and found equally rich in evidences of a similar import. But none, perhaps, approach quite so nearly to a demonstration, as the beautiful series of cardiac organs met with by the comparative anatomist in his study of zoology.

Origin of Circulatory Organs.—In the lower forms of life, the Protozoa, where no differentiation of structure has yet taken place, the organs of circulation, like those of digestion, are not needed, for every part of the organism performs its own act of digestion and absorption of nutriment. Where a digestive tube is formed, as in the Hydra, the digested food passes by direct absorption into the tissues of the body. In the same group with the Hydra, the Cœlenterata, there are species where from the digestive tube radiate numerous canals which distribute the chyme to every part of the body.

In other species of the same group we see slight but significant and progressive changes in these canals. This "gastro-vascular system," as it has been called, is the first approach to *circulation* we meet with in ascending the animal scale. It is for all practical purposes an efficient circulatory system, yet it is, structurally, nothing more than an amplification of the digestive tract.

The first approach to independence of the organs of circulation from those of digestion is within the Vermes or worms. They have walls and are blood-vessels indeed, since they have a regular circulation of a blood-fluid. A simpler kind is that of some Nemertina, where the main trunks are three long canals connected by transverse shorter ones (Fig. 1).

In Fig. 2 is represented a more complicated system as found in a higher class of the Vermes, which are furnished with both dorsal and ventral vessels, with pairs connecting them at regular intervals. One or more of these transverse vessels may be enlarged and pulsatile. While at other times the dorsal vessel itself acts as a heart. In this last we are to trace the origin of the heart of both anthropods and vertebrates.



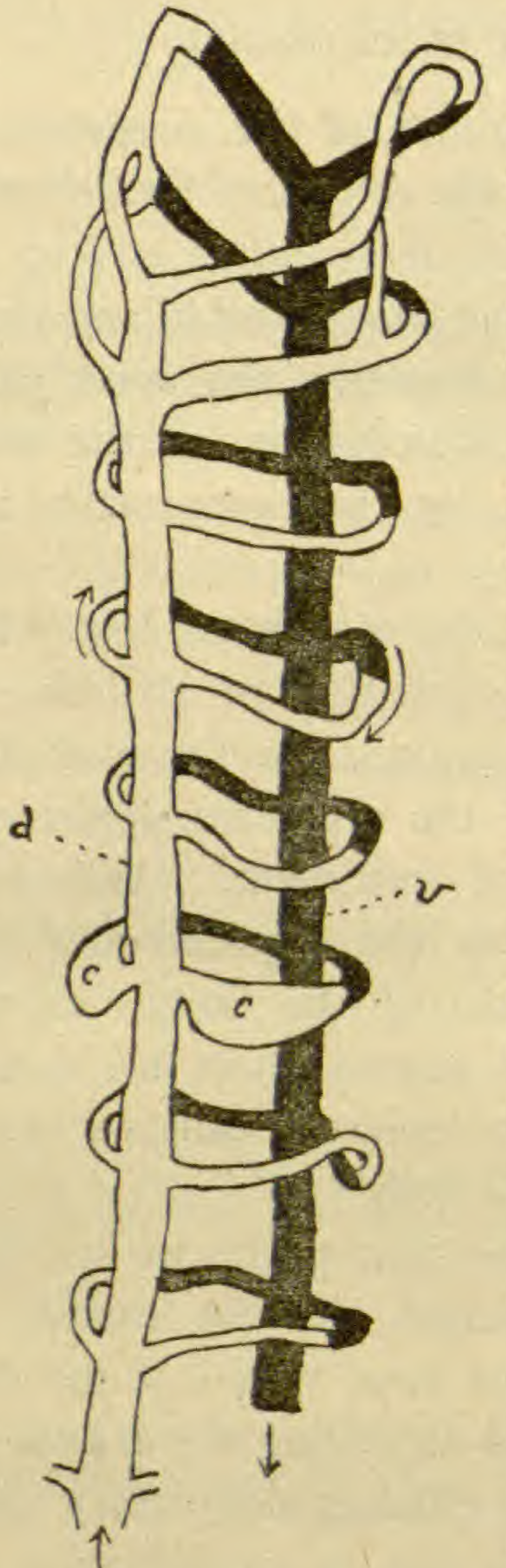


FIG. 1.—Diagram of the vascular system of Nemertina: *d*, dorsal longitudinal trunk; *l*, lateral vessels. The arrows indicate the direction of the stream of blood. After Gegenbaur.

FIG. 2.—Vascular system of *Sænuris variegata*: *d*, dorsal vessel; *v*, ventral vessel; *c*, heart-like enlargement of a transverse. The arrows indicate the direction of the current of blood. After Gegenbaur.

In the one great group, the Mollusca, there are four types whose several hearts furnish as clear a demonstration of the evolution of an organ as could well be desired. Some reader, unacquainted with comparative anatomy, may even imagine the sketch (Fig. 3) an ideal one by some over-zealous evolutionist, made to confirm his theory; but myriads of these hearts are throbbing to-day as living contradiction to this suspicion. *A* represents a dorsal vessel and transverse trunks of the worm, such as we have already seen in Figs. 1 and 2. *B*. Here we have the single, straight, pulsating ventricles (*v*) with the branching auricles (*a*), as found in the Nautilus. In *C* we have a similar organ of the Loligo, with the auricles reduced to two. *D* is a diagram of the heart of the Octopus, where for the first time we meet with the organ bent upon itself *E* represents the heart of ventricle and single auricle of the Gastropod, the extreme of development in one direction.

The heart of the fishes likewise consists of two cavities, one auricle and one ventricle, but this is not to be homologised with the two cavities of the molluscan heart. In the Mollusca the auricle receives aërated blood from the respiratory organs, and passes it to the ventricle, which propels the oxygenated blood throughout the body, thus forming a systemic circulation. The Mollusca have no capillaries save in the respiratory organs, so that the blood, after leaving the arteries, flows through canals or lacunæ within the substance of the body. In the fishes, on the contrary, the two cavities convey only venous blood, thus performing the same function as the right side of the heart of mammals. The deoxygenated blood is gathered up from all parts of the body, and conveyed by the veins to the auricle, thence to the ventricle, which organ forces it through the truncus arteriosus into the capillaries of the gills, where he blood is oxygenated by the free oxygen held by the water. The now aërated blood is gathered up by the radices aortæ, and the dorsal aorta disttributes it throughout the body (Fig. 4.) This figure should be compared with Fig. 2, when it will at once be seen, after making allowances for the inverted position of the worm, that the heart of the fish corresponds with the dorsal vessel of that figure, the gill circulation to the transverse vessels of the worm, and the ventral vessel of the one to the dorsal aorte of the other. The resemblances to the Mollusc are largely those of analogy; those to the Annelid, those of true homology.

In the reptiles we see a further development of this central engine of life. Here we have two auricles with one ventricle. The auricle of the fish has had a septum placed down its middle, forming two cavities. In some lower forms this septum is incomplete, but in typical reptiles it is complete. The ventricle also has the rudiments of a septum. Indeed, in some of the higher reptiles, the crocodile for instance, the separation is almost perfect, thus approaching the normal condition of the bird and mammalian heart. The impure blood which has passed through the system is conveyed to the right auricle, while the left auricle receives the oxygenated blood from the lungs. Thus pure and impure blood become mixed in the ventricle. There are two aortic arches arising from the ventricle, one from the right side and the other from the left. The blood coming through the right aortic arch, now become the pulmonary artery, flows through the pulmonary artery to the lungs, while that entering the left aortic arch is carried throughout the system (Fig. 5).

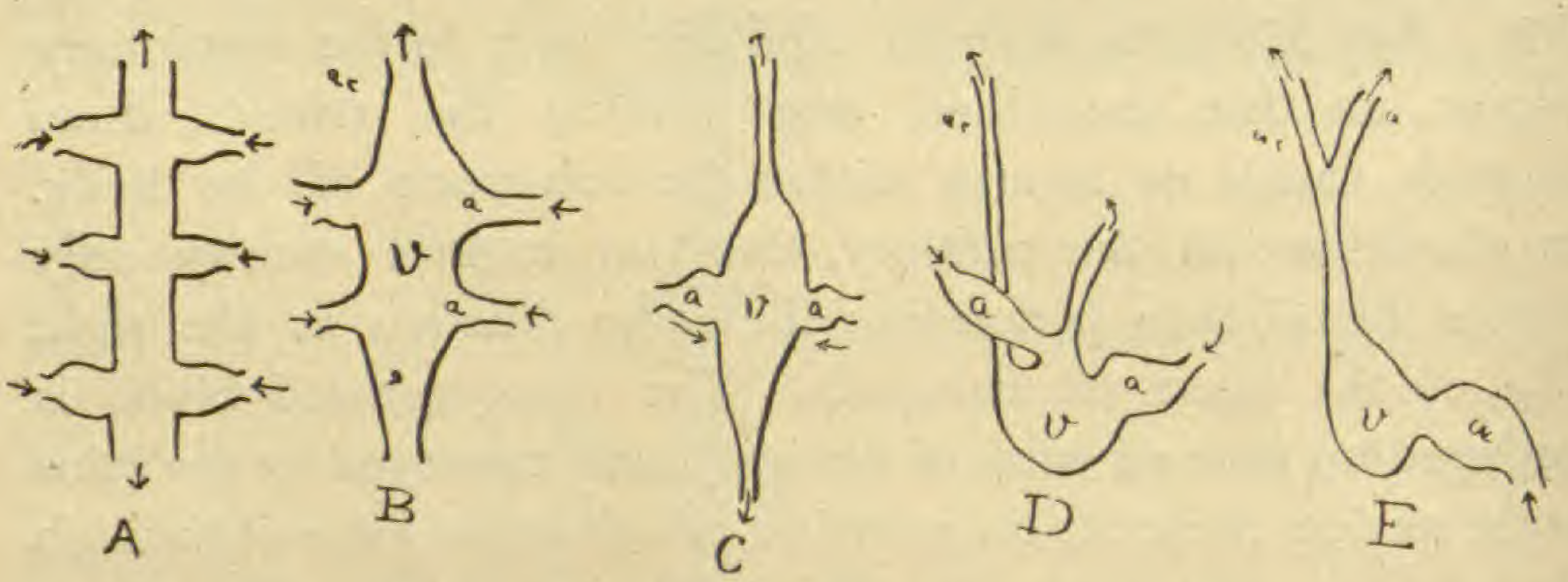


FIG. 3.—CIRCULATORY CENTERS OF MOLLUSCA.—*A*, dorsal and transverse trunks of worm; *B*, heart and auricles of Nautilus; *C*, heart and auricles of Loligo; *D*, heart and auricles of Octopus; *E*, heart and auricles of Gastropod; *v*, ventricle; *a*, auricle; *ac*, arteria cephalica; *a*, arteria abdominalis. The arrows show the direction of the current of blood. After Gegenbaur.

The heart of the bird and of mammals consists of two auricles and two ventricles. The venous blood is gathered up from all parts of the body and emptied into the right auricle, whence it flows through the tricuspid valves into the right ventricle, which by its forcible contraction drives the blood through the pulmonary artery into the lungs. Here the aërated blood is returned to the heart again through the pulmonary veins to the left auricle, thence through the mitral valves to the left ventricle, which sends it bounding throughout the system. There are in the bird and mammal, then, two distinct hearts; the right half, like the heart of the fishes, carrying only venous blood, and the left side, like the heart of the Mollusca, carrying only arterial or aërated blood, while the heart of the reptile is an intermediate organ between the simple apparatus of the fishes and the compound heart of the Mammalia (Fig. VI.).

. Thus we have traced, by easy and gradual steps, the complete evolution of the simple pulsating vessel of the Annelid unto the marvelously perfect organ of man. We have seen how the one pulsating tube has divided into two by a partial and then a perfect septum, into an auricle and a ventricle, and then have seen these cavities, by a partition more and more complete, separated into four distinct cavities. Yet all this is done with but slight alterations of preëxisting structure, and without a link in the chain missing This is an argument approaching a demonstration, and must appeal to all candid minds. To those who might object that even the slight changes could not be made without the destruction of the animal or species, I would instance the transformation of every tadpole into a frog. Surely no one will assume that tadpoles are changed now into a frog by any power save that residing in natural laws. Yet the changes are profound.

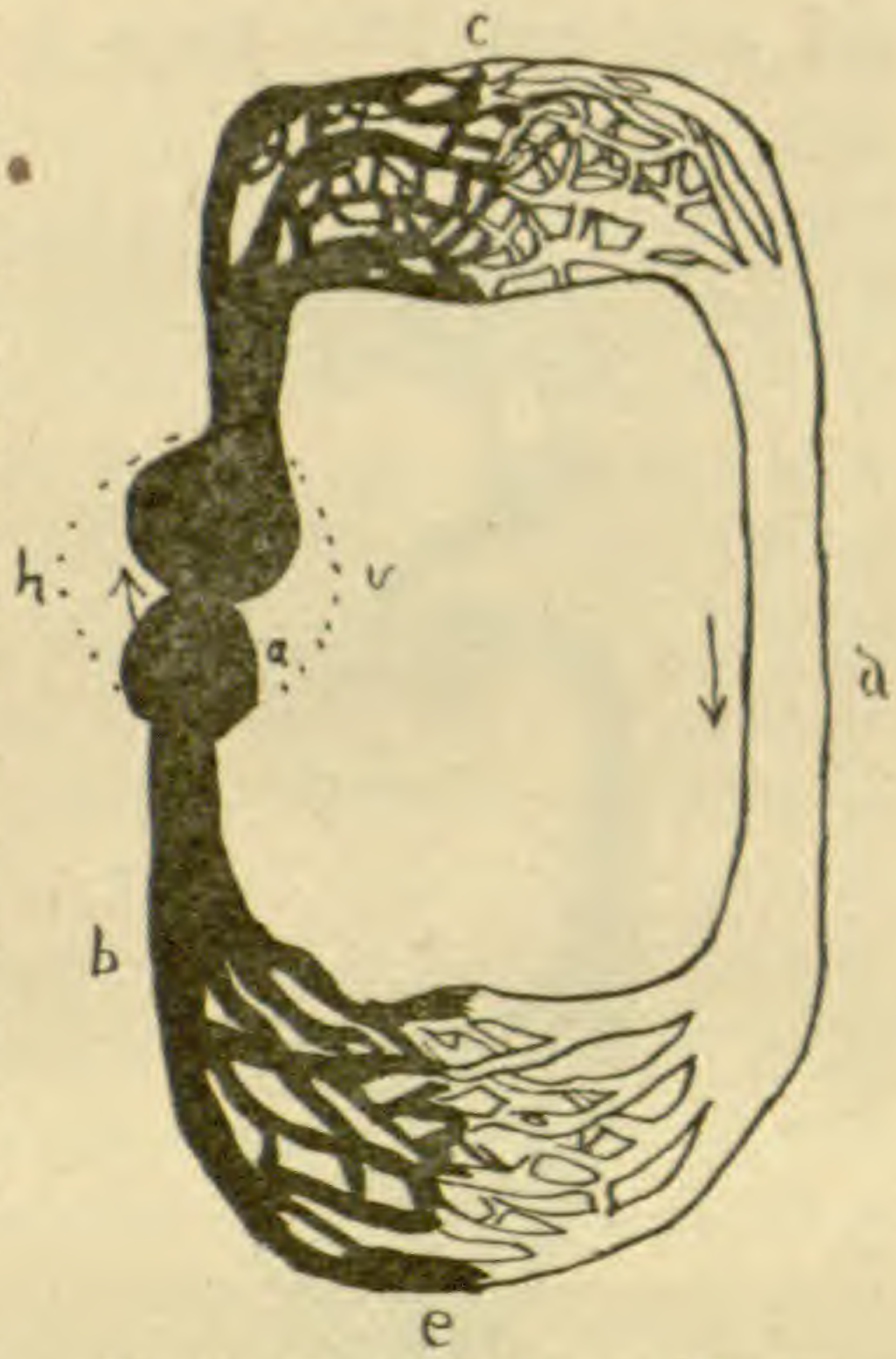


FIG. 4.—CIRCULATION IN FISHES.—*h*, heart, enclosed in pericardium; *a*, the auricle; *v*, the ventricle; *c*, the capillary action in the gills; *d*, the dorsal artery; *e*, the systemic capillaries; *b*, the veins.

The heart of a tadpole is practically that of a fish, having one auricle and one ventricle, and the animal breathes by gills; yet a frog has two auricles and a ventricle, and breathes by lungs. Here we see changes equivalent to the transformation of a fish into a reptile. And among reptiles we meet with hearts with every degree of partition, until in the crocodile the heart is partitioned off very nearly the same as in birds and mammals. In the development of the heart in embryos of birds and mammals we find the organ passing through the conditions found permanently in lower forms. A distinguished comparative anatomist thus outlines the development of the embryo chick: "The first rudiments of the heart appear about the 27th hour, and is a mass of cells, of which the innermost soon break down, so as to form a tubular cavity; for some time it is simple and undivided, extending, however, through nearly the whole length of the embryo. No motion of fluid is seen in the heart or vessels until the 38th or 40th hour. When the heart, which may be considered analogous at this period to the dorsal vessel of the Annelida, first begins to pulsate, it contains only colorless fluid mixed with a few globules. Between the 40th and 50th hours a separation in its parts may be

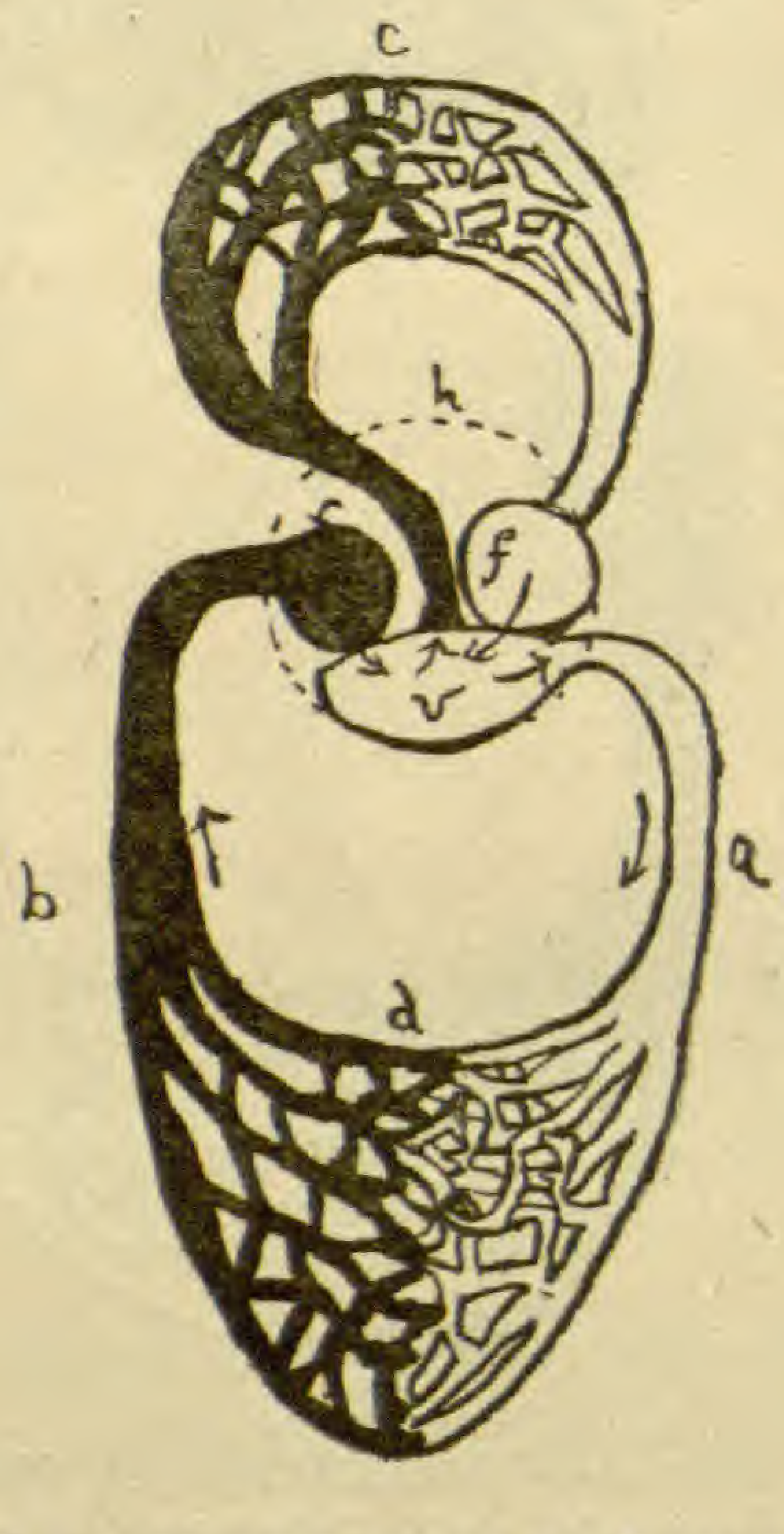


FIG. 5.—CIRCULATION IN REPTILES.—*h*, heart, enclosed in pericardium; *f f*, right and left auricles; *v*, single ventricle; *a*, aorta; *v*, vena cava; *c*, smaller circulation; *d*, greater circulation.

FIG. 6.—CIRCULATION IN MAMMALS AND BIRDS.—*h*, heart; *v*, right ventricle; *v'*, left ventricle; *c*, right auricle; *c'*, left auricle; *a*, aorta; *d*, vena cava; *e*, greater circulation; *f*, pulmonary artery; *g*, pulmonary veins.

observed, which is effected by a constriction round the middle of the tube; and the dilation of the posterior portion becomes an auricular sac, and that of the anterior a ventricular cavity. Between the 50th and 60th hours the tube of the heart becomes more and more bent together until it is doubled, so that this organ becomes much shorter relatively to the dimensions of the body, and is more confined to the portion of the trunk to which it is subsequently restricted. About the same time the texture of the auricle differs considerably from that of the ventricle; the auricle retaining the thin and membranous walls which it at first possessed, while the ventricle has become stronger and thicker, both its exterior and interior surfaces being marked by the interlacement of muscular fibres, as in the higher Mollusca. About the 65th hour the grade of development of the heart may be regarded as corresponding with that of the fish, the auricle and ventricle being perfectly distinct; but their cavities are as yet quite single. During the fourth day the cavities of the heart begin to be divided, for the separation of the right and left auricles and ventricles. About the 80th hour the commencement of the division of the auricle is indicated, externally, by the appearance of a dark line on the upper part of its wall; and this, after a few hours, is perceived to be due to a contraction, which, increasing downwards across the cavity, divides it into two nearly spherical sacs. The division of the ventricle commences *some time before* that of the auricle, and is effected by a sort of duplicature of its walls. At last, however, the division is complete, and the interventricular septum becomes continuous with the interauricular, so that the heart may be regarded as completely a double organ. The progressive stages presented in the development of this septum are evidently analogous to its permanent conditions in the various species of reptiles. In the heart of mammals (embryo) the same changes take place, but more slowly. Soon after the septum of the ventricles begins to be formed in the interior, a corresponding notch appears on the exterior, which, as it gradually deepens, renders the apex of the heart double.

"This notch between the right and left ventricles continues to become deeper until about the eighth week in the human embryo, when the two ventricles are quite separated from one another, except at their bases; this fact is very interesting from its relation with the similar permanent form presented by the heart of Dugong.

"At this period the internal septum is still imperfect, so that the ventricular cavities communicate with each other, as in the chick, on the fourth day. After the eighth week, however, the septum is complete, so that the cavities are entirely insulated; whilst at the same time their external walls become more connected towards their base, and the notch between them is diminished; and at the end of the third month the ventricles are very little separated from one another, though the place where the notch previously existed is still strongly marked.

"In the state of the circulatory system in the early embryo, where the heart is as yet but a pulsating enlargement of one of the principal trunks, and the walls of the vessels are far from being complete, we have the representation of its condition in the higher Radiata, and in the lower Articulata and Mollusca. In the subsequent division of the cardiac cavity into an auricle and ventricle an advance is made, corresponding to that which we encounter in passing from the Truncata to the higher Mollusca. And when the branchial arches are formed, which enclose the pharynx and meet in the aorta, the type of the fish is obviously attained, and at a subsequent period the condition of the heart and great vessels presents a strong general resemblance to that of the typical reptiles."

Even at birth the true mammal heart is still incomplete, for there is an opening in the septum between the right and left auricles called the *foramen ovale*, which does not entirely close until after birth, and not in all cases then, leaving the child so formed in a condition almost certain to lead to early death. Does not this opening, which is of no use to fœtus or child, seem more likely to be the result of a general evolution, rather than of a special creation of a useless and oftentimes a harmful accident?

There is also, in the fœtal circulation, a connecting vessel between the pulmonary artery as it emerges from the right ventricle and the aorta as it leaves the left ventricle. This *ductus arteriosus* soon becomes obliterated after birth, so that man has only temporarily what is persistent through life in the reptile.

The peculiar relation of the valves of the veins to the vessels they occupy in man has furnished Dr. S. V. Clevenger, of Chicago, the material for a striking argument for the evolutionary origin of man. (See AMERICAN NATURALIST, Vol. XVIII.)

The veins which return the blood to the heart against gravity, as in the legs and arms, are supplied with valves which allow the blood to flow upward, yet close and hold the column of blood upon any tendency to regurgitate.

Now this writer claims that the valves of the veins have not yet become accommodated to the upright position of man, for there are several instances in man where the persistence of the valves in certain veins are not only useless for their original purpose, but by their position are actually obstructive to the return of the blood to the heart. He asks, What earthly use has a man for valves in the intercostal veins which carry blood almost horizontally backward to the azygos veins?

When recumbent they are actually a detriment to the free flow of blood. The inferior thyroid veins, which drop their blood into the innominate, are obstructed by valves at their junction. Two pairs of valves are situated in the external jugular and another pair in the internal jugular, but in recognition of this uselessness they do not prevent regurgitation of blood nor liquids from passing upwards. Where apparently most needed, such as venæ cavæ, spinal, iliac, hemorrhoidal, and portal, there are none. The azygos veins have imperfect valves; their rudimentary condition suggests that they may be of recent origin. Now place man on "all fours," and these anomalies disappear. The veins which in man erect do not need valves will be seen to need them against gravity when on "all fours," and as they are found in all four-footed animals; and where, in man erect, those veins which need valves but have them not, when on "all fours" will not need them. Valves in hemorrhoidal veins in quadrupeds would be out of place, yet their absence in man sacrifices many lives and produces untold suffering. It is difficult to escape from the consequences of Dr. Clevenger's logic.

Malformations.—Cyanosis results from the *foramen ovale,* which establishes a communication between the auricles, remaining open after pulmonary respiration had been established, a condition permanent in the crocodile. An arrest of development at an earlier period may cause still greater imperfections in the formation of the heart. Thus, the septum of the ventricles is sometimes found incomplete, the communication between the cavities usually occurring in the part which is last formed, and which in most reptiles remains open. A still greater degradation in its character has been occasionally evinced, for several cases are now on record in which the heart has preserved but two cavities, an auricle and a ventricle, thus corresponding with that of the fish; and in one of these instances the child has lived for seven days, and its functions had been apparently but little disturbed.

The bifed character of the apex, which presents itself at an early period of the development of the mammalian heart, and is permanent in the Dugong, sometimes occurs as a malformation in the adult subject, evidently resulting, like the others which have been mentioned, from an arrest of development.

The Blood.—The form-elements of the blood itself indicate a parallel evolution with that of the heart and vessels. In the Vermes, where the vascular system is first separated from the digestive tract, the liquid contents known as the blood are generally colorless, occasionally green or reddish in color, and the form-elements are of but slightly different cells. The blood of the Echinoderma (sea-stars and sea-urchins) is of clear or slightly opalescent color, and the form-elements are simple cells.

The blood of the Arthropoda is generally colorless; only in a few insects is it greenish or reddish; even then the color is due to the plasma and not to the cells, which are colorless and of variable size and form, and absent entirely in some of the lower forms, as the Crustacea. The blood of the Mollusca is generally colorless, sometimes bluish, violet, or green; only in one species is the blood red, and then from the plasma, for the blood-cells are simple, undifferentiated, and always colorless.

The blood of crabs and other Crustacea has been proved by M. Fredericq to contain the same saline elements and the same strong and bitter taste as the waters they inhabit. But the blood of sea-fishes is very different. It has not the same constitution as that of the crabs, and shows a marked superiority over them. In fact, the character of the blood-fluid of the invertebrates is strikingly similar to the lymph of the higher vertebrates where the lymphatic and vascular systems are separated. In both, the cells are simple and undifferentiated, colorless, opalescent, or pink.

Even after we enter into an examination of the vertebrates we will meet with a species, and, as we should be led to expect from an evolutionary standpoint, it happens to be of the very lowest class of the vertebrates, the Amphioxus, where the blood-fluid is colorless, and its form-elements are very small, indifferent cells. It is also significant that here also the lymphatic system is not entirely distinct from the vascular system.

But in all other vertebrates, after we leave this lowest class, we shall find the two systems separate, and the blood color red. While the blood is uniformly red, the form-elements of each of the great families of the vertebrates are distinctive and characteristic. The color of the blood now depends upon the coloring matter contained in the blood-cells, and not, as in the few instances of colored blood of the invertebrates, upon the colored plasma. The blood-cells of all vertebrates are highly differentiated, and all contain a nucleus, save the red corpuscles of the highest, the mammals, and even here the nucleus is present in the fœtal stages. The cells are generally flattened. In fishes, Batrachia, reptiles, and birds they are oval and biconvex, while in mammals they are biconcave. The relative quantity of blood in the higher classes of the vertebrates remains the same, yet the relative cell surface varies decidedly.

The red blood-cells are essential to respiration and as carriers of oxygen to the tissues. Fishes consume very little oxygen, and so the red blood-cells are not relatively numerous, and they are called cold-blooded animals, having a temperature but little above that of the surrounding medium. The Batrachia are similarly constituted, but the reptiles have some higher qualites, but still inferior to birds and mammals, which are classed as warm-blooded.

The physiological data contained herein are not the teachings of any special school of science, but the well-digested and generally accepted conclusions of the principal modern authorities on comparative anatomy,—as may be seen more in detail in such works as Carpenter's "Comparative Anatomy," Cope's "Origin of the Fittest," Gegenbaur's "Elements of Comparative Anatomy," Huxley's "Anatomy of Vertebrated Animals," and Owen's "Comparative Anatomy and Physiology."

A FEW NATIVE ORCHIDS.

BY MRS. PRESTON LOVELL.

WHOEVER reads that much-berated production, "The Modern English Novel," remembers the gorgeous young man who disports himself in its pages. However else his attire may vary, in one particular it is invariable: "an orchid in his button-hole" always adds to it the last touch of elegance. This gorgeous creature may seem a trifle remote from our every-day American civilization, but in this point we may emulate his magnificence. We may, if we will, deck ourselves with the flower which is usually considered beyond the reach of those who cannot build an orchid-house, or seek this latest of fashion's floral favorites in Amazonian forests or the islands of the sea. If you are fearless of bogs and quagmires; if you are ready to tramp through swampy underbrush, disputing territory with snakes and mosquitoes; and if, in addition, you are endowed with what Thoreau named "the instinctive second sight of a flower-hunter," —then let us seek out a few of our wild orchids.

In mid-June, on the low, boggy shores of some lake, we shall find the first-comer, the dainty Arethusa. The flowers of rose purple, borne singly on a short stem, have a curious expectant air, as if a breath of wind would send them fluttering away on their rosy, outspread wings. The closely allied Calopogon differs from the Arethusa in its taller growth and brighter colors. But no orchid is without marked individuality, and we accordingly find the flowers of the Calopogon borne in an apparently inverted position on the stem. It also affords an excellent opportunity to study the strange methods of fertilization peculiar to this order. Few orchids are capable of self-fertilization, depending in most cases upon insect help; and I have often watched the bees coming and going about these flowers, intent only on honey-gathering, but unconsciously working out thereby the fertilization of the Calopogon.

To the sensitive student of plant life every order or family possesses characteristics and peculiarities of its own. I do not here refer to those obvious differences and resemblances upon which classification is based, but something much more intangible, which I do not know how to characterize, otherwise than as difference of *temperament.* In this sense the orchids are a conservative, stay-at-home class, possessed not at all by the spirit of adventure. Other plants may roam far or near in the track of man or beast, but they are impatient of new conditions, and stay firmly rooted in their original haunts. They are a law unto themselves, and usually a law past finding out. Why, for instance, did the quaint Ladies' Tresses (*Spiranthes cernua*) bloom year after year on the edge of the old brick-kiln, and nowhere else by bog or lakeside in the whole vicinity? Indeed, so tenaciously did it cling to this spot, that when years of disuse had dried the kiln I have found the short stems, with their spiral rows of tiny white flowers, among the meadow-grasses, which had usurped the place of the rushes and sedges. And why, of all the lakes scattered throughout the neighborhood, is Clear Lake the only one where the Fringed Purple Orchis (*Platanthera bigelovii*) deigns to rear her splendid spike of rose-red flowers? And this, too, in open defiance of the dictum of the botanist,—"common in wet meadows"! Her sister, the lovely Yellow Fringed Orchis (*P. ciliaris*) does not thus overstep the bounds marked out for her. "Very rare" she is indeed! Only twice have I found the slender stem, crowned by two or three delicate orange flowers, looking like nothing so much as some marvelous insect poised for flight. Once it was the sufficient reward of a long tramp under an August sun to the low-lying meadows which border the Battle Creek; and again, years after, it was the sole trophy of a trip to Hawkin's swamp for huckleberries.

This family trait is also well illustrated by the White Prairie Orchis (*P. leucophæa*). Climax is one of the prairies of small extent scattered throughout Southern Michigan; but small as it is, this characteristic prairie flower has found it out, and blooms there in profusion. Yet a short distance away, under seemingly similar conditions, except the prairie soil, you may search for it in vain. Just where Climax prairie begins to lose itself in the Jordan marshes you may find the foot-high stem, with its raceme of greenish-white flowers, of the characteristic shape of the Platantheras. In this variety the long, curved, deflexed spur gives to the raceme of flowers a curious, ragged, unkempt appearance.

With the Cypripediums, or Lady's Slippers, few are entirely unfamiliar. "Moccasin flower" the Indians named it, far more appropriately, for its shape is very suggestive of the rounded, soleless moccasin. How vivid is the memory of our childish excursions to Markham's woods! How we searched the dry knolls and oak-crowded uplands for Trilliums, Phlox, Lupines ("Quaker bonnets" we called these), and Painted Cups, but still unsatisfied till we found the Yellow Lady Slipper. This was the supreme reward of our long tramp. In very different environment did we find her dainty cousin, the Pink Lady Slipper. Down in the "bottom-lands," where the sluggish Oonadaga drags through bogs and morasses, where all is shadow and rank growth, there she lifts her delicate cups of pink and white, preaching nature's unending sermon of beauty, purity, and sweetness from filth, decay, and corruption. Rarer than these, but still occasionally to be found by diligent search in swamp or marsh, is the Tall White Lady Slipper.

The time-honored maxim, "All things come round to him who waits," may, for the flower-hunter, be fitly paraphrased, "All things come round to him who *tramps*." For sooner or later, by lonely lake or grassy meadow, on mountain-top or busy side, the flower of his quest will shine before him. So I found the Tiny White Lady Slipper. I had heard of it now and then,—not often, for it is one of the shyest of its shy kind. I had sought for it, in coolness and damp, where it seemed as if it *must* be growing, and once a friend sent me one or two specimens. But at last an early morning walk brought me to the brow of a hill, from whose base a bit of lowland meadow stretched to the banks of Battle Creek. This interval was thickly dotted with the flower of my long search. They stood in patches, in the thick, lush grass, as if a band of fairies had danced the night away on the level greensward, and, fleeing away at my approach, had left behind their dainty footgear. And dainty indeed must be the feet for such slippers! Into the largest one could scarcely insert the tip of a baby's finger. Pure white, with the gleam of the golden stamens within the tiny sac, the whole plant scarce five inches high, I know of no flower more instinct with mystery and grace.

I have mentioned in this sketch only those orchids with which I am personally familiar. A friend tells me of finding the Rattlesnake Plantain, whose leaves are curiously netted and banded with white, as if its ugly namesake had dragged over them his loathsome length. I think it very probable that this list may be extended, and I am rarely in swamp or marsh that I do not find myself peering curiously around for some strange freak of growth in petal or calyx which shall announce "a new orchid."

RECORD OF AMERICAN ZOOLOGY.

BY J. S. KINGSLEY.

(Continued from Vol. XXIV., page 1169.)

GENERAL.

FEWKES. J. W.—A zoological reconnoissance in Grand Manan. AM. NAT., XXIV., p. 423, 1890.

MERRIAM, C. H.—Results of a biological survey of the San Francisco Mountain region and Desert of the Little Colorado, Arizona. *North American Fauna*, No. 3, 1890.—Contains, besides special papers on vertebrates, general discussion of biological regions of North America.

HAGEN, H. A.—Do animals count? *Nature*, XL., p. 299.

* BEHR, H. H.—Changes in the fauna and flora of California. Proc. Cal. Acad., II., p. 94.

* COCKERELL, T. D. A.—Contributions towards a list of the fauna and flora of West Mountain Valley, Colorado. *West Am. Scientist*, VI., p. 103, 1889.

COLLINS, D. E., BEAN, T. H., AND RATHBUN, R.—Results of investigations by the schooner "Grampus" on the southern mackerel grounds in the spring of 1887. Bull. U. S. Fish Com., VII., p. 217, 1889.—Narrative; notes on fishes, invertebrates, etc.

SEAL, W. P.—The a quarium: A brief exposition of its principles and management. Bull, U. S. Fish Com., VI., p. 274, 1889.

* LEIDY, J.—Remarks on the nature of organic species. Trans. Wagner Free Inst., II., p. 51.

OSBORN, H. L.—A preservative. *Nature*, XLI., p. 199.—Ten per cent. brine.

* COPE, E. D.—An outline of the philosophy of evolution. Proc. Am. Phil. Socy., XXVI., p. 495, 1890.

GULICK, J. T.—Divergent evolution and the Darwinian theory. *Am. Jour. Sci.*, III., xxxix., 21, 1890.

RYDER, J. A.—Proofs of the effects of habitual use in the modification of animal organisms. Proc. Am. Phil. Socy., XXVI., 541, 1890.

* FLOWER, W. H., MORRIS, D., CARRUTHERS, SCLATER, THISELTON-DYER, SHARP, GODMAN, AND NEWTON.—Second report of the committee appointed for the purpose of reporting on the present state of our knowledge of the zoology and botany of the West India Islands. Rep. Brit. Assoc. Adv. Sci., LIX., p. 93.

* HEILPRIN, A.—The Bermuda Islands. 8vo., Philadelphia, 1890.

* GARMAN, S. W.—Cave animals from Southwestern Missouri. Bull. M. C. Z., XVII., No. 6, p. 225.

WATASE, S.—Karyokinesis and the cleavage of the ovum. Johns Hopkins Circ., IX., 53, 1890.

HARKNESS, H. W.—The nomenclature of organic life. *Zoe*, I., p. 1, 1890.

BEHR, H. H.—Economy of nature as exemplified by parasites. *Zoe*, I., p. 33, 74, 1890.

MINOT, C.-S.—Morphology of blood corpuscles. AM. NAT., XXIV., 1020, 1890.

CURTICE, C.—The animal parasites of sheep. Washington, 1890, Dept. Agr., Bureau of An. Industry, pp. 222, pls. 36.

PROTOZOA.

KILLICOTT, D. S.—Observations sur des Infuisores d'eau donce. *Jour. Micographie*, XIII., p. 560, 1889.—From American Socy. of Microscopists. Describes *Enchyhodon pellucidus* (Michigan), *E. farctus* (Buffalo) *Balantidium gyrans*, (Niagara) *Pyxidium hebesu* (*l. c.*), *Vorticella rubistigma* (Shiawasser River), *Zoothamnium arbuscula*, *Opercularia niagaræ*, *Stichotricha ampulla* (Ontario, Mich.)

STOKES, A. C.—How to collect Hydra and Vorticella. *Microscope*, X., p. 69, 1890.

WILLISTON, S. W.—*Uroglena volvox* Ehr. *Microscope*, X., p. 81, 1890.—Wants information as to habits, etc.

CALVIN, S.—Notes on some gigantic specimens of *Actinosphærium eichhornii*. AM. NAT., XXIV., 964, 1890.

SPONGES.

* POTTS, EDW.—Report upon some fresh-water sponges collected in Florida by Joseph Wilcox. Trans. Wagner Free Institute of Science, Vol. II., p. 5.

——Fresh-water sponges—what they are not. *Microscope*, X., p. 140, 1890.

——Fresh-water sponges—what they are; *l. c.*, p. 161, 193, 257.

RUGE, J. G.—The sponge fisheries of Florida. Bull. U. S. F. C., VII., p. 22, 1889.

* DENDY, A.—Observations on the West Indian chalinine sponges, with description of new species. Trans. Zool. Socy. London, XII., 349, 1890.

COELENTERATA.

AGASSIZ, L.—The anatomy of *Astrangia danæ.* Smithsonian Inst., 1889.—Six plates 4° by Sonrel, with explanation by J. W. Fewkes.

HASKINS, B. W.—Explanation of Mr. H. E. Valentine's observations of the Hydra. *Microscope*, X., p. 52, 1890.—Nothing new.

STOKES, A. C.—To collect Hydra and Vorticella. *Microscope*, X., p. 69, 1890.

HEILPRIN, A.—The corals and coral reefs of the western waters of the Gulf of Mexico. Proc. Phila. Acad., 1890, p. 303.—List of species and description of reefs at Vera Cruz.

BIGELOW, R. P.—Notes on the physiology of *Caravella maxima.* J. H. U. Circ., IX., 61, 1890.—Feeding, etc., of "Physalia."

——The marginal sense organs in the Pelagiidæ. J. H. U. Circ., IX., p. 933, 1890.

DANA, J. D.—Coral and coral islands. III. edit., N. Y., 1890. —*Vide* AM. NAT., XXIV., p. 933, 1890.

MCMURRICH, J. P.—Contributions on the morphology of the Actinozoa. I. The structure of *Cerianthus americanus. Jour. Morphol.*, IV. 131, 1890.

ECHINODERMATA.

CRAGIN, F. W.—Sea-urchin excavations at Guaymas, Mexico. AM. NAT., XXIV., p. 478, 1890.

IVES, J. E.—Echinoderms from the northern coast of Yucatan and the harbar of Vera Cruz. Proc. Phila. Acad., 1890. p. 317.

—New species are *Holothuria heilprinii, H. silamensis, H. nitada.* Thyraster, nor. gem. for *Echinaster serpentarius* (Val.).

*Agassiz, Alex.—Liber einen neurn Tiefser-Crinoidm aus der Familie der Apioeriniden. *Neu. Jahrb. Min. Geol. u.*, Paleont, 1890, p. 94.

PLATHELMINTHES.

Leidy, J.—Parasites of *Mola rotunda.* Proc. Phila. Acad., 1890, p. 281. *Tristomum rudolphianun, Distomum pedoestyle*, and *Acanthocephalus elŏngatus.*

Curtice, C.—The animal parasites of sheep. Washington, 1890.—*Taenia marginata, T. coenurus, T. echinococcus, T. tenelia, T. fimbriata, T. expansa. Distoma hepaticum, D. lanceolatum.*

MEMATHELMINTHES.

*Atkinson, G. F.—Nematode root galls. Jour. Elisha Mitchell Sci. Soc'y., VI., pt. 2, 1890.

——A preliminary report on the life-history and nutamorphoses or a root-gall nematode, *Heterodera radicola* (Graeff) Müll. Bull., No. 9. Alabama Agric. Exp. Sɿation.

Neal, J. C.—The root-knot disease of the peach, orange, and other plants in Florida, due to Anguillula. Bull. Divis. Entom. U. S. Dept. Agric,, No. 20, 1889.

Curtice, C.—The animal paratites of sheep. *Strongylus contortor, S. filicollis, S. ventricosus, S. ovis pulmonalis, S. filaria. Dochmus cernuus, Ascaris lumbricoides, Trichocephalus affinis, Sclerostomum hypostomum, Œsoptagostoma columbianum.*

ANNELIDA.

Forbes, S. A.—Note on an American species of Phreoryctus. Am. Nat., XXIV., p. 477, 1890.

——An American terrestrial leech. Am. Nat., XXIV., p. 646, 1890.

Fewkes, J. W.—A new marine larva and its affinities. *Ann. and Mag. Nat. Hist.*, VI., p. 177, 1889.

——Curious larva found in Bay of Fundy, with Brachiopod, Chætopod, and Polyzoan affinities.

WILSON, E. B.—The embryology of the earthworm in the system. *Jour. Morph.*, III., p. 387, 1889 [1890].

BEDDARD, F. E.—On the structure of a species of earthworm belonging to the genus Diachæta. *Quart. Jour. Micros. Sci.*, XXXI., p. 159, 1890.—Structure of *Diachæta windlei*, from the Bermudas.

BENHAM, W. B.—An attempt to classify earthworms. *Quart. Jour. Micros. Sci.*, XXXI., p. 201, 1890.—An extended paper upon anatomy and classification, giving family and generic characters and a list of all known species.

FORBES, S. A.—On an American earthworm of the family Phreoryctidæ. Bull. Ill. Lab. Nat. Hist., III., p. 107, 1890.—Detailed description of species described in AM. NAT., XXIV., p. 477.

——An American terrestrial leech. Bull. Ill. Lab. Nat. Hist., III., p. 119, 1890.—*Vide* AM. NAT., XXIV., p. 646, 1890. *Semiscolex terrestris.*

WILSON, E. B.—The origin of the mesoblast bands in Annelids. *Jour. Morph.*, IV., p. 205, 1890.

PROSOPYGII.

ANDREWS, E. A.—On a new American species of the remarkable animal Phoronis. *Ann. and Mag. Nat. Hist.*, June, 1890, p. 445.—*Ph. architecta*, from Beaufort, N. C. *Vide* AM. NAT., XXIV., p. 1083, 1890.

SHIPLEY, A. E.—On *Phymosoma varians. Quart. Jour. Micros. Sci.*, XXXI., p. 1, 1890.—Extended study of the anatomy, based upon material from the Bahamas.

ANDREWS, E. A.—Notes on the body-cavity liquid of *Sipunculus gouldii* Pourtales. J. H. U. Circ., IX., 65, 1890.—Notes on character and chromatology.

ROTATORIA.

PELL, ALF.—Three new rotifers. *Microscope*, X., p. 143, 1890—*Mastigocerca bicuspis, Cathypna stokesii, Copeus americanus.* No localities.

MOLLUSCA.

SURFACE, H. A.—A descriptive catalogue of the shells of Franklin county, Ohio. Pt. I., Land Shells. Bull. Ohio Exp. Sta. Tech. Series I., p. 121, 2 pls., 1890.—Analytical keys separating genera and species.

* DALL, W. H.—Report on the Mollusca [collected by the "Blake" in 1877–1880]. Bull. Mus. Comp. Zool., Vol. XVIII.

* BINNEY, W. G.—Third supplement to the five volumes of the terrestrial air-breathing Molluscs of the United States and adjacent territories. Bull. Mus. Comp. Zool., XIX., p. 183, 1890.

PILSBRY, H. A.—Manual of Conchology (Tryon's). Pt. 45, pp. 64, pls. 15, Vol. XII., 1890.—Contains Stomatellidæ and Scissurellidæ.

COOPER, J. G.—Fresh-water Mollusca of San Francisco county [California]. *Zoe*, I., p. 196, 1890.—Nominal list.

DALL, W. H.—Description of a new species of land shell from Cuba, *Vertigo cubana*. Proc. U. S. Nat. Mus., XIII., p. 1, 1890.

COLLINS, J. W.—Notes on the use of squid for food in the United States. Bull. U. S. Fish Com., VII., p. 127, 1889.—Increasing use in New York city; sell for three to six cents apound.

* MARTENS, E. VON.—Eine ausgestorbene Landschnecke von den Bermuda Inseln. Stz. Ges. Nat. Fr. Berlin, 1889, No. 10, p. 201.—*Helix nelsonii* Bland.

JACKSON, R. T.—Phylogeny of the Pelecypoda.—The Aviculidæ and their allies. Mem. Bost. Soc. Nat. Hist., IV., p. 277, 1890.—*Vide* AM. NAT., XXIV., Dec., 1890.

SHARP, B.—Variations in *Bulimus exilis*. Proc. Phila. Acad., 1890, p. 148.—From Guadeloupe and Dominica.

PILSBRY, H. A.—On *Helix albolabris* var. *maritima*. Proc. Phila. Acad., 1890, p. 282.—New var. from New Jersey.

——New and little-known American Molluscs. No. 3. Proc. Phila. Acad., 1890, p. 296.—The following are new: *Pupa syngenes* (Ariz.), *Vaginulus schivelyæ* (Bermuda), *Goniobasis crandalli* (Ark.)

ARTHROPODA.

WATASE, S.—On the morphology of the compound eyes of Arthropods. *Quart. Jour. Micros. Sci.*, XXXI., p. 143, 1890.—General part of article in Johns Hopkins Studies, IV.

PATTEN, W. H.—Is the Ammatidium a hair-bearing sense-bud? *Anat. Anzeiger,* V., p. 353, 1890.—*Vide* AM. NAT., XXIV, p. 1084, 1890.

WATASE, S.—On the migration of the retinal area, and its relation to the morphology of the simple ocelli and the compound eyes of Arthropods. J. H. U. Circ., IX., 63, 1890.

CRUSTACEA.

PARKER, G. H.—The histology and development of the eye in the lobster. Bull. Mus. Comp. Zool., XX., p. 1, 1890.

GARMAN, H.—A new fresh-water crustacean. Bull. Essex Inst., XXII., p. 28, 1890.—*Mancasellus macrurus,* from Ky.

FAXON, WALTER.—Notes on North American crayfishes—family Astacidæ. Proc. U. S. Nat. Mus., XII., p. 619, 1889 [1890].—Additional localities for many species. *Cambarus evermanni, C. hylas* are new.

HARGITT, C. W.—Some habits of the crayfish. *Am. Mo. Micros. Jour.,* XI., p. 111, 1890.

HERRICK, F. H.—The development of the American lobster (*Homarus americanus*). J. H. Circ., IX., p. 67, 1890.

LEIDY, J.—Parasites of *Mola rotunda.* Proc. Phila. Acad., 1890, p. 281.—*Penella filosa, Conchoderma virgata. Cicrpos latreillei, Læmargus muricatus.*

ARACHINDA.

MICHAEL, A. D.—On a collection of Acarina formed in Algieria. Proc. Zool. Socy. London, 1890, p. 414.—Describes as new *Notaspis burrowsii,* from specimens collected in Algiers, and from "the district of Lake Winnipeg, Canada."

LEIDY, JOSEPH.—Remarks on ticks. Proc. Phila. Acad., 1890, p. 278.—Habits of tick referred to *Amblyomma americanum.*

* SIMON, E.—Arachnides recueilles au Greenland, en 1888, par M. Ch. Rabot. Bull. Soc. Zool., France, XIV., p. 289.—Four species, one new.

MORGAN, T. H.—Preliminary note on the embryology of the Pycnogonids. J. H. U. Circ., IX., p. 59, 1890.

* PECKMAN, ELIZABETH G.—Protective resemblances in spiders. Oc. papers Wisc. Nat. Hist. Soc., I., p. 61, 1890.

* PECKMAN, G. W. and E. G.—Sexual selection in Attidæ; *l.c.,* I., p. 3, 1890.

RILEY, C. V., AND MARLATT, C. L.—The clover-mite (*Bryobia pratensis*). *Insect Life*, III., p. 45, 1890.

POCOCK, R. I.—A revision of the genera of scorpions of the family Buthidæ [etc]. Proc. Zool. Soc. London, 1890, p. 114. —American genera are Isometrus, Centrurus.

BALZAN, L.—Revisione dei Pseudoscorpioni del bacino dei fiume Paranà e Paraguay nell'America meridionale. Ann. Mus. Civ. Gens., 1890, p. 55, 5 pls.

MARX, GEORGE.—Catalogue of the described Araneæ of temperate North America. Proc. U. S. Nat. Mus., XII., p. 497, 1889 [1890].

KINGSLEY, J. S.—The ontogeny of Limulus. *Zool. Anz.*, XIII., p. 536, 1890.—*Vide* AM. NAT., XXIV., p. 678.

* SIMON, EUG.—Arachnides recueilles au Greenland, en 1888. Bull. Soc. Zool., France, XIV., p. 289.—Describes one new species.

WEED, C. M.—A new harvest spider. AM. NAT., XXIII., p. 1102, 1889 [1890].

PATTEN, WM.—On the origin of vertebrates from Arachnids. *Quart. Jour. Micros. Sci.*, XXXI., p. 317, 1890.—Contains many facts relating to embryology of Limulus and Scorpion. *Vide* AM. NAT., XXIV., p. 1084, 1890.

WEED, C. M.—The long-legged harvest spider. AM. NAT., XXIV., p. 866, 1890.

MCCOOK, H. C.—La force des araignées et de leurs toiles. *Rev. Scient.*, XIV., p. 787.

WEED, C. M.—A partial bibliography of the Phalangiinæ of North America. Bull. Ill. Lab. Nat. Hist., III., p. 99, 1890.

——A descriptive catalogue of the Phalangiinæ of Illinois. Bull. Ill. Lab. Nat. Hist., III., p. 79, 1889.—Enumerates eight species Liobunum, one of Oligolophus, and one of Phalangium. *L. elegans*, *L. politus* are new.

——The harvest spiders of North America. AM. NAT., XXIV., p. 914, 1890.

CURTICE, C.—The animal parasites of sheep. Washington, D. C.—*Linguatula tænioides*, *Chorioptes communis*, *Psoroptes communis*, *Scarcoptis scabei* var. *ovis*.

RECENT LITERATURE.

Sir Samuel Baker on Wild Beasts and Their Ways.[1]—This book will be found very interesting to the general reader, and also instructive to the naturalist. The author restricts his descriptions to what he has actually observed himself, and they therefore have an especial value. As he has hunted in all the continents excepting South America and Australia, his observations cover much ground; in fact, probably no sportsman has lived who can record such a varied experience of wild animals. His observations have also the value which is to be derived from long familiarity with most of the species which he describes. This record is the more useful as many of the species which he has hunted have been already much restricted in numbers and distribution since the author began his career, and some of them are probably doomed to extinction. His accounts of the mental peculiarities and habits of the animals which have come under his observation in a state of nature are very valuable, as such opportunities are rarely enjoyed by persons competent to record them accurately. His book affords, therefore, a mine of information to the student of animal psychology. Sir Samuel Baker is a true sportsman; that is, he observes such methods as will preserve from extinction the species which he pursues, bearing in mind what is remembered too little by the average man with a gun, that if he desires sport in the future he must not destroy females and young, and must protect game sufficiently to ensure its continuance.

His observations cover the larger Mammalia, and include one reptile, the *Crocodilus vulgaris* of Africa. His descriptions of the haunts of these animals will be attractive to all lovers of scenery. They are so exact in detail as to enable the reader to realize it much better than if clothed in more eloquent and enthusiastic language. Incidentally the peculiarities of the people with whom his travels brought him in contact are referred to. Such are the shikaris of India, the hunters of the Hamram Arabs of Abyssinia, and the skin-hunters of the wilds of Western North America.

His description of the habits and manners of the Indian honey-bear (*Melursus labiatus*) are curious. He goes into greatest detail in the history of his experience with the Indian elephant, with whose charac-

[1] Wild Beasts and Their Ways: Reminiscences of Europe, Asia, Africa, and America. By Sir Samuel W. Baker, F.R.S., etc. London, MacMillan & Co., 8vo., pp. 455. Illustrated.

ter he makes his readers fully familiar. We make the following extract, which narrates the behavior of this noble animal when engaged in hunting tigers:

"The foregoing chapter is sufficient to explain the ferocity of the male elephant at certain seasons which periodically affect the nervous system. It would be easy to multiply examples of this cerebral excitement, but such repetitions are unnecessary. The fact remains that the sexes differ materially in character, and that for general purposes the female is preferred in a domesticated state, although the male tusker is far more powerful, and when thoroughly trustworthy is capable of self-defence against attacks, and of energy in work, that would render it superior to the gentler but inferior female.

"It may be inferred that a grand specimen of a male elephant is of rare occurrence. A creature that combines perfection of form with a firm but amiable disposition, and is free from the timidity which unfortunately distinguishes the race, may be quite invaluable to any resident in India. The actual monetary value of an elephant must of necessity be impossible to decide, as it must depend upon the requirements of the purchaser and the depth of his pocket. Elephants differ in price as much as horses, and the princes of India exhibit profuse liberality in paying large sums for animals that approach their standard of perfection.

"The handsomest animal I have ever seen in India belongs to the Rajah of Nandgaon, in the district bordering upon Reipore. I saw this splendid specimen among twenty others at the durbar of the chief commissioner of the central provinces in December, 1887, and it completely eclipsed all others, both in size and perfection of points. The word points is inappropriate when applied to the distinguishing features of an elephant, as anything approaching the angular would be considered a blemish. An Indian elephant, to be perfect, should be nine feet six inches in perpendicular height at the shoulder. The head should be majestic in general character, as large as possible,—especially broad across the forehead, and well rounded. The boss or prominence above the trunk should be solid and decided, mottled with flesh-colored spots; these ought to continue upon the cheeks, and for about three feet down the trunk. This should be immensely massive, and when the elephant stands at ease the trunk ought to touch the ground when the tip is slightly curled. The skin of the face should be soft to the touch, and there must be no indentations or bony hollows, which are generally the sign of age. The ears should be large, the edges free from inequalities or rents, and above all they ought to be smooth, as though they had been carefully ironed. When an elephant is old the top of the ear curls, and this symptom increases with advancing years. The eyes should be large and clear, the favorite color a bright hazel. The tusks ought to be as thick as possible, free from cracks, gracefully curved very slightly to the right and left, and projecting not less than three feet from the lips. The body should be well rounded, without a sign of any rib. The shoulders must be massive, with projecting muscular development; the back very slightly arched, and not sloping too suddenly towards the tail, which should be set up tolerably high. This ought to be thick and long, the end well furnished with a double fringe of very long, thick hairs, or whalebone-looking bristles. The legs should be short in proportion to the height of the animal, but immensely thick, and the upper portion above the knee ought to exhibit enormous muscle. The knees should be well rounded, and the feet be exactly equal to half the perpendicular height of the elephant when measured upon them whilst standing. The skin generally ought to be soft and pliable, by no means tight or strained, but lying easily upon the limbs and body. An elephant which possesses this physical development should be equal in the points of character that are necessary to a highly trained animal.

"When ordered to kneel, it should obey instantly, and remain patiently upon the ground until permitted to rise from this uneasy posture. In reality the elephant does not actually kneel upon its fore knees, but only upon those of its hind legs, while it pushes its fore legs forward and rests its tusks upon the ground. This is a most unnatural position, and is exceedingly irksome. Some elephants are very impatient, and they will rise suddenly without orders while the ladder is placed against their side for mounting. Upon one occasion a badly trained animal jumped up so suddenly that Lady Baker, who had already mounted, was thrown off on one side, while I, who was just on top of the ladder, was thrown down violently upon the other. A badly tutored elephant is exceedingly dangerous, as such vagaries are upon so large a scale that a fall is serious, especially should the ground be stony.

"A calm and placid nature, free from all timidity, is essential. Elephants are apt to take sudden fright at peculiar sounds and sights. In traveling through a jungle path it is impossible to foretell what animals may be encountered on the route. Some elephants will turn suddenly round and bolt, upon the unexpected crash of a wild animal startled in the forest. The scent, or still worse the roar, of a bear within fifty yards of the road will scare some elephants to an extent that will

PLATE VII.

TIGER DEFYING ELEPHANTS.

make them most difficult of control. The danger may be imagined should an elephant absolutely run away with his rider in a dense forest; if the unfortunate person should be in a howdah, he would probably be swept off and killed by the intervening branches, or torn to shreds by the tangled thorns, many of which are armed with steel-like hooks.

"It is impossible to train all elephants alike, and very few can be rendered thoroughly trustworthy; the character must be born in them if they are to approach perfection.

"Our present perfect example should be quite impassive, and should take no apparent notice of anything, but obey his mahout with the regularity of a machine. No noise should disturb the nerves, no sight terrify, no attack for one moment shake the courage; even the crackling of fire should be unheeded, although the sound of high grass blazing and exploding before the advancing line of fire tries the nerves of elephants more than any other danger.

"An elephant should march with an easy swinging pace at the rate of five miles an hour, or even six miles within that time upon a good flat road. As a rule, the females have an easier pace than the large males. When the order to stop is given, instead of hesitating, the elephant should instantly obey, remaining rigidly still without swinging the head or flapping the ears, which is its annoying and inveterate habit. The well-trained animal should then move backward or forward, either one or several paces, at a sign from the mahout, and then at once become as rigid as a rock.

"Should the elephant be near a tiger, it will generally know the position of the enemy by its keen sense of smell. If the tiger should suddenly charge from some dense covert with the usual short loud but roar, the elephant ought to remain absolutely still to receive the onset, and to permit a steady aim from the person in the howdah. This is a very rare qualification, but most necessary in a good shikar elephant. Some tuskers will attack the tiger, which is nearly as bad a fault as running in the opposite direction; but the generality, even if tolerably steady, will swing suddenly upon one side, and thus interrupt the steadiness of the aim.

"The elephant should never exercise its own will, but ought to wait in all cases for the instructions of the mahout, and then obey immediately.

"Such an animal combining the proportions and the qualities I have described might be worth in India about £1,500 to any Indian Rajah, but there may be some great native sportsmen who would give double that amount for such an example of perfection,—which would combine the beauty required for a state elephant with the high character of a shikar animal.''

The character of the tiger (*Uncia tigris*) is illustrated in following extract:

"I had a practical example of this shortly after the departure of Suchi Khan, when I pushed on to Rohumari and met Mr. G. P. Sanderson, April 1st, 1885. He had brought with him the entire force of elephants from the Garo Hills, the season for capturing wild elephants having just expired. Many of his men were suffering from fever, and he himself evidently had the poison of malaria in his system.

"A bullock had been tied up the preceding evening within three-quarters of a mile from our camp, and on the morning of April 1st this was reported to have been killed. We accordingly sallied out, and in a few minutes we found the remains, above which the vultures were soaring in large numbers. The high grass had been partially burnt, and large patches remained at irregular distances where the fire had not penetrated or where the herbage had been too green to ignite; however, all was as dry as tinder at this season, and having formed the elephants in line, I took up a position with my elephant about three hundred yards ahead.

"The elephants came on in excellent formation, as Mr. Sanderson was himself with them in command. Presently I saw a long tail thrown up from among the yellow grass, and quickly after I distinguished a leopard moving rapidly along in my direction. For a few minutes I lost sight of it, but I felt sure it had not turned to the right or left, and, as a clump of more than ordinary thick grass stood before me, I concluded that the animal had probably sought concealment in such impervious covert.

"When the elephants at length approached, I begged that half a dozen might just march through the patch within a few yards of my position. I was riding an elephant called Rosamund, which was certainly an improvement upon my former mount.

"Hardly had the line entered the patch of grass when, with a short, angry roar, a leopard sprang forward, and passed me at full speed within twenty-five yards, and immediately turned a somersault like a rabbit, with a charge of 16 S. S. G. from the No. 12 fired into its shoulders.

"This was very rapidly accomplished, as our camp was within view, certainly not more than a mile distant.

"We placed the leopard upon a pad elephant, and sent it home; while we once more extended the line, and as usual I took up a position some hundred yards in advance, in a spot that was tolerably clear from high grass.

"Almost the same circumstance was repeated. I saw another leopard advancing before the line, and pushing my elephant forward to a point that I considered would intercept it, I distinctly saw it enter a tangled mass of herbage hardly large enough to shelter a calf; there it disappeared from view.

"The line of elephants arrived, and no one was aware that another leopard had been moved. I pointed out the small clump of grass, and ordered an elephant to walk through it. In an instant a leopard bolted, and immediately rolled over like its comrade; but as I had to wait until it cleared the line of elephants before I fired, it was about thirty-five yards distant, and although it fell to the shot, it partially recovered, and limped slowly forward with one broken leg, being terribly wounded in other places. It only went about forty paces, and then lay down to die. One of the mahouts dismounted from his elephant, and struck it with an axe upon the head. The leopard was dispatched to camp, and we proceeded to beat fresh ground, as no tiger had been here, but evidently the two leopards had killed the bullock the preceding night, and nothing more remained.

"Rosamund had stood very steadily, but she was very rough to ride, and the howdah swung about like a boat in a choppy sea.

"A couple of hours were passed in marching through every place that seemed likely to invite a tiger; but we moved nothing but a great number of wild pigs. A few of these I shot for the Garo natives who accompanied us. At length we observed in the distance the waving, green, feathery appearance of tamarisk, and as the sun was intensely hot, we considered that a tiger would assuredly select such cool shade in preference to the glaring yellow of withered grass. At all times during the hot season a dense bed of young tamarisk is a certain find for a tiger, should such an animal exist in the neighborhood. The density of the foliage keeps the ground cool, as the sun's rays never penetrate. The tiger, being a nocturnal animal, dislikes extreme heat; therefore it invariably seeks the densest shade, and is especially fond, during the hottest weather, of lying upon ground that has previously been wet, and is still slightly damp. It is in such places that the tamarisk grows most luxuriantly.

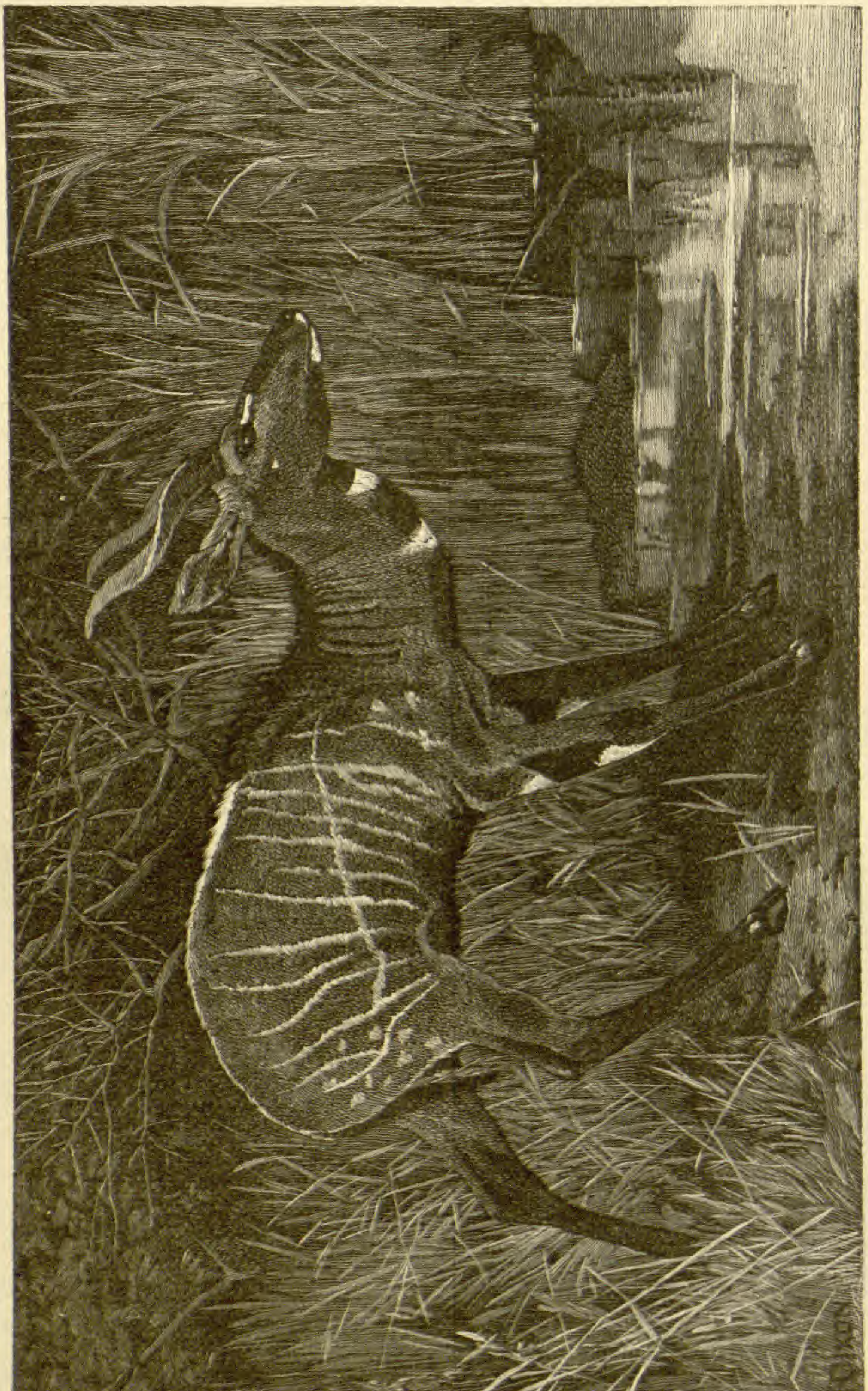
"We were now marching through a long strip of this character, which had at one time formed a channel. On either side the tamarisk strip was enormously high and dense grass. Suddenly an elephant sounded the kettle-drum note. This was quickly followed by several others, and a rush in the tamarisk frightened the line, as several animals had evidently broken back. We could see nothing but the waving of the bush as the creatures dashed madly past. These were no doubt large pigs; but I felt certain, from the general demeanor of the elephants, that some more important game was not far distant.

"The advance continued slowly and steadily. Presently I saw the tamarisk's feathery tops moving gently about fifteen paces ahead of the line. The elephants again trumpeted, and evinced great excitement. This continued at intervals, until we at length emerged from the tamarisk upon a flat space, where the tall grass had been burned while yet unripe, and, although killed by the fire and rendered transparent, it was a mass of black-and-yellow that would match well with a tiger's color. We now extended the line in more open order,—to occupy the entire space of about two hundred yards front. Sanderson kept this position in the center of the line, while I took my stand in an open space about one hundred and fifty yards in advance, where an animal would of necessity cross should it be driven forward by the heat. The line advanced in good order, but the elephants were much disturbed, for they evidently scented danger.

"They had not marched more than fifty or sixty yards before a tremendous succession of roars scattered them for a few moments, as a large tiger charged along the line, making splendid bounds, and showing his entire length, as he made demonstrations of attack upon several elephants in quick rotation. It was a magnificent sight to see this grand animal, in the fullest strength and vigor, defy the line of advancing monsters, every one of which quailed before the energy of his attack, and the threatening power of his awe-inspiring roars. The sharp crack of two shots from Sanderson, whose elephant was thus challenged by the tiger, hardly interrupted the stirring scene; but as the enemy rushed down the line, receiving the fire from Sanderson's howdah, he did not appear to acknowledge the affront, and having effected his purpose of paralyzing the advance, he suddenly disappeared from view.

"I was in hopes that he would break across the open which I commanded, but there was no sign of movement in the high grass. The line of elephants again advanced slowly and cautiously. Suddenly, at a signal, they halted, and I observed Sanderson, whose elephant was a few yards in advance of the line, halt, and, standing up, take a deliberate aim in the grass in front. He fired. A tremendous roar was the response, and the tiger, bounding forward, appeared as though he would assuredly cross my path. Instead of this, after a rush of

PLATE VIII.



Tragelaphus scriptus.

about fifty or sixty yards, I saw the tall grass only gently moving, as the animal reduced its pace to the usual stealthy walk. The grass ceased moving in a spot within thirty paces, and exactly opposite my position. I marked a bush upon which were a few green shoots that had sprouted since the fire had scorched the grass. I was certain that the tiger had halted exactly beneath that mark. My mahout drove the elephant slowly and carefully forward, and I was standing ready for the expected shot, keeping my eyes well open for an expected charge. Sanderson was closing in upon the same point from his position. Presently, when within a few feet of the green bush, I distinguished a portion of the tiger; but I could not determine whether it was the shoulder or the hind-quarter. Driving the elephant steadily forward, with the rifle to my shoulder, I at length obtained a complete view. The tiger was lying dead!

"Sanderson's last shot had hit it exactly behind the shoulder; but the first right and left had missed when the tiger charged down the line, exemplifying the difficulty of shooting accurately with an elephant moving in high excitement.

"We now loaded an elephant with this grand beast, and started it off to camp, where Lady Baker had already received two leopards. We had done pretty well for the first of April; but after this last shot our luck for the day was ended."

The black African rhinoceros (*Atelodus bicornis*) receives considerable attention, and Sir Samuel's testimony as to its blind ferocity is confirmatory of all that previous authors have told us about it. Of the white rhinoceros (*Atelodus simus*) an interesting account is given. From this we extract the history of the adventure of Oswell, taken from the writings of that African hunter of a previous generation:

"Mr. Oswell was one of the early Nimrods in South Africa, at the same time that the renowned Roualeyn Gordon Cumming was paving the way for fresh adventures. There never was a better sportsman or more active follower of the chase than Oswell. He had gone to Africa for the love of hunting and adventure, at a time when the greater portion was unbroken ground. He was the first to bring Livingstone into notice when he was an unknown missionary, and Oswell and Murray took him with them when they discovered the Lake N'gâmé. He had a favorite double-barreled gun made by Purdy. This was a smooth-bore, No. 10, specially constructed for ball. Although a smooth-bore, it was sighted like a rifle, with back-sights. The gun weighed ten pounds. The owner most kindly lent me this useful weapon when I first went to Africa in 1861, therefore I can attest its value, and the hard work that it had accomplished. A portion of the walnut stock had been completely worn away to the depth of an inch by the tearing friction of the wait-a-bit thorns, when carrying the gun across the saddle in chase at full speed through the hooked-thorn bushes. The stock had the appearance of having been gnawed by rats.

"At the time of Oswell's visit the country was alive with wild animals, all of which have long since disappeared before the advance of colonial enterprise and the sporting energy of settlers. There was a particular locality that was so infested with rhinoceroses that Oswell had grown tired of killing them, and he passed them unnoticed, unless he met some specimen with an exceptional horn. He was riding a favorite horse, which had been his constant companion in countless shooting incidents, and he happened to remark a large white rhinoceros standing in open ground alone. This animal possessed a horn of unusual length, which made the owner worthy of attention.

"Oswell immediately rode towards it. The animal took no notice of his approach until he arrived within about one hundred yards. The *Rinoceros simus* (white species) is not considered dangerous, therefore he had approached without the slightest caution or hesitation. I forget whether he fired; but I well remember that the beast calmly confronted the horse, and slowly but determinedly, with measured space, advanced directly towards the rider. Like an object in a disturbed dream, this huge creature came on, step by step, leisurely but surely, never hesitating or halting, but with eyes fixed upon the attacking party. Firing at the forehead being useless, Oswell endeavored to move either to the left or right, to obtain a shoulder shot; but the horse, that was accustomed to a hundred contests with wild animals, was suddenly mesmerized and petrified with horror. The quiet and spectre-like advance of the rhinoceros had paralyzed and rooted it to the ground. Trembling all over, its limbs refused to move. The spur and whip were unavailing. The horse felt that it was doomed. This horrible position endured until the rhinoceros was within only a few paces. It then made a dash forward.

"Oswell describes his first sensations, upon returning consciousness, nearly as follows: He found himself upon a horse. The reins were not in his hands. A man was walking in front, leading the animal by the reins, which had been pulled over its head. There were natives upon either side, apparently holding him upon the saddle. A dreamy feeling, and a misty, indistinct view of the situation, was sufficient to assure him that something must have happened. He felt certain that he must be hurt; but he had no pain. He began to feel himself with his hands, and he felt something wet and soft upon one thigh.

"The fact was, that the long horn of the rhinoceros had passed *through* his thigh. It not only had passed through his thigh, but through the saddle flap, then completely through the horse, and was stopped by the flap upon the other side. The horse and rider together were thrown into the air, and the inversion was so complete that one of Oswell's wounds—a cut upon the head—was occasioned by the stirrup-iron, which proved the inverted position.

"The horse was, of course, killed upon the spot, and the Caffres came to their master's assistance, and placed him upon his spare horse, upon which they held him until they reached the camp. This wound kept the great hunter prostrate for months. It is many years since Oswell told me this story, but I think I have narrated it exactly.

"It must be remembered that this rhinoceros belonged to the so-called harmless species. This incident is sufficient to exhibit the utter fallacy of a belief that any kind of an animal is 'invariably harmless.' We find that many beasts which are accredited with bad characters conduct themselves occasionally as though abject cowards. In the same manner, those which are considered timid may, when least expected, exhibit great ferocity."

The chapter on wild-boar hunting is interesting, and that on the cape buffalo (*Bos caffer*) is especially full of adventure. The habits of the Sambur deer (*Cervus aristotelis*) of India are described with much vividness. Our own hunters will read with interest the adventures of the author in the Big Horn Mountains shooting wapiti (*Cervus canadensis*) and bison (*Bos americanus*).

Altogether we have not had for a long time such a treat as the reading of this book. We give two of the twenty-nine plates with which the book is illustrated.

The Tenth Annual Report of the State Mineralogist of California[1] is a well-illustrated volume, containing a number of general articles descriptive of geological phenomena observed in California during the past year, as well as detailed accounts of the geology of the fifty-three counties into which the state is divided, special reports upon the geology of various mining districts, and upon methods of treating ores. As is to be expected, a large portion of the report is occupied with a discussion of gold mining in its various phases. There is, how-

[1] California State Mining Bureau, William Ireland, Jr., State Mineralogist; Tenth Annual Report of State Mineralogist for year ending December 1, 1890; Sacramento State Office, 1890. Pp. 983, 42 Figs., 7 Pls. and Maps.

ever, in it also much of interest to the general geologist, especially in the essays upon the individual counties, although even in these the greatest emphasis is placed on the geological features of the mines situated within their borders. To the geologist the most valuable portions of the book are the few handsome maps of counties and of mining districts accompanying it, and the mineralogical and geological map of the state, on a scale of twelve inches to the mile. It is proposed in the near future to issue this map by counties on a larger scale. It is unfortunate that California has no geological survey to cooperate with its mineralogical survey in making known to the scientific world the interesting features of its geology hinted at in the report. The state mineralogist feels the need of such a survey, and makes known his desire for it in the opening pages of the volume before us. If a geological survey is instituted, it is to be hoped that its work will be as successful as that of the mineralogical survey.—W. S. B.

Mexicology[1] in our country is a province of archæologic research of but very recent birth. It was inaugurated about 1875 by Raming, and since cultivated, with more or less success, by specialists like Brinton, Bandelier, Thomas, and Valentini. In the person of Dr. Ed. Seler a new ally and collaborating force appears to have joined the ranks of the students enumerated. He comes well prepared for his task. He has traveled extensively in Mexico, and commands the Spanish, Nahuatl, and Maya languages to a high degree. He is in intimate connection with the museums of both America and Europe, and has taken wise care in working only in sight and with the aid of complete literary material,—a luxury which each true scholar longs for, but is rarely able to indulge in. Besides, Dr. Seler possesses that "sense of form" which is so necessary to the true recognition of all the objects drawn, painted, or sculptured, with and which the student of this special branch preëminently has to deal. It was owing to the lack of this artistic sense that some of his predecessors have been lured into the grotesque belief that the ancient Mexi-

[1] Dr. Ed. Seler (Berlin, Kaiser Wilhelm-Strasse, No. 3): (1) "Das Tonalamatl der Aubin'schen Sammlung und die verwandten Kalenderbucher;" 217 pages, with 173 printed illustrations, in Compts Rendus du Congrès International des Américanistes, 7e session, Berlin, 1888. (2) Id., "Alt-mexicanische die Wurfbretter; 12 pages, with 1 colored and 32 printed illustrations; in Internationales Archiv fur Ethnographie, Band III., Berlin. 1890. (3) Id., "Alt-Mexikanische Studien." (*a*) "Ein Kapitel ans dem Geschichtswerk des P. Sahagun." (*b*) "Die sogenannten Sacralen Gefaesse der Zapoteken;" 71 pages, with resp. 108 and 25 printed illustrations; in Veroeffentlichungen aus dem Koeniglichen Museum der Voelkerkunde, I. Band, 4 Heft, Berlin, 1890, bei W. Speeman.

can and Maya records were susceptible of phonetic interpretation. Although, when undertaking to give a full description of Aubin's Tonalamatl (the ritual calendar of the pre-Mexicans), it was not Dr. Seler's object to uproot the aforesaid erroneous theory, yet he did so incidentally. It is a pleasure to see how, under his sagacious guidance, all those curious forms and objects which, influenced by Egyptology, certain students believed to represent letters, syllables, words, and sentences, more or less dissolve, and group together into such objects and paraphernalia as those dress-loving people, men and women, liked to don, to wear, to carry, when going to war or to the temple, or which were in use in their humble households as well as in the sumptuously decorated chambers of their gods and goddesses. We hail the appearance of Dr. Seler's Tonalamatl as a sign and promise of still more work in this direction. Landa's Alphabet at last has become a dead letter. It has not shown from its first publication any trustworthy elements for interpretation, nor had it any claims to be advertised as a new Rosetta Stone.

No. 2, "Alt-mexicanische Wurfbretter" treats of the Mexican "amiento," a sliding apparatus, from which darts and javelins were hurled. This instrument was known to the Eskimos, the Polynesians, and various African tribes, but has been discarded by these peoples, as it had at the time of the Conquest by the Mexicans, according to Dr. Seler's opinion, at least for the purposes of war. In this monograph the author again gives proof of his singular power of identification, finding the picture for the "amiento" in the illustrations embodied in the so-called Mexican Codices, which picture hitherto had been left unrecognized. From thirty diagrams, represented and discussed on the pages of the pamphlet, we learn its various shapes and contrivances, and what is still more interesting, how these various specimens were grasped for action, and held with hand and varying position of the fingers. The correctness of Dr. Seler's recognition is warranted by comparison of the pictured specimens with six real ones recently found in Mexico, and of which three colored illustrations are given. It may here be in place to mention that Christopher Columbus seems to have been the first European to become acquainted with the "amiento," on his fourth voyage on the eastern shores of Chiriqui. He calls it "ballista." From the "amiento," undoubtedly, by the later addition of the bow, the cross-bow has been evolved.

In No. 3 a chapter of a still unpublished work from the pen of Father Sahagua (1570) has been extracted in its original Nahuatl language, with the corresponding Spanish text and illustrations, and an additional ample discussion of it by Dr. Seler. Fragments only of the padre's great historical work have been known until now, these fragments, however, being so full of valuable, suggestive material to every student of Mexican antiquities that the apparent loss of the whole bulk of the work was universally deplored. It was known from the preserved preface that the padre had taken care to gather from the mouths of competent natives all that was still alive in their memory of the traditional history of their ancestors, of their former social, hierarchic, and political institutions, and that the text of this collective work had been written in the best language of their own, so as to preserve not only the material itself, but this to be also in the clothing of their technical vocabulary and syntactic phraseology. This work has recently been discovered, and in three different copies. One of these is preserved in the Biblioteca Laurentiana of Florence, showing the combined Aztec-Spanish text; the two others in the Biblioteca del Palario and the Biblioteca de la Academia de la Historia, both of them in Madrid, give only the Aztec text. As it appears the printing of the Laurentiana copy has been undertaken at the expense of the Mexican government, it is to be feared that it will be long ere the whole work, embracing twelve volumes, will be in the hands of the students. To quote Dr. Seler's own words: "The publication of Father Sahagua's work would not only be an immense gain to linguistics and Mexican archæology proper, but also to the still unwritten history of the development of this race, of its degree of intellect, and its peculiar notions and conceptions." The paragraphs 5–32, edited and commented by Dr. Seler, are only a "minimal fragment" of the whole, and were selected on account of the richness of the costumes and attributes exhibited in the illustrations of the several deities in discussion.

In an appendix to the previous pamphlet (pages 183–188) a discussion is given on twenty-three Zapotecan figure-vessels, with cuts. In following up the detailed analysis of the characteristic and sumptuous head-dresses that adorn the figure-heads of the aforesaid vessels, we cannot help noticing that what is said of them does not always quite come up to that which we are taught to see. Apart from some splendid identifications which the author's trained eye reveals, and which the student will readily accept, he will miss a comprehensive statement of each of the single components, of their material, their interlacing, their gradual growth, and the final outcome of that enormous "toupée," of which nothing like it is found in the whole ancient and modern history of dress and costume. We are fully aware it is a problem of no little difficulty for both the "perruquier" and the antiquary. But, on the other hand, if it is to be approached at all, we do not see that its solution will be successfully attained by a refuge to or an introduction of such similies as are taken from Aztec paintings. The two nations differ essentially in their mode of delineation, and still more in that of moulding, carving, and sculpturing. Therefore, in our conception, the true similes for the interpretation of the Zapotecan head-dresses ought to be sought by Dr. Seler in the *cognati* tablets, katanes or steles of Palenque and Copan.—V.

General Notes.

GEOGRAPHY AND TRAVELS.

The Sierra Madre Expedition.—News has been received from the scientific expedition which Dr. Carl Lumholtz is now conducting in the wilds of the Sierra Madre and Northern Mexico.

The expedition started from Bisbee, Arizona, in the early part of September, and, entering Mexico, traveled southward through the State of Sonora, with the intention of crossing the Sierra in the direction of Yanos and Casas Grandes. Before entering the mountain region, however, the explorers separated for a time, and whilst Dr. Lumholtz, with the main body, pursued his intended route, a detachment under Dr. Libbey, of Princeton, made an excursion in a more westerly direction, covering some 300 miles of territory. From Granados the ascent began, and continued steadily until, on December 2d, the western slopes of the Sierra Madre were reached at Nacory, when a northeasterly direction was taken.

Three mountain ranges had to be scaled, the highest some 9,000 feet in height, and the magnificence of the scenery made a strong impression upon the minds of the travelers, who took hundreds of photographs. The weather was very cold. There was snow on the mountain tops, and men and beasts suffered severely in many ways. One man, a guide, whose health was already impaired, succumbed under the strain, and his death was a serious loss to the explorers, as he knew of ruined pueblos to which he had pledged himself to lead them. Several beasts also perished. After a month of severe exertion the party reached the eastern slope of the Sierra, near Pacheco, and there took a well-earned rest.

The journey had proved a most interesting one from a scientific standpoint. Many specimens of birds and plants were collected, as well as some important fossils.

Cave and cliff dwellings were also met with, some of these in perfect condition and showing signs of having been inhabited by men who had reached a comparatively high stage of culture. In one stairs were found. In the largest of these caves remains of a whole village were discovered, and in front of it stood a huge "olla" (*i.e.*, Mexican water jar), made of clay mixed with straw and very solid, the pottery being eight inches thick. This olla was twelve feet in height and twelve feet in diameter, and when first caught sight of presented the appearance of a huge balloon. In one of the cliff dwellings were found some human remains—a complete skeleton, which had undergone some process of mummification.

The plateau on which the party was encamped when last heard from is near Pacheco, a few days' march from Casas Grandes. The neighboring country is dotted over with many large mounds, some of which it was the intention of Dr. Lumholtz to open. Altogether, the expedition promises well, and there is no doubt that Dr. Lumholtz will bring back much valuable information and make many important additions to our knowledge of the archæology and the natural history of Northern Mexico, past and present.

GEOLOGY AND PALEONTOLOGY.

The Cuyahoga Shales.—C. L. Herrick has published a paper in which he summarizes his studies of the Cuyahoga shale and the Ohio Waverly as follows:

1. The Berea grit is the natural floor of the series, the Bedford shale having its faunal relations decidedly with the shales of the Devonian below.

2. The Bedford forms a striking exemplification of the doctrine of colonies, and that portion lying to the southwest, beyond the western limits of the Erie, retained a fauna derived from the Hamilton long after this fauna had perished to the eastward.

3. The Cuyahoga shales (including the whole series above the Berea so far as present in the Cuyahoga valley) is divisible into three minor sections, the uppermost of which is characterized by a vast abundance of fossils, which are specially well preserved in calcareous or ferruginous concretions, and is a constant and almost unvarying horizon, extending from Lake Erie to the Ohio River. The Cuyahoga proper is never more than 200 feet thick, and forms a transition zone, with a prevailing Devonian habitus.

4. The upper portion of the Waverly is quite distinct from what precedes in fauna, and contains an undoubtedly Lower Carboniferous assemblage.

5. None of the larger divisions of the Carboniferous of the west are entirely unrepresented in Ohio.

6. The transition is nevertheless so gradual that we have an instructive illustration of the evolution of one age from the preceding, with neither catastrophy nor annihilation.

7. There is an opportunity to trace the geological variations in a species as distributed over a great area, and to observe the evolution of new types therefrom.

8. The entire thickness of the Waverly is not far from 700 feet, though the highest consecutive section measures only 670 feet.

9. The Cuyahoga fauna bears an unmistakable resemblance to the so-called Subcarboniferous of Belgium, especially that of Etage I., the limestone of Fornari.

The Pilot Knob of Texas.—Robt. T. Hill has made a study of Pilot Knob in the vicinity of Austin, Texas, and has reached the following conclusions:

"From its structure it is shown that Pilot Knob is the neck of an ancient volcano which rose out of and deposited its débris in the deep water of the Upper Cretaceous sea (probably Niobrara sub-epoch). From its isolated position, remote from any contemporaneous shore-line, it must have been an island eruption. Pilot Knob probably belongs to a great chain of igneous localities, eruptive and basaltic, extending from the mountains of Northern Mexico to the Ouachita system of Arkansas, both of which regions abound in related features. The great Balcones system of N. 20° E. faults of Central Texas are later than Upper Cretaceous. In late Cretaceous and Tertiary times Pilot Knob was either totally submerged or greatly denuded." (*Am. Geol.*, Nov., 1890.)

The Sierra Nevada of Central California.—During the past season G. F. Becker has studied the structure of the Sierra Nevada Mts. in the neighborhood of the Stanislaus and Truckee Rivers, with the following results:

The whole area in this region has been glaciated up to the summits of passes. There are six systems of fissures. The fissures are fault planes. The disturbances which caused the fissures happened since the close of the Miocene. The faults rarely exceed three inches. A careful study of the vertical fissures leads to the hypothesis of a horizontal thrust acting on a south-southwest to north-northeast line. Mr. Becker advances arguments to show that no important tilting of this portion of the Sierra has taken place at or since the post-Miocene disturbances. The paper closes with the assertion that the theory that the earth is a solid highly viscous mass, is in all respects compatible with the observations, fully explaining every one of the six fissure systems, the faults observed, and the enormous resistance to tilting which the range has displayed. (Bull. Geol. Soc. Am., Vol. II., pp. 49–74).

The Origin of the Great Lakes.—In discussing the origin of the basins of the great lakes of America, J. W. Spencer concludes that the valleys of Lakes Erie, Huron, and Michigan are the result of erosion of the land surfaces by the ancient St. Lawrence River and its tributaries during a long period of continental elevation, and that meteoric agencies had broadened the valleys. This condition was at its maximum just before the Plistocene period. The closing of portions of the old Laurentian valley into water-basins occurred during and at the close of the Plistocene period, owing, in part, to Drift filling some portions of the original valley, but more especially to different warpings of the earth's crust. (*Quart. Geol. Soc.*, Nov., 1890.)

Age of the Glacial Period.—In discussing the cause of the Glacial period, Mr. Warren Upham discards the astronomic theory, since it seems wholly untenable in view of the geologic evidences that not many thousand of years have passed since the departure of the ice-sheets. The measurements of the gorge and Falls of St. Anthony, the surveys of Niagara Falls, the rates of wave-cutting along the sides of Lake Michigan, the rates of filling of kettle-holes, and the rate of deposition in the Connecticut valley at Northampton, Mass., all indicate that the time since the Glacial period cannot exceed 10,000 years. Mr. Upham cites evidence in proof of the theory that the cause of the Glacial period was great uplifts of the glaciated areas, probably in conjunction with important changes in the course and volume of the warm ocean currents. (*Am. Geol.*, December, 1890.)

Geological News.—General.—In a recent paper Mr. E. W. Claypole replies to the four leading arguments for the permanence of the ocean abysses and the continental masses. While he does not advocate the extreme views of Forbes, he gives many good reasons for not adopting the permanence theory in its entirety (Bull. Geol. Soc. Am., Vol. II., p. 10).——Contrary to the general belief that coral reefs are not formed in the western waters of the Gulf of Mexico, Prof. Heilprin and Frank C. Bahn found thirteen species of corals in the neighborhood of Vera Cruz. There are a number of reefs consisting of detached islands extending eastward from the coast nearly six miles. In some cases the greatest development of coral growth is on the lee or shore side. They belong to the same category as the Florida reefs and banks (Proc. Acad. Nat. Sciences, Phila., 1890, p. 303).——In discussing the phosphates of Redonda, a volcanic island in the Caribbean sea, Prof. C. H. Hitchcock maintains that the enormous quantity of mineral precludes the possibility of its having been derived from the droppings of birds, and suggests that it may have come up from below as a phosphuret, which has since changed its character through oxidation and hydration (Bull. Geol. Soc. Am., Vol. II., p. 6).——According to D'Invilliers, the output of guano from the Island of Nevassa is between sixty and seventy-five tons per day. There are two varieties, the gray and the red; the former is the more valuable, since it contains a less percentage of sesquioxide of iron and alumina (Bull. Geol. Soc. Am., Vol. II., pp. 75–84).

Paleozoic.—Mr. A. Smith Woodward considers *Ctenodus interruptus* the Lower Carboniferous representative of the well-known *C. cristatus* (Rept. Yorkshire Philos. Soc., 1889).——According to

H. S. Williams, the Pennine Range of North England affords a typical section upon which the Carboniferous system was founded; and as the term Carboniferous is a misnomer geologically, since coal-bearing rocks are not confined to the system generally so-called, and as the name does not indicate the geographic position of the typical section, he believes that the adoption of the name Pennian System may be of advantage (Bull. Geol. Mag., Vol. II., p. 16).

Mesozoic.—The dentition and dorsal fin-spines of a shark (*Hybodus delabechei*), from the Lower Lias of Lyme Regis, Dorsetshire, have been described by A. Smith Woodward. This specimen is of special interest since it gives the first information as to the number and proportions of the dental series in the jaw of the typical members of the genus to which it belongs (Yorkshire Philos. Soc., 1888).——Some Triassic plants from New Mexico have been described by Wm. H. Fontaine and F. H. Knowlton. They include *Equisetum abiquiense*, *E. knowltonii*, *Zamites powellii* (*?*), *Z. occidentalis* (*?*), *Cheirolepis munsterii*, *Palissya braunii* (*?*), *P.* cone (*?*), *Cycadites* (*?*), and *Ctenophyllum* (*?*). They were found in the shale of a copper mine, and many of the specimens were not well enough preserved to permit of a positive identification. In the sandstone above the shale was found *Araucarioxylon arizonicum* Knowlton (Proc. U. S. Nat. Mus., Vol. XIII., pp. 281–285, Pl. XXII.–XXVI.)——A. Smith Woodward has described a new Pycnodont fish from the English Portlandian bed, and named it *Mesodon damonii*, in memory of one of the most successful explorers of that formation (*Geol. Mag.*, Decade III., Vol. VII., No. 310, p. 158, April, 1890).——A. Smith Woodward announces the discovery of a Jurassic fish fauna in the Hawksbury beds of New South Wales (*Ann. and Mag. Nat. Hist.*, Nov., 1890).——In a recent paper A. Smith Woodward summarizes the skeletal anatomy of the genera Centrolepis and Oxygnathus, and refers two new fishes from the Lower Lias to Cocolepis and Undina respectively, under the names *C. liassicus* and *M. barroviensis* (*Ann. and Mag. Nat. Hist.*, June, 1890).——A. Smith Woodward has recently elucidated some new points in the skeletal anatomy of the genus Eurycormus. This genus has been placed in the same great group as the existing Amia, and the new osteological facts tend to confirm the accepted determination (*Geol. Mag.*, Decade III., Vol. VII., No. 313, p. 289, July, 1890).——According to A. S. Woodward, the fossil fishes of the English oölites are listed as follows: Selachii, 14; Chimæroidei, 11; Ichthyodorulite, 1; Dipnoi, 1; Ganoidei, 18 (Proc. Geol. Ass., Vol. XI., No. 6).

Cenozoic.—A unique siluroid fish from the London clay of Sheppey has been figured and described by A. Smith Woodward. From the character of the fossil its precise affinities cannot be determined, but it closely approaches the living Auchenoglanis of the African rivers. König's name of *Bucklandium diluvii* has been retained (Proc. London Zool. Soc., 1889).——Mr. L. C. Hicks has been studying the lagoons of Custer county, Nebraska, and reaches the conclusion that they are the result of sedimentation upon a surface previously shaped by the action of the winds. In other words, the lagoon type is a combination of the sedimentary and æolian types of conformation (Bull. Geol. Soc. Am., Vol. II., p. 25).——In a discussion of the Glacial epoch, F. Leveret presents a line of evidence in support of the theory of two distinct epochs. This evidence is based upon the character of the buried soil and leached till of ten moraines in Illinois, Indiana, and Ohio. The amount of oxidation and leaching would require the lapse of a long interval of time; that is, an epoch of deglaciation in the midst of the Glacial period (Proc. Boston Soc. Nat. Hist., Vol. XXIV., 1889).——According to L. C. Johnston, the flood of muddy waters from the Nita crevasse in the Mississippi River has seriously affected the marine life in the Mississippi Sound. Oyster plantings have been destroyed, and many valuable food fishes have been driven out (Bull. Geol. Soc. Am., Vol. II., p. 20).

ZOOLOGY.

Function of Gemmiform Pedicellariæ of Echinoids.[1]—H. Prouho contributes a very interesting observation to the very vexed question of the functions of pedicellariæ. If a specimen of *Strongylocentrotus lividus* or *Sphærechinus granulatus* be placed in a vessel in which there are one or more specimens of *Asterias glacialis* which have been compelled to fast for some time, the Echinoid will be immediately attacked by the starfishes. As soon as it feels the touch of their ambulacral tubes, it rapidly withdraws its spines from the part threatened; the spines bend out from the center of attack to so great an angle that they become almost tangential to the test. In thus removing its spines the urchin unmasks its gemmiform pedicellariæ, which are then stretched towards the arms of the starfish with the jaws

[1] *Comptes Rendus*, CXI., p. 62, 1890. Abstract from *Jour. Roy. Micros. Socy.*, Oct., 1890, p. 611.

wildly open. The starfish continues its attack, but as soon as one of the pedicellariæ touches an ambulacral tube it immediately bites it; we may suppose that the pain produced is considerable, for the arm of the starfish is actively withdrawn, but it always carries with it the offending pedicellaria fixed in the wound.

In some cases the first bites are sufficient to drive off the starfish, but in others it prolongs the attack, and then it is very interesting to see the urchin unmask its pedicellariæ on the points attacked, and, so to speak, follow the movements of the enemy by showing its teeth. In a first fight the victory is always with the urchin, and the starfish retires covered with wounds. But, as each pedicellaria serves only once for the defense of the urchin, it is gradually deprived of its organs for this purpose. If an urchin is put with several starfishes and abandoned to its fate it succumbs at last.

The moment an Echinoid is warned by its peripheral nervous system of the danger which threatens it, it moves its spines in a way which has nothing in common with the ordinary movements of these organs, and which has no other object than to unmask its gemmiform pedicellariæ. It is of interest to observe that this movement is exactly the opposite of that which is produced when the surface of the test is wounded by, for example, the point of a needle; in that case the spines and pedicellariæ are inclined towards the wounded part.

Hekaterobranchus is the name given by Miss F. Buchanan[2] to a Spionid worm discovered at the mouth of the Thames; but in a postscript she thinks it may belong to Webster's genus Streblospio. The characters are a single pair of dorsal branchiæ situated on the first segment; cephalic tentacles, not grooved but ciliated all over; prostomium well developed; four eyes; first segment prolonged below to form a collar; pharynx evertible and richly ciliated; a single pair of thoracic nephridia, opening on second segment, reaching back to sixth segment, and thence bending forward again.

The Anatomy of Scutigera.—Curt Herbst has discovered some interesting facts regarding this Myriapod. In his Dissertation[3] he describes five systems of glands in the head where he only expected to find the salivary gland described by Dufone. The first is a pair of tubular glands opening at the base of the first maxillæ. The second pair belong principally to the segment of the second maxillæ and open in a deep pit on the side of the head. The third system belongs to the

[2] *Quarterly Jour. Micros. Sci.*, XXXII., p. 175, 1890.

[3] Anatomische Untersuchungen an Scutigera Coleoptrata. Jena, 1890.

same segment and has its openings at the base of the second maxillæ. The fourth and fifth systems are very similar in structure, but differ in the position of their ducts. The fourth opens just behind the second system, the fifth goes through the body wall immediately behind the commissure uniting the dorsal and supraneural vessels. The histology and structure of these systems are detailed. Regarding the functions of these glands Herbst has but little to offer. He thinks that some of them (possibly System III.) may act as spinning glands; while others may play a part in preparing food material. A discussion of the homology of these glands with the head glands of Hexapods and the coxal glands of other Arthropods follows, but our knowledge of these is not sufficient to lead to sure results, though the author considers them as homologous with the coxal glands.

The circulatory apparatus is also described, the most interesting features pointed out being the existence of a cardiac nerve, arising probably from the sympathetic; and the comparison of the supraneural vessel and the arteries on either side of the œsophagus with the similar organs in the Annelids.

The Balancers of Diptera.—Ernst Weinland presents a long and detailed account [4] of his studies of the balancers or halteres in twenty genera of flies. The position, color, hairs, relations, the chitinous skeleton, internal structure, canals, terminal vescicle, nerves and nerve-end structures are described at great length and illustrated by five plates. The results may be summarized in a few words. The balancers are to be regarded as extremely modified wings with internal canals corresponding to those in the "veins" or "nervures" of the true wings. They have not yet lost their powers of motion, a hinge remaining at the base, and in accordance with their position the direction of the flight of the fly is changed. The sense organs with which they are clothed must be regarded as organs of equilibrium.

Nerves of Tortoise Shell.—J. B. Haycraft has noticed the sensitiveness of the carapace of the land tortoise (*Testudo græca*) of Southern Europe. He finds that nerve-fibres penetrate the osseous portion of the carapace and enter a connective-tissue layer immediately beneath the scutes. In this latter they lose their undulated character, and become covered with a dense sheath of tissue. With suitable preparations these nerves are seen to branch, and the ultimate fibres can be traced to the nuclei of the epidermal cells. Not all cells are thus innervated, nor were any nerves found within the shell itself.

[4] *Zeitsch. f. wiss. Zoologie*, LI., p. 55, 1890.

The Cannon-Bone of Ruminants.—The usually accepted view has been that the cannon-bone of the hind leg of the ruminants consists of the coalesced metatarsals three and four, and that the metatarsals two and five become lost during development. J. E. V. Boas now offers evidence [5] which goes far to show that in these forms we are to recognize besides the coalesced metatarsalia three and four the upper ends of metatarsalia two and five. His views are thus in correspondence with those arrived at by various authors in the fossil forms.

EMBRYOLOGY.[1]

Embryology of Limulus.—Professor J. S. Kingsley publishes a preliminary note on the "Ontogeny of Limulus." [2] The segmentation nucleus undergoes several divisions before any signs of segmentation of the egg are seen at the surface. The resulting nuclei migrate towards the surface, and forty hours after impregnation the egg itself begins to cleave, so that the whole becomes separated into cells, with a nucleus in each segment, and a blastoderm forms on one side of the egg. Here the cells are smaller, forming a primitive cumulus, comparable to that of spiders. A circular spot appears in the center of the cumulus, becomes triangular, elongates, and forms a shallow groove,—the blastopore. The mesoderm forms along its margins. Later six pairs of segmentally arranged sensory thickenings appear outside the legs. The first pair gives rise in the median ocelli, the second to a new sense organ, the third disappears, the fourth remains as the "dorsal organ," the fifth gives rise to the paired compound eyes, the sixth is evanescent. All of these organs are connected by a longitudinal nerve. The facts obtained from the ontogeny point to a close relationship between Arachnids and Limulus.

Embryology of Phalangium.—A preliminary note on the early stages of Phalangium is published by Victor Faussek.[3] The egg breaks up into a solid mass of cells, each filled with yolk, and each containing a nucleus. From the large superficial cells there separates by *delamination* small cells, while the resulting small cells form the blastoderm, which soon appears on one side of the egg. The large

[5] *Morph. Jahrbuch.*, XVI., p. 526, 1890.

[1] Edited by Dr. T. H. Morgan, Johns Hopkins University, Baltimore, Md.

[2] *Zoologisches Anzeiger*, No. 345, 1890.

[3] *Zool. Anz.*, January, 1891, No. 353.

yolk-cells in the center of the egg have their nuclei undergo a process of fragmentation, increasing by direct development. The germ-cells (sexual cells) appear when there is but a single-layered blastoderm. A few of the blastoderm cells, which later form the sexual cells, enlarge and form a group of cells which push beneath the surface. The epithelium of the midgut forms from entoderm cells. The nuclei of the yolk-cells form many small nuclei, surrounded by a quantity of plasma lying between the yolk and mesoderm, and soon arrange themselves into the cylindrical epithelium of the midgut. The author points out the correspondence between the early stages of Phalangium and Limulus.

The Embryology of a Scorpion.—Malcolm Laurie publishes a paper under the above title.[4] The earliest stage observed had a small blastoderm at the surface of one end of the egg. This becomes several layered by a process resembling delamination. At a later stage there is a single outer row of cells over one end of the egg, and a thickened mass of cells beneath, some of which are migrating into the yolk. The presence of a primitive groove is doubtful. At the posterior end of the blastoderm there is formed a mass of hypoblast cells, and these may represent invaginated hypoblast. Later a layer of primitive hypoblast cells is to be found under the rest of the blastoderm, and seems to be simply "*split*" from the epiblast. Numerous cells migrate into the yolk. The mesoblast forms under the whole ventral plate from a multiplication of cells of the primitive hypoblast. The origin of the serous membrane and the amnion is described in detail. Cœlomic spaces form in the mesoblast of the segments, and the thoracic appendages contain portions of the cœlom. The coxal glands open at the base of the fifth appendages, and are at first a pair of simple tubes, opening exteriorly at one end and into the cœlom at the other. They seem to be homologous with nephridia. The lateral eyes are as Lankester and Bourne affirmed, monostichous. The central eyes arise by invagination. The stomodæum forms early; the proctodæum much later as a solid plug of cells. The gill-books are appendages comparable to the abdominal appendages of Limulus.

Development of the Fresh-Water Sponge.[5]—Dr. Otto Mass has studied the development from the egg of Spongilla. The first two segments are equal in size and structure, and similarly the 4, 8, and 16 segments, are all alike, giving similar reactions to staining reagents.

[4] *Quart. Jour. Micro. Sci.*, Vol. XXXI., Pt. II.

[5] *Zeit. f. wiss. Zool.*, Band 50, Heft 4.

There results a solid morula. Serial sections demonstrate that at one pole of the morula the cells sink inwards, while the peripheral cells grow over, enclosing a cavity within one end of the egg. Whether this process is a process of growth of cells around one pole of the egg, or whether we have here a process between epibolic and embolic gastrulation, cannot be definitely decided. The cells soon begin to differentiate into tissues, and only the inner ones retain the yolk spherules. The outer layer becomes columnar ciliated ectoderm. Those cells lining the enclosed cavity become flattened at several places, and push out into passages ending in ciliated chambers. Later these latter form the inhalent passages. The remaining cells filling the egg contain yolk, and are the so-called mesoderm cells. Some of these form needles, each needle the product of a single cell, and by their growth push out the ectoderm before them. These changes have taken place while the larva was within the sponge tissues; but it now becomes free and swims about with the pole containing the cavity directed *forwards*. The method of swimming described by Götte, with the pole containing the cavity directed upwards, is undoubtedly pathological. The larval life lasts about twelve hours,—never so long as twenty-four. The best observations on the method of fixation were made with the horizontal microscope. The larva fixes itself by the pole which was directed forwards in swimming,—that is, the end containing the gastric cavity. The cavity itself diminishes. The young sponge flattens to a crust. The high, cylindrical, ectodermal cells become more cubical, then flatten till their longest diameter is tangential to the surface. At first the cilia, one to each cell, were close together, but as the cells flatten they lie farther apart. The above process of fixation and flattening lasts about one-half to three-quarters of an hour. The ectoderm cells around the periphery of the young sponge begin to spread out over the support to which the sponge is fixed, and it takes place by the amœboid-like migrations of the peripheral ectoderm cells. The ectoderm is never thrown off, as Götte supposed, and it seems probable that owing to rough treatment of the embryos they lost their delicate ectoderm. After the fixation of the larva the ciliated chambers—evagination from the inner cavity—come nearer to the surface, fuse with the ectoderm, and form the inhalent orifices. The exhalent orifice originates through a secondary connection of the inner cavity with the outer world.

Descensus Testiculorum.—Under the above title Dr. Hermann Klaatsch, of Heidelberg, has given, in the *Morphologisches Jahrbuch*, Dec. 16, 1890, what promises to be an important contribution to that most interesting *problema magnum*.

Regarding the recent work upon the actual ontogenetic changes taking place in the human embryo as insufficient for explaining the true morphological descent of the testis in the Mammalia, the author returns to the comparative methods of Hunter and others, and ultimately sees reasons for associating this change of position with changes in other organs,—namely, mammary glands.

From the position of reproductive glands, Wolffian body and body-wall in many mammals the gubernaculum is found to be a complex structure, not entirely homologous in different groups. Thus the testis is first attached to the Wolffian body; only later does the latter become connected with the body-wall by a special "inguinal ligament," which is connected with a peculiar inward process of the muscular body-wall, an "inguinal cone." The separateness of these three parts of a complex gubernaculum is shown in the adult Monotremes.

The phenomena occurring in the periodic descent in the rodents and insectivores furnish the starting point for the interpretation of all other groups.

Here the gubernaculum is chiefly a much-enlarged "inguinal cone," or modified ingrowth of transverse and internal oblique muscles (cremaster). *Pari passu* with the descent of the testis in the adult occurs the evagination of this cone to form a scrotal pouch. This descent appears to correspond to the period of enlargement of the testis; the withdrawal into the body to the period of enlargement of the mammary glands of the female.

In lemurs, apes, and man secondary changes have resulted in the occurrence of the descent once for all in the embryo. Even here the "inguinal cone," though not playing so important a part, in the single descent has muscles resembling those in the rodent. The preformation of a scrotum independent of the descent is not found in all these animals so markedly as in man, where it is to be regarded as a newly acquired falsification of the true record of sequences, and one that is here alone transferred to the female (in the form of the labia majora).

In man, again, an interesting exception to the lack of periodicity occurs,—a reminiscence of a previous adult rodent-like condition being represented by two successive descents in the embryo. Thus a temporary descent has already taken place in embryo of eight cm. This is followed by what is interpreted as a true reditus testium, subsequent to which the permanent, commonly described descent takes place.

The anatomical relations in the marsupialia, carnivora and ungulates are to be regarded as indicating a separate line of divergence of these groups from the rodent-like conditions. The position of the scrotum is not really so aberrant in the marsupial as to interfere with close comparisons.

A preformed scrotum is here again to be regarded as a falsification of the phylogenetic history, associated with the permanent establishment of the descent in the embryonic period.

From numerous facts, of which I have given an imperfect survey above, the author establishes a connection between the mammary gland and the descent as follows:

The embryo rodent differs from the adult Monotreme in having the gubernacular "inguinal cone."

The descent is not found in the Monotremes and lower vertebrates, and must have arisen in higher mammals.

In these the descent is associated with the modification of the belly-wall, the "inguinal cone." In seeking a cause for the production of this modification of the belly-wall, some external factor and not internal organs is to be considered.

This external factor in the modification of the muscular body-wall was a mammary gland.

The simplest mammary gland is the small area of skin glands with well-developed skin muscles in the inguinal region, on each side, in the Monotremes. This is present in the male also, but is to be considered as secondarily derived from the female.

That such a body might react upon the body-wall is indicated by the existence of the cremaster muscles in the female marsupial, gland and muscle functioning together. Some such change in connection with a mammary gland may have formed the "inguinal cone."

This cone in the male was utilized as being the point of least resistance in the body-wall, and evaginated when the testes enlarged periodically. Though such a cone is present in female animals, it is not associated with the ovary, as this does not enlarge.

The origin of the inguinal ligament remains unexplained, but this also may have been handed over from the female, with other organs connected with the mammary gland.

Granting the scrotum represents such a primary mammary gland area, we would expect to find no true mammary glands in males.

Those present anterior to the inguinal region are easily explained as recent acquisitions from new organs in the female; while the state of things in the marsupial strengthens the hypothesis. In the lowest Australian marsupial there are no glands in the male, but a scrotal pouch in the place of the female inguinal glands. In Monotremes there are male glands, but no scrotum as yet formed.

The discovery of remnants of such mammary glands in the area into which the testes descend would increase the value of the hypothesis. Such are present in all groups of mammals, conspicuous in apes, and even found in man, in embryos.

The "area scroti" are warty, circumscribed regions of the scrotum, one on each side, in which peculiarities of skin glands, hairs, and especially of skin muscle, form strong contrasts to the rest of the scrotal skin.

These "area scroti" are the externally visible outlines of these primitive mammary organs that gave rise to the descent of the testes.

On the Urinogenital System of the Crocodile and Turtle.[6] —1. There is an undoubted trace of a pronephros in embryos of both, which soon degenerates. 2. A very large glomerulus hanging into the body-cavity on either side. Often the nephrostomes of the pronephros are close to its sides. 3. A segmental arrangement could not be made out for pronephros or glomerulus; no very young embryos were examined. 4. The boundary between pronephros and mesonephros could not be made out, and it was not possible to count the number of nephrostomes belonging to either. 5. The origin of the pronephros—whether from ectoderm or mesoderm—could not be determined. 6. Nephrostomes of the mesonephros often become partially or wholly separated from the body-cavity by a growth upward of the lower lip of the funnel, which surrounds the glomerulus above it. 7. The Müllerian duct is formed entirely independently of the segmental duct, by a földing of the peritoneal ephithelium anteriorly, constricting off the proximal end of the duct, which then grows backwards to the cloaca as a solid rod of cells, which soon acquires a lumen. —J. L. Kellogg.

The Development of Cyanea arctica.—Since the publication by Louis Agassiz of the third volume of his "Contributions to the Natural History of the United States" no observations have been recorded upon the development of *Cyanea arctica*. During the month of May of the past summer this Medusa was exceedingly abundant in Vineyard Sound and the adjacent waters, and on my arrival at the

[6] R. Weidersheim. *Arch. f. Mik. Anat.*, Band 36, Heft 3, 1890.

Marine Biological Laboratory at Woods Holl, towards the end of that month, I had no difficulty in obtaining large quantities of ova in the earliest stages of development, and I succeeded in keeping the embryos alive until the end of August, by which time they had developed into Scyphistomas with about twenty tentacles.

The developmental history as I observed it differs in so many points from what Agassiz has described, as well as from the observations of other authors upon European forms, that I wish to postpone a detailed account of my observations until I shall have had an opportunity of studying for comparison the embryology of *Aurelia flavidula*, which I hope to accomplish during the coming summer. In the meantime I wish to record here briefly some of the more important facts which I have been able to establish.

The segmentation is practically regular (though the relative size of the first-formed spherules *may*, vary considerably), and results in the formation of a blastula. Certain cells then migrate into the blastocœle, and arrange themselves as an incomplete layer below the cells which remain at the surface, and at the same time an opening appears at one pole of the embryo. This pseudogastrula is, however, very transient. The immigration of cells continues, being apparently multipolar in its distribution, and the opening closes up. Eventually a solid planula or sterrula results, consisting of an external layer of columnar cells and a central mass in which the cell outlines cannot be made out in sections.

In this condition the embryos may persist for some time, swimming about actively. From time to time, however, some settle down to the bottom of the vessel in which they are contained, and enclose themselves in a circular plano-convex cyst. I found a few free-swimming embryos, out of the many hundred which I examined, which had developed a mouth and a central cavity, and possessed a rudiment of a single tentacle, but their further development I was not able to observe. It is certain that the majority encysted themselves in the manner described, but it is of course possible that this may be due to unsatisfactory conditions of life, though the fact that large numbers of the encysted form developed into Scyphistomas argues against such an idea.

While within the cyst, the hollowing out of the central mass and the formation of the endoderm take place. The encysted state lasts for several days, but finally the embryo emerges from the cyst through a circular aperture in the center of the free convex surface of the cyst, formed apparently by solution, as I never saw any ragged edges to the opening. I could not at first believe that the encystment was a stage in the development; it seemed rather to mean the death of the embryos.

The fact that every young Scyphistoma was attached to a cyst, its stalk passing through the opening and spreading out on the lower flat wall, first aroused my suspicions, and I finally succeeded in observing the embryos leaving the cyst, and have sections through forms in various stages of emergence. Encystment has been observed by Kowalewsky in Lucernaria, but was supposed to be a precursor of death. No one has yet observed what I have mentioned above in any Scyphomedusa, but my preparations do not allow of any doubt as to its existence in *C. arctica.*

Shortly after their emergence from the cyst the mouth forms, placing the internal cavity in communication with the exterior, and four tentacles make their appearance. I could not detect any invagination to form the mouth, such as Claus, and especially Goette, have described for other Scyphomedusæ. My preparations show that the ectoderm and endoderm come into contact at the margin of the mouth opening, and that there is no stomatodæal invagination of ectoderm such as Goette maintains exists in Cotylorhiza and Aurelia. It is to be noticed that a similar absence of an ectodermal stomatodæum occurs in *Lipkea ruspoliana*, described by Vogt as the representative of a new tribe of sessile Medusæ, but which, it seems probable, is simply a Scyphistoma.

With regard to the formation of the mesenteries of the Scyphistoma, my results are quite at variance with those of Goette. The young Scyphistomas with four tentacles show no signs of them; in older specimens with the same number of tentacles traces of them are occasionally to be found; but as a rule they are not formed till the young larva has acquired eight tentacles. It is unnecessary to state that in *Cyanea arctica* their formation stands in no connection with the formation of an ectodermal stomatodæum, since this structure does not exist.

An account of the structure of the mesenteries, and the formation of the "trichter" and of the mesenterial filaments, will be given in the complete paper.—J. PLAYFAIR MCMURRICH, *Clark University, Worcester, Mass.*

PHYSIOLOGY.

Vasomotor Nerves of the Portal Vein.—Mall[1] makes an important advance by finding experimental evidence of the existence of vasomotor nerves in the portal vein. This strengthens the idea that this vein and its branches play the rôle of arteries with reference to the capillaries of the liver. If the flow of blood from the aorta to the alimentary canal be stopped, and the splanchnic nerve be stimulated, a narrowing of the portal vein may be detected. If the stimulation be continued, the lumen entirely disappears; at the same time there is an increase in arterial pressure. The subject is to be investigated more fully.

Relation between Molecular Weight, Molecular Structure, and Physiological Action.—Recent work of Gürber[2] on the physiological action of lupetidine and related substances has led Gaule[3] to the conclusion that it is not the weight or size of the molecule that determines the physiological action, but the latter is the product of the effects of the different components of the molecule. If, then, a gradual increase in molecular weight be brought about by the continued addition of a CH_3 group, for example, similarly placed in the molecule, the physiological effects of the compounds so produced will be similar, varying only in degree; but if an NH_2 group be added instead of a CH_3 group, the increase in molecular weight will be essentially the same, but the physiological effects will be different. Thus the physiological effects of drugs will vary with the molecular weight, only when the variation in the latter results from an increase or decrease in the number of identical atomic groups. A second point established by Gürber's work is that different groups of atoms act differently, and that these different groups act on different sets of organs. This would suggest the idea that the living substance in each system of organs represents a peculiar chemical proportion; certain groups of atoms in the body immediately entering into combination with certain groups of atoms in the molecules of substances taken in.—L. G.

Life-History of Blood Corpuscles.—A valuable addition to the literature of the blood corpuscles has appeared recently in the

[1] Archiv für Anatomie und Physiologie. Phys. Abth., Suppl. Bd., 1890.

[2] Archiv f. Anat. u. Phys. Physiol Abthlg., 1890, p. 401.

[3] Ibid., p. 478.

form of a careful paper by Dr. W. H. Howell,[4] of Michigan University. As a result of work extending over a period of two years, most of which was confined to the cat, the author concludes that the corpuscles originate not, as is usually assumed, in different ways, but in accordance with one scheme of reproduction, which is essentially the same in health as in disease, in the embryo as in the adult.

As regards the red corpuscles, these arise in the very young embryo from cords of mesoblastic cells, which outline the position of future veins; the central cells of the cord form corpuscles, while the peripheral ones form the walls of the veins. Such developing blood vessels were found in the liver and in the muscular tissue of the posterior limb, and it seems probable that corpuscles are thus formed wherever there are developing blood vessels. In the second half of embryonic life red corpuscles are formed in the liver, the spleen, and the red marrow. At first this function is most active in the liver, next in the spleen, and lastly in the red marrow. A few weeks after birth, in the cat, the liver and spleen cease to take part in their formation, and in the adult healthy animal they are produced in the red marrow alone. In case of extreme anæmia, resulting from bleeding or whatever cause, the spleen may resume its embryonic function. Wherever and whenever red corpuscles are produced, nucleated forms precede the mature non-nucleated forms, the latter being derived from the former by the *extrusion or migration of the nucleus*,—a process which the author was able to follow in part in the living cell. The life-history of the corpuscle was studied most fully in preparations from the marrow, and is given in brief below. In the very young embryo two forms of red corpuscles occur. One is very large, oval, and always nucleated, which the author regards as possibly an ancestral form. These disappear in early embryonic life. The other, the true mammalian corpuscle, is much smaller, circular in outline, and is found both nucleated and non-nucleated. These apparently arise from colorless, spherical cells —erythroblasts—found in the marrow and elsewhere. The marrow erythroblasts are derived from large embryonic cells, known in the adult simply as marrow-cells,—the unchanged descendants apparently of the original mesoblastic cells from which the marrow is formed. These embryonic marrow-cells multiply by karyokinesis, the daughter cells sooner or later acquiring the structure of the erythroblasts. The erythroblasts multiply rapidly by karyokinesis, giving rise ultimately to cells from which the nucleated red blood corpuscles are derived by the development of hæmoglobin within the cell substance. These

[4] *Journal of Morphology*, Vol. IV., p. 57, 1890.

nucleated red corpuscles multiply also by karyokinesis. When mature they are converted into the ordinary non-nucleated forms by the extrusion of the nucleus. The extruded nuclei are dissolved in the blood plasma, and there is evidence to show that they take part in the formation of fibrinogen. Owing to the loss of the nucleus the corpuscle assumes the biconcave form seen in circulating blood.

The white corpuscles, or leucocytes, arise from the lymphocytes, which are formed in the lymphoid tissue, especially the lymphatic glands. The leucocytes enter the blood apparently as unchanged lymphocytes. Each possesses a single vesicular nucleus, surrounded by a small protoplasmic envelope, and has not the power of making amœboid movements. From this stage the cell develops by growth into a second stage, characterized by a large protoplasmic envelope and amœboid movements. In the third stage the nucleus is drawn out into an elongated strap shape, and may become horseshoe shaped or coiled into a spiral. This cell is actively amœboid, and by the fragmentation of its nucleus becomes converted into the multinucleated leucocyte of the blood. This latter is not, as was formerly thought, a cell in process of division, but rather a disintegrating form, the fragmentation of the nucleus being the first step in the process. The author believes that the fragmented nuclei persist for a time as the blood plates. He is led to this conclusion both by an examination of the leucocytes when in the act of disintegrating, and by the similarity in the appearance and manner of staining of the fragmented nuclei and the blood plates. The disintegrated leucocytes are dissolved in the plasma to form the paraglobulin, which is believed to be derived wholly from this source.

The author discusses fully the work of others and his work has been already reviewed by Minot in the AMERICAN NATURALIST. In addition to the results of actual observation the paper contains a number of interesting suggestions. The most potent of these, perhaps, is the view as to how we may best attack the dark problems concerning the origin and relationship of the blood proteids, and the part which they play in the general metabolism.—E. COOKE.

ENTOMOLOGY.[1]

Dr. Lintner's Sixth Report.—Through the kindness of the author we have been favored with Dr. J. A. Lintner's Sixth Report as State Entomologist of New York. Though less bulky than some of its predecessors, the present volume shows the same painstaking preparation that is characteristic of all of Dr. Lintner's work. The report covers a little more than one hundred pages, illustrated by twenty-five figures, mostly from the writings of Riley, Packard, Glover, etc. After a short introduction of general and popular interest, there is a more or less complete discussion of the following insects: *Eumenes fraternus, Hypoderma bovis*, Drosophila sp., *Adalia bipunctata, Dermestes lardarius, Agrilus ruficollis, Coptocycla aurichalcea, C. clavata, Bruchus scutellaris, Hymenorus obscurus, Meloë angusticollis, Epicauta vittata, E. cinerea, E. pennsylvanica, Pomphopœa sayi, Podisus spinosus, Prionidus cristatus, Pulvinaria innumerabilis, Aphis brassicæ, Gryllotalpa borealis, Melanoplus femur-rubrum, Ixodes bovis*, and *Bryobia pratensis* (?). To these accounts a list of publications of the author during 1880, 1881, and 1889 is added as Appendix A, while Appendix B contains a list of contributions to the department.

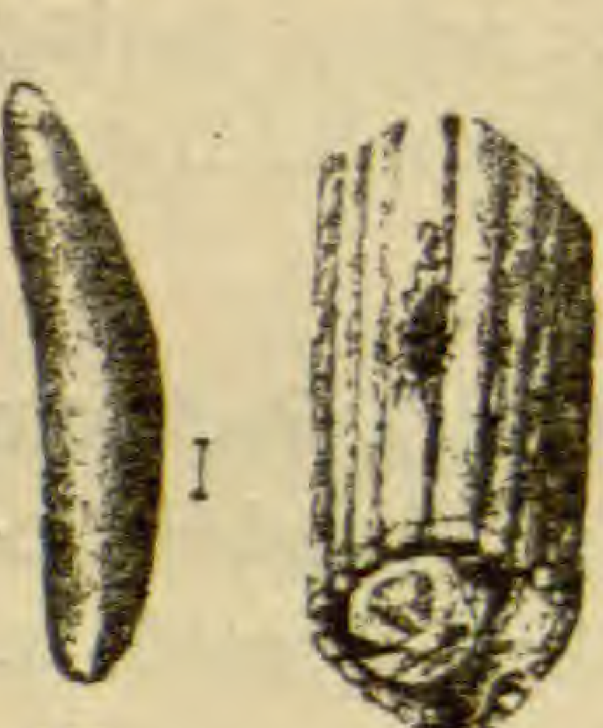
Sexual Selection in Spiders.—Mr. and Mrs. W. G. Peckham have lately published "Some Additional Observations on Sexual Selection in Spiders of the Family Attidæ,"[2] to which they append an interesting discussion of Mr. Wallace's theory of sexual ornamentation. Observations on the mating habits of an undescribed Habrocestum, *Attus leopardus*, and *Synageles picata* are recorded, showing that the males during courtship so deport themselves that many of the bright markings are displayed before the female to advantage. The authors then take up Mr. Wallace's attempt to explain the superior beauty of male animals without the aid of selection, by attributing it to their greater vigor and activity and higher vitality. "This proposition," the authors state, "is a complexus holding within it three implications which must be proved before its acceptance can be demanded: First, that male animals have higher vitality than females second, that those males that have the highest vitality have also the most brilliant and intense colors; and third, that the superior ornamentation of the males is due to their activity." The authors discuss each of these

[1] Edited by Dr. C. M. Weed, Hanover, N. H.

[2] Occasional Papers of the Natural History Society of Wisconsin, Vol. I., No. 3.

propositions in turn, and, in their concluding summary, state: "We have found that the weak point in Mr. Wallace's argument was in the small amount of evidence that he was able to offer in support of each of the three propositions, so that the successive steps in the argument grew weaker and weaker. Indeed, it seemed to us that although many of his arguments were strikingly ingenious, they all appeared to rest on very slender evidence, or to admit of another interpretation." The mechanical execution of this brochure, like that of its predecessors, is altogether admirable, and several excellent figures by Mr. J. H. Emerton add to the interest of the text.

Oviposition of Dectes spinosus.[3]—Late in the forenoon of the 12th of last July I came upon a female *Dectes spinosus* in the act of depositing an egg in the stem of horseweed (*Ambrosia trifida*). When discovered she had gnawed away the outer fibres of the stem over a small area, and was standing head downward attempting to insert her ovipositor into the stalk. After three trials she succeeded, and the instrument was inserted to its base. About a minute later the posterior portion of the abdomen began to contract and expand, and in less than a minute an egg was placed in the stalk. The beetle then withdrew the ovipositor, and walked rapidly to the top of the plant.


a b

The egg was deposited obliquely in the pith on the opposite side of the stem from which the beetle stood. The place of oviposition was about two-thirds of the way from the bottom to the top. The egg is 2 mm. long by 0.3 mm. wide; elongate oval, slightly curved, and of a pale yellow color. It is represented, magnified, at *a* of the accompanying figure, while *b* represents, nearly natural size, a section of the Ambrosia stem with the place of oviposition on its side.—C. M. WEED.

Species of Hymenoptera.—The thirty-seventh fascicle of M. Ed. André's Species des Hymenoptera d'Europe et d'Algerie has lately been issued. It completes the first volume of the Braconidæ, by Rev. T. A. Marshall, and adds about twenty pages to the volume on the Sphegidæ, by M. André, who states that the work on this last-named family is now suspended on account of his inability to use his eyes for microscopic work,—an embarrassment which his entomological brethren will join us in hoping may be speedily terminated.[4] Four excellent

[3] Read before the Entomological Club, A. A. A. S., August, 1890.

[4] Since this was written information has been received of the death of M. André.

colored plates of Braconidæ accompany the fascicle. Future issues are to contain a discussion of the Chrysididæ and Cynipidæ, the former by M. R du Buysson. This admirable series of monographs will prove indispensable to American students of Hymenoptera, and should be in every entomological library.

Papers by Miss Murtfeldt.—The 1889 Report of the Missouri State Horticultural Society contains three excellent papers by Miss Mary E. Murtfeldt. The first, entitled "Outlines of Entomology," contains six chapters discussing the structure, habits, and transformations of insects; the second, "Our Insect Musicians," is a popular discussion of an interesting subject; and the third consists of the Report of the Committee on Entomology for the year. In the last reference is made to the injuries of *Ceresa bubalus*, *Ceutorrhyncus napi*, *Lygus pratensis*, and *Gortyna nitela*, each of which did considerable damage in Missouri during the year.

American Tertiary Hemiptera.—Under the title "Physiognomy of the American Tertiary Hemiptera," Mr. S. H. Scndder published a few months ago [5] an important contribution to our knowledge of fossil Hemiptera. It consists of a summary statement of the results of the author's extended study of the subject, with remarks upon the relation of the American Tertiary Hemiptera to those of the present day, and to the Tertiary fauna of Europe. We have room only for the following generalizations: "(1) The general facies of the hemipterous fauna [of North America] is American, and distinctly more southern than its geographical position would indicate. (2) All the species are extinct, and . . . there is scarcely an instance where the same species occurs in two localities. (3) No species are identical with any European Tertiary forms. (4) A very considerable number of genera are extinct, often including numerous species. (5) Existing genera which are represented in the American Tertiaries are mostly American, not infrequently subtropical or tropical American, and where found also in the old world are mostly those which are common to the north temperate zone. A warmer climate than at present is distinctly indicated. (6) There are no extinct families. (7) The appearance of the same familes, and even of the same groups of genera, in the European and the American Tertiaries is common, but of the same restricted genus very rare."

The Polished Harvest Spider.—This handsome species (*Liobunum politum*) was first described in my "Catalogue of the Phalangiinæ

[5] Proceedings Boston Society Natural History, Vol. XXIV., pp. 562–579.

of Illinois,"[6] from three specimens taken about a shed in Champaign county, Illinois. It has not since been discussed.

This harvest spider is an outdoor species, occurring abundantly in fields and woods, although seldom found about barns and outhouses. During the past summer I have taken great numbers in Franklin county, Ohio, in the grass along the banks of a small creek, and among the driftwood left by the overflowing of the Olentangy River. The species becomes fully developed early in July; and the males and females are about equally abundant. Both sexes, when disturbed, emit from the coxal region a liquid having a peculiarly sharp, pungent odor.

I placed a number of these harvest spiders in a large glass vivarium July 10th, 1890. Two days afterward a pair were observed mating. They were standing on one of the vertical sides of the vivarium facing each other. The male kept waving his second pair of legs in the air; his body was somewhat higher than that of his mate, being inclined downward and forward, while that of the latter was inclined upward in front. Similar observations were subsequently made on many other individuals. When alarmed both sexes have a habit of standing on six legs, rapidly vibrating the body, and moving the second legs in a partial transverse circle in the air. In confinement they eagerly devour plant-lice.

The male *L. politum*, is represented, natural size, at Fig. 1, Plate IX. At Fig. 2 are shown the more important structural details, magnified. The body with the legs detached is represented at *a*; *b* represents the eye eminence, side view; *c*, the same, front view; *d*, the palpus, side view; and *e*, the palpal claw.

DESCRIPTION.

Male.—Body, 5 mm. long; 2.8 mm. wide. Palpi, 3.5 mm. long. Legs: I., 25 mm.; II., 51 mm.; III., 26 mm.; IV., 36 mm.

Dorsum smooth, finely granulated; clear reddish-brown, with no markings, except occasionally a faint indication (shown by a slightly darker shade) of the usual central dark marking. Eye eminence rather prominent, slightly constricted at base, black above, canaliculate, with a regular curved series of small, acute, black spines over each eye. Cheliceræ whitish, tips of claws black. Palpi slender, light brown, with femur and patella dusky; finely pubescent, with a subobsolete row of minute dark tubercles on the inner ventro-lateral surface of femur, and another row on the inner ventro-lateral surface of

[6] Bull. Ill. St. Lab. Nat. Hist., Vol. III., pp. 89–90.

PLATE IX.

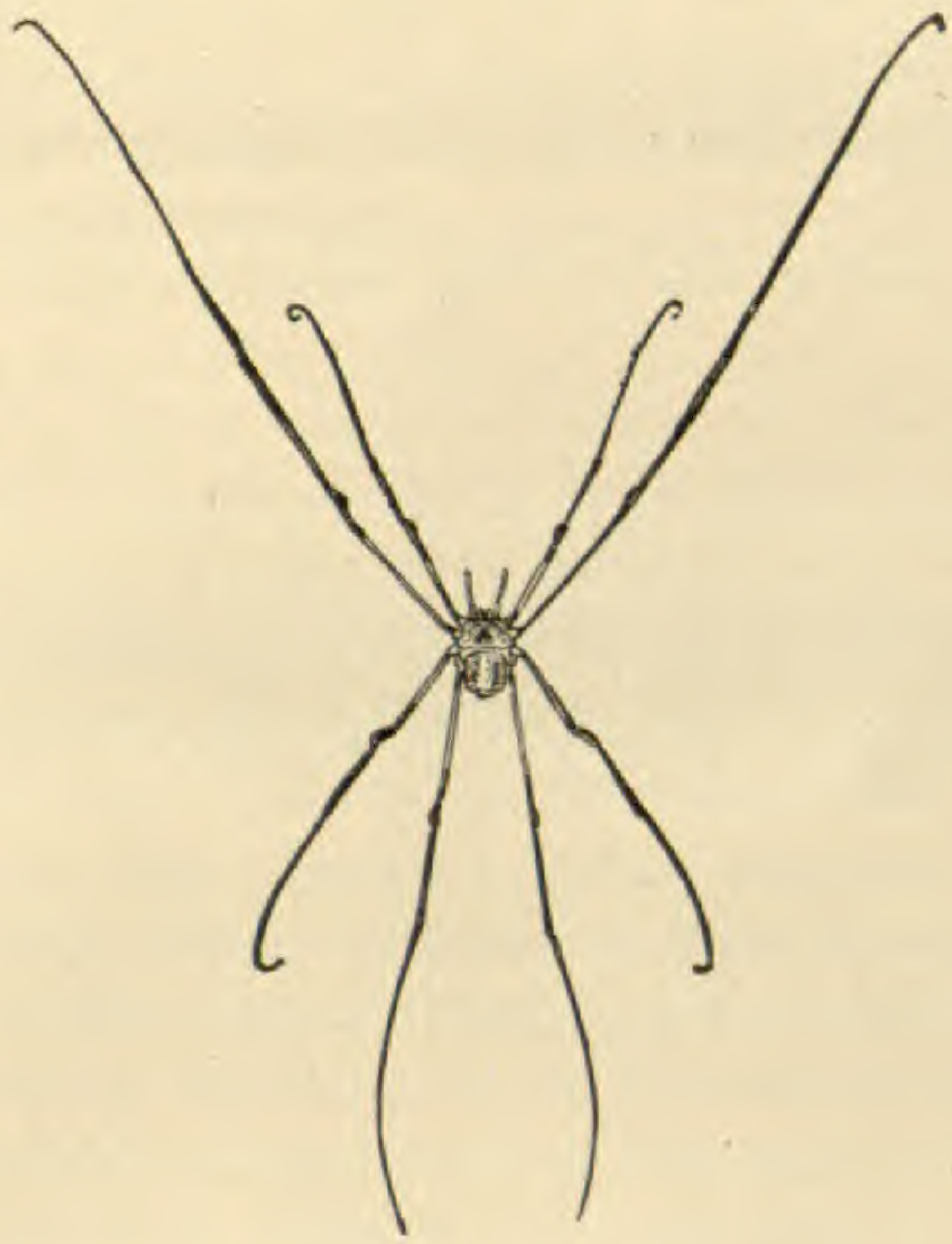


FIG. 1.

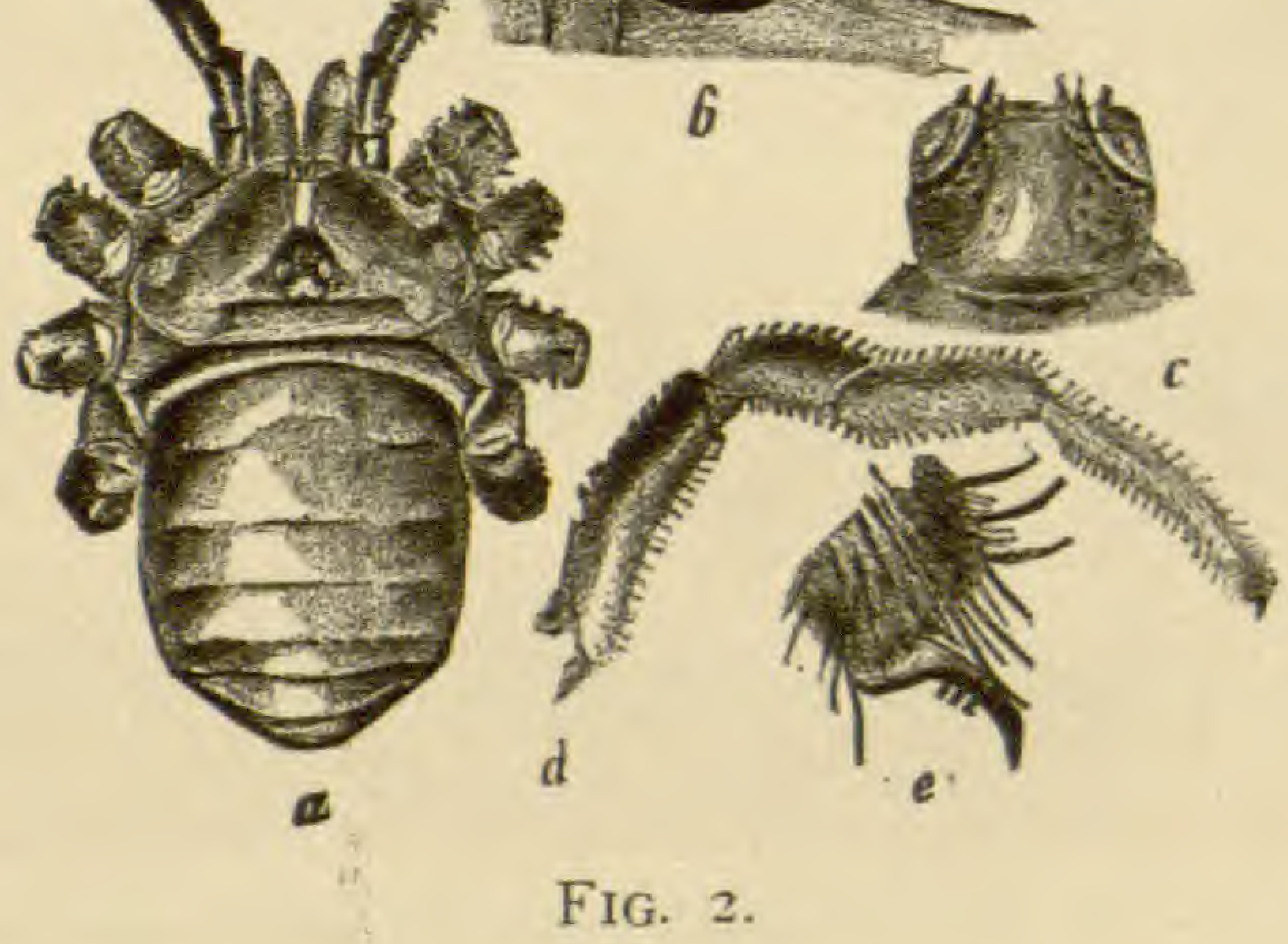


FIG. 2.

Liobunum politum Weed.

tarsus; joints slightly arched. Ventrum with coxæ, including the membranous distal lateral tips, and generally the trochanters, vermilion red. Legs with proximal portions light brown; distally dark brown or blackish. Shaft of genital organ nearly straight, slender, flattened, canaliculate; distal portion very slightly expanded, then slightly contracted, and again expanded into a half spoon-shaped portion, and terminating in a small acute point.

Female.—Body, 6 mm. long; 3.5 mm. wide. Palpi, 4 mm. long. Legs: I., 24 mm.; II., 52 mm.; III., 25 mm.; IV., 38 mm.

Differs from the male in having a larger, rounder body; and in the color of the dorsum, which is brown, with a rather distinct, darker central marking and numerous whitish spots arranged more or less transversely. In some specimens the central marking is subobsolete. Apical rings of ovipositor white. Described from many specimens.

It is a curious fact that while I have found this species one of the commonest harvest spiders in Ohio, especially during 1889 and 1890, I took it but once during three seasons' collecting in Illinois, and have received it but once from outside these two states. Not a single specimen has been found, except in this one case, in the numerous collections received from friends and correspondents in twenty other states. The specimens in my collection represent the following counties in the three states named, the dates given being the time the specimens were collected. All were taken by myself or my assistants, except those from Iowa, which were received from Professor Herbert Osborn. Illinois: Champaign. Iowa: Story (Osborn). Ohio: Champaign, 18 August, 1890; Clermont, August, 1890; Delaware, 18 September, 1890; Franklin, 9 July, 1889, 7, 8, 9, 10, 27, 31 July, 6 August, 2, 5, 6, 9 September, 1890; Lawrence, 5, 6 September, 1890; Madison, 19 July, 1890; Sciota, 3 September, 1890; Warren, 5 July, 14, 16 August, 1890.

It is extremely probable that this species occurs, at least in limited numbers, in most of the central western states.—CLARENCE M. WEED.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

The Biological Society of Washington.—The eleventh anniversary meeting was held in the lecture-room of the Columbian University, on Saturday evening, January 24th, at half-past eight o'clock. The retiring president, Professor Lester F. Ward, delivered an address entitled "Neo-Darwinism and Neo-Lamarckism," in which he took strong ground in favor of the latter doctrine.

February 7th, 1891.—Prof. H. F. Osborn read a paper entitled "A Review of the Cretaceous Mammalian Fauna of North America." It was in effect a review of a paper by Prof. O. C. Marsh upon this subject, in which six new families, sixteen new genera, and twenty-seven new species were described. He illustrated his remarks upon the blackboard, first giving a sketch of the differences between the tri-tuberculate and multituberculate groups of mammals. He then examined in detail the species described as new by Professor Marsh, stating that in no case was more than a single tooth described, and in all cases this was stated to be the upper molar. He stated it as his belief that in numerous instances the teeth were in reality lower molars; and he showed by drawings how teeth referred to distinct species, genera, and even families, seemed to belong to one species. In one instance he mentioned four families, six genera, and seven different species that seemed to belong to one species.

One tooth which had been described as mammalian he thought probably was reptilian, though it was not possible to say positively until the lower part was known.

Professor Marsh was present, and replied to Professor Osborn, stating that he had seen all the specimens of Cretaceous and Jurassic mammals of Europe, and had most of those of Cretaceous age from America in his own collection. He differed *in toto* from Professor Osborn, and had specimens which showed Professor Osborn was entirely mistaken in his assertions. He defended his method of describing and illustrating a single tooth, believing it to be better to describe a single typical example, at least in a preliminary paper, rather than more than one not so perfect or typical. He believed the Cretaceous fauna to have been a large one, the mammals varying from one the size of a shrew to one as large as an opossum; and when he had leisure to describe and illustrate the thousand specimens he now had of Cretaceous Mammalia he was convinced the number of species would be increased rather than diminished.

In respect to the tooth considered possibly reptilian by Professor Osborn, he now had a specimen showing it to possess a double fang, so its mammalian character was established. He criticised the use of Multituberculata for a group of mammals, and defended the use of a term applied by himself some years previous to the establishment of the one used instead by the author of the paper.

Dr. Theodore Gill spoke in reference to nomenclature and the value of making priority of proposal of a name the established law in zoology. He believed the proposal of the name, when it was understood to what group or genus or species it was intended to be applied, was of more value than a strict definition. He cited several examples of defective definition; but where the animal to which the term had been applied was well known, he believed it should be recognized.—JOSEPH F. JAMES.

Indiana Academy of Science.—The sixth annual meeting was held at Indianapolis, December 30th and 31st, 1890. Officers and ex officio, Executive Committee of the Academy: T. C. Mendenhall, president; O. P. Hay, John L. Campbell, J. C. Arthur, vice presidents; Amos W. Butler, secretary; O. P. Jenkins, treasurer; D. S. Jordan, J. M. Coulter, J. P. D. John, J. C. Branner, ex-presidents. List of papers read:

Physics and Engineering.—A Set of Resistance Coils and Wheatstone's Bridge, J. P. Naylor; Transformer Tests, A. P. Carman; Note on the Magnetic Permeability of an Impure Nickel at Low Temperature, A. P. Carman; Freezing Process of Excavation, B. A. Lackey; A Brief Description of the New Steam Engineering Laboratory at Purdue University, W. F. M. Goss; A Refraction Rainbow, W. J. Spillman; President's Address—The Work of the U. S. Coast and Geodetic Survey, T. C. Mendenhall.

Chemistry.—Notes on Xylose, W. E. Stone; On Qualitative and Quantitative Reactions for Furfurol, W. E. Stone; On a Pentaglucose Obtained from Corncobs, W. E. Stone and Dumont Lotz; Detection and Estimation of Titanium, W. A. Noyes; A New Method for Quantitative Determination of Albumen in Urine, F. C. VanNuys and R. F. Lyons; An Improved Chemical Test for Blood in Urine, R. F. Lyons; An Apparatus for Determination of Water in Oils and Fats, R. F. Lyons; Oxidation of Phosphoric Acid, H. A. Huston; Albuminoid Nitrogen in Indiana Feeding Material, H. A. Huston.

Geology.—A Recent Find of Musk Ox Remains in Indiana, Joseph Moore; A Review of the Niagara Group in Bartholomew Co., Ind. (by title), J. F. Newsom; Shelby County "Earthquake," J. F. Newsom; Some New Crustacean Fossils, C. E. Newlin; Geological Section at Vincennes, W. J. Spillman; Sections of Drift in Vigo Co., Ind., J. T. Scovell; The Highest Old Shore-line on Mackinac Island, F. B. Taylor; The Effect of the Great Lakes on the Ice Sheet, F. B. Taylor.

Botany.—Preliminary Notes on Genus Polygonum, Stanley Coulter; Aberrant Fruit of *Juglans nigra*, Stanley Coulter; Aberrant Forms of *Juglans nigra*—Structural Changes, D. T. McDougal; Value of Minute Anatomy in Plant Classification, Stanley Coulter; Notes on the Apical Growth of Liverworts, David M. Mottier; Notes on the Germination of Spores of Notothylus (by title), David M. Mottier; A Remarkable Oscillating Movement of Protoplasm in a Mucor, J. C. Arthur; Accelerating Germination by Previous Immersion of the Seed in Hot Water, J. C. Arthur; Notes on Gautemalan Compositæ, Henry E. Seaton; Parasitic Fungi of Indiana, E. M. Fisher; Circulation of Sap, John Morgan; Distribution of Peucedanum in North America, J. N. Rose; Plants Collected by Dr. Palmer in Arizona in 1890, J. N. Rose; Comparative Structure of the Roots of Osmunda and Botrychium, D. H. Campbell; Notes on the Prothallium of the Osmundaceæ, D. H. Campbell; Notes on a New Puccineæ, Henry L. Bolley; On the Manufacture of Plant Infusions for the Culture of Bacteria, Henry L. Bolley; The Occurrence of *Veratrum woodii* in Decatur, Ind., W. P. Shannon; Some Features of the Occurrence of *Viola pedata* var. *bicolor*, Jos. H. Tudor; Preliminary List of Knox County Plants, W. J. Spillman; Introduction of Noxious Weeds, W. J. Spillman; Biological Surveys, John M. Coulter; The Flora of Texas, John M. Coulter; Weight of the Seed in Relation to Production, Katherine E. Golden.

Zoology.—The Identification of Ghost-fishes, Chas. H. Gilbert; The Deep-Water Fishes of the Pacific, Chas. H. Gilbert; The Fishes of the Interior of Kentucky (by title), A. J. Woolman; Notes on Indiana Reptiles, Amos W. Butler; Observations on the Habits of *Synaptomys cooperii*, Amos W. Butler; Chætodontidæ of the Sandwich Islands, O. P. Jenkins; Notes on Structure of Muscle Cells in Salamanders, O. P. Jenkins; Geophila in Jefferson County, Ind. (by title), Geo. C. Hubbard; Notes on Some Actina, W. F. Glick; Some Notes on Indiana Birds, B. W. Evermann; Contribution to the Distribution of the Fishes of the West Coast of North America, O. P. Jenkins and B. W. Evermann; Sailor Spiders on Lake Maxinkuckee, O. P. Jenkins; The Butterflies of Indiana, W. S. Blatchley; The Batrachians and Reptiles of Vigo Co., Ind., W. S. Blatchley; The Death of Salmon After Spawning, D. S. Jordan; The Fishes of the Upper Columbia and the Shoshone Falls, D. S. Jordan; Eels of America and Europe (by title), D. S. Jordan and B. M. Davis; Food Habits of the Blue Jay, C. W. Hargitt; Notes on *Hydra fusca,* C. W. Hargitt; Acrididæ of Vigo Co., Ind., W. S. Blatchley; On a Bird New to the State Fauna, W. S. Blatchley; On *Cnicus discolor* as an Insect Trap, W. S. Blatchley; Relation of the Number of Vertebræ in Fishes to the Temperature of Water, D. S. Jordan; Notes on Indiana Mammals, B. W. Evermann and A. W. Butler; Audubon's Old Mill at Henderson, Ky., B. W. Evermann; The Range of the Evening Grosbeak in the Winter of 1889–'90, Amos W. Butler; Carolina Parakeet in Indiana, Amos. W. Butler; The Colors of Sounds, Gustaf Kartsen; The Colors of Letters, D. S. Jordan; A List of the Orthoptera of Illinois, with descriptions of new species and observations on the songs and habits of little-known species (by title), Jerome McNeill; Description of a New Æsthesiometer, Wm. Bryan; Researches on the Tactual Perception of Distance, Wm. Bryan; Researches on Reaction Time, Wm. Bryan; Fishes of the Wabash Basin, B. W. Evermann and O. P. Jenkins; Hypnotism, W. B. Clarke.

Addenda.—Notes on Distribution and Habits of *Argynnis diana,* S. G. Evans; Exact and Approximate Formulæ for Calculating the Force at Any Point in the Plane of a Circular Circuit Conveying an Electric Current, Thomas Gray; Some Data as to the Resistance to Cutting of Metals, Thomas Gray; Description of a Powerful Electro-Magnet, with preliminary determination of its magnetic field, C. Leo Mees; Continuation of Experiments in the Change of Density of Metals Under Stress, C. Leo Mees; An Apparatus for Determining Strength of Electric Currents in Absolute Measure, Thomas Gray; Specimens of Diagrams Obtained in Testing Iron and Steel, Thomas Gray; The Relative Magnetic Resistance of Air and Iron, Thomas Gray; On the Solution of the Equation $du = \frac{dx}{(a^2-x^2)^{\frac{1}{2}}}$ Thomas Gray.

The officers for next year are: President, O. P. Hay; vice presidents, J. L. Campbell, J. C. Arthur, W. A. Noyes; secretary, A. W. Butler; treasurer, O. P. Jenkins.

American Physiological Society.—The annual meeting of the American Physiological Society was held on December 30th, 1890, at the Harvard Medical School, Boston. The following papers were presented: On the Growth of Children, Studied by Galton's Method of Percentage Grades, H. P. Bowditch; A Contribution to Our

Knowledge of the So-called Poisonous Albumens, V. C. Vaughan; Suggestions for the More Effective Advancement of Physiology, Through the American Physiological Society, T. W. Mills; Further Observations in Regard to the Stimulation of Ganglion Cells, C. F. Hodge; On the Vasomotor Nerves of the Heart, H. N. Martin; On Muscle Fatigue, W. P. Lombard; Reaction-time Apparatus, J. G. Curtis.

SCIENTIFIC NEWS.

The last legislature of Alabama made the annual appropriation for the geological survey, $7,500, and continuous,—*i. e.,* till otherwise provided. This places it on a very desirable footing as to permanence, for there will be no effort to bring the survey to a close so long as the state continues to advance in the direction it is now going, and so long as we have anything to report npon. The amount of the appropriation is not so great as could have been wished, but a good deal can be done with it, especially as all engraving, printing, etc., come out of another fund. The survey, under Prof. Eugene Smith, is mapping the Warrior and Coosa coal fields.

Prof. Alpheus Hyatt has published an article in the February *Atlantic Monthly* entitled "The Next Stage in the Development of Public Parks." In this paper Prof. Hyatt advocates the establishment of zoological collections in our public parks, grouped in a way to be of use to the student of zoology. He also suggests the establishment of marine and fresh-water aquaria, and believes that not only fish, but marine animals, insects, water plants, etc., should be shown in them.

NOTICES.

Notices for scientific societies and private individuals inserted under this head free of charge. For business houses, two cents per word.

MINERALOGY. — Course conducted by correspondence. First collection and book $1. Postage 25 cents. Address
GUSTAVE GUTTENBERG,
Central High School, Pittsburgh, Pa.

WANTED—To correspond with conchologists in America, especially in California, with a view to exchange. Many British land, fresh-water, and marine duplicates; some foreign. Address Mrs. Falloon, Long Ashton Vicarage, Bristol, England.

WANTED—Position in Academy, Normal or High School, as teacher of the Natural Sciences and Modern Languages. Latin taught in addition, if necessary. Address G., box 441, Hanover, N. H.

A COLLEGE PROFESSOR of Natural Sciences and German, of four years experience and special Biological training received at the Universities of Leipzig and Bonn, Germany, is open for a position in a college. Good references.
Address, C., Box 136, New Berlin, Pa.

FOR EXCHANGE.—14 Volumes (1883–1889) AMERICAN JOURNAL OF SCIENCE; 10 volumes (1880–1889) AMERICAN NATURALIST; 21 volumes (1879–1890) ENGLISH MECHANIC; all in good condition for binding; also, Morris Typewriter. If you have a good Microscope, Camera, or anything else to offer, please send full description.
E. R. CHADBOURN, LEWISTON, ME.

FOR SALE.—Beautiful sets of Fossil Plants from the Dakota Group Cretaceous. On receipt of $3.00 I will forward, prepaid, to any address in Europe or America, 20 different species and varieties of Dakota Plants. Send 5 cents for plate illustrating the set. The specimens will equal the figures. CHAS. H. STERNBERG,
P. O. Box 60, Lawrence, Kans.

WANTED—Hall's works on Palæontology, and other works giving plates which show fossils of the Niagara Epoch. Address M. D. Sullivan, St. Ignatius College, Chicago, Ill.

VOLUMES I., II., III., and IV., of THE AMERICAN NATURALIST, in first-class condition, bound in half Morocco, for sale. Price $16.00. Address GEO. W. MACKAY,
25 Congress St., Boston, Mass.

WANTED—For dissection and microscopic work, Polyps, Jelly-fish, or other Hydrozoa, Actinozoa, and Ctenophora; also Echinodermata and Mollusca. Cash or exchange given. J. A. Leighton, Trinity College, Toronto, Can.

I HAVE FOR EXCHANGE for other shells from sea or land, very fine specimens of *Unios trigon, occidens, coccineus, lacrymosus, lævissimus, rectus, alatus, gracilis, turberculata, ventricasus; Margaritania confrogosis, complanata, rugosa, gibbosus*, and others; *Anadonta corpulenta* and *suborbiculata*. Will send six of the beautiful *Anadonta suborbiculata* by mail for one dollar.
DR. W. S. STRODE, BERNADOTTE, ILL.

CLUBBING LIST.

The publishers offer to send the NATURALIST, together with any one of the following periodicals, at the prices named for both. If any not on the list are wanted, or if two or more are selected from the list, the publishers will be pleased to quote low prices on application.

	Regular subscription price.	Regular price of both.	Our price for both.
Popular Science Monthly,	$5 00	$ 9 00	$ 8 00
The American Journal of Science,	6 00	10 00	8 75
American Meteorological Journal,	3 00	7 00	6 40
American Geologist,	3 50	7 50	7 00
School of Mines Quarterly,	2 00	6 00	5 50
The Microscope,	1 00	5 00	4 50
The Scientific American,	3 00	7 00	6 50
The American,	3 00	7 00	Old, 6 50 New, 6 00
Lippincott's Magazine,	3 00	7 00	6 00
Cosmopolitan,	2 40	6 40	5 40
Belford's Magazine,	2 50	6 50	5 75
Scribner's Magazine,	3 00	7 00	6 40
Century Magazine,	4 00	8 00	7 50
St. Nicholas,	3 00	7 00	6 50
Atlantic Monthly,	4 00	8 00	7 00
Harper's Magazine,	4 00	8 00	7 00
Harper's Weekly,	4 00	8 00	7 00
Harper's Bazar,	4 00	8 00	7 00
The Nation,	3 00	7 00	6 50
Outing,	3 00	7 00	6 25
Cassell's Family Magazine,	1 50	5 50	5 00
American Garden,	2 00	6 00	5 40
North American Review,	5 00	9 00	8 00
Forum,	5 00	9 00	8 00
Country Gentleman,	3 00	7 00	6 00
Vick's Magazine,	1 25	5 25	4 75
America,	3 00	7 00	6 00
New York Observer,	3 00	7 00	6 00
Public Opinion,	3 00	7 00	6 52

Orders from this list must in all cases be accompanied by the cash or its equivalent,—*i.e.*, drafts on New York or Philadelphia, money orders or postal notes.

FERRIS BROS., Publishers,

Sixth and Arch Sts., Phila.

NOTICE TO CONTRIBUTORS
TO THE
AMERICAN NATURALIST

Send Contributions to the EDITORS ONLY.

Send to the PUBLISHERS ONLY:

All Orders for Extra (or Reprint) Copies.
All Proofs of Texts and Engravings.

NOTE.—All orders for reprint or extra copies must be given before the number containing the article goes to press; otherwise none will be furnished.

$4.00 per Year. 40 cts. per Copy.

THE AMERICAN NATURALIST.

A MONTHLY JOURNAL
DEVOTED TO THE NATURAL SCIENCES
IN THEIR WIDEST SENSE.

Vol. XXV. APRIL, 1891. No. 292

CONTENTS.

PHILADELPHIA:
FERRIS BROS., PUBLISHERS
SIXTH AND ARCH STREETS

Entered at the Philadelphia Post-Office as second-class matter.

THE

AMERICAN NATURALIST

VOL. XXV. APRIL, 1891. 292.

MORTUARY CUSTOMS OF THE NAVAJO INDIANS.

BY R. W. SHUFELDT, M.D.

WHILE in New Mexico, a few years ago, the writer had abundant opportunities to study the various modes that the Navajo Indians resort to for the purpose of disposing of their dead. Heretofore it has been very generally supposed that this tribe practices but three well-defined methods of burial, and it is never their custom to deviate from them. I find, however, that the Navajos may choose any one of *four* means of disposing of their deceased, and in this matter they are very much controlled by circumstances.

First and by far the commonest method is the cliff burial, wherein the body of the man, woman, or child is removed from the lodge or "hogan" where the death took place, and is carried to some neighboring cañon, deposited without much ceremony in any of its semi-horizontal rents or fissures in its sides, and there thoroughly covered and walled in with pieces of rock and smaller stones. Most frequently this is performed at dusk, and the body of the deceased may be dressed in clothes that the individual possessed and valued during life. I have often seen their dead children decked out in buckskin garments, and wearing both bracelets and necklace of beads. The "hogan" in which the sick person succumbed is either abandoned or immediately burned, but in no event is it ever occupied by any of the tribe again. They have a notion that the devil (*Chinde*) long haunts the locality where death has taken place, and they all shun it. After a burial the burial party thoroughly wash themselves and make a complete change of clothing. Often wolves or other wild animals may succeed in getting at a body thus placed in a rocky cleft, and, pulling it out, devour it, and the bones subsequently come to be scattered about in the neighborhood of the grave. This has led many to believe that the Navajos are careless of their dead, though there is no truth in this. A few years ago I remembered very well the danger that attended my efforts to secure a few Navajo skulls for Professor Sir William Turner, of the University of Edinburgh. It came to the ears of these Indians in the vicinity, and I was repeatedly cautioned not to make the attempt to carry out my designs.

On another occasion I was at the Navajo agency, Fort Defiance, in Northwestern New Mexico, and while there I learned that some fifty or sixty of these Indians had been buried at different times, extending over many years, in a kind of a cave up among the rocks of a neighboring cañon. I postponed my investigation of the place until daylight of the last day of my stay there, not breathing my plans to any one in the interim. With a large bag rolled up under my arm, and my ambulance awaiting my return at the entrance of the gorge, I climbed up to the place in a blinding snowstorm. Notwithstanding all my precautions, however, my reputation had gone ahead of me, and I found armed Indians posted in several localities, evidently there to resist my depredations at any hazard. They showed their agitation upon my approach, and I returned unsuccessful. Skulls of these Indians were, nevertheless, secured by me at a later date, and are now in the anatomical museum at the Edinburgh University.

Secondly, we may have what I will call here the *brush burial*, and it is resorted to principally in those cases where illness has been long and protracted and no hope for recovery is entertained. The patient is then taken out of the hogan, especially if he or she be old in years, and is carried to some secluded spot in the vicinity of their camp. Here the sufferer is densely surrounded with brush-cuttings as a protection against wild animals, and is either at once abandoned to fate, or else may be fed from time to time by relatives until death comes in relief.

Navajos believe that an evil spirit or devil is at the bottom of everything that has in any way anything to do with death, and they rarely speak of their dead, for fear of offending the evil one; and it has been said that one of these Indians will freeze to death rather than build a fire for himself out of the logs of a hogan wherein one of their number has died.

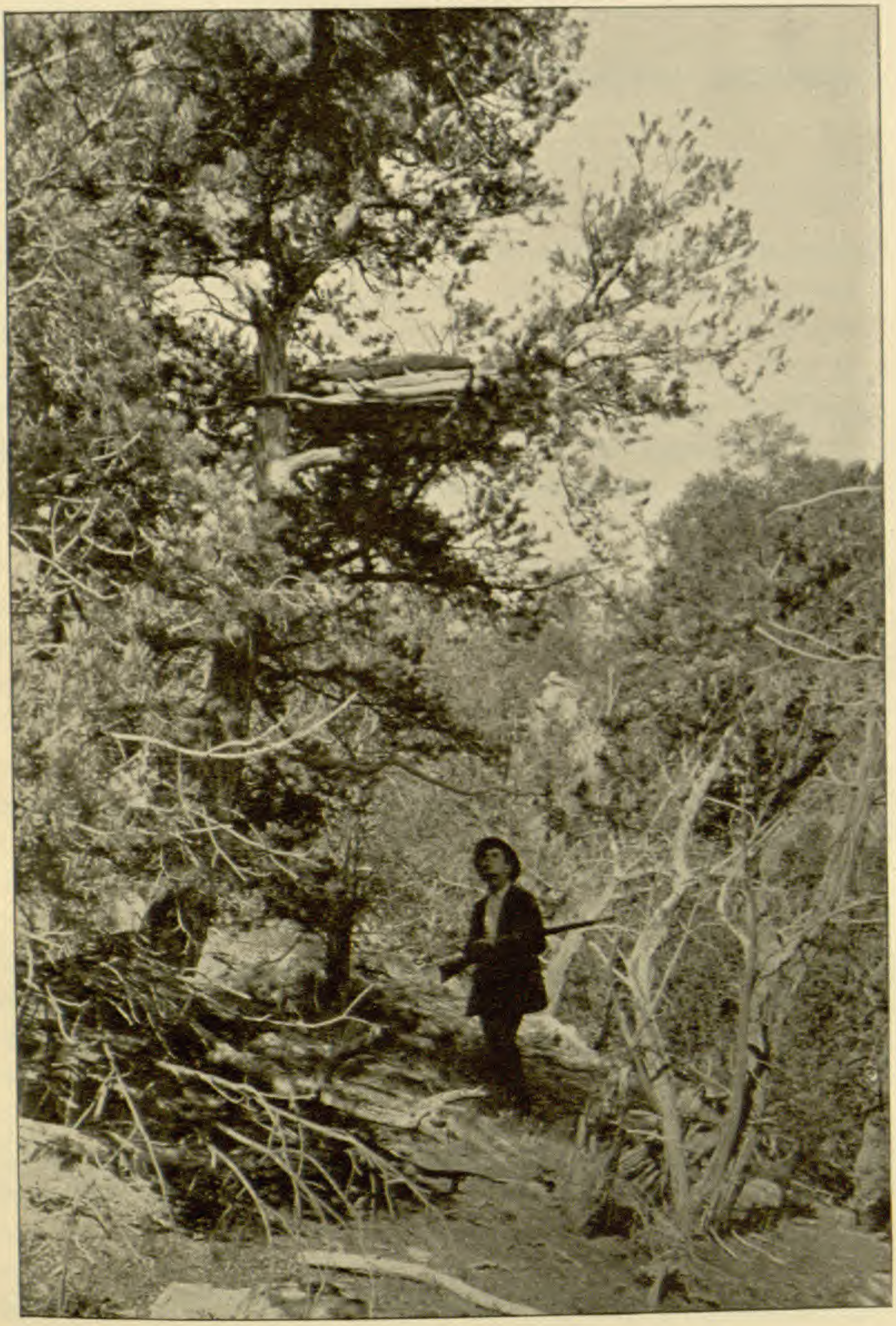
Next, or in the third place, the Navajos will resort to grave-digging as a means sometimes of disposing of their dead, and of this method I have seen one or two examples. While living at Fort Wingate, New Mexico, a few years since, there was a drunken brawl among some of those Indians at a hogan on a hill within a few steps of my house. During the fracas a Navajo squaw was shot and killed. The following day the party pulled down the hogan and burned it, and, wrapping the body of the woman in some cocoa coffee-sacks obtained at the trader's, they buried her on the spot in a grave so shallow that she was hardly covered from sight. A heavy log or two was placed to protect the corpse against dogs and wolves, and the place was abandoned. A year afterwards I secured her skull, and at this writing it adorns the top of one of the bookcases in my study.

In none of these burials do any ceremonies ever seem to be indulged in by the Indians; but it has been reported that the mourners, after the death of a relative, smear their foreheads and under their eyes with tar obtained from the piñon tree, leaving it there until it wears off, and do not renew it. I have never observed any custom of this character.

Others have said that in the event of a Navajo dying and leaving no kin, the lodge of the deceased is pulled down over his or her dead body, stones piled over it, with a few branches and mud, and the vicinity is at once deserted. Instances of this kind must also be rare, and it has never been my fortune to see a similar case. Sometimes the shallow grave is dug within the hogan, and the latter pulled down over it, and the Indians move away from the place as usual.

Fourthly, and last of all, the Navajos may occasionally resort to a tree burial. This practice with them, however, must be extremely rare, and up to the present writing I have succeeded in collecting but one instance of it. This occurred at about a mile from Fort Wingate, and its locality, as well as the mode of placing the body in the tree, are well shown in the plate illustrating this article, and which is a copy from a photograph. The deceased was a child, and its body was wrapped in a Navajo blanket and carried up into a large piñon tree to a horizontal limb about fifteen feet above the ground. At that point a rude platform had been constructed of dead and broken limbs, but the whole so arranged that after the body had been laid in its final resting-place it supported it perfectly, and that completely in the horizontal position. I have never ascertained the name of the family of Indians to which this child belonged, nor why in its case they were led to make such a remarkable departure from their more common mortuary customs. Perhaps in times gone by some of the Navajos may have witnessed the practices of other tribes who were "tree-buriers," and thus had the idea suggested to them. All such theories, however, are purely speculative in the light of the meagre data now at my hand on this form of burial, though it in no way diminishes the interest that attaches to the settlement of such a point.

PLATE X.



A NAVAJO TREE BURIAL.

ON THE ORIGIN OF THE GALAPAGOS ISLANDS.

BY G. BAUR.

(*Continued from page 229.*)

I STARTED with the sentence that continental islands must have a harmonic flora and fauna. In the Galapagos we found absolute harmony; my conclusion, therefore, is: *The Galapagos are continental islands, originated through subsidence;* they all formed at a past period one large island, and this island itself was at a still former period in connection with the American continent. This result is in direct opposition to the opinion of all authors who have worked on this group of islands, like Darwin, Hooker, Salvin, Grisebach, Engler, M. Wagner, Wallace, Peschel. All declare that these islands are of recent volcanic origin, that they have emerged out of the sea through volcanic activity, and that they have become peopled from the continent successively. Henri Milne-Edwards alone holds a different opinion; he believes that the Galapagos represent the remains of a former continent, and in this opinion I agree.

The principal reason of the believers of the elevation theory is the volcanic condition of the islands. But I do not see any difficulty in that. If mountain ranges like the Himalayas, the Alps, the Andes, the Rocky Mountains, could be elevated thousands and thousands of feet, why could not subsidence take place in other places? If Central America should disappear by-and-by through subsidence, the result would be that the tops of the highest mountains would form volcanic islands, some with still active volcanoes. This would be exactly the condition we see to-day in the Galapagos. I think, therefore, that the volcanic nature of a group of islands is no positive proof of its recent origin. Such groups of islands can be just as well considered as formed by the tops of the volcanic mountains of a sunken part of a continent.

But at first let us consider how the facts of the distribution of flora and fauna agree with the elevation theory. Islands which

$4.00 per Year. 40 cts. per Copy.

THE AMERICAN NATURALIST.

A MONTHLY JOURNAL
DEVOTED TO THE NATURAL SCIENCES
IN THEIR WIDEST SENSE.

Vol. XXV. APRIL, 1891. No. 292

CONTENTS.

PHILADELPHIA:
FERRIS BROS., PUBLISHERS
SIXTH AND ARCH STREETS

THE

AMERICAN NATURALIST

VOL. XXV. APRIL, 1891. 292.

MORTUARY CUSTOMS OF THE NAVAJO INDIANS.

BY R. W. SHUFELDT, M.D.

WHILE in New Mexico, a few years ago, the writer had abundant opportunities to study the various modes that the Navajo Indians resort to for the purpose of disposing of their dead. Heretofore it has been very generally supposed that this tribe practices but three well-defined methods of burial, and it is never their custom to deviate from them. I find, however, that the Navajos may choose any one of *four* means of disposing of their deceased, and in this matter they are very much controlled by circumstances.

First and by far the commonest method is the cliff burial, wherein the body of the man, woman, or child is removed from the lodge or "hogan" where the death took place, and is carried to some neighboring cañon, deposited without much ceremony in any of its semi-horizontal rents or fissures in its sides, and there thoroughly covered and walled in with pieces of rock and smaller stones. Most frequently this is performed at dusk, and the body of the deceased may be dressed in clothes that the individual possessed and valued during life. I have often seen their dead children decked out in buckskin garments, and wearing both bracelets and necklace of beads. The "hogan" in which the sick person succumbed is either abandoned or immediately burned, but in no event is it ever occupied by any of the tribe again. They have a notion that the devil (*Chinde*) long haunts the locality where death has taken place, and they all shun it. After a burial the burial party thoroughly wash themselves and make a complete change of clothing. Often wolves or other wild animals may succeed in getting at a body thus placed in a rocky cleft, and, pulling it out, devour it, and the bones subsequently come to be scattered about in the neighborhood of the grave. This has led many to believe that the Navajos are careless of their dead, though there is no truth in this. A few years ago I remembered very well the danger that attended my efforts to secure a few Navajo skulls for Professor Sir William Turner, of the University of Edinburgh. It came to the ears of these Indians in the vicinity, and I was repeatedly cautioned not to make the attempt to carry out my designs.

On another occasion I was at the Navajo agency, Fort Defiance, in Northwestern New Mexico, and while there I learned that some fifty or sixty of these Indians had been buried at different times, extending over many years, in a kind of a cave up among the rocks of a neighboring cañon. I postponed my investigation of the place until daylight of the last day of my stay there, not breathing my plans to any one in the interim. With a large bag rolled up under my arm, and my ambulance awaiting my return at the entrance of the gorge, I climbed up to the place in a blinding snowstorm. Notwithstanding all my precautions, however, my reputation had gone ahead of me, and I found armed Indians posted in several localities, evidently there to resist my depredations at any hazard. They showed their agitation upon my approach, and I returned unsuccessful. Skulls of these Indians were, nevertheless, secured by me at a later date, and are now in the anatomical museum at the Edinburgh University.

Secondly, we may have what I will call here the *brush burial*, and it is resorted to principally in those cases where illness has been long and protracted and no hope for recovery is entertained. The patient is then taken out of the hogan, especially if he or she be old in years, and is carried to some secluded spot in the vicinity of their camp. Here the sufferer is densely surrounded with brush-cuttings as a protection against wild animals, and is either at once abandoned to fate, or else may be fed from time to time by relatives until death comes in relief.

Navajos believe that an evil spirit or devil is at the bottom of everything that has in any way anything to do with death, and they rarely speak of their dead, for fear of offending the evil one; and it has been said that one of these Indians will freeze to death rather than build a fire for himself out of the logs of a hogan wherein one of their number has died.

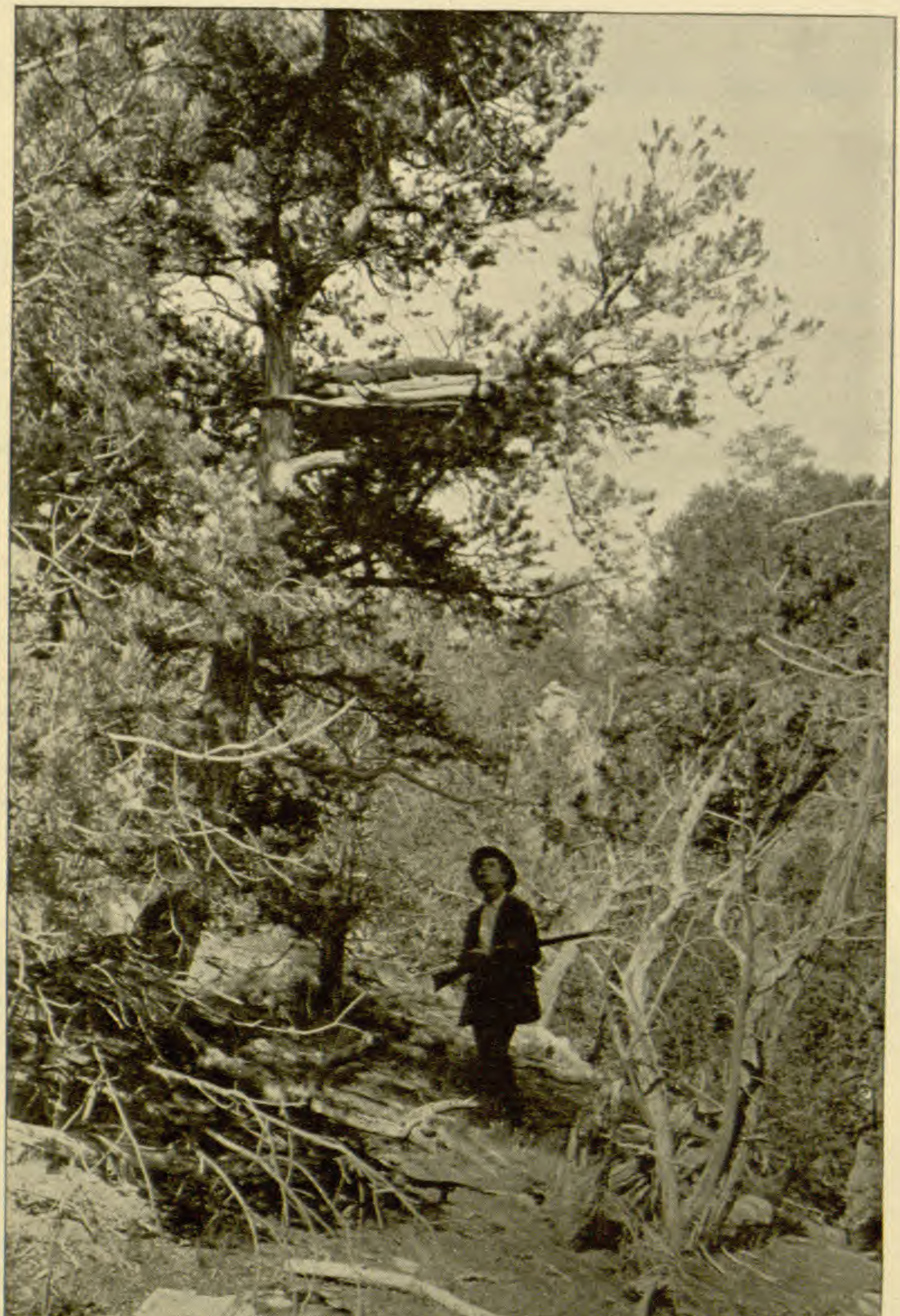
Next, or in the third place, the Navajos will resort to grave-digging as a means sometimes of disposing of their dead, and of this method I have seen one or two examples. While living at Fort Wingate, New Mexico, a few years since, there was a drunken brawl among some of those Indians at a hogan on a hill within a few steps of my house. During the fracas a Navajo squaw was shot and killed. The following day the party pulled down the hogan and burned it, and, wrapping the body of the woman in some cocoa coffee-sacks obtained at the trader's, they buried her on the spot in a grave so shallow that she was hardly covered from sight. A heavy log or two was placed to protect the corpse against dogs and wolves, and the place was abandoned. A year afterwards I secured her skull, and at this writing it adorns the top of one of the bookcases in my study.

In none of these burials do any ceremonies ever seem to be indulged in by the Indians; but it has been reported that the mourners, after the death of a relative, smear their foreheads and under their eyes with tar obtained from the piñon tree, leaving it there until it wears off, and do not renew it. I have never observed any custom of this character.

Others have said that in the event of a Navajo dying and leaving no kin, the lodge of the deceased is pulled down over his or her dead body, stones piled over it, with a few branches and mud, and the vicinity is at once deserted. Instances of this kind must also be rare, and it has never been my fortune to see a similar case. Sometimes the shallow grave is dug within the hogan, and the latter pulled down over it, and the Indians move away from the place as usual.

Fourthly, and last of all, the Navajos may occasionally resort to a tree burial. This practice with them, however, must be extremely rare, and up to the present writing I have succeeded in collecting but one instance of it. This occurred at about a mile from Fort Wingate, and its locality, as well as the mode of placing the body in the tree, are well shown in the plate illustrating this article, and which is a copy from a photograph. The deceased was a child, and its body was wrapped in a Navajo blanket and carried up into a large piñon tree to a horizontal limb about fifteen feet above the ground. At that point a rude platform had been constructed of dead and broken limbs, but the whole so arranged that after the body had been laid in its final resting-place it supported it perfectly, and that completely in the horizontal position. I have never ascertained the name of the family of Indians to which this child belonged, nor why in its case they were led to make such a remarkable departure from their more common mortuary customs. Perhaps in times gone by some of the Navajos may have witnessed the practices of other tribes who were "tree-buriers," and thus had the idea suggested to them. All such theories, however, are purely speculative in the light of the meagre data now at my hand on this form of burial, though it in no way diminishes the interest that attaches to the settlement of such a point.

PLATE X.



A NAVAJO TREE BURIAL.

ON THE ORIGIN OF THE GALAPAGOS ISLANDS.

BY G. BAUR.

(*Continued from page 229.*)

I STARTED with the sentence that continental islands must have a harmonic flora and fauna. In the Galapagos we found absolute harmony; my conclusion, therefore, is: *The Galapagos are continental islands, originated through subsidence;* they all formed at a past period one large island, and this island itself was at a still former period in connection with the American continent. This result is in direct opposition to the opinion of all authors who have worked on this group of islands, like Darwin, Hooker, Salvin, Grisebach, Engler, M. Wagner, Wallace, Peschel. All declare that these islands are of recent volcanic origin, that they have emerged out of the sea through volcanic activity, and that they have become peopled from the continent successively. Henri Milne-Edwards alone holds a different opinion; he believes that the Galapagos represent the remains of a former continent, and in this opinion I agree.

The principal reason of the believers of the elevation theory is the volcanic condition of the islands. But I do not see any difficulty in that. If mountain ranges like the Himalayas, the Alps, the Andes, the Rocky Mountains, could be elevated thousands and thousands of feet, why could not subsidence take place in other places? If Central America should disappear by-and-by through subsidence, the result would be that the tops of the highest mountains would form volcanic islands, some with still active volcanoes. This would be exactly the condition we see to-day in the Galapagos. I think, therefore, that the volcanic nature of a group of islands is no positive proof of its recent origin. Such groups of islands can be just as well considered as formed by the tops of the volcanic mountains of a sunken part of a continent.

But at first let us consider how the facts of the distribution of flora and fauna agree with the elevation theory. Islands which emerge from the sea can only be peopled accidentally, and must have a disharmonic flora and fauna. This is seen in all such islands, like the coral islands, which originated in this way. But in the Galapagos we found absolute harmony. Besides that we would have the greatest difficulty in explaining the presence of such peculiar forms as the gigantic land tortoises and the large lizards and the snakes, and so on ; and again we would have the greatest difficulty to explain the peculiar distribution of the forms, and their peculiar differentiation on the more peripheral islands. To take only one example, how is it imaginable to explain the presence of these gigantic tortoises, some of which reach a weight of 700 pounds ? They have not been introduced by man. When the islands were discovered by the Spaniards in the sixteenth century they were present in enormous numbers, like the other animals. According to the elevation theory we can only think of an accidental importation of these tortoises by some current, because they are quite unable to swim. After the islands had been elevated from the sea, and some vegetation had found its place there, it happened once, by a peculiar accident, that a land tortoise was carried over to the island. Alone it was helpless ; it could not propagate. This was only possible after a similar accident imported another specimen *of the same species, of the other sex, to the same island.* Or we could imagine that at the same time animals of both sexes were thus accidentally introduced. By this we could at least explain the population of a single island. But how did all the other islands become populated ? To explain this we would have to invoke a thousand accidents. But how can we explain that the members of one genus reached all the islands, and again those of another genus all the islands? *How can we explain that each island has a peculiar form of these genera? With one word, how can we explain the harmony of distribution by the theory of elevation ?* All this is simply unexplainable by this theory.

The theory of subsidence, however, explains every point in an absolutely easy manner. All islands were connected together at a former period ; at this time the number of species must have been small ; through isolation the peculiar specialization of the species began; an originally single species was differentiated in many different forms; every island developed its peculiar races.

What seems to me to be a support of the subsidence theory is the fact mentioned by Wolf, that the flora of the Galapagos at elevations of about 900 feet is typically that of the Andes at an elevation of 9,000 feet. How could this alpine flora be explained by the theory of elevation; what is the reason that plants characteristic of an elevation of 9,000 feet are found at an elevation of 900 feet? This peculiar fact is also explicable by the theory of subsidence. I have shown above that an elevation of 300 fathoms, or 550 m., would bring together all the central islands. There are two lines of soundings made by the Fish Commission Steamer "Albatross," one between the Galapagos and Panama, and one to Acapulco. The deepest sounding of the first line is 1,927 fathoms (3,470 m.), at 6° 44′ N., 80° 27′ W.; that of the other is 2,256 fathoms, at 11° 45′ N., 97° 3′ W.

We need only an elevation of about 10,000 feet to connect the Galapagos with America. This would give the highest mountain on the Galapagos an elevation of 14,700 feet. This height is reached by many mountains and very often surpassed. The elevation of 900 feet on the Galapagos of to-day would correspond to an elevation of 10,900 feet. This is, of course, only an approximate value, which may be less or more. But there is no very great difficulty in adopting such an amount of subsidence.

The next question is, Is it not possible to determine during which geological period this subsidence of the Galapagos group, which we have to accept, has taken place? If any form becomes isolated for long a time it preserves the original general character that it possessed at the time of its isolation. This we see very well exemplified by the study of isolated dialects of a language. *I believe, therefore, that the peculiar genera we find to-day on the Galapagos have not originated there, but have been preserved in their old condition.* Let us again take the tortoises as an example. The tortoises found on these islands belong to the true land tortoises Testudinidæ; they represent, together with the forms from the islands round Madagascar and the peculiar Manouria from India and the Sunda Islands, the oldest living representatives of the family. The paleontological history of the Testudinidæ reaches back to the Bridger Eocene. From this formation the oldest land tortoise, Hadrianus, has been recorded, which is nearly related to Manouria, characterized by the double caudal-shield, as in the Emydidæ. Forms very much like those from the Galapagos we find in the Miocene. *We do not go too far to say that it is probable that during the Eocene period, and possibly a little later, the Galapagos were still in connection with the continent.*

The important question is, Where was this connection? In their general characters the fauna and flora of the Galapagos show resemblances to the great Mexican and Sonoran province, and also to the West Indies. And it may be that the connection was with these regions (and it seems more probable than any other), but of course it is quite impossible to bring to-day any positive proof for this idea. It would appear that the whole west coast of America has undergone subsidence. We find there a great number of islands: Prince Wales, Queen Charlotte, Vancouver, Santa Barbara, Guadaloupe, and so on. That all these islands have been in connection with the continent at a former period seems to be certain. They appear as the result of subsidence. The Revilla Gigedo Islands are in the line of this sunken district. Farther south we find the small island Clipperton, and in a southeastern direction the Galapagos. Between Clipperton and the Galapagos two islands, Duncan and Galego, have been recorded; but they are of a doubtful nature,—at least they have not been seen again in latter times. But could we not imagine that they have disappeared in the course of this and the last century by subsidence?

Near the Mexican coast we have the Tres Marias Islands. These are considered as continental even by Wallace; but the more distant Socorro of the Revilla Gigedos are considered by Wallace as oceanic. Wallace believes, therefore, in subsidence in regard to the Tres Marias, in elevation in regard to the Revilla Gigedos, simply because there are no mammals on the barren Revilla Gigedos, and because they are placed within the thousand-fathom line. The fauna of the Revilla Gigedos is typical of that of lower California and the Sonoran province, and I believe also that the

Revilla Gigedos are nothing but a part of the American continent; they are also, like the Galapagos, within the 4000 m. line.

South of the Galapagos we have the islands Felice and Juan Fernandez, with their peculiar flora and fauna. It is not possible to determine whether there has been any connection between these islands and the Galapagos, but the fact that we find on the Galapagos three forms of Antarctic animals, which reach the most northern limit in this group, is to be mentioned. These animals are the *Otaria jubata*, *Arctocephalus australis*, and the peculiar penguin, *Spheniscus mendiculus* Sundev., only found on the Galapagos. Another interesting point is that the albatross, which so far as I know has only been described as breeding from the southern islands, especially Tristan daCunha, breeds on Hood's Island, as observed by Delano and Wolf.

Much work remains to be done. A great number of systematic deep-sea soundings have to be made between these different groups of islands and the continent. And the islands themselves have to be examined very carefully. We know nothing at all about the fauna and flora of the isolated Clipperton Island and Malpelo; we hardly know anything about Cocos Island, which seems to be in many respects quite different from the others, having a more tropical appearance. An enormous and highly interesting field of research is here open. After all this has been done, we may be able to discuss fully the question of the connection of the different islands. One thing, however, we assume to-day: *the probability of the origin of the Galapagos through subsidence.* But if this be probable for the Galapagos, how is it with the Sandwich Islands, for instance; so far as they are known they seem to be of the same harmonic nature in flora and fauna. Have they not originated in the same way? How about the other islands in the Pacific, and how about the theory of the consistency of the Pacific Ocean? Is this theory really established on a sound basis?

We now come to another very important question, What is the reason of the variation of the forms on the different islands? In other words, What is the origin of the different species of the different islands?

the family. The paleontological history of the Testudinidæ reaches back to the Bridger Eocene. From this formation the oldest land tortoise, Hadrianus, has been recorded, which is nearly related to Manouria, characterized by the double caudal-shield, as in the Emydidæ. Forms very much like those from the Galapagos we find in the Miocene. *We do not go too far to say that it is probable that during the Eocene period, and possibly a little later, the Galapagos were still in connection with the continent.*

The important question is, Where was this connection? In their general characters the fauna and flora of the Galapagos show resemblances to the great Mexican and Sonoran province, and also to the West Indies. And it may be that the connection was with these regions (and it seems more probable than any other), but of course it is quite impossible to bring to-day any positive proof for this idea. It would appear that the whole west coast of America has undergone subsidence. We find there a great number of islands: Prince Wales, Queen Charlotte, Vancouver, Santa Barbara, Guadaloupe, and so on. That all these islands have been in connection with the continent at a former period seems to be certain. They appear as the result of subsidence. The Revilla Gigedo Islands are in the line of this sunken district. Farther south we find the small island Clipperton, and in a southeastern direction the Galapagos. Between Clipperton and the Galapagos two islands, Duncan and Galego, have been recorded; but they are of a doubtful nature,—at least they have not been seen again in latter times. But could we not imagine that they have disappeared in the course of this and the last century by subsidence?

Near the Mexican coast we have the Tres Marias Islands. These are considered as continental even by Wallace; but the more distant Socorro of the Revilla Gigedos are considered by Wallace as oceanic. Wallace believes, therefore, in subsidence in regard to the Tres Marias, in elevation in regard to the Revilla Gigedos, simply because there are no mammals on the barren Revilla Gigedos, and because they are placed within the thousand-fathom line. The fauna of the Revilla Gigedos is typical of that of lower California and the Sonoran province, and I believe also that the

Revilla Gigedos are nothing but a part of the American continent; they are also, like the Galapagos, within the 4000 m. line.

South of the Galapagos we have the islands Felice and Juan Fernandez, with their peculiar flora and fauna. It is not possible to determine whether there has been any connection between these islands and the Galapagos, but the fact that we find on the Galapagos three forms of Antarctic animals, which reach the most northern limit in this group, is to be mentioned. These animals are the *Otaria jubata*, *Arctocephalus australis*, and the peculiar penguin, *Spheniscus mendiculus* Sundev., only found on the Galapagos. Another interesting point is that the albatross, which so far as I know has only been described as breeding from the southern islands, especially Tristan daCunha, breeds on Hood's Island, as observed by Delano and Wolf.

Much work remains to be done. A great number of systematic deep-sea soundings have to be made between these different groups of islands and the continent. And the islands themselves have to be examined very carefully. We know nothing at all about the fauna and flora of the isolated Clipperton Island and Malpelo; we hardly know anything about Cocos Island, which seems to be in many respects quite different from the others, having a more tropical appearance. An enormous and highly interesting field of research is here open. After all this has been done, we may be able to discuss fully the question of the connection of the different islands. One thing, however, we assume to-day: *the probability of the origin of the Galapagos through subsidence.* But if this be probable for the Galapagos, how is it with the Sandwich Islands, for instance; so far as they are known they seem to be of the same harmonic nature in flora and fauna. Have they not originated in the same way? How about the other islands in the Pacific, and how about the theory of the consistency of the Pacific Ocean? Is this theory really established on a sound basis?

We now come to another very important question, What is the reason of the variation of the forms on the different islands? In other words, What is the origin of the different species of the different islands?

Of all the forms from the islands, the genus Tropidurus is best known. The most divergent species of this genus we find on Abingdon on one side, and on Hood on the other. On Abingdon we also find a peculiar species of Nesomimus, of Certhidea, of Cactornis, of Testudo, and probably of Geospiza. On Hood Island we also find a peculiar species of Nesomimus, of Certhidea, of Geospiza (Cactornis has not yet been discovered), and of Testudo. These forms are entirely different from each other, and different from the forms of the central islands. What is the reason of this difference? The fact is that *all* forms of an island become modified, and not alone a single species; the plants and the different groups of animals all at the same time. *There must be a common cause which produces this effect. And this cause can only be looked for in the surroundings, in the physical conditions of each island.* That there is a difference among these islands is evident. All the lower islands do not reach the damp region; they must be therefore in quite a different physical state. Some of these islands are without a drop of fresh water; others are furnished with this element. This difference must have a different effect on the same forms of animal and vegetable life.

I have expressed the opinion that when these islands were still in connection, forming one large island, there was probably only a single species of Tropidurus, Testudo, Nesomimus, and so on. There were probably certain small local variations, but they were not so expressed, being not separated; and besides that any new characters appearing were checked by intercrossing. We could imagine, for instance, that the large island had the higher moist region over its whole extent; the effect would have been that humidity was spread more equally over the whole island. If a certain portion became separated, and lost that upper horizon, it was at once in a fundamentally different condition. This affected the flora and fauna; and the flora again the fauna. All these changes, of course, must have gone on *very gradually*.

From these considerations we may proceed to get an explanation of the variation. Hoffmann and others have succeeded, in the course of several years, in changing wild plants by cultivation in gardens. Thus Hoffman could change the wild carrot considerably, and this change became inherited. Let us consider what was done in this case. The wild carrot was isolated from the others, and brought under different conditions; it received, for instance, more food, and the effect was the change. It is exactly in the same way that we have to explain the change of forms on the different islands; an arid, dry island must have a different effect on an organism than a fertile and moist island. The different condition produces a different effect, and thus a different form. If the conditions were absolutely the same, the effect would be the same. Let us imagine that we have a form A, which has, and so have its ancestors, been for a long time in the same conditions. This form A will be represented at a certain moment by very numerous individuals of different age, between the egg and the senile stage. Now let us change the conditions; the change will affect this long series of individuals of the same species in a very different way. The new-born will react differently from the senile form. But among this long series of individuals there will be a certain number of organisms which will be *most plastic*, as I may express it, *to the stimulus of the new conditions*. The senile forms, for instance, probably are not affected at all; they die out through senility. Between these and the egg-stage, however, certain members must be in the condition which I call most plastic. The different individuals may be expressed according to their age, A^1, A^2, A^3, A^4, A^5, . . A^n.

A^n, the oldest individual, disappears by senility and A^{n-1} takes its place; the whole series is moved one line; the individuals of the greatest plasticity, for instance, do not remain the same, but are replaced by the next younger group. In this way a constant flow takes place, which continues until harmony is reached again between the individuals and the conditions.

I may explain this a little better by an example. The different stages of a plant, from the youngest to the oldest, may be expressed in a certain moment by A^1, A^2, A^3, A^4, A^5, . . A^n.

Now new conditions begin to appear, for instance, by the gradual disappearance of water. The result will be that the plant has to depend on less food than before; the large forms which have become so large through ample food will die out through senility;

others come in their place, but these will not develop so highly, because the necessary food is not given. The younger forms have to depend from the beginning on less food, and cannot grow to such extent as their ancestors ; the result probably would be the evolution of a smaller race. This will become constant as soon as it is in harmony with the surroundings. We can easily imagine a differentiation on the same spot, through the change of conditions ; but great effects are produced by isolation. If a part of the individuals of a certain form become separated, the slightest difference in the conditions of the new locality must work on the individuals, until harmony is produced. The absence of intercrossing of the separated forms will preserve the characters of each. I shall give an example for both cases, taken from the well-known communications of Vladimir Schmankewitsch.

Let us imagine that the brine shrimp (*Artemia salina*) is living in a salt-water lake which is supplied with fresh water by a river. Through some cause this river may be prevented from emptying its waters in the lake, being forced to take another course. The result will be that the water will increase gradually in density. By this gradual change *Artemia salina* will be transformed into *A. muhlhausenii*. Of course it is impossible that any adult Artemia is changeable ; but the changed conditions will have an effect on the egg and the younger plastic stages ; the old forms will disappear. The young ones will change until harmony with the surroundings is restored. Exactly the same will take place if *A. salina* is brought from its original locality to another place, in which the density of the water is greater than on the original locality. In the first instance a new species originates on the same spot, through the change of conditions ; in the second a portion of the individuals becoming isolated from the original stock develop into a new form.

This whole consideration is based on continuous growth, and on the fact that members of the same form are in a different stage of plasticity at a different age. If the harmony of a certain group is affected by the intercourse of any disturbing factor,—in other words, if the conditions are changed,—a general alarm is raised in the group until harmony is reëstablished. I may call this process the process of harmonic growth, founded on the plasticity of the younger individuals. I believe that most of the variation goes on in certain definite directions produced by the conditions, this word taken in the widest sense. I do not believe that species originate through indefinite variation, produced by the mingling of different germ-plasmas on which natural selection works. I am inclined to believe that any change must stimulate the organism, and I think it is this stimulus which affects the germ-plasma just as well as the somatic plasma, if we want to make any such artificial distinction.

Perhaps we may be allowed to make some remarks in this connection about the inheritance of acquired characters. If any form shows a new character produced during the lifetime of the form, and not dependent upon any portion of the germ-plasma, we speak, in Weismann's meaning, of an acquired character of this form. I may use a very clear example, taken from Darwin: "The natives of the Amazonian region feed the common green parrot (*Chrysotis festiva* L.) with the fat of large Siluroid fishes, and the birds thus treated become beautifully variegated with red and yellow feathers. In the Malayan Archipelago the natives of Gilolo alter, in an analogous manner, the colors of another parrot, namely the *Lorius garrulus* L., and thus produce the Lori rajah or King Lory. These parrots in the Malay Islands and South America, when fed by the natives on natural vegetable food, such as rice and plantains, retain their proper colors."

Now here we have an acquired character. Will it be inherited? Certainly not, if the animal is fed with its natural food; but it will *appear again* when the animal receives the food producing the peculiar color. Another example: If an alpine plant is transported to a botanical garden, and has become different from the alpine form, it has acquired a new character. The question is, Is this character "inherited" by the next generation? The answer will be *yes*, if the conditions that produced this new character remain; for instance, if we leave the plant in the botanical garden. The answer will be *no*, if we change the conditions that produced that new character; for instance, if we bring the plant back to its original locality.

Hoffmann has given to the wild carrot a new character through long cultivation; this character has become inherited,—that is to say, seeds of the plants showing this acquired character show it again if placed in the same conditions. But let us plant the seeds in the original place; they do not receive the food they had in the cultivated ground, and will in a very short time fall back to the original wild state; simply, as it seems, because the conditions under which the character appeared are not given any more. The word inheritance is very often used in an absolutely wrong and misleading way. We cannot speak of direct inheritance of an acquired character; what is called here inheritance is simply the reappearance of the acquired character under the same stimulus; it is not, strictly speaking, inherited. For instance, we cannot say that the reduction of the biting muscles of lap-dogs is directly inherited. The biting muscles are simply kept low by the effect of the peculiar soft food that these animals receive, and by their peculiar mode of living; but if we change the food and bring the animal into different conditions, these muscles will increase again.

Inheritance is somewhat comparable to reflex motion and automatic motion. Inheritance in its beginning is comparable to reflex motion,—that is to say, a certain character appears under a certain stimulus. Inheritance is comparable to automatic motion when a certain character appears without that stimulus. In other words, the germ is first reflective, then automatic.

The difference between my opinion and that of Weismann is this: According to Weismann, the mingling of germ-plasma of different individuals produces variation, on which natural selection acts. According to my opinion, variation is the product of the stimulus of the conditions on the germ and somatic plasm; it is therefore definite. Variation goes on in certain definite lines. It is the surroundings which change the germ and somatic plasm, which determine variation.

That variation goes in definite lines, determined by the conditions in which the organism lives, is admitted by all those who ever studied species; I mean by all those who studied, for instance, all the representatives of a single genus and its geographical distribution ; the researches of Joel A. Allen and Dr. Merriam are highly instructive in this line. It is also admitted by nearly all paleontologists. I have expressed the opinion that "inheritance" takes place only after a very long repetition of the same stimulus on an organism. Why is it not imaginable that under *certain* conditions, when the organization, instead of receiving an endless repetition of a stimulus, suddenly receives a single most effective stimulus, that the effects are inherited, and appear for some generations? I do not want to be misunderstood; I do not believe in the general inheritance of mutilations ; nobody can believe in such a theory. But that certain mutilations, under certain conditions, *may be inherited,* this I think is a possibility which cannot be entirely neglected. And we have to consider such cases, dark and unexplainable as they appear. Of course, in the origin of species, I do not think that this question is of any importance, If even certain mutilations in nature would become inherited, they could not have any influence whatever on the great harmonic number of the same species. I do not think that a species has ever been developed through inheritance of a mutilation. I think we are yet far from understanding the true nature of inheritance.

The objection will be made to me that I do not consider the sexes at all. To this I may reply that I am not inclined at present to lay so much stress on the effects of the mingling of different germ-plasmas. This mingling doubtless produces slighter or greater individual variation, and is certainly one factor of variation. But we have to consider that nearly all our researches on variation in this respect are based on domesticated organisms, which are, of course, under entirely different conditions from those in free nature. I can only think that certain even apparently most useful variations, created by the mingling of the germ-plasmas, must soon be swallowed up by the governing mass of harmonic forms, and are thus generally unable to develop a new branch. I consider sexual union more as a *stimulative* than a *formative* factor. *The same causes that produce variation in asexual animals must produce variation in sexual animals.* What we have to do is to study species and variation in nature; to study their conditions of life, their surroundings; to find out how these are in relation to each other. Such a work, in fact, has never been done. Dr. Merriam has undertaken such a task, however, for some of the American mammals.

There is no other place on the whole earth which affords better opportunities for such a work than the Galapagos. Here we have the original natural conditions, hardly influenced by man. If all the variations of the forms on this group of islands, or even only the variations of a few genera, are studied, and the conditions of each variation are examined, then we may perhaps be able to express a more definite opinion on the causes of variation itself. Such work ought to be done *before it is too late.* I repeat, before it is too late! Or it may happen that the natural history of the Galapagos will be lost, as it has unfortunately been lost in so many islands; for instance, of St. Helena and the Mascarenes, lost forever, irreparably!

If I can succeed in raising the necessary funds, I shall try to do something for the solution of this important question. A visit of several months would bring out a good deal of light. The question of the origin of the islands themselves could be solved by the most careful collections of the flora and fauna of each, even the smallest island. The conditions of the flora and fauna as well as the domesticated animals which have become wild, could be studied on the spot. I may make some remarks upon this point. The following animals have become wild on the Galapagos, according to Wolf: Cattle, goats, horses, asses, hogs, dogs, cats, chickens. Cattle are found wild on Charles (8–900); Chatham (2–3000); South Albemarle some; horses only on Charles Island; and asses are very numerous on Charles, Chatham, Indefatigable, and Albemarle. They live together in troops of ten to fifteen. Why, Dr. Wolf asks, have these animals adopted the peculiar habit of sitting on the hind legs like a dog or a cat? And he adds that the most learned man could not help laughing at seeing these animals in this peculiar position. Goats are said to have diminished on account of the dogs. They are found on the arid mountains of Charles, Chatham, and Barrington. Hogs occur on all larger islands. Dogs live in droves in the upper and lower regions. The wild-cats on Charles and Chatham are all black,—a peculiar fact, since this color is hardly ever seen in Ecuador. They live in the roughest fissures of the lava near the coast, hunting for crabs and fishes. Chickens are found on the highest most inaccessible regions of Charles. Also here a great field of research is open.

But besides these questions of general interest, some special points could be studied. For instance, material could be collected for the embryology of the penguin, the frigate-bird, the albatross, the seals, the Iguanidæ, and the large myriapod Scolopendra.

"The ground is classic ground," says Mr. Salvin, "and the natural products of the Galapagos Islands will ever be appealed to by those occupied in investigating the complicated problems involved in the doctrine of the derivative origin of species."

But beside studies in nature, we need experiments; biological experimental stations would be of an enormous help in the question of variation. Our means of communication and transportation are so highly developed to-day that it is easy to get animals and plants from very remote places in short time; by bringing these organisms in different conditions a great number of very valuable experiments at least could be made.

I will finish these considerations, which I hope will be taken for what they are,—*ideas—not definite opinions,*—with a word from Darwin, in a letter to M. Wagner:

"In my opinion, the greatest error which I have committed has been not allowing sufficient weight to the direct action of the environment,—*i. e.*, food, climate, etc.,—independently of natural selection."

Clark University, Worcester, Mass., December 6th, 1890.

PRINCIPAL BIBLIOGRAPHY OF GALAPAGOS ISLANDS.

I. Descriptive.

1. Ribero, Diego. J. G. Kohl, Die beiden aeltesten General Karten von America ausgeführ in den Jahren, 1527 and 1529, auf Befehl Kaiser Carl's V. Weimar, 1860. (On this splendid map the Galapagos are not mentioned.)

2. Ortelius, Abraham. Typus Orbis Terrarum, 1570 (Karte No. 5). Second edition, 1580. Theatrum oder Schawbuch des Erdkreys, Autdorff. Americæ sive novi orbis novæ descriptio. (Galopegos und Galepegos geschr.) 1570. (First notice of Galapagos Islands.)

3. The observations of Sir Richard Hawkins Knight, in his voyage into the South Sea. Anno Domini, 1593 London, 1622. Sect. LI.

4. Hacke, W. A collection of original voyages, containing Captain Cowley's voyage round the globe; 8vo, London, 1699.

5. Wafer, Lionel. A new voyage and description of the Isthmus of America. London, 1699.

6. Dampier, G. Nouveau voyaye autour du monde, où l'on a joint les voyages de Wafer, Wood, Sharp, Cowley, et Robert. 5 vols. Amst., 1711 '12, 8°.

7. Rogers, Captain Woodes. A cruising voyage round the world, begun in 1708 and finished in 1711. London, 1718.

8. Carte de l' Amérique et des Mers voisins, 1763. I. Galapos, I. de Sante, I. de Tabac, I. Mascarin. Le petit atlas Maritime, Vol. II., Pl. 2. S. Bellin.

9. Harris, John. Navigantium atque itinerantium Bibliotheca, or a complete collection of voyages and travels. Vol. I. London, 1764. (Cowley, pp. 78–79; Dampier, p. 84; Woodes Rogers, p. 250; Clipperton, p. 192, 190.)

10. Colnett, Captain James. A voyage to the South Atlantic coast, and round Cape Horn into the Pacific Ocean. London, 1798.

11. Vancouver, G. Voyage of discovery to the North Pacific Ocean and round the world, 1790–'95. London, 1798, Vol. III., pp. 381–388; Atlas pl. II., XVI., Feb. 7, 1795.

12. Thompson, G. A. The Geographical and Historical Dictionary of America and the West Indies, containing an entire translation of the Spanish work of Colonel Don Antonio de Alcedo. Vol. II., pp. 124–125. London, 1812.

13. Porter, Captain David. Journal of a cruise made to the Pacific Ocean by Captain David Porter in the United States frigate "Essex" in the years 1812, 1813, 1814. 2 vols. Philadelphia, 1815. Second edition. New York, 1822. Other edition. London, 1823, in New Voyages and Travels. Vol. VIII.

14. DELANO, AMASA. Narrative of voyages and travels in the Northern and Southern Hemispheres. Boston, 1817; second edition, 1818.

15. KRUSENSTERN, A. J. de. Recuel de Mémoires Hydrographiques pour servir d' analyse et d' explication a' l' Atlas de l'Ocean Pacifique. 2 vols., 4°, St. Petersb., 1824.

16. HALL, CAPTAIN BASIL. Extracts from a journal written on the coast of Chili, Peru, and Mexico in the years 1820–21–22. Edinburgh, 1824.

17. BYRON, LORD. Voyage of H. M. ship "Blonde" to the Sandwich Islands in the years 1824–'25. 4to. London, 1826.

18. MORRELL, BENJAMIN, JUN., CAPT. A narrative of four voyages to the South Sea and South Pacific Ocean, . . . Indian, and Antartic Oceans, from 1822–1831. Pp. 124–126. New York, 1832.

19. REYNOLDS, T. N. Voyage of the United States frigate "Potomac," under the command of Commodore John Downes, during the circumnavigation of the globe, in the years 1831, 1832, 1833, and 1834. New York, 1835.

20. FITZ-ROY, CAPTAIN ROBERT. Narrative of the surveying voyages of H. M. ships "Adventure" and "Beagle." Vol. II. London, 1839.

21. THOUARS, CAPTAIN DU PETIT. Voyage autourdu Monde sur la Frigate "Venus" pendant les années, 1836–1839. Vol. II. Paris, 1841, pp. 270–322.

22. BELCHER, SIR EDWARD. Narrative of a voyage round the world in H. M. ship "Sulphur." 2 vols., 8°. London, 1843.

23. COULTER, JOHN, M.D. Adventures in the Pacific, with observations on the natural productions, manners, and customs of the natives of the various islands. Dublin, 1845.

24. HOPKINS, C. T. San Francisco Pioneer, I., p. 97 1850.

25. SKOGMAN, C. Fregatten Eugenies resa. Stockholm, 1854.

26. SEEMANN, B. Narrative of H. M. ship "Herald." London, 1853. Vol. I., pp. 53, 59, 61.

27. ETZEL, ANTON V. Erdumsegelung der K. Schwedischen Fregatte Eugenie. In den Jahren, 1851–1853, ausgeführt unter dem Befehl des Commandeur-Capitain C. A. Virgin Berlin, 1856. Bd. I., p. 218–243. (10 Mai–20 Mai, 1852.)

28. VILLAVICENCIO. Geografia de la Rep. del Ecuador. 1858.

29. PESCHEL, OSCAR. Geschichte der Erdkunde. München, 1865, p. 323.

30. THE "Hassler" Expedition. *Nature*, Aug. 29, 1872, pp. 352–354. (*New York Tribune.*)

31. AGASSIZ, E. C. A cruise through the Galapagos. *The Atlantic Monthly*, Boston, 1873, Vol. XXXI., May, pp. 579–584.

32. WOLF, DR. THEODOR. Ein Besuch der Galapagos-Inseln. Samml. von Vortraegen. W. Frommel und Friedr. Tfaff., I., 9–10. Heidelberg, 1879, 44 p., 3 Kärtchen.

33. PESCHEL, OSKR. Physische Erdkunde. Bd. I., Leipzig, 1879, p. 391.

34. WOLF, DR. TEODORO. Apuntes sobre el clima de las islas Galapagos, segun las observacions hechas durante un viaje enlos meses de Agosto à Noviembre de 1872. Quito, 1879. Verh. Ges. Erdk. Berlin, 1879, pp. 245–256.

35. *Nature*, Sept. 16th, 1880, p. 480.

36. AMEZAGA, C. DE. Cenni suu' Arcipelago Gallàpagos secondo i relievi del Dr. Wolf e le indicazioni, del sig Icaza. Bou. Soc. Geogr. Ital., XVII,, 1883, p. 551.

37. AGASSIZ, ELIZABETH CARY. Louis Agassiz, his life and correspondence. Boston, 1885, Vol. II., pp. 759–767. (Letter from Ag. to Pierce on Galap., pp. 762–763.)

38. PANDOLFINI, ROBERT GRAF. Ein Besuch auf den Galapagos-Inseln, Globus, Illustrirte Zeitschr. f. Laend. und Völkerkunde. Bd. XLIX., No. 6, 1886, pp. 92–95. (From Boll. Soc. Geogr. Ital., Aug., 1885.)

39. South American Pilot, Part II. Eighth edition, London, 1889, pp. 449–456. *Ib.*, Notice No. 1, London, 1887, pp. 12–14.

40. L. H. Der Galapagos Archipel. Das Ausland, Jahrg., 60, No. 37. Stuttgart, 1887, pp. 725–728.

41. LEE, LESLIE A. Recent visit of naturalists to the Galapagos. *Nature*, Vol. XXXVIII., Oct. 11, 1888, p. 569.

42. FINDLAY. South Pacific Directory.

43. LYELL, CHARLES. Principles of Geology, Vol. I., II. Twelfth edition, London, 1875.

44. DARWIN, CHARLES. A naturalist's voyage round the world.

45. ——. Variation of animals and plants under domestication.

46. ——. Geologische Beobachtüngen über die vulcanischen Inseln.

II. FAUNA AND FLORA.

1. GAIMARD. Description d'une nouvelle Espéce de Tortue et de trois espéces nouvelles de Scingues rapportées par MM. Quoy et Gaimard. Mémoire lu à la Soc. d' Hist. Nat. de Paris, le 7 Nov. 1823, par M. Gaimard. Tortue noire. Testudo californiana, "Quoy et Gaim." Ferussac. Bull. Soc. Nat., T. I., pp. 90–91, Paris, 1824.

2. FREYCINET, LOUIS DE. Voyage autour du Monde. Zoologie par MM. Quoy et Gaimard. Paris, 1824, pp. 174–175, pl. 40.

3. BELL, THOMAS. On a new genus of Iguanidæ (Amblyrrhynchus). *Zool. Journ.*, II., 1826, pp. 204–208. Oken Isis, XXI., 1828, pp. 940–941.

4. HARLAN, RICHARD, M.D. Description of a land tortoise from the Galapagos Islands, commonly known as the elephant tortoise (Read. Sept. 5, 1876). Journ. Acad. Nat. Sci., Phila., Vol. V., Part II., pp. 284–292, pl. XI., 1827.

5. GRAY. Zool. Misc., 1831.

6. P. Z. S., 1834, p. 113. (Tort.)

7. WIEGMAN, DR. A. F. A. Amphibien in: Dr. F. J. F. Meyen; Beitræge zur Zoologie gesammelt auf einer Reise um die Erde. Breslau und Bonn, 1835, pp. 188–189, Pl. XIII. (*T. elephantopus.*)

8. JACKSON, J. B. S., M.D. Anatomical description of the Galapagos Tortoise. Read Feb. 1st, 1837. Bost. Soc. Nat. Hist. Journ., I., 1837, pp. 443–464., Pl. XXI.; *ib.*, p. 521.

8*a*. GOULD, JOHN. Remarks on a group of Ground Finches from Darwin's collection, with characters of the new species. P. Z. S., 1837, pp. 4–7; *ib.*, p. 7–11; p. 22.

9. MILNE-EDWARDS, HENRI, Memoire sur la distribution geographique des Crustaces. Ann. Sc. Nat., 1838, 2d serie f. x., pp. 129–174; Froriep. Not. VIII., 1838, pp. 241–248; Compt. Rend. VII., 1838, pp. 514–522.

10. GRAY, J. E. Zoology of Beechey's voyage to the Pacific and Behring's Straits. London, 1839.

11. NEBOUX, ——. Descriptions d'oiseaux nouveaux recueillis pendant l' expedition de da Vénus. *Revue Zool.*, III., 1840, pp. 289–291; 320–325.

12. BELL, THOMAS. Some account of the Crustacea of the coasts of South America, with descriptions of new genera and species, founded principally on the collections obtained by Mr. Cuming and Mr. Miller [1835]. Zool. Soc. Trans., II., pp. 39–65, 1841.

13. Zoology of the "Beagle," 1832–36. London, 1843.

14. BELL THOMAS. Reptiles collected during the voyage of the "Beagle," 1832–'36. London, 1843.

15. GOULD, JOHN. In Zoology of the voyage of the "Beagle," Pl. III., 1843.

15*a*. FRESNAYE, BARON DE LA. Magasin de Zool., 1843.

16. FITZINGER, LEOPOLDUS. Systema Reptilium. Fasc. I., p. 44. Vindobonae, 1843.

17. WATERHOUSE, G. R. Descriptions of coleopterous insects collected by Charles Darwin in the Galapagos Islands. *Ann. Mag. Nat. Hist.*, 1845, pp. 19–41, Vol. XVI.

18. GRAY, J. E. Catalogue of Lizards in the British Museum. London, 1845.

19. HOOKER, JOSEPH DALTON. Enumeration of the Plants of the Galapagos Islands, with descriptions of the new species. Linn. Soc. Proc., I., 1849, pp. 276–279. Trans. Linn. Soc., XX., 1851, pp. 163–234.

20. ——. On the vegetation of the Galapagos Archipelago, as compared with that of some other tropical islands and of the continent of America. Linn. Soc., Proc. I., 1849, pp. 313–314. Trans. Linn. Soc., XX., 1851, pp. 235–262.

20*a*. BONAPARTE, PRINCE C. L. Conspectus Avium, I., p. 479. 1850–'51. Notes Ornithologiques, p. 92. Paris, 1854.

21. DUMÉRIL, C. ET. A. Catalogue méthodique des Reptiles du Museum d' Hist. nat. de Paris. Paris, 1851.

22. DUMÉRIL, A. M. C., ET BIBRON, G. Herpetologie generale ou Hist. Nat. compl. des Reptiles. Paris, 1834–'54. Vol. IV.

23. FITZINGER, LEOPOLD JOSEPH. Versuch einer Geschichte der Menagerien des K. Oester. Hofes. Wiener Sitzungsber, X., 1853, p. 403.

24. MILNE-EDWARDS. [Remarques sur la fauna des iles Galapagos.] Compt. Rend., 1859, Vol. XLVIII., pp. 147, 148.

25. THOUARS, DU PETIT, ADMIRAL. Observations faites aus iles Galapagos. Compt. Rend., 185, pp. 140–147, Vol. XLVIII.

26. GUENTHER, ALBERT. On a new snake from the Galapagos Islands (*Herpetodryas biserialis*). *Ann. Nat. Hist.*, VI., 1860, pp. 78–79. P. Z. S., 1860, pp. 97, 98.

26*a*. Konglica Svenska Fregatten Eugenies Resa omkring Jorden under Befäl af C. A. Virgin. Aren, 1831–53. Stockholm, 1861.

27. ANDERSSON, N. J. Enumeratio plantarum in insulis Galapagensibus observ. Holm., 1861, 4, c, 10, tab.

28. ——. Uber die Vegetation der Galapagos Inseln. Linnæa, XXXI., 1861–'62, pp. 571–632.

29. ——. Om Galapagos oarnes vegetation. Stockh. Acad. Handl., 1853, pp. 61–256.

30. PETERS, WILHELM CARL HARTWIG. Uber eine neue Eidechsenart (*Phyllodactylus galapagensis*) von den Galapagos Inseln. Monatsber. Berl. Ac., 1869, pp. 719, 720.

31. HABEL. Exhibition of a collection of birds from the Galapagos. P. Z. S., 1869, p. 433; P. Z. S., 1870 (May). Compt. Rend., XIX., pp. 273–277.

32. GUENTHER, ALBERT. [*Herpetodryas biserialis* and *Dromicus chamissonis*.] *Zool. Rec.*, 1870, Vol. VI., p. 115.

33. SCLATER, T. L., AND SALVIN, V. Characters of new species of birds collected by Dr. Habel in the Galapagos Islands. P. Z. S., 1870, pp. 322, 327.

34. PETERS, WILHELM CARL HARTWIG. Uber einige Arten der herpetologischen Sammlung des Berliner Zool. Museums. Monatsber. Berl. Ac., 1841, p. 645.

35. SUNDEVALL, C. J. On birds from the Galapagos Islands. P. Z. S., 1871, pp. 124–130.

36. BENTHAM, GEORGE. Notes on the classification, history, and geographical distribution of the Compositæ. Journ. Linn. Soc., XIII., 1873, p. 556.

37. DARWIN, CHARLES. Reise eines Naturfoschers um die Welt. Aus dem Englischen übersetztvon J. Victor Carus. Stuttgart, 1875, pp. 427–460. Pt. VI. Also Origin of species.

38. WALLACE, A. R. Geograph. distribution of animals. 2 vols., London, 1876. Die geographische Verbreitung der Thiere übers. v. A. B. Meyer. 2 Bd., Dresden, 1876, pp. 34–42.

39. GUENTHER, ALBERT. Extract from a letter received from Commander W. E. Cookson, R. N., concerning two large land tortoises from the Galapagos Islands. P. Z. S., 1876, p. 422.

40. GUENTHER, ALBERT, DR. Description of the living and extinct races of gigantic land tortoises. Parts I. and II., Introduction and the tortoises of the Galapagos Islands. Phil. Trans., Vol. 165, Lond, 1876, pp. 251–284, pl. 33–45.

41. STEINDACHNER, DR. FRANZ. Die Schlangen und Eidechsen der Galapagos Inseln. Festschrift d. kk. zool. botan. Ges. in Wien., 1876, pp. 303–330. pl., I.–VII.

42. COOKSON, W. E. Letter of Commander W. E. Cookson. P. Z. S., 1876, pp. 520–526.

43. SALVIN, O. On the Avifauna of the Galapagos Archipelago. Trans. Z. S., 1879, May, Vol. IX., Part IX., pp. 447–510, pls. 84–89, with a map of the archipelago.

44. GUENTHER, A. Account of the zool. coll. made during the visit of H. M. S. "Petrel" to the Galapagos Islands. P. Z. S., 1877, pp. 64–93.

45. ——. The gigantic land tortoises (living and extinct) in the collection of the British Museum. London, 1877, 4to, 96 pp., 54 pl.

46. STEINDACHNER, T. VIII., Ueber zwei neue Fischarten von den Galapagos Inseln. Sitzungsber, K. Ak. Wiss. Wien., 1878.

47. ENGLER, A. Versuch einer Entwicklungschichte der Pflanzenwelt 2 Thle., Leipzig, 1879–1881.

48. SHARPE, R. BOWDLER Notes on Anous. (*Anous galapagenis*, sp. n.) Philos. trans., CLXVIII., 1879, 469.

49. ALLEN, JOEL ASAPH. History of North American Pinnipeds. Washington, 1880, pp. 211–212, p. 769. (*Otaria jubata; Arctocephalus australis.*)

50. MARKHAM, A. H. A visit to the Galapagos. Proc. Roy. Geogr. Soc., II., 1880, pp. 742–755. Salvin's notes on birds, p. 755.

51. WALLACE, ALFRED RUSSELL. Island Life. New York, 1887, pp 261–275.

52. GRISEBACH, A. Die Vegetation der Erde nach ihrer klimat. Anormung. 2 Bds., 2 Aufl., Leipzig, 1885.

53. RIDGWAY, ROBERT. *Auk*, III., July, 1886, 331.

54. ——. Description of a recently new oyster-catcher (*Hæmatopus galapagensis*), from the Galapagos Islands. Proc. U. S. Nat. Mus., Vol IX., 1886, pp. 325, 326.

55. SHARPE, R. BOWDLER. Cat. Birds, Brit. Mus., XII., 1888, 12.

56. RIDGWAY, ROBERT. Birds collected on the Galapagos Islands in 1888. Proc. U. S. Nat. Mus., Vol. XII., pp. 101–128. Washington, 1889.

57. COPE, E. D. Report of the batrachians and reptiles collected in 1887–'88. Proc. U. S. Nat. Mus., Vol. XII., pp. 141–147, Washington, 1889.

58. BOULENGER, G. A. Catalogue of the Chelonians, Rhynchocephalians, and Crocodiles. London, 1889.

59. HOWARD, L. O. (Sc. res. of expl. by St. "Albatross.") V. Annotated catalogue of the insects collected in 1887–'88. Proc. U. S. Nat. Mus., XII., 1889, pp. 185–216.

60. DALL, WILLIAM HEALY. (Sc. res. of expl. by St. "Albatross.") No. VII. Preliminary report on the collection of Mollusca and Brachiopoda obtained in 1887–'88. Proc. U. S. Nat. Mus., Vol. XII., 1889, pp. 219-362.

61. JORDAN, DAVID STARR, and BOLLMAN, CHARLES HARVEY. (Sc. rep. expl. St. "Albatross," IV.) Description of new species of fishes collected at the Galapagos Islands and along the coast of the United States of Columbia, 1887–'88. Proc. U. S. Nat. Mus., XII., 1889, pp. 149–183.

62. WAGNER, MORIZ. Die Enstehung der Artendurch Fräumliche Sonderung. Basel, 1889,

63. BAUR, G. The gigantic land tortoises of the Galapagos Islands. AM. NAT., Dec. 1889, pp. 1039–1057.

64. ——. Das Variiren der Eidechsen-Gattung Tropidurus auf den Galapagos-Inseln und Bemerkungen über den Ursprung der Insel-gruppe. *Biol. Centralbl.*, Vol. X., No. 15, 16. Sept. 15, 1890. Nachtrag, *ib.*

65. Moreno Boll. Mus. La Plata., p. 29, 1889.

66. HEMSLEY, WILLIAM BOTTING. Report on present state of knowledge of various Insular Floras. The voyage of H. M. ship "Challenger." Botany, Vol. I., London, 1885.

REVIEW OF THE PROGRESS OF AMERICAN INVERTEBRATE PALEONTOLOGY FOR THE YEAR 1890.

BY CHARLES R. KEYES.

SINCE the last consideration of the subject in this journal important contributions to American invertebrate paleontology have been made. The number of titles is considerably in excess of that of last year. Several extensive state reports have appeared; but the large majority of the papers issued have been incorporated in serials. With the exception of a few brief presentations on small zoological groups no monographical works have been distributed during the year just closed. The several great works alluded to last year as in an advanced state of preparation have been necessarily delayed by the discoveries of much new material; but the evidence at hand clearly indicates that the delay will not be unaccompanied by more suggestive results than could otherwise have been reached.

Excepting those proposed in a single brochure which has not as yet been generally distributed, the number of new species considered is very much below that of any similar period during the past decade, thus greatly emphasizing the statements made in the last "review." On a former occasion the fact was mentioned that the interdependence of the stratigraphical geologist, the biologist, and the paleontologist is constantly becoming more and more intimate. This suggestion has never been more fully corroborated than by the recent appearance of several most valuable morphological memoirs, based largely upon critical studies of extinct forms of life. Nor is the reality of the remark less apparent in certain late articles dealing with problems of stratigraphy.

In the annual report (pp. 116–120) of the Geological and Natural History Survey of Canada, Henry M. Ami has a Systematic List of Fossils with Localities referred to in Report K.

Charles E. Beecher, has in the *American Journal of Science* (3), Vol. XL.: North American Species of Strophalosia, pp. 240–246; On Leptænisca, a New Genus of Brachiopod from the Lower

Helderberg Group, pp. 238–240, 1 plate; Koninckia and Related Genera, pp. 211–219, 1 plate; and On the Development of the Shell in the Genus Tornoceras Hyatt, pp. 71–75.

I. P. Bishop communicates a note on A New Locality of Lower Silurian Fossils in the Limestone of Columbia County, N. Y., to *American Journal of Science*, Vol. XXXIX., pp. 69–70.

Samuel Calvin describes Some New Species of Paleozoic Fossils, in the Bulletin of the Laboratories of Natural History of the State University of Iowa, Vol. I., 173–181, 3 plates; also, Note on a Specimen of *Conularia missouriensis* Swallow with Crenulated Costæ, in *American Geologist*, Vol. V., pp. 207–208.

E. J. Chapman has some Remarks on the Classification of the Trilobites, with Outline of a New Grouping of These Forms; Transactions Royal Society of Canada, Vol. VII., Sec. vi., pp. 113–120.

William B. Clark notes the occurrence of certain fossils, in a Third Annual Geological Expedition into Southern Maryland and Virginia; Johns Hopkins University Circulars, No. 81, pp. 69–71.

J. M. Clarke has: As Trilobitas do Grez de Ereré e Maecurú Estado do Pará, Brazil, in the Archivos de Museu Nacional do Rio de Janeiro, Vol. IX., pp. 1–57, two plates.

E. W. Claypole considers a new form of crustacean in Paleontological Notes from Indianapolis; *American Geologist*, Vol. VI., pp. 255–260.

F. W. Cragin, in the Bulletin of Washburn College, Vol. II., pp. 65–68, has Contributions to the Paleontology of the Plains.

Coral and Coral Islands (third edition), by James D. Dana, has appeared, with considerable new material added. The author also has a note on fossils in the Taconic limestone belt at the west foot of the Taconic Range in Hillsdale, N. Y., in *American Journal of Science* (3), Vol. XL., pp. 256, 257.

William H. Dall contributes to the knowledge of the Tertiary Fauna of Florida; Transactions of the Wagner Free Institute of Science, Vol. III., pp. 1–200, 12 plates.

J. William Dawson has: A Note on a Fossil Fish and Marine Worm Found in a Pleistocene Nodule in Green's Creek, Ottawa, in *Canadian Record of Science*, Vol. IV., pp. 86–88; On Burrows and Tracks of Invertebrate Animals in Paleozoic Rocks, and Other Markings, in the Quarterly Journal of Geological Society of London, Vol. XLVI., pp. 595–618 ; and On New Species of Fossil Sponges from the Siluro-Cambrian at Little Metis, on the lower St. Lawrence, in Transactions Royal Society of Canada, Vol. VII., Sec. iv., pp. 31–55.

In the *Canadian Record of Science*, Vol. IV., pp. 104–109, William Deeks gives a List of Fossils from the Lower Helderberg formation of St. Helen's Island.

W. W. Dodge notes Some Lower Silurian Graptolites from Northern Maine, in the *American Journal of Science* (3), Vol. XL., pp. 153–155.

P. Martin Duncan, in the Journal of the Linnæan Society, Vol. XXIII., pp. 1–311, gives a Revision of Generic and Great Groups of the Echinoidea.

R. W. Ells lists many fossils in his Second Report on the Geology of a Portion of the Province of Quebec; Annual Report Geological and Natural History Survey of Canada, Vol. III., Report K.

Oliver Everett with E. O. Ulrich describes some new Silurian sponges, in the Geological Survey of Illinois, Vol. VIII., pp. 253–282.

A. H. Foord revises the Group of *Nautilus elegans* Sowerby; *Geological Magazine* (3), Vol. VII., pp. 542–552.

C. H. Gordon gives his Observations on the Keokuk Species of Agaricocrinus, in the *American Geologist*, Vol. V., pp. 257–261; and On the Keokuk Beds at Keokuk, Iowa, in the *American Journal of Science* (3), Vol. XL., pp. 295–300.

James Hall has an abstract On New Genera and Species of the Family Dictyospongidæ, in Bulletin of the Geological Society of America, Vol. I., p. 22. Also Some Suggestions Regarding ing the Subdivisions and Grouping of the Species Usually Included Under the Generic Term Orthis, in Accordance with the External and Internal Characters and Microscopic Shell Structures; pp. 19–21 of same publication.

A Preliminary Catalogue of the Fossils Occurring in Missouri is given in Bulletin No. 1, Geological Survey of Missouri, pp. 60–85, by G. Hambach.

The Occurrence of Goniolina in the Comanche Series of the Cretaceous is noted by R. T. Hill in the *American Journal of Science* (3), Vol. XL. pp. 64, 65.

Jos. F. James discusses the Maquoketa Shales and their Correlation with the Cincinnati Group of Southwestern Ohio, in the *American Geologist*, Vol. V., pp. 335–356; and, On Variation, with Special Reference to Certain Paleozoic Genera, in AMERICAN NATURALIST, Vol. XXIII., pp. 1071–1087.

T. Rupert Jones describes Some Paleozoic Ostracoda from North America, Wales, and Ireland, in Quarterly Journal Geological Society of London, Vol. XLVI., pp. 1–30; also in the same journal, pp. 534–556, Some Devonian and Silurian Ostracoda from North America, France, and the Bosphorus; and Some Fossil Estheriæ, in the *Geological Magazine*, Vol. IX., pp. 385–390.

Charles R. Keyes has a Review of the Progress of American Invertebrate Paleontology for the Year 1889, in the AMERICAN NATURALIST, Vol. XXIV., pp. 131–138; Certain Forms of Straparollus from Southeastern Iowa, in *American Geologist*, Vol. V., pp. 193–197; Genesis of the Actinocrinidae, in AMERICAN NATURALIST, Vol. XXIV., pp. 243–254; Generic Relations of Platyceras and Capulus, in the *American Geologist*, Vol. VI., pp. 6–9; Note on the Preservation of Color in Fossil Shells, in *The Nautilus*, Vol. IV., pp. 30–31; Synopsis of American Carbonic Calyptræidæ, in Proceedings of the Academy of Natural Sciences, Philadelphia, 1890, pp. 150–181; Discovery of Fossils in the Limestones of Frederick County, Maryland, in Johns Hopkins University Circulars, No. 84, p. 32; and The Naticoid Genus Strophostylus, in the AMERICAN NATURALIST, Vol. XXIV., pp. 1111–1117.

Remarks on the Nature of Organic Species are given by Joseph Leidy in Transactions Wagner Free Institute of Science, Vol. II. pp. 51–53.

J. P. Lesley has issued Volumes II. and III. of his Dictionary of Fossils; P 4, Geological Survey of Pennsylvania.

Joshua Lindahl has prepared a General Index to the Eight Reports of the Illinois Geological Survey; Paleontology, pp. 62–151 of appendix.

G. F. Mathew has Cambrian Organisms in Acadia; Transactions Royal Society of Canada, Vol. VII., Sec. iv., pp. 135–162.

A Note on Some of the Causes of Extinction of Species appears in the *American Geologist,* Vol. V., pp. 100–104, by J. M. McCreery.

S. A. Miller has the Structure, Classification, and Arrangement of American Paleozoic Crinoids into Families, in the *American Geologist,* Vol. VI., pp. 340–357; and with W. F. E. Gurley, Descriptions of Some New Genera and Species of Echinodermata from the Coal Measures and Subcarboniferous Rocks of Indiana, Missouri, and Iowa, in the Journal of Cincinnati Society of Natural History, April, 1890.

In the AMERICAN NATURALIST, Vol. XXIII., pp. 261–266, Henry F. Osborn gives The Paleontological Evidence for the Transmission of Acquired Characters.

E. N. S. Ringueberg describes some Crinoidea of the Lower Niagara Limestone at Lockport, N. Y., in the Annals New York Academy Sciences, Vol. V., p. 301.

Charles W. Rolfe has Characters and Distribution of the Genera of Brachiopoda, in the AMERICAN NATURALIST, Vol. XXIII., pp. 983–998.

Studies on Monticulipora are given in the *American Geologist,* Vol. VI., pp. 102–121, by C. Rominger.

R. R. Rowley has some Observations on Natural Casts of Crinoids and Blastoids from the Burlington Limestone, in the *American Geologist,* Vol. VI., pp. 66–67; and *Batocrinus calvini,* in same journal, Vol. V., pp. 146, 147.

Samuel Scudder has, in the Memoirs of the Boston Society of Natural History, pp. 401–472: New Types of Carboniferous Cockroaches from Carboniferous Deposits of the United States; New Carboniferous Myriapods from Illinois; Illustrations of Carboniferous Arachnida of North America, of the Orders Anthracomarti and Pedipalpi; and Insects of the Triassic Beds of Fairplay, Colorado.

In the 23d Report of the New York State Museum, pp. 230–239, Charles Schuchert has: On Syringothyris, Winchell, and its American Species; and List of the American Paleozoic Orthis, Spirifera, Spiriferina, and Syringothyris.

B. Shimek discusses the Löss and Its Fossils, in the Bulletin of the Laboratories of Natural History of the State University of Iowa, Vol. I., pp. 200–214, and Vol. II., pp. 89–98.

G. B. Simpson has Descriptions of New Species of Fossils in the Transactions American Philosophical Society, Vol. XVI., pp. 435–460.

J. B. Tyrrell incidentally refers to certain fossils from the Cretaceous of Manitoba; *American Journal of Science* (3), Vol. XL., pp. 227–232. Also has Foraminifera and Radiolaria from the Cretaceous of Manitoba, in the Transactions of the Royal Society of Canada, Vol. VIII., Sec. iv., pp. 111–115.

American Paleozoic Sponges and Bryozoa are described by E. O. Ulrich in the Geological Survey of Illinois, Vol. VIII., pp. 209–678; also New Lamellibranchiata, in *American Geologist,* Vol. V., pp. 270–284, and Vol. VI. pp. 173–181, and 382–389.

A. W. Vogdes issues as Bulletin 63 of the U. S. Geological Survey, Bibliography of Paleozoic Crustacea.

Charles Wachsmuth and Frank Springer have New Species of Crinoids and Blastoids from the Kinderhook Group of Lower Carboniferous Rocks at Le Grand, Iowa, and A New Genus from Niagara Group of Western Tennessee, in Geological Survey of Illinois, Vol. VIII., pp. 155–208; also, Peristomic Plates in Crinoids, in Proceedings Academy of Natural Sciences, Philadelphia, 1890, pp. 345–392.

Charles D. Walcott has, in the Proceedings U. S. National Museum, Vol. XIII., pp. 266–279: Descriptions New Forms of Upper Cambrian Fossils; and in Bulletin Geological Society of America, Vol. I., pp. 335–356, The Value of the Term "Hudson River Group" in Geological Nomenclature; also, A Review of Dr. R. W. Ells' Second Report on the Geology of a Portion of the Province of Quebec, with Additional Notes on the Quebec Group, in the *American Journal of Science,* Vol. XXXIX., pp. 101–115.

A. Warner notes some casts of Scolithus flattened by pressure, in the *American Geologist,* Vol. V., pp. 35–38.

In the AMERICAN NATURALIST, Vol. XXIII., pp. 710–712, C. L. Webster has a Description of a New Genus of Corals from the Devonian Rocks of Iowa; and on pp. 621–625, Contributions to the Knowledge of the Genus Pachyphyllum.

J. F. Whiteaves describes Some New Species of Fossils from the Devonian Rocks of Manitoba, in the Transactions of the Royal Society of Canada, Vol. VIII., Sec. iv., pp. 93–110, six plates.

H. S. Williams has the Devonian System of North and South Devonshire, in the *American Journal of Science,* Vol. XXXIX., pp. 31–38; and, The Cuboides Zone and Its Fauna: A Discussion of the Methods of Correlation, in the Bulletin of the Geological Society of American, Vol. I., pp. 481–500.

L. C. Wooster gives a few notes on the fossils of the Permo-Carboniferous of Greenwood and Butler counties, Kansas, in the *American Geologist,* Vol. VI., pp. 8–18.

A. H. Worthen notes certain Cretaceous fossils in the drift deposits of Illinois, Geological Survey of Illinois, Vol. VIII., pp. 1–24; also, Descriptions of Fossil Invertebrates, pp. 69–154 of the same publication.

RECENT STUDIES OF THE VERTEBRATE HEAD.

BY H. W. NORRIS.

(*Continued from page 102.*)

FROM researches on Amphioxus and the Craniata Van Wijhe ('89) concludes that the skull never consists of metameres; that only in the occipital region behind the vagus were there at one time separate cartilaginous neural arches. The parietal musculature, and the peripheral nervous system, with the exception of the I., II., and III. nerves, were once segmented in the region of the head, as well as in the body. The number of the myotomes of the head is in general nine, but in those Craniata which have no hypoglossus, less. To a cranial or a body segment belong both a dorsal and a ventral nerve, which were originally separate. Wherever in the Craniata the ventral roots are wanting the corresponding myotomes do not appear. The vagus is a complex of two dorsal nerves. There are no grounds for assuming that the Craniata ever possessed more than eight branchial sacks, unless an additional aborted one belongs to the hyoid arch.[1]

Beard ('89*a*) states that certain portions of the cranial and spinal nerves arise not as outgrowths from the central nervous system, but from the ectoderm just outside the neural tube. This mode of development agrees with that described by Kleinenberg for the parapodial ganglia of Annelida. The parapodial ganglia arise as ectodermal differentiations just above the lateral limit of the ventral cord, and like the ganglia of vertebrates arise segmentally. It is to be noted that Rabl and Dohrn both controvert the above theory. Beard farther says that before the closure of the two limbs of the neural plate the neuro-epithelium of one limb is separated from that of the other by a ciliated groove. Two bands of neuro-epithelium separated by a ciliated groove are characteristic of Annelids. This ciliated groove in vertebrates later forms most, if not all, of the ciliated epithelium of the permanent central canal.

[1] It is interesting to compare the above statements of Van Wijhe with the more recent observations of Dohrn.

Beard ('89*b*) reiterates his former conclusions that the nose, like the ear, represents a branchial sense organ. The olfactory nerve, like a typical branchial nerve, develops from two sources: from the ectoderm just outside the foundation of the central nervous system, and from the special neuro-epithelium.[2] The latter grows in length by increase within itself, and later on in development, in many cases it divides up into a number of smell-buds, comparable exactly to the sense organs of the lateral line. The origin of the olfactory nerve in reptiles is essentially similar to that in Elasmobranchs. In the chain connecting the sensory cells of a vertebrate sense organ with the central nervous system there are ganglion cells arising from three different sources: from the neuro-epithelium itself; between the lateral ganglion and the central nervous system; as a special differentiation in the central nervous system. Jacobson's organ is a specially differentiated part of the nose. There is nothing in the development of the nose *per se* to suggest a gill-cleft.

Golowine ('90*a*) confirms many of the statements of Beard. He thinks that in the chick the ectoderm situated at the sides of the not-yet-closed medullary tube represents two sensitive organs, and that from these latter the ganglionic system is developed. Beard had stated that the ganglion Anlagen are, after the first stages, independent of the ectoderm, but Golowine observed their formation from ectoderm cells up to the time the neural ridge is complete. In most respects he agrees with Beard as to the origin of the Anlagen. Before the neural ridge segments it becomes separated from the sensitive ectoderm by a layer of indifferent ectoderm. Thus in the so-called sensitive organ can be recognized two distinct portions: ganglion Anlagen and the Anlagen of the special sense organs. The neural ridge in the cephalic region divides successively into three ganglion groups. Kastschenko's conclusion that the dorsal parietes of the medullary tube degenerates to such an extent that a second closing occurs is erroneous. As the neural ridge divides, to each ganglionic segment corresponds a segment of sensitive ectoderm, which

[2] Beard, it should be remembered, holds that the neural ridge is independent of the central nervous system.

latter is to be regarded as an organ of special sense. The subsequent development of the ganglionic system is entirely independent of the special sense organs. Though later the ganglia in the region of the head are directly connected with the branchial sense organs, yet the former are never developed at the expense of the latter, Beard, Froriep, and Spencer to the contrary. The olfactory ganglia are probably formed from the neural ridge. They are not derived from the cells of the nasal fossa. The posterior roots of the cranial and spinal nerves are at first cellular, and are formed from that part of the neural ridge placed between the dorsal borders of the medullary tube.

Houssay ('90), in his observations on the development of the Axolotl, agrees with Beard as to the ectodermal origin of the Anlagen of the dorsal nerve-roots. The cranial ganglia first appear as an unsegmented ectodermal band, which afterwards extends into the trunk, forming the lateral line and nerve. In the meantime, while this posterior differentiation is occurring, the band anteriorly segments to form the cranial ganglia. The central nervous system, though at first unsegmented, is soon metameric, both in brain and spinal cord, and this metamerism is called "neurotomy." The dorsal nerve-roots arise each behind the "neurotome" of its segment,[3] this relation being secondary. The author thinks there is a complete homodynamy of the peripheral nervous system in all the metameres of the body. In discussing the metamerism of the head he states that the segments do not appear with any regularity as to time and location. The neurotomes, neuromeres, branchiomeres, and myotomes agree in the manner of segmentation. He believes he finds evidence of the existence of an oculohypophysial, a buccal, a hyomandibular, and an auditory segment. The IV. and VI. nerves cannot be certainly identified as ventral roots.

Gaskell ('89*a*, '89*b*, '90) considers the central nervous system of vertebrates as made up of two parts: a non-nervous supporting tube, and a nervous portion surrounding that tube. He bases his observations on Ammocœtes, and concludes that the non-nervous tube is the altered alimentary canal of a Crustacean-like

[3] *Vide* Platt and McClure.

ancestor. The functions of the supraœsophageal and the infrasœophageal ganglia and the ventral chain correspond to the functions of those parts of the vertebrate central nervous system which are situated in the same anatomical position, with respect to the non-nervous tube, as the corresponding ganglia of the Crustacean with respect to the alimentary canal. The Crustacean cephalic stomach is represented in the brain of the Ammocœtes by the choroid plexuses, the continuation of the tissue of the latter that lines the cavities of the brain being the ventral portion of the stomach walls. The nervous masses lying outside this lining epithelium are probably composed of tissue arranged in the same way and of the same structure as the supraœsophageal, infraœsophageal, and thoracic ganglia of the Crustacean-like ancestor. The two nervous masses which form the brain proper and olfactory lobes are in the position of the supraœsophageal ganglia with respect to the walls of the cephalic stomach, and in connection with a special optic portion which gives rise to eyes of a strictly Arthropod type. Rudiments of the old mouth and œsophagus are seen in the infundibular process. A bilaterally arranged mass of pigmented tissue that fills up a large portion of the space around the brain is looked upon as the rudiment of the Crustacean liver, while its duct is seen in the conus postcommissuralis. The pigment is regarded as the remains of the blood channels of the old cephalic liver. The original Crustacean-like ancestor had a pair of median eyes, represented in the Ammocœtes by the "dorsal" and "ventral" pineal eyes, the dorsal eye remaining functional much longer than the ventral. The central nervous system of the Ammocœtes, and therefore of all other vertebrates, is the direct descendant of the Arthropod nervous system in all respects. The vertebrate alimentary canal is formed by the prolongation of a respiratory chamber, the latter containing the gill-bearing legs of the ancestral form; the legs being still present in Ammocœtes in the form of branchial bars. The segmental cranial nerves are the nerves arising from the infraœsophageal and thoracic ganglia. The first two cranial nerves are the nerves of special sense arising from the supraœsophageal ganglia.[4]

[4] To fully comprehend the above theory one must ignore all morphological principles.

Miss Platt ('89) finds that in the chick the first mesodermal cleft occurs anterior to the first protovertebra, and that two protovertebræ are subsequently formed anterior to this cleft. The four pairs of protovertebræ entering into the formation of the head are thus evenly divided by the first mesodermal cleft. During the second and third days of incubation the medullary tube becomes divided by a series of constrictions into vescicles or neuromeres. Anterior to the first protovertebra there are seven of these neuromeres. As the protovertebræ are successively formed, neuromeres are added, each opposite a protovertebra; but as the neuromeres often appear before the corresponding protovertebræ, the former are independent of any mechanical influence of the latter. The anterior neuromere gives rise to the prosencephalon, thalamencephalon, and mesencephalon. The development of these three brain vescicles is coincident with the cranial flexure, and the latter may be due to the rapid development of the dorsal and lateral walls of the first cerebral vescicle. From the second neuromere is developed the cerebellum. The succeeding vescicles, including those between the first five protovertebræ, share in the formation of the medulla oblongata. Orr and Béreneck correctly described the number and appearance of the neuromeres, and the ultimate relations of the cranial nerves to these medullary folds observed by them in the lizard and chick are the same as those observed by Platt in the salmon and chick. The primitive relation in the chick is different. The V. nerve arises not as Béreneck says, from the outward convexity of the first neuromere of the medulla, but from the concavity between the first and second neuromeres. Opposite this concavity a ridge[5] projects into the fourth ventricle, composed of lines of cells converging like the rays of a fan toward the point of origin of the V. nerve. At the time when the VII. and VIII. nerves have just left the neural ridge, from the concavities between the second and third and the third and fourth neuromeres spring nerve-fibres which unite in a large ganglion. Thus at an early period the VII. and VIII. nerves are distinct from each other, but as the third neuromere is smaller than the others the space between the roots

[5] See Orr. *Journ. Morph.*, Vol. I., No. 2, p. 335.

of these two nerves is very slight. The IX. nerve arises from the concavity between the fourth and fifth neuromeres. The X. nerve is evidently made up of the fused roots of several spinal nerves. The latter arise like the cranial nerves from corresponding concavities in the spinal cord. The cranial neuromeres are to be regarded as homologous with the neuromeres of the spinal cord. Orr stated that the internal ridges projecting into the fourth ventricle corresponded not to the nerve-roots, but to the spaces between the nerve-roots. In Acanthias, Platt ('90) describes a pair of head-cavities anterior to the premandibular cavities. This observation is of great interest in the light of Dohrn's recent studies on Torpedo.

While many observers have noted the relations of the cranial nerves to the neuromeres, McClure ('89, '90) seems to be the first to attempt to comprehend the entire brain in a schematic, segmental arrangement of neuromeres. Basing his observations on the embryos of Amblystoma, Anolis, and the chick, he concludes that the primitive brain consisted of approximately ten neuromeres, which, beginning with the anterior, he calls olfactory, optic, oculomotor, trochlear, trigeminal, abducens, facial, auditory, glossopharyngeal, and vagus neuromeres respectively. He follows closely the observations of Orr on the lizard, and quotes his definition of a typical neuromere.[6] The forebrain is to be considered as consisting of two neuromeres and possibly part of a third, the midbrain of two, and the hindbrain of six. "The olfactory neuromere is connected with the olfactory nerve." The two neuromeres of the forebrain described by McClure are the same as those described by Orr in the region of the thalamencephalon of the lizard posterior to the secondary forebrain. But Orr says "they never give off any nerves." As McClure studied Orr's preparations, this disagreement is interesting. The segmental nerve belonging to the optic neuromere is assumed to have degenerated. The midbrain probably consists of two neuromeres, since the III. and IV. nerves arise from this brain segment, and the view is further strengthened by the fact that Scott figures in Petromyzon an appearance of neuromeres in the midbrain.

[6] Orr. *Journ. Morph.*, Vol. I., No. 2, p. 335.

Hoffmann found that the trochlear nerve arises in the lizard from the anterior neuromere of the hindbrain, and subsequently shifts forward to the midbrain. McClure promises to prove that Hoffman has probably mistaken the posterior segment of the midbrain for the anterior segment of the hindbrain, but as he figures in the chick and lizard an unnamed neuromere between the midbrain and trigeminal neuromere, the promise is not fulfilled. This unnamed neuromere is described by Orr. Hoffman says it forms part of the cerebellum. Miss Platt, with whom McClure closely agrees in many points, but whose work he utterly ignores, states essentially the same. Four neuromeres of the hindbrain give rise to dorsal nerve-roots. The abducens and auditory neuromeres possess no nerve-roots, and in Amblystoma the abducens neuromere is wanting. The VI. nerve cannot be certainly identified with any neuromere. It should be noticed that while McClure gives theoretical evidence for the separate origin of the VII. and VIII. nerves, Miss Platt has already demonstrated the same. McClure agrees with Miss Platt in homologizing the neuromeres of the brain with those of the spinal cord. He considers the dorsal roots of the nerves to arise from the outward convexity of the respective neuromeres, or to be intersomitic. Miss Platt says that in the chick the spinal nerves spring from the internal ridge opposite the myotomes or somites. Houssay says that in the Axolotl the dorsal nerve-roots arise each behind the neurotome of its segment. Nine myotomes in the body region would correspond to the nine spaces between ten neuromeres of the spinal cord. Therefore our author says the nine mesodermal head-somites, or myotomes, of Van Wijhe "theoretically correspond to the nine spaces between the ten encephalomeres."[7]

Ayers ('90*a*, '90*b*) sees in Amphioxus, which, as Steiner showed, consists of a series of physiologically equal segments, a region comparable to the brain of higher vertebrates. The anterior end of the neural axis of Amphioxus is a brain, for it terminates the

[7] This statement shows a surprising lack of acquaintance with the morphology of the head. Moreover, Dohrn's recent investigations show conclusively that the primitive brain consisted of many more than ten segments.

neural axis anteriorly; it is intimately connected with the sense organs, eye and nose; it gives off at least two pairs of sensory nerves with peripheral ganglia; it possesses ganglionic centers of coördination; it has an enlarged central canal with three diverticula, two optic and one olfactory; it is the largest part of the nervous system in early stages; it possesses a cranial flexure; it shows a differentiation into ganglionic and fibrous tracts. The large collections of ganglion cells just posterior to the thalamocœle are homologous with the medullary nuclei of other vertebrates. In the ontogeny of other vertebrates the brain passes through a condition which remains as adult in Amphioxus. All the sense organs of the anterior end of the body of Amphioxus are probably paired. The eye-spot is the forerunner of the vertebrate eye, and shows several stages in development. The pigment of the eye-spot is contained in cells that lie normally inside the bounds of the nerve-mass. The pigment bodies form a part of segmental sensory structures. Each of the pigment bodies forms a deposit in an amœboid cell. The pigment of the the axial nervous system of Amphioxus is in process of migration towards the anterior end of the body. The vertebrate ear has developed within the phylum above Amphioxus, and arose from one of the primary sense organs of the lateral line system, at a period phylogenetically later than the formation of the canal system of these sense organs. The ear capsula does not separate two morphologically different portions of the brain.[8] The higher sense organs of all the Cyclostomata are all paired. The parietal-pineal eye of the Cyclostomata and other vertebrates has been developed from a median portion of the pigmented eye of Amphioxus. The neural axis of all vertebrates is coëxtensive with that of the chorda. The pituitary prominence of the skull of vertebrates does not mark a fixed point. The chondro- or ossicranium possesses no more segmental value than the intestine. The head-cavities possess relatively the greatest importance before a primordial cranium has made its appearance. The hypophysis arose in the vertebrate phylum long after the appearance of the chorda, and was connected with the infundibulum. It arose as a

[8]See Rabl. Theorie des Mesoderms.

taste organ, and the infundibulum was its nerve. The optic and trochlear chiasms have arisen within the vertebrate group above the Amphioxus condition. The large number of gill-slits in Amphioxus is due to physiological conditions, the branchial apparatus serving for collecting food as well as for respiration.

LITERATURE.

'90*a*. AYERS, H. Contribution to the Morphology of the Vertebrate Head. *Zool. Anz.*, No. 344, 1890.

'90*b*. ——. Vertebrate Cephalogenesis. *Jour. Morph.*, Vol. IV., No. 2, 1890.

'89*a*. BEARD, J. Some Annelidan Affinities in the Ontogeny of the Vertebrate Nervous System. *Nature*, p. 259, 1889.

'89*b*. ——. Morphological Studies, No. 4: The Nose and Jacobson's Organ. *Zool. Jahrb.*, Bd. III., Heft. 5, 1889.

'89*a*. GASKELL, W. H. On the Relation between the Structure, Function, Distribution, and Origin of the Cranial Nerves; together with a Theory of the Origin of the Nervous System of Vertebrata. *Jour. Physiol.*, Vol. X., p. 153, 1889.

'89*b*. ——. On the Origin of the Central Nervous System of Vertebrates. *Brain*, Vol. XII., p. 1, 1889.

'90. ——. On the Origin of Vertebrates from a Crustacean-like Ancestor. *Quar. Jour. Mic. Sci.*, No. CXXIII., 1890.

'90*a*. GOLOWINE, E. P. Sur le développement du système ganglionnaire chez le Poulet. *Anat. Anz.*, No. 4, 1890.

'90*b*. ——. Sur le développement du système ganglionnaire chez le Poulet. Travaux de la Société des Naturalistes de St. Pétersbourg, Tome, XXI., 1890.

'90. HOUSSAY, F. Études d'embryologie sur les vertébrés. Archiv. de zool. expér. et gén., VIII., No. 2, 1890.

'89. MCCLURE, C. F. W. The Primitive Segmentation of the Vertebrate Brain. *Zool. Anz.*, No. 314, 1889.

'90. ——. The Segmentation of the Primitive Vertebrate Brain. *Jour. Morph.*, Vol. IV., No. 1, 1890.

'89. PLATT, JULIA B. Studies on the Primitive Axial Segmentation of the Chick. Bull. Museum Compar. Zool., Harvard College, Vol. XVII., No. 4, 1889.

'90. ——. The Anterior Head-Cavities of Acanthias. *Zool. Anz.*, No. 344, 1890.

'89. VAN WIJHE, J. Die Kopfregion der Cranioten beim Amphioxus nebst Bemerkungen über die Wirbeltheorie des Schädels. *Anat. Anz.*, No. 18, 1889.

RECORD OF AMERICAN ZOOLOGY.

BY J. S. KINGSLEY.

(Continued from Vol. XXV., page 259.)

HEXAPODA.

WHEELER, W. M.—On the appendages of the first abdominal segments of embryo insects. Trans. Wisc. Acad., VIII., p. 87, 1890.—Figures and describe these organs in many forms, and regards them as glandular.

PATTEN, WM.—Is the ommatidium a hair-bearing sense bud? *Anat. Anz.*, V., p. 353, 1890.

RILEY, C. V.—Some insect pests of the household. IV., Cockroaches. *Insect Life*, II., 266, 1890.

HYATT, A., AND ARMS, J. M.—Guides for science-teaching. No. VIII., Insecta. Boston, 1890, pp. xxiii+300, 13 plates.—See AM. NAT., Jan., 1891.

WEED, C. M.—Partial bibliography of insects affecting clover. Bull. Ohio Agr. Exp. Sta., Tech. Series, I., p. 17.

COCKERILL, T. D. A.—Asymmetry in insects. *Ent. Mo. Mag.*, XXV., p. 382.

* PACKARD, A. S.—Notes on the epipharynx and the epipharyngeal organs of taste in mandibulate insects. *Psyche*, V., p. 222.

* MCNIELL, JEROME.—The male element the originating factor in the development of species. *Psyche*, V., 269.

COCKERELL, T. D. A.—Entomological notes from Colorado. *Ent. Mo. Mag.*, XXV., 324, 363, 1889.

WEBSTER, F. M.—Garden insects. *Insect Life*, III., 148, 1890.

Proceedings of the second annual meeting of the Association of Economic Entomologists. *Insect Life*, III., p. 180, 1891.

RILEY, C. V.—The outlook of applied entomology. *Insect Life*, III., p. 181, 1891.

COOK, A. J.—Work of the entomologists in the experiment stations. *Insect Life*, III., p. 212, 1891.

SMITH, J. B.—Fertilizers as insecticides. *Insect Life*, III., p. 217, 1891.

BRUNER, L.—Notes on beet insects. *Insect Life*, III., p. 229, 1891.

FLETCHER, JAS.—Notes upon some injurious insects of the year in Canada. *Insect Life*, III., p. 247, 1891.

RILEY, C. V.—Report of the entomologist. Rep. U. S. Dep. Agric. for 1888, p. 53, 1889. Contains essays upon the fluted scale (*Icerya purchasi*), hop-plant louse, and papers by Riley and Howard, Webster, Alwood, Walker, and reports by field agents of the entomologist.

* COCKERELL, T. D. A.—On the variation of insects. *Entomologist*, XXII., 176, 198, 226, 243, 1889.

HENSHAW, S.—The more important writings of B. D. Walsch and C. V. Riley. Washington, 1890.

* COCKERELL, F. D. A.—Temperature and melanism. *Entomologist*, XXIII., 133, 1890.

* ——Evolution of insect galls; *l. c.*, 73.

* ——Colorado entomology; *l. c.*, p. 19.

C[ALVERT], P. P.—Elementary entomology. *Ent. News*, I., 70, 86, 102, 119, 140, 157, 1890.

SLOSSON, A. T.—Winter collecting in Florida. *Ent. News*, I., p. 81, 101.

SKINNER, H.—Geographical variation; *l. c.*, p. 84, 1890.

SMITH, J. B.—Catalogue of the insects of New Jersey. In final report of state geologist, Vol. II., p. 486, 1890.

COOK, A. J.—Teaching entomology. *Insect Life*, III., p. 107, 1890.

OSBORN, H.—On the use of contagious diseases in contending with injurious insects. *Insect Life*, III., 141, 1890.

SCHWARTZ, E. A.—Notes on the comparative vitality of insects in cold water. Trans. Ent. Soc. Washington, I., p. 208, 1890.

——Stray notes on injurious insects in semi-tropical Florida; *l. c.*, p. 221, 1890.

HOWARD, L. O.—A few additions and corrections to Scudder's "Nomenclator Zoologicus"; *l. c.*, p. 258, 1890.

FLETCHER, JAS.—[Presidential address before Entomological Club, A. A. A. S.] *Entom. Amer.*, VI., 1, 1890.—Economic entomology.

Cockerell, T. D. A.—Appendix to notes on insect fauna of high altitudes. *Can. Ent.*, XXII., 76, 1890.—Orthoptera and Lepidoptera.

Wickham, H. F.—A month on Vancouver Island. *Can. Ent.*, XXII., 169, 1890.—Results of collecting.

Cockerell, T. D. A.—A suggestion as to the generic nomenclature of insects. *Can. Ent.*, XXII., 173, 1890.—Use of section names.

Cook, A. J.—On teaching entomology. *Can. Ent.*, XXII., 193, 1890.

Proceedings of the Entomological Club of the American Association for the Advancement of Science. *Can. Ent.*, XXII., 193, 213, 1890.—Proceedings of Indianapolis meeting. For papers, *vide infra*.

Murtfeldt, M. E.—Some experiences in rearing insects. *Can. Ent.*, XXII., 220, 1890.

Cockerell, T. D. A.—Notes on the insect fauna of high altitudes in Custer county, Colorado. *Can. Ent.*, XXII., 55, 1890.

French, G. H.—Subdivision of genera. *Can. Ent.*, XXII., 251, 1890.

Robertson, C.—Flowers and insects. *Bot. Gazette*, XIV., pp. 120, 172, 297, 1889; XV., pp. 79, 199, 1890.

——Flowers and insects. Trans. St. Louis Acad. Sci., V., p. 449, 1890.

Wheeler, W. M.—Two cases of insect mimicry. Proc. Wisc. N. H. Socy., 1889, p. 217.

THYSANURA.

Fernald, H. T.—Studies on Thysanuran anatomy. J. H. U. Circ., IX., 62, 1890.

Bergroth, E.—Note on *Lepisma domestica* Packard. *Ent. Amer.*, VI., 233, 1890.—Is Thermobia = Thermophila preoc.

ORTHOPTERA.

Wheeler, W. M.—Über ein eigenthümliches organ im Locustidenembryo. *Zool. Anz.*, XIII., p. 475, 1890.—Disc-like organ in front of head.

* PICTET, A.—Mem. Soc. Phys. N. H. Geneve, XXX.—Describes *Idostatus* [n. g.] *californicus* [n. s.].

BRUNER, L.—Local outbreak of grasshoppers in Idaho. *Insect Life*, III., 135, 1890.

HOWARD, L. O.—Note on the mouth-parts of the American cockroach. Trans. Ent. Soc. Washington, I., p. 216, 1890.

TOWNSEND, TYLER.—Further note on *Dissoteira* (*Œdipoda*) *carolina; l. c.*, p. 266, 1890.

GODING, F. W..—A new Orthopter from Tennessee. *Entom. Amer.*, VI., 13, 1890.—*Stetheophyma doranii.*

BRUNER, L.—Ten new species of Orthoptera from Nebraska. Notes on habits, wing variation, etc. *Can. Ent.*, XXIII., p. 37, 1891.—*Cycloptilus borealis, Ceuthophilus pallescens, Udeopsylla compacta.*

PSEUDONEUROPTERA.

CALVERT, P. P.—Notes on a few Virginia dragon-flies. *Ent. Notes*, I., p. 22, 1890.

WADSWORTH, M.—List of dragonflies (Odonata) taken at Manchester, Kennebec co., Maine. *Ent. Notes*, I., pp. 36, 55, 1890.—List of 43 species.

CABOT, L.—The immature state of the Odonata, Pt. III., Cordulinæ. Mem. M. C. Z., XVII., p. 1, 6 pls., 1890.

* HAGEN, H. A.—Synopsis of the Odonata of North America. I. *Psyche*, V., 2 VI., 1889.

CALVERT, P. P.—Additional notes on some North American Odonata. *Ent. News*, I., p. 73, 1890.

BEUTENMULLER, W.—Mode of oviposition of certain species of Odonata. *Entom. Amer.*, VI., p. 165, 1890.

KIRBY, W. F.—On some new or little-known species of Libellulinæ from Jamaica. *Ann. and Mag. Nat. Hist.*, VI., p. 231, 1889.

* KIRBY, W. F.—A revision of the subfamily Libellulinæ, with descriptions of new genera and species. Trans. Zool. Soc. London, XII., p. 249, 1889.

* HAGEN, H. A.—Synopsis of the Odonata of North America. No. II., The genus Anax. *Psyche*, V., p. 303, 1890.

COLEOPTERA.

* VAN DORSBURGH, DE VRIES.—Nueva especie de Tachys. Mem. Soc. Cient. Antonio Alzate, Mex., III., 1890.

RIVERS, J. J.—Habits in the life-history of *Pleocoma behrensii*. *Zoe.*, I., p. 24, 1890.

WEBSTER, F. M.—Injury to grass from *Gastroidea polygoni*. *Insect Life*, II., p. 275, 1890.

RILEY, C. V.—The rose chafer (*Macrodactylus subspinosus* Fabr.) *Insect Life*, II., 295, 1890.

WEBSTER, F. M.—Experiments with the plum curculio. *Insect Life*, II., p. 305, 1890.

CHITTENDEN, F. H.—Notes on Languria. *Insect Life*, II., p. 346, 1890.

WEBSTER, F. M.—An experiment with Coccinellidæ in the conservatory. *Insect Life*, II., p. 363, 1890.—Did not destroy Aphides, etc.

WEED, C. M.—Food plants of the clover-stem borer. AM. NAT., XXIV., p. 867, 1890.

* WATERHOUSE, C. O.—Description of two new Central American Buprestidæ, *Ann. and Mag. Nat. Hist.*, V., No. 27.

WICKHAM, H. F.—On the habits of some Meloini. *Ent. News*, I., p. 89, 1890.

SCHWARTZ, E. A.—Sudden spread of a new enemy to clover. Trans. Ent. Soc., Wash., I., p. 248, 1890.—*Sitones hispidulus*.

LENG, C. W.—Synopsis of Cerambycidæ. *Entom. Amer.*, VI., pp. 9, 65, 97, 104, 156, 185, 213, 1890.

RILEY, C. V.—Platypsyllus egg and ultimate larva; *l. c.*, p. 27, 1890.

RIVERS, J. J.—Description of a new Cychrus; *l. c.*, p. 71.—*C. fuchsianus* (Cal.).

HORN, G. H.—[Description of *Cychrus merkelli*, from Idaho]; *l. c.*, p. 71, 1890.

WICKHAM, H. F.—Remarks on some western Tenebrionidæ; *l. c.*, p. 83, 1890.

CHITTENDEN, F. H.—On the habits of Phlœophagus and Stenoscelis; *l. c.*, p. 99, 1890.

RIVERS, J. J.—Three new species of Coleoptera; *l. c.*, p. 3, 1890.—*Amblychila baronii* (Ariz.), *Cychrus* (*Brennus*) *oreophilus* (Cal.), *Necydalis barbaræ* (Cal.).

SMITH, J. B.—Notes on Elaphidion; *l. c.*, p. 136, 1890.

HAMILTON, J.—Notes on Coleoptera. No. 6. *Can. Ent.*, XXII., p. 237, 1890.

HARRINGTON, W. H.—Notes on a few Canadian Rhynchophora. *Can. Ent.*, XXIII., p. 21, 1891.

HORN, G. H.—A synopsis of the Halticini of boreal America. Trans. Am. Ent. Soc., XVI., p. 163, 1889.—Many new species described. The new genera are Pseudolampis, Phydanis, Hemiphrymus, Hemiglyptus, Leptotrix.

*TOWNSEND, T.—Contribution to a list of the Coleoptera of the lower peninsula of Michigan. *Psyche*, V., p. 231, 1889.

* RIVERS, J. J.—A new genus and species of North American Scarabæidæ. Proc. Cal. Acad., I., p. 100.—*Anoplognatha dunniana.*

CHITTENDEN, F. H.—Remarks on the habits of some species of Cleridæ. *Ent. Amer.*, VI., 154, 1890.

——Notes on the habits of some species of Rhynchophora; *l.c.*, 167, 1890.

BEUTENMULLER, W.—Food habits of some Chrysomelidæ; *l.c.*, 175, 1890.

HAMILTON, J.—[On Leptura]; *l.c.*, 214.

LUY, C. W.—[On Leptura]; *l.c.*, 215.

HARRINGTON, W. H.—Two interesting monstrosities. *Can. Ent.*, XXII., 124, 1890.—*Pterostichus lucublandus* with trifid tarsus.

——On the lists of Coleoptera published by the geological survey of Canada, 1842–1888. *Can. Ent.*, XXII., 135, 153, 184, 1890.—Gives catalogue of species.

BEUTENMULLER, W.—On the food habits of North American Rynchophora. *Can. Ent.*, XXII., 200, 258, 1890.

OSBORN, H.—On a peculiar form of Coleopterous larva. *Can. Ent.*, XXII., 217, 1890.—With dorsal prolegs, in stems of Helianthus; adult unknown.

* HEYDEN, L. VON—Europäisch-nordamerikanische Coleoptera Synonyma. *Entom. Zeit.*, IX., p. 131, 1890.

* ——Über *Epicauta bicolor* Fischer, *armeniaca* Fald., und *dichroa* Leconte. *Wien. Ent. Zeit.*, IX., 99, 1890.

* BEUTENMULLER, W.—Description of the larva of *Megalodacne fasciata. Psyche*, V., 317, 1890.

* HAGEN, H. A.—*Otiorhynchus sulcatus* injurious to plants in greenhouses in Mass. *Psyche.*, V., 333, 1890.

GILLETTE, C. P.—Parasitism of *Hippodamia convergens. Psyche*, V., 279, 1889.

WEED, C. M.—On the preparatory stages of the 20-spotted lady bird. Ohio Exp. Sta. Bulletin., Tech. Series, I., p. 3, 1889.

* CASEY, T. L.—A preliminary monograph of the North American species of Troglophœus. Ann. N. Y. Acad. Sci., IV., 322, 1889.

GILLETTE, C. P.—Notes on the plum curculio and plum gouger. *Insect Life*, III., 227, 1891.

SMITH, J. B.—An invasion by the clover-leaf beetle. *Insect Life*, III., p. 231, 1891.

FORBES, S. A.—On the life-history of the white grub. *Insect Life*, III., p. 239, 1891.

HART, C. A.—The life-history of wire worms. *Insect Life*, III., 246, 1891.

RILEY, C. V., and HOWARD, L. O.—The plum curculio. Rep. Dep. Agric. for 1888, p. 57, 1889.

WEBSTER, F. M.—Experiments in rearing the plum curculio (*Conotrachelus nenuphar*) from plums and other fruit; *l. c.*, p. 78, 1889.

SCHWARTZ, E. A.—On the Coleoptera common to North America and other countries. Trans. Ent. Soc. Washington, I., p. 182, 1890.

——Notes on the tobacco beetle (*Lasioderma serricorne*). Trans. Ent. Soc. Washington, I., p. 225, 1890.

——Food plants and food habits of some North American Coleoptera. Trans. Ent. Soc. Washington, I., p. 231, 1890

——Myrmecophilus Coleoptera found in Temperate North America; *l. c.*, p. 237, 1890.—List of known species, etc.

*SCHMIDT, J.—Ent. Nachrichten, XVI., Feb., 1890.—Describes *Saprinus sulcatulus*, from California.

LIEBECK, CHAS.—Cicindelidæ of a season. *Ent. News.*, I., p. 158, 1890.—Eastern Pennsylvania and New Jersey.

* LEFEVRE, E.—Ann. Soc. Ent. France, VI., 9, 1889–'90.—Describes *Alethaxius tuberculifer* (Mex.)

* FLETIAUX, E., AND SALLÉ, A.—*l. c.* Catalogues 517 species of Coleoptera (some new) from Guadeloupe.

* BATES, H. W.—Additions to the Cicindelidæ fauna of Mexico. Trans. Ent. Soc. London, 1890.

SMITH, J. B.—An experience with rose-bugs. *Insect Life*, III., p. 113, 1890.

WEBSTER, F. M.—Notes upon some insects affecting corn; *l. c.*, p. 159, 1890.

SMITH, J. B.—Notes on the plum curculio. *Insect Life*, III., p. 219, 1891.

——An experience with the rose-bug. *Insect Life*, III., p. 220, 1891.

HEMIPTERA.

WEED, C. M.—Injuries of the buffalo tree-hopper. AM. NAT., XXIV., p. 785, 1890.

——Fourth contribution to a knowledge of the life-history of certain little-known plant lice. Bull. Ohio Exp. Sta., Tech. Series, I., p. 111, 5 pls., 1890.

WHEELER, W. M.—Über drüsenastigen gebilde im ersten abdominal segment der Hemipterenembryonen. *Zool. Anz.*, XII., 317, 1889. *Vide* AM. NAT., XXIII., 644, 1889.

* WEED, C. M.—Second contribution to the a utumnlife-history of certain little-known Aphididæ. *Psyche*, V., p. 208, 1889.

* ——The strawberry root louse (*Aphis forbesii* n.s.); *l. c.*, p. 273, 1889.

* ——Notes on *Emesa longipes; l. c.*, p. 280, 1889.

* VAN DUZEE, E. P.—On a new species of Pediopsis; *l. c.*, p. 238.—*P. occidentalis.*

WOODWORTH, C. W.—North American Typhlocybini; *l. c.*, V., p. 211, 1889.

ASHMEAD, W. H.—The corn Delphacid (*Delphax maidis*). *Psyche*, V., 321, 1890.

OSBORN, H.—On the metamorphoses of a species of Aleyrodes. Proc. Iowa Acad. Sci. for 1888, p. 39, 1890.

RICE, G.—Historical sketch of the rise and downfall of the cottony cushion scale (*Icerya purchasi*). State Board of Hort. California, Bull. XIV., 1890.—Controversial.

VAN DUZEE, E. P.—Descriptions of two Jassids from the cranberry bogs of New Jersey. *Entom. Amer.*, VI., p. 133, 1890.—*Thamnotettix fitchii*, *Athysanus striatulus*; also figure of *Agallia 4-punctata*.

BERGROTH, E.—Note on the genus Protenor; *l. c.*, p. 217, 1890.

VAN DUZEE, E. P.—Review of the North American species of Bythosocopus; *l. c.*, p. 221, 1890.—New species are *B. distinctus* (N. Y., Md., N. C.), *cognatus* (Ont., N. Y.)

——New North American Homoptera. *Can. Ent.*, XXII., p. 110, 1890.—*Idiocerus crategi* (Ont., N. Y.), *Platymetopius frontalis* (N. Y., Iowa).

OSBORN, H.—Period of development in Mallophaga. *Can. Ent.*, XXII., p. 219, 1890.

VAN DUZEE, E. P.—New North American Homoptera; II. *Can. Ent.*, XXII., p. 249, 1890.—*Pediopsis tristis* (Kan., I., Mich., N. Y., Ont.), *Thamnotettix lurida* (Iowa, Mich.)

* UHLER, P. R.—Observations on North American Capsidæ, with descriptions of new species. Trans. Maryland Acad. Sci., 1890, p. 73.—Describes as new *Ectopiocerus* (n.g.) *anthracinus*, *Teleorhinus* (n.g.) *cyaneus*, *Closterocoris* (n.g.) *ornata*, *Coquillettia* (n.g.) *insignis*, *Xenetus regalis*, *X. scutellatus*, *Rhinocapsis* (n.g.) *vanduzeii*, *Mimoceps* (n.g.) *insignis*, *M. gracilis*, *Macrotylus regalis*, *M. tristis*, *M. vestitus*.

GODING, F. W.—A new apple pest. *Ent. News*, I., p. 123, 1890.—*Empoasca birdii* (Ill.)

RILEY, C. V., and HOWARD, O.—Some new Iceryas. *Insect Life*, III., p. 92, 1890.—*I. rosæ* (Fla.), *I. montserratensis* (W. I.), *I. palmeri* (Mex.), and a catalogue of the known (6) species.

OSBORN, H.—Note on the period of development in Mallophaga. *Insect Life*, III., p. 115, 1890.

CURTICE, C.—The animal parasites of sheep. Washington, 1890.—*Trichodectes limbatus T. climax, T. sphærocephalus.*

SMITH, J. B. Some questions relating to Aphididæ. *Insect Life*, III., p. 226, 1891.

FORBES, S. A.—A summary history of the corn root Aphis. *Insect Life*, III., p. 233, 1891.

RILEY, C. V.—The flutes scale (*Icerya purchasi*). Rep. Dep. Agr., 1888, p. 80, 1889.

——The hop plant louse; *l. c.*, p. 93, 1889.

ALWOOD, W. B.—Report on experiments with remedies against the hop louse; *l. c.*, p. 102, 1889.

SCHWARTZ, E. A.—Notes on *Cicada septendecim* in 1889. Trans. Ent. Soc. Washington, I., p. 230, 1890.

VAN DUZEE, E. P.—New California Homoptera. *Entom. Amer.*, VI., pp. 35, 49, 77, 91, 1890.—*Pediopsis nubila* (Uhler Mts.), *Agallia oculata, Thamnotettix subænea, Th. coquilletii, Th. geminata, Th. flavocapitata, Th. atropuncta, Th. limbata, Allygus inscriptus, Platymetopus elegans, Deltocephalus coquilletti, D. minutus.*

SMITH, E. F.—The black peach Aphis; *l. c.*, pp. 101, 201.—*Aphis persicæ-niger* nov. (Mich. to Va.)

THYSANOPTERA.

GARMAN, H.—The mouth parts of the Thysanoptera. Bull. Essex Inst., XXII., p. 24, 1890.

——An asymmetry of the head and mouth parts of the Thysanoptera. *Can. Ent.*, XXII., p. 215, 1890.

HYMENOPTERA.

* ASHMEAD, W. H.—On the Hymenoptera of Colorado. Bulletin Colorado Biol. Assoc., No. 1, 1890, pp. 47.

HOWARD, L. O.—Two spider-egg parasites. *Insect Life*, II., 269, 1890.—*Acoloides* (n.g.) *saitidis*, and *Bæus americanus* See *Insect Life*, II., p. 359.

RILEY, C. V., and HOWARD, L. O.—The wheat saw-fly. *Insect Life*, II., 286, 1890.—Note on and figure of *Cephus pygmæus.*

——Two parasites of the garden web-worm. *Insect Life*, II., p. 327, 1890.—Figures *Limneria eurycreontis*.

——Some of the bred parasitic Hymenoptera in the national collection. *Insect Life*, II., 348, 1890; III., p. 15, 57, 151, 1890.

HOWARD, L. O.—A North American Axima and its habits. *Insect Life*, II., 365, 1890.—*Aximi zabriskiei*, nov. sp., from New York.

MALLY, F. W.—*Monostegia ignota* Norton. *Insect Life*, III., 9, 1890.—Notes on life-history.

COCKERELL, T. A. D.—What are the uses of bright colors in Hymenoptera? *Ent. News*. I., p. 65, 1890.

FOX, W. J.—Aculeate Hymenoptera new to Pennsylvania and New Jersey. *Ent. News*, I., 83, 1890.

CORDLEY, A. B.—Sports in venation; *l. c.*, p. 88, 1890.

FOX, W. J.—*Polybia cubursis* in Florida, *l. c.*, p. 93, 1890.

* SCHLETTERER.—Ann. K. K. Nahrrh. Hofsmuseum Wien. IV., No. 4, 1889.—Monograph of Evaniidæ. 5 American species of Gasteruption.

* KOHL. F. F.—*l. c.* Describes new N. A. species of Cremonus, Ammoplanus, and Stigmus.

FOX, W. J.—Descriptions of three new species of Hymenoptera. *Ent. News*, I., p. 106, 1890.—*Hoplisus foveolata* (*Fla.*), *Philanthus eurynome* (*Fla.*), *Cœlioxys dolichos* (*Fla.*)

FOX, W. J.—Three new species of aculeate Hymenoptera; *l. c.*, p. 137, 1890.—*Sphex* (*Isodontia*) *macrocephalus* (*Pa.*) *Miscophus americanus* (*N. J.*), *Photopsis cressoni* (*N. J.*)

GILLETTE, C. P.—Oviposition of Anomalon. *Ent. News*, I., p. 139, 1890.

* EMERY, C.—Bull. Soc. Ent. Itala., XXII., 1890.—Catalogues 107 species of Formicidæ (18 new) from Costa Rica, and describes new species of Pseudomyrma, Strumigenys, Epiptritis, etc., from America.

KOHL, F. F.—Ann. K. K. Hofmuseum Wien. V., 1890.—First part of monograph of Sphex; new species are *S. morio* (Brit. Columbia), *S. præstans* (Cal.), *S. neoxenus* (Vancouv.), *S. excisus* (Vanc.), *S. clavipes* (Cuba), *S. maximiliani* (Mex.), *S. spiniger* (Mex.).

HOWARD, L. O.—A new and remarkable Encyrtid: Is it parasitic? *Insect Life*, III., p. 145, 1890.—*Tanaostigma coursetiæ*, n. g. and sp. from Mex.

——The habits of Pachyneuron. *Insect Life*, III., 218, 1890.

——Note on the hairy eyes of some Hymenoptera. Trans. Ent. Soc. Washington, I., p. 195, 1890.

COVILLE, F. V.—Notes bumble bees; *l. c.*, p. 197, 1890.

MARLATT, C. L.—An ingenious method of collecting Bombus and Apathus. Trans. Ent. Soc. Washington, I., p. 216, 1890.

HOWARD, L. O.—Authorship of the family Mymaridæ. Trans. Ent. Soc. Washington, I., p. 221, 1890.

ASHMEAD, W. H.—An anomalous Chalcid. Trans. Ent. Soc. Washington, I., p. 234, 1890.—*Hoplocrepis albiclavis*, n. g. and sp. from Florida.

——Remarks on the Chalcid genus Halidea; *l. c.*, p. 264.—Describes as new, *H. schwazi* (Virginia).

GILLETTE, C. P.—New Cympidæ. *Entom. Amer.*, VI., 21, 1890.—*Neuroterus flavipes*, *N. vermes* (on bur oak), *Acraspis niger* (white oak), *Dryophanta liberacellentæ* (on red and scarlet oaks), *Rhodites multispinosa* (Rose).

——Notes on *Sigalphus curculionis* and *Sigalphus canadensis*. *Canad. Ent.*, XXII., 114, 1890.

ROBERTSON, C.—New North American bees of the genera Halictus and Prosopis. Trans. Am. Ent. Soc. XVII., p. 315, 1890.—*H. forbesii*, *H. pectinatus*, *H. nelumbonis*, *H. 4-maculatus*, *H. gracilis*, *H. palustris*, *H. cressonii*, *H. albipennes*, *H. tegularis*, *P. nelumbonis*.

COMSTOCK, J. H.—On a saw-fly borer in wheat. Bull. Cornell Exp. Sta., No. 11, p. 127, 1889.—*Cephus pygmæus*.

* BASSETT, H. F.—A short chapter in the history of Cynipidous gall flies. *Psyche*, V., p. 214, 1889.

* GILLETTE C. P.—Notes on certain Cynipidæ, with descriptions of new species. *Psyche*, V., 214, 1889.

* JACK, J. G.—*Emphytus cinctus* in America. *Psyche*, V., 279, 1889.

* SCUDDER, S. H.—Power of vision in Vespidæ. *Psyche*, V., p. 279, 1889.

* ASHMEAD, W. H.—On the Hymenoptera of Colorado; descriptions of new species, notes, and a list of the species found in the state. Bull. I., Colorado Biol. Assoc.—64 new species. Neolarra Microbracon, and Dolichopcephalus are new genera.

CLARKSON, F.—*Argiope riparia* and its parasite; *Ichneumon aranearum* and its parasite, a Chalsid fly. *Can. Ent.*, XXII., p. 122, 1890.

HARRINGTON, W. H.—Two interesting monstrosities. *Can. Ent.*, XXII., p. 124, 1890.—*Fœnus tarsitorius* with trifid tibia.

COOK, A. J.—*Aphidius granariaphis*, n. sp. *Can. Ent.*, XXII., p. 125, 1890.—From grain Aphis in Michigan.

ROBERTSON, C.—Habits of *Empor bombiliformis. Can. Ent.*, XXII., p. 216, 1890.

ASHMEAD, W. H.—Descriptions of some new Canadian Braconidæ. *Can. Ent.*, XXIII., p. 1, 1891.—*Bracon brachyurus, melanaspis, nigrodorsum, Spathius canadensis, Cœnophanes borealis, Rhogas mellipes, Microplitis cincta, Opius canadensis, O. bicarinatus, Idiasta macrocera, Aphidius tumacrogas, A. crassicornis, A. pinaphidis, A. bifaciatus, A. nigriceps, Lipolexis fuscicornis, Histeromerus canadensis.*

DAVIS, W. T.—The habits of a ground hornet. *Can. Ent.*, XXIII., p. 9, 1891.—*Stizus speciosus.*

RECENT BOOKS AND PAMPHLETS.

Abstract Proceedings Thirty-fifth Annual Meeting Haverford Alumni Association.

ADLER, CYRUS.—Report on the Section of Oriental Antiquities in the U. S. Nat. Mus., 1888. Rept. Smith. Inst., 1887-'88. From the Smithsonian Institution.

ALLEN, J. A.—The American Ornithologists' Union: A Seven Years' Retrospect. From the author.

Annual Report Arkansas Geological Survey, 1888.

Annual Report of the Board of Regents of the Smithsonian Institution, 1887 and 1888.

AYERS, H.—Contribution to the Morphology of the Vertebrate Head. Separat-Abdruck aus dem *Zoologischen Anzeiger*, No. 344, 1890. From the author.

BEAN, T. H.—New Fishes Collected off the Coast of Alaska and the Adjacent Region Northward. Ext. Proc. U. S. Nat. Mus., Vol. XIII., pp. 37-45. From the author.

BERGEN, J. Y. and F. D.—A Primer of Darwinism and Organic Evolution. From the authors.

BOETTGER, O.—Bericht über die Leistungen in der Herpetologie während des Jahres 1887. From the author.

BONNEY, S. G.—On the Crystalline Schists and Their Relation to the Mesozoic Rocks in the Lepontine Alps. Ext. *Quart. Journ. Geo. Soc.*, May, 1890. From the author.

BREWER, W. H.—The English Race-Horse: A Lesson in the History and the Art of Breeding. Ext. Conn. State Board Agri., 1889. From the author.

Bulletin No. 22, Expt. Stat. Cornell University, Dec., 1890. Insects Injurious to Fruits.

CAPELLINI, G.— Ichyosaurus campylodon e Tronchi di Cicadee Nelle Argille Scagliose dell' Emilia, From the author.

CHAPMAN, H. C., and A. P. BRUBAKER.—Researches upon Respiration Made in the Physical Laboratory of Jefferson Medical College.—On the Consumption of Oxygen and the Production of Carbon Dioxide in Animals. Exts. Proc. Phila. Acad. Nat. Sci., Jan., 1891. From the authors.

COX, C. F.—Protoplasm and Life. From the author.

DALL, W. H.—Description of a New Species of Sand Shell from Cuba—*Vertigo cubana*. Ext. Proc. U. S. Nat. Mus., 1890. From the author.

DAMES, W.—*Anarosaurus pumilio*, nov. gen. nov. sp. Besonderer Abdruck aus der Zeitschrift der deutschen geologischen Gesellschaft, Jahrgang, 1890. From the author.

FRAZER, P.—The Philadelphia Meeting of the International Congress of Geologists. Ext. *Am. Geol.*, June, 1890. From the author.

FRECH, F.—Die Korallen Fauna der Trias. *Paleontographica*, Vol. XXXVII., Part I.

GAUDRY, A.—Les Enchainements du monde Animal dans le temps géologique Fossiles Secondaires. From the author.

Geological Survey of New Jersey, Vol. II., Part II., Zoology.

GOODE, G. B.—The Origin of the National Scientific and Educational Institutions of the United States. Ext. Papers Am. Hist. Assoc. From the author.

GILBERT, C. H.—A Preliminary Report on the Fishes Collected by the "Albatross" on the Pacific Coast of North America, 1889, with Descriptions of Twelve New Genera and Ninety-two New Species. Ext. Proc. U. S. Nat. Mus., Vol. XIII., pp. 49-126. From the author.

HECTOR, J.—Twenty-fourth Annual Report of the New Zealand Colonial Museum and Laboratory. From the director.

HOUGH, W.—Fire-Making Apparatus in the U. S. National Museum. Ext. Rept. Nat. Mus., 1887–'88. From the Smithsonian Institution.

HYATT, A., and J. M. ARMS.—Guides for Science-Teaching. Insecta. From the authors.

IVES, J. E.—Echinoderms from the Northern Coast of Yucatan and the Harbor of Vera Cruz. Ext. Proc. Phila. Acad. Nat. Sciences, Sept., 1890. From the author.

JOUY, P. L.—The Collection of Korean Mortuary Pottery in the United States National Museum. Rept. Nat. Mus. 1887–'88. From the Smithsonian Institution.

KILIAN, W.—Système Crétacé. Ext. de l'Annuaire Géologique Universal, 1888. From the author.

KIRK, E. C.—The Manual-Training Idea as a Factor in Dental Education. Ext. *Dental Cosmos*, June, 1890. From the author.

LOMMEL, E.—Georg Simon Ohm's wissensshaftliche Leistungen. Festrede gehalten in der offentlichen Sitzung der k. b. Akad. der Wissenschaften zu Munich, Marz, 1889. From the author.

LUCAS, F. A.—The Expedition to the Funk Island, with Observations upon the History and Anatomy of the Great Auk. Ext. Rept. Nat. Mus, 1887–'88. From the Smithsonian Institution.

——Catalogue of Skeletons of Birds Collected at the Abrolhos Islands, Brazil, the Straits of Magellan, and the Galapagos Islands, 1887–'88. Ext. Proc. U. S. Nat. Mus., Vol. XIII., pp. 127–130. From the author.

LYDEKKER, R.—Catalogue of the Fossil Reptilia and Amphibia in the Britis Museum. Parts III. and IV. From the trustees of the British Museum.

LYMAN, B. S.—An Old Japanese Foot Measure. Ext. Proc. Numismatic and Antiquarian Society of Phila., 1887–'89. From the author.

MEYER, A. B.—Der Knochen Entfettungsapparat des Königlichen Zoologischen Museums zu Dresden. From the author.

NEWBERRY, J. S.—The Paleozoic Fishes of North America. Monograph U. S. Geol. Survey, No. 16. From the author.

NEWHALL, C. S.—The Trees of Northeastern America. From the author.

OVERLOOP, E. VAN.—Les Origines du Bassin de l'Escant avec une Planche et deux Cartes. Annexe an Bull. de la Soc. Belge de Geol. de Paleont. et d'Hydrol. From the author.

PARKER, T. J.—Skeleton of the New Zealand Crayfishes (Palinurus and Paranephrops). Studies in Biology for New Zealand Students, No. 4. From the author.

PEET, S. D.— Prehistoric America. Vol. II., Emblematic Mounds and Animal Effigies. From the author.

Report State Geologist of New Jersey. Vol. II., Mineralogy, Botany, Zoology.

RIDGWAY, R.—Further Notes on the Genus Xiphocolaptes of Lesson. Ext. Proc. U. S. Nat. Mus., Vol. XIII. From the Smithsonian Institution.

JORDAN, D. S., and B. W. EVERMANN.—Description of a New Species of Fish from Tippecanoe River, Indiana. Ext. Proc. U. S. Nat. Mus., Vol. XIII. From the Smithsonian Institution.

SCHLOSSER, M.—Die Differenzierung des Säugethiergebisses. Sonder-Abdruck aus dem *Biologischen Centralblatt*, Bd. X., June, 1890. From the author.

SCOTT, W. B.—Beiträge zur Kenntnis der Oreodontidæ. Separat-Abdruck aus *Morpholog. Jahrbuch*, XVI. Band, 2 Heft. From the author.

SMITH, D. T.—The Philosophy of Memory. Reprint from *Practitioner and News*.

——The Georgia Wonder, Mrs. Abbott. From the author.

STEFANESCU, G.—Cursŭ Elementarŭ de Geologiă, Bucharest. From the author.

TRUE, F. W.—A Review of the Family Delphinidæ. Bull. U. S. Nat. Mus., No. 36. From the author.

TUCKERMAN, F.—On the Gustatory Organs of Some Edentata. Aus der internationalen Monatsschrift f. Anat. u Phys., 1890, Bd. VII., Heft 9. From the author.

WATKINS, J. E.—Report on the Section of Transportation and Engineering in the United States National Museum, 1888. Ext. Rept. Nat. Mus., 1887-'88. From the Smithsonian Institution.

WHEELER, H. J.—Soils and Fertilizers. Bull. No. 8, Agri. Exp. Stat., Rh. Is. State Agri. School, Sept., 1890.

WILSON, T.—A Study of Prehistoric Anthropology. Ext. Rept. Nat. Mus., 1887-'88, pp. 597-671.

——Results of an Inquiry as to the Existence of Man in North America during the Paleolithic Period of the Stone Age. Ext. Rept. Nat. Mus., 1887-'88. From the Smithsonian Institution.

WOODWARD, A. S., and C. D. SHERBORN.—A Catalogue of British Fossil Vertebrata. From the authors..

RECENT LITERATURE.

TO THE EDITOR OF THE AMERICAN NATURALIST:

DEAR SIR: I have just seen the review of the "Guide for Science-Teaching," No. VIII., on "Insecta," in the January number of the AMERICAN NATURALIST. One sentence of that review cannot be passed unnoticed by those who are laboring for the cause of science-teaching. When Mr. Kingsley says: "We cannot help wishing that we had some really first-class text-book of entomology which would attack the subject from every side," I must reply, emphatically, that this was the very thing we did not aim to write, and which we did not think was needed.

As is well known, the "Science-Guides" are written for the great body of teachers of our public and private schools,—that is, for teachers of the young from five to eighteen years of age. Do these teachers need a text-book which shall attack the subject from every side, or a guide *to show them how to make their pupils attack the subject from a few sides?* Will boys and girls trained from early childhood to do this by direct observation and comparison of specimens in hand *need a text-book* when they enter college? I think not. Nowhere along the way is a text-book needed, even if it be "first-class," and nowhere should it be placed between nature and the child. It may be that the special student in college or the professor would find a *reference book*, presenting the subject from every point of view, very convenient, but it is not for specialists that those most deeply interested in the cause of science-teaching are working. These recognize the fact that while the science primer, conceived in the scientific spirit, but treating the subject from a few sides, may shoot far below the minds of specialists, a reference book, treating the subject from every side, would fall as a heavy weight upon the teachers of the young, *because it would not meet their imperative needs.*

The time has come when we must explain the ways and means whereby teachers shall be able to make their large classes of children do independent observational and mental work,—in a word, scientific work,—and when this difficult task is accomplished we may rest assured that the power thus gained by the young will enable them to seek and find for themselves those original sources of knowledge on any given subject which are contained in many libraries. We may go even a step farther and make the logical prediction that this same power will enable some of them, perhaps, to add to the stock of absolute knowledge.

I desire to thank Mr. Kingsley for the expression of his views on other subjects concerning which naturalists are by no means agreed, and I write this reply only because the part of his review to which I have taken exception touches upon what Professor Hyatt and I consider a vital principle of science-teaching.

Respectfully yours, J. M. A.

General Notes.

GEOLOGY AND PALEONTOLOGY.

On a Collection of Fossil Birds from the Equus Beds of Oregon.[1]—Silver Lake is one of the alkaline lakes of Oregon, and lies somewhat to the southward of the middle part of the state, or, approximately speaking, in 43° .05′ N. lat., and 43° 25′ W. long. In a direct line it is a little more than sixty miles from Fort Klamath. It is a small lake, not over twelve miles long by some eight or nine wide. Fresh water passes into it from Silver Creek over a swampy delta near its northwestern extremity, and a smaller stream of pure water enters it from the westward. The topography of the country about it, as well as the geology of the vicinity, is interesting, and the fauna will well repay the further investigation of the naturalist. So far as at present known, there is but one species of fish that occurs in this lake, *Mylo-leucus formosus* of Girard, one of the Cyprinidæ. Numerous species of aquatic birds are found in numbers on the lake, and frequent its limiting shores and marshes. Chief among these are the swans and geese, the pelicans and the cormorants. *Æchmophorus occidentalis*, the western grebe, represents one of the constantly present podicipidine forms found upon this sheet of water; and there they may be

[1] Read before the Biological Society of Washington, March 21st, 1891.

seen at any time of the day, either singly or in pairs. Probably, although I have no authority for it, the larger waders and several species of the limicoline birds are also to be found upon the shores of Silver Lake during the vernal and autumnal migrations.

At various distances, and in nearly all directions from it, are to be found a number of other lakes more or less like the one we have been considering, though in most instances larger than it, as in the case of Abert's Lake, found some forty-five miles to the southward and eastward.

In the Oregon desert, about forty miles east of Silver Lake, lies Fossil Lake, so named from the rich deposit of fossil mammals, birds, fish, and so forth that have been found there. This lake has long since dried up, though water may yet be obtained by digging, and that at a depth of two feet or more, anywhere over its former bottom. This latter is a perfect mine of wealth for the paleontologist, as it is absolutely filled with the fossil remains of many of the former inhabitants of, or animals that resorted to, what at one time must have been a sheet of water considerably like Silver Lake. Unfortunately for science, when the cattle men first went into that country they gathered up as objects of curiosity the majority of the best fossils of this locality, and they have thus been forever lost to us. This will account, I think, for nearly the entire absence of bird skulls among that kind of material subsequently obtained there by naturalists.

Professor Thomas Condon, of the University of Oregon, was the first scientific man that visited Fossil Lake, and he made a very carefully selected and highly valuable collection there; and some of the fossil birds found by him are now in my hands for description. A few years afterwards, Professor Cope despatched one of his assistants there, Mr. Chas. H. Sternberg, of Lawrence, Kansas, who made an enormous collection on the same ground. Later, in the '80's, Professor Cope visited the region in person, and made another fine collection, including many forms previously found by both Professor Condon and Mr. Sternberg.

In the November number, 1889, of the AMERICAN NATURALIST, Professor Cope, in an article entitled "The Silver Lake of Oregon and Its Region," to which I am indebted for the information above recited, presents us with some of the results of his eminently important researches in that country.

Setting aside the mammals and other vertebrates, it is my intention to say only a few words here about the collection of fossil birds that were obtained by the authorities mentioned.

After these latter were safely transferred east by their distinguished owner and deposited in his cabinets, he, in various scientific publications, described a number of them. They were the following species, viz.: Two forms of Podiceps, *P. occidentalis* and *P. californicus*, the first-named Professor Cope believing to be identical with the now-existing *Æchmophorus occidentalis* of that region, a species referred to above; *Podilymbus podiceps*, *Graculus macropus* s. n., *Anser hypsibatus* s. n., *canadensis*, *albifrons gambeli*, and another species near *Anser nigricans*; also a swan, which he named *Cygnus paloregonus*, and finally the fossil remains of *Fulica americana*. There were many other species still remaining, and a few years afterwards—that is, early in the present year—Professor Cope did me the honor to pass all this material into my hands for full description and illustration. Coming, as it does, just as I am about to undertake that volume of my "Osteology of the Birds of the United States" which has to deal with the water birds, now in course of preparation, this material is especially welcome to me, as the fossil forms can be conveniently compared with the existing species of birds which I shall describe in that work.

This beautiful collection of fossils consists of some fifteen hundred or more specimens of bones, many of which are perfect, many of which can be restored, and many fragmentary pieces.[2] They are all perfectly clean, the vast majority of them being of a deep leaden hue, almost black in some instances, and exhibit their characters admirably. My preliminary examination of this material leads me to believe that there are still over twenty species of fossil birds represented by it which still remain to be described. This is interesting in view of the fact that up to the present time there have been less than fifty fossil birds of the United States described by naturalists. As we all know, they constitute the rarest of all vertebrate fossil remains. So far as the birds are concerned, when the chapter is written and printed on the Equus beds of Fossil Lake, of later Tertiary times, it may prove that some of those forms still exist; others are undoubtedly extinct; while the general character of the whole agrees with forms that go to make up the existing avifauna of that region. But a close study of the departures therefrom is of the highest importance, and it is rendered the more interesting from the fact that we can compare it with the mammalian, reptilian, and icthyian faunæ of the same horizon. I find that some of these bones must have belonged to rather remarkable types of birds, and different from anything now in existence. They were all found either on or in the loose, friable deposit, the sedimentary

[2] The writer here exhibited some fine selected specimens from the collection, and submitted them to the members of the society present for their examination.

remains of the former bottom of the lake. Furthermore, such comparative studies of this material as a whole is enhanced by the discovery of other relics found commingled with it. Of this Professor Cope has said that "Scattered everywhere in the deposit were the obsidian implements of human manufacture. Some of these were of inferior, others of superior workmanship, and many of them were covered with a patine of no great thickness, which completely replaced the natural lustre of the surface. Other specimens were as bright as when first made. The abundance of these flints was remarkable, and suggested that they had been shot at the game, both winged and otherwise, that had in former times frequented the lake. Their general absence from the soil of the surrounding region added strength to this supposition. Of course it was impossible to prove the contemporaneity of the flints with animals with whose bones they were mingled, under the circumstances of the mobility of the stratum in which they all occurred. But had they been other than human flints, no question as to their contemporaneity would have arisen. . . . . The probability of the association is, however, greatly increased by the discovery, by Mr. Wm. Taylor, of paleolithic flints in beds of corresponding age, on the San Diego Creek, Texas."[3]

Should, in the future, sufficient evidence come to light to establish any such theory as this, then there will indeed be opened to us another important and interesting chapter upon the paleontologic history of man.—R. W. SHUFELDT, *Takoma Park, D. C.*

Flora of the Great Falls Coal Field, Montana.—Prof. J. S. Newberry gives an interesting account of this flora in the *American Journal of Science*, XLI., March, 1891. A number of specimens were submitted to him for examination, which he found without exception to be species described by Sir Wm. Dawson from the Kootanie Group, Canada, or by Prof. Heer from the Kome Group, Greenland. Further examination by Prof. Fontaine showed them to be also identical with fossils of the Potomac formation. This proves conclusively the general identity of the geological horizons of these four groups, and confirms the view that the Potomac group is Lower Cretaceous, and not Jurassic. A comparison with the Old World forms leads Prof. Newberry to assert that the Potomac, the Kootanie, and the Kome groups represent perhaps distinct but closely related epochs of the Neocomian or Lower Cretaceous of the Old World.

The paper closes with a brief description of the new species: *Chiropteris williamsii, Chiropteris spatulata, Zamites apertus, Baiera*

[3] AMERICAN NATURALIST, Nov., 1889, pp. 979, 980.

brevifolia, Chadophlebis augustifolia, Sequoia acutifolia, Podzamites nervosa, and Oleandra artica Heer.

Secular Disintegration of Rocks.—In a recent paper Mr. Raphael Pumpelly insists that the recognition of the importance of secular disintegration is essential to the proper interpretation of some of the most difficult points in the study of the crystalline schists. It gives a key to the problem in the Green Mountains, N. H. He instances Iron Mountain, Mo., as a convincing illustration of a deep-reaching disintegration in pre-Silurian time, in a region which has not been folded. A mantle of disintegrated rock would be easily and quickly removed by the breaching action of the advancing sea line. "If we substitute this process in each period for the accepted one of slow erosion and breaching of hard rock, we shall," says the writer, "have to materially reconsider our time scales, in so far as they depend upon the rate of accumulation of detrital materials." (Bull. Am. Geol. Soc., Vol. II.)

The Origin of the Bahama Islands.—A careful study of the geography and geology of the Bahamas leads Dr. Northrop to declare himself in favor of a theory of elevation of these islands, instead of subsidence. The main facts that bear on the question of the most recent movement are as follows:

1. The soft calcareous mud on the west coast of Andros grows gradually harder and harder toward inland.

2. The depth of the fine calcareous deposit close to shore.

3. The extension of the pine forest.

4. Mangroves were found high above water-mark apparently dying, but none were seen in situations that indicated that the water was becoming too deep for them.

Note was taken of the extensive erosion of both the surface and the shore line of the islands. (Trans. N. Y. Acad. Sciences, Oct. 13, 1890.)

Geological News. — General. — In a recent paper on the "Resources of the Black Hills," Mr. Robert T. Hill says that this region is certainly capable of supporting a large and prosperous population. Aside from its agricultural resources and scenic beauty, it possesses bituminous coal and coke of good quality, lubricating and illuminating oil, with a possibility of natural gas, ores of precious metals, and of iron, copper, and tin. (Am. Inst. Mining Engineers, Sept., 1890.)

Paleozoic.—Prof. Alexander Winchell calls attention to some Canadian rocks in the vicinity of Echo Lake. They consist of rugged strata standing vertically, with a strike east,—a discordance of stratification with the Huronian beds, which dip at an angle of 20°, with a strike mostly northeast and southwest. He is convinced of their identity with the vertical strata in Minnesota, and the Kewatin system. Also, they are the prolongation of the "Lower Slate Conglomerate" of the Thessalon valley. (*Am. Geol.*, Dec., 1890).——Charles Proiser has examined the records of drilling in western central New York, and from these well sections has compiled a general section giving the thickness of the different geological formations, together with the total thickness of the series from the lowest Coal Measures down to the Archean. The results show that the thickness of these formations has been greatly underestimated. (*Am. Geol.*, Oct., 1890.)——Messrs. H. R. Geiger and Arthur Keith have worked out the structure of the Blue Ridge near Harper's Ferry, and refer the disputed sandstones to the Upper Silurian. (Bull. Am. Geol. Soc., Vol. II., pp. 155–164.) ——The recent studies of C. Willard Hayes in the Southern Appalachians have shown a modification of the well-recognized types of *unsymmetrical fold* and the *reversed fault*, namely, broad *overthrust faults* which, as developed in Northwestern Georgia, are comparable in magnitude with those of the Scottish Highlands and the Rocky Mountains, as described by Geikie and McConnell. (Bull. Am. Geol. Soc., Vol. II., pp. 141–154).——An Ordovician chert has been found in the Llandeilo-Caradoc rocks of South Scotland, which is considered by G. J. Hinde to be due to an accumulation of the tests of Radiolaria. The beds of fine-grained red and green mudstones associated with the chert favor the view of a deep-sea origin. Mr. Hinde has described twenty-five new species from this rock, referable to fifteen genera, for the most part also new. (*Ann. and Mag. Nat. Hist.*, July, 1890.)——Mr. A. Winslow states that the flexing of the strata in the coal region of Western Arkansas is essentially Appalachian. A study of the various flexures reveals many features which call for compression and lateral movement, and this movement was from the south. The date of elevation must have been post-Carboniferous and pre-Mesozoic. (Bull. Am. Geol. Soc., Vol. II., pp. 225–242.)——According to Eugene A. Smith, the Alabama Coal Measures have an aggregate thickness of 5,525 feet. They are characterized by the small amount of sulphur, by an almost entire absence of limestone, and by having a conglomerate at the top of the series. (Alabama Geol. Survey, 1890.)——Mr. A. C. Seward agrees with Dr. Stur that Asterophyllites and Sphenophyllum are parts of the same plant. This idea was first suggested in 1853 by Newberry, who stated at that time that the difference between the wedge-shaped and filiform leaves on the same plant was due to emergence and submergence. Newberry's explanation was subsequently adopted by Colemans and Kickx. (Journ. Cin. Soc. Nat. Hist., Jan., 1891.)

Mesozoic.—Mr. Otto Lerch has made a further study of the beds between the Lower Cretacic, the Trinity sands of R. T. Hill, and the Permian, a few miles west of San Angelo, Texas, and concludes that they are pre-Cretacic and post-Permian, and probably may be the continuation and southward thinning out of the Jura and Trias. (*Am. Geol.*, Feb., 1891.)——The Report of the Yorkshire Philosophical Society, 1888, contains a description of a head of *Hybodus delabechei* from the Lower Lias of Lyme Regis, Dorsetshire, England, by A. Smith Woodward, in which he says that the teeth of the Wealden species differ so much from those of the Liassic that possibly this later Mesozoic shark may eventually prove to pertain to a distinct genus. ——In discussing the economic features of the Cretaceous rocks of Texas, Mr. R. T. Hill urges the necessity of recognizing the chalky formations of Texas as a distinct geographic region of the United States. This individuality must be recognized, and the economic development based thereon, instead of the conditions of entirely different non-chalky regions. The agricultural experience of northern and eastern states will not apply to these soils, but we must go to the chalky regions of France and England, where there are analogous formations, to learn for what they are best adapted. This region is especially rich in mineral fertilizers, and there is a great variety and abundance of building material. Owing to the slightly disturbed conditions of the formations, the district east of the Pecos is not a profitable field for the search of metallic minerals. (Report Texas Geol. Survey, 1889.)——A. Smith Woodward has figured and described two groups of teeth of the Cretaceous Selachian fish Ptychodus found in the English chalk. (Ann. Rept. Yorkshire Phil. Soc., 1889.)——Montagu Browne has revised the genus Dapedius,—a group of fossil fishes not far removed from Lepidotidæ. (Trans. Leicester Lit. and Philos. Soc., Oct., 1890.)——A study of the Shasta Group leads Mr. George Becker to conclude that the conditions and associations on the British Pacific coast appear to correspond completely with those in the United States so far as the Aucella beds are concerned, and the present indications are that all of them are to be regarded as equivalent to the Gault. (Bull. Am. Geol. Soc., Vol. II., pp. 201–208.)——The newly opened oil field of Colorado is located in the valley of the Arkansas, between Pueblo and Cañon City. At present its limits are undetermined. The bituminous shales of the Colorado group, which are evidently the source of the oil, underlie a wide belt of country along the eastern base of the Rocky Mountains. Along this zone, intermediate between the mountains and plains, oil fields will probably be found in places where the shales have been somewhat affected by the proximity of the crystalline rocks, and yet have not been too much disturbed and broken. (Prof. J. S. Newberry, *School of Mines Quart.*, Vol. X., January, 1889.)——In a recent paper, Prof. Angelo Heilprin has presented the leading facts touching the geological and paleontological relations of the Cretaceous deposits of Mexico. These deposits cover, or are scattered over, the greatest part of Mexico, from the Rio Grande to (or through) the states of Colima, Michoacan, Guerero, and Oaxaca. (Proc. Acad. Nat. Sciences, Phila., Dec., 1890.)

Cenozoic.—R. Lydekker has collected circumstantial evidence which justifies him in regarding the so-called genus Sceparnodon as based upon the upper incisors of the gigantic wombat known as Phascolonus. (Proc. Roy. Soc., Vol. 49.)——Mr. George Becker has published new evidence in favor of the authenticity of the Calaveras skull, and amply sufficient of itself to prove that man existed during the auriferous gravel period in California. He has the sworn statement of John H. Neale of the discovery of a mortar and pestle and some spear-heads, in place, in the gravel underlying the lava of Table Mountain. He also records the discovery, by Mr. Clarence King, of a polished stone implement from the same locality. The character of the tools found, which indicate a high stage of development, and their association with an extinct fauna, incline some students to discredit the discoveries. Mr. Becker suggests the reasonable hypothesis that a local glaciation of the Sierra, confined to limits later than what is known as the Glacial epoch, may be made to account for the extraordinary association of neolithic implements with Pliocene bones in California. (Bull. Am. Geol. Soc., Vol. II., pp. 189–200.)——In discussing facts bearing upon the pre-Glacial drainage of Western Pennsylvania, M. P. Foshay thinks the conclusion imperative that this area must have drained northwardly into the Erie basin. This ancient basin would then include the areas now drained by the Lower Allegheny, Clarion, Redbank, Mahoning, Conemaugh, Youghiogheny, Cheat, Monongahela, and Little Beaver rivers. (*Am. Journ. Science*, Vol. XL., Nov., 1890.)——In describing the eruption of a volcano on the island of St. Vincent, W. I., Dr. Benjamin Sharp says that the mass of material thrown out from this single vent relieved an area of the earth's crust nearly as large as that of Europe. Volcanic dust fell on an island ninety-five miles to the windward in such quantities that trees were crushed to the earth by the weight of its mass. During the eruption subterranean noises were heard at Caracas, and in the midst of the Llanos, which cover a space of 36,000 square miles. (Proc. Phila. Acad. Nat. Science, 1890.)

MINERALOGY AND PETROGRAPHY.[1]

Petrographical News.—The protogine of Mont Blanc is shown by Lévy[2] to be a true eruptive, apophyses from which penetrate the surrounding schists and alter them, and break from them fragments which they hold as inclusions. These fragments have been regarded as basic segregations, and the surrounding schists have been looked upon as dynamo-metamorphosed phases of the protogine. Both of these views the author combats. Among the schists he finds eclogites, with diopside in micropegmatitic intergrowths with quartz and feldspar, amphibolites and mica-schists, each of which classes is briefly described. The segregations mentioned occur most frequently near the contact of the granite with the schists. Many of them resemble so closely certain phases of the schists that Lévy is compelled to regard them as fragments of these caught up by the eruptive during its passage from below. A microgranite from the periphery of the main mass of granite consists of corroded crystals of the first generation cemented by a granitic ground-mass. This fact is thought to be an indication of the correctness of the view that the constituents of granite are mainly of the second generation, those of the first consolidation having disappeared. To the southeast of Mont Blanc are quartz-porphyries which, according to Graeff,[3] are genetically related to the granite composing the body of the mountain. Like the latter, the porphyries have been subjected to pressure, by which process much sericite has been developed, resulting in sericite-schists. The present contact of the eruptives with the gneisses and mica-schists of the Mont Blanc "massif" is thought not to be an original contact, but one brought about by dislocations. The conclusions of Lévy and Graeff are thus seen to be in accord in some particulars, while in others they are at variance. Fuller discussions are promised later.——In the first part of a general

[1] Edited by Dr. W. S. Bayley, Colby University, Waterville, Me.

[2] Bull. des Serv. d. l. Carte. gèol. d. la France, No. 9, 1890.

[3] Archiv. des Sciences phys. et nat., Nov., 1890.

sketch of the geology of the Japanese Islands Harada[4] gives short descriptions of Archean gneisses and schists, and of eruptive rocks of more recent age. Among the schists are mentioned graphitic sericite-schists, with well-developed crystals of tourmaline and hematite, and a chloritic amphibolite whose principal feldspar is albite. Gabbros and peridotites cut the Paleozoic strata. In some specimens of the former piedmontite was noticed as an alteration product of hornblende. In the Mesozoic occurs the largest quantity of eruptives. Granite and diorite in many varieties cut through the sedimentary rocks, and change them near the contact into hornstones holding cordierite and ottrelite. In sericite-gneiss garnets are produced, in amphibolites andalusite is a new product, and in limestone wollastonite and garnet result from the contact action. The eruptives, on the other hand, become coarse-grained and porphyritic near the contact, the diorite losing hornblende and gaining quartz and orthoclase, until it finally resembles a granite. Among the effusives of this age are mentioned quartz-porphyries and porphyrites.——Weinschenck[5] communicates additional information with respect to the rocks of these islands, as a result of the study of some hand specimens. Most of the sections examined by him are of a hypersthene andesite, with a plagioclase full of inclusions, and a pleochroic monoclinic pyroxene which sometimes forms intergrowths with hypersthene. Among the rocks from the extinct volcanoes is a bronzite trachyte containing biotite, garnet, and tridymite in a ground-mass of the same minerals and zircon, in a trichitic glass. The most interesting rock of the series bears the same relation to the andesites as the augitites do to the basalts. It consists principally of acicular crystals of bronzite in a ground-mass consisting of clear glass and magnetite grains, with porphyritic plagioclase and garnets. The author calls the rock *sanukite*, from the province in which it is found.

Mineralogical News.—The regular silicates are very few in number, and of them eight are orthosilicates,—viz., *eulytite*, *zunyite*, *helvite*, *danalite*, *garnet*, *sodalite*, *nosean* and *hauyne*, and *lasurite*. These Brögger and Backström[6] would include in one group, which they would call the garnet group. The members of this group is divided into two sub-groups, in one of which the tetrahedral habit is predominant and the cleavage is octahedral. This includes the first four minerals mentioned above, and is known as the helvite group. All its members can be represented by formulas of the garnet type. Helvite may be

[4] Die Japanischen Inseln., 1st Lief., Berlin, Parey, 1890.

[5] *Neues Jahrb. f. Min.*, etc., B. B. VII., p. 133.

[6] *Zeits. f. Kryst.*, XVIII., 1890, p. 209.

written $(MnFeCa)_2(Mn_2S)Be_3(SiO_4)_3$, danalite as $(FeZnMn)_2[(Zn Fe)_2S]Be_3(SiO_4)_3$, zunyite as $[(OH)_9Fe_2ClAl_6](SiO_4)_3$, and eulytite as $Bi_4(SiO_4)_3$. The second sub-group includes the species with with dodecahedral habit and cleavage. Embraced in this is the garnet series proper, with a composition $R_3^{II} R_2^{III} (SiO_4)_3$, and the series of the alkaline garnets. The etched figures on the latter indicate that they are all tetrahedrally hemihedral, and a discussion of the best analysis of them leads to the conclusion that they are all of the chemical type. of common garnet. Sodalite is $Na_4(AlCl)Al_2(SiO_4)_3$ and nosean is $Na_4[Al(NaSO_4)]Al_2(SiO_4)_3$. In hauyne, calcium replaces some of the sodium in nosean. Lapis-lazuli, or natural ultramarine, is a mixture of several minerals, of which one is bright blue. The authors have isolated this and found it to contain:

SiO_2	Al_2O_3	CaO	Na_2O	K_2O	SO_3	S	Cl
32.52	27.61	6.47	19.45	.28	10.46	2.71	.47

Upon the assumption that this is a mixture of hauyne, sodalite, and ultramarine, it is calculated that the latter substance must be represented by the formula $Na_4[Al(S_3Na)]Al_2(SiO_4)_3$. The authors then discuss the nature of artificial ultramarine, and conclude that it is a mixture of five isomorphous substances. A microscopical examination of lapis-lazuli reveals the fact that in all cases this is a mixture of several substances, among which may be mentioned hauyne, diopside, kokscharowite, calcite, pyrite, and a muscovite-like mineral, together with a little scapolite, plagioclase, orthoclase, apatite, sphene, zircon, and an unknown, probably positive, uniaxial mineral.——The interesting Chilian minerals continue to be subjects of investigation to those who are fortunate enough to come into possession of them. Frenzel[7] describes briefly a few of the rarer among them. *Sideronatrite,* with a yellow color and a metallic lustre, has a density of 2.31, and a composition as follows:

$$\begin{matrix} SO_3 & Fe_2O_3 & Na_2O & H_2O \\ 42.93 & 22.86 & 17.49 & 15.66 \end{matrix} = 2Na_2SO_4 + Fe_2S_2O_9 + 6H_2O$$

The mineral is from Sierra Gorda, near Caracoles. It is identical with the Peruvian sideronatrite described by Raimond,[8] which, however, was regarded by him as possessing but one molecule of Na_2SO_4 to one of the iron sulphate. It is probably an alteration product of *hohmannite,* occurring associated with it, and found also in the Sierra de la Caparrosa, as brownish-red, glassy plates and crystals, often arranged in radial aggregates. Their hardness is 3, and specific gravity 2.17.

[7] *Miner. u. Petrog. Mitth.*, XI., 1890, p. 214.

[8] *Zeits. f. Kryst.*, 1882, VI., p. 627.

They remain unchanged in the air, and have the same composition as amarantite and the specimens of hohmantite[9] analyzed a short time since,—viz., $Fe_2S_2O_9 + 7H_2O$. Various other minerals from the same region are briefly alluded to in this paper, and two new ones (quetenite and gordaite)[10] are described. Messrs. Genth and Penfield[11] have examined some of these species in more detail. The material in their possession is from the Mina de la Campania, near Sierra Gordo. *Amarantite* is found to be triclinic with $a : b : c = .76915 : 1 : .57383$ $\alpha = 95° 38' 16''$, $\beta = 90° 23' 42''$, $\gamma = 97° 13' 4''$. The habit of the crystals is prismatic. The brachy, and macropinacoids are vertically striated, and a perfect cleavage is parallel to each. The optical angle $2E^{na} = 63° 3'$, and the extinction in the macropinacoid is 16°–17°, in acute β. Fibres of *sideronatrite* show a slight pleochroism, with a pale straw-yellow color parallel to the longer axis, and no color at right angles to this. The formula ascribed to the substance differs from Frenzel's formula in lacking one molecule of water. *Ferronatrite*, although obtainable only in white or grayish cleavage masses, is thought to be hexagonal. Its indices of refraction are $\omega = 1.558$, $\varepsilon = 1.613$, and its composition is $SO_3 = 51.30$; $Fe_2O_3 = 17.30$; $Na_2O = 19.95$; $H_2O = 11.89$; specific gravity = 2.547–2.578. Darapsky[12] also gives a few notes of observations on a few of the minerals from Atacama. Among these are *aromite, paposite, amarantite, hohmannite, coquimbite, fibroferrite, nebrite, botryogen, thenardite, quartz*, and *halite*.—Bauer[13] describes the first interpenetration twin of *tourmaline*, from an unknown locality. The twinning plane is R, and the forms observed in the individuals are ∞P2 and —2R. A pseudomorph of *aragonite* after calcite, from Müsen in Siegen, is one of the few instanesc described in which the latter mineral is known to have changed into the former one. They consist of shells of calcite enclosing a white granular calcite holding crystals of barite and snow-white aragonite. These fill two-thirds of the space within the shell, the remaining one-third being hollow. The pseudomorph is supposed to be due not to the molecular replacement of the calcite, but to solution of the interior of the crystal and subsequent deposition of calcium carbonate from calcium-bearing solutions containing traces of barium. By experimentation Bauer has found that barium bearing calcium carbonate solu-

[9] *Miner. u. Petrog. Mitth.*, IX., p. 397.

[10] AMERICAN NATURALIST, Dec., p. 1190.

[11] *Amer. Jour. Sci.*, Sep., 1890, p. 199.

[12] *Neues Jahrb. f. Min.*, etc., 1890, I., p. 49.

[13] *Neues Jahrb. f. Min.*, etc., 1890, I., p. 10.

tions deposit crystals with the properties of aragonite. The crystals of *lievrite*, from Dillenburg, Nassau, fall into two classes. The first includes well-developed prismatic forms with large macrodomes ($\bar{P}\infty$) on both terminations. The others are prismatic with $\bar{P}40$ and $\bar{P}\frac{2}{2}\frac{8}{5}$ on one termination. The other is attached to the gangue. Their axial ratio is .6795 : 1 : .4576. In the article by Messrs. Genth and Penfield [14] referred to above appear analyses of *picropharmacolite* from Joplin, Mo., of a substance supposed to be ———— from near Georgetown, N. M.; of *pitticite* from the Clarissa Mine, in the Tintic District, Utah; and of *gibbsite* from White Horn Station, Chester Co., Pa. The last-named mineral is discovered to be a hydrous aluminium phosphate. The pitticite corresponds in composition to $4Fe_2As_2O_8\ Fe_2(OH)_6 + 20H_2O$.——The remarkable mineral locality, Branchville, has again been reported upon by Messrs. Brush and Dana.[15] During the ten years that have elapsed since their previous report [16] extensive mining has been carried on at the locality for the purpose of obtaining quartz and microcline for technical uses. During the past two years large quantities of rare magnesian phosphates have been brought to light, and these have been investigated by the mineralogists mentioned. The minerals whose indentification is recorded are *lithiophilite*, *hureaulite*, *reddingite*, *fairfieldite*, *dickinsonite*, and *fillowite*. The lithiophilite is in rudely crystalline masses in a vein, associated with albite, quartz, and spodumene. It is, as a rule, fresh. Occasionally it is extensively altered into hureaulite through the intermediate product dickinsonite. The succession in age of its various decomposition products, among which are all the other minerals mentioned above, could not be determined, as they seem to occur together promiscuously. The hureaulite, heretofore known only at Limoges, France, is in small monoclinic crystals, varying in color from violet to orange red, and united into parallel aggregates. Their axial ratio is $a : b : c = 1.9192 : 1 : .5245$ with $\beta = 84° 1'$, on the assumption of the plane $\frac{4}{5}\bar{P}\frac{4}{3}$, determined by Descloizeaux in the Limoges crystals as the ground form. The habit of the Branchville crystals is short prismatic, with $\infty\bar{P}\infty$ and various pyramids well developed. The crystals have a good cleavage parallel to the orthopinacoid, a specific gravity of 3.149, and a composition as follows:

P_2O_5	FeO	MnO	CaO	H_2O	Quartz.
38.36	4.56	42.29	.94	12.20	1.76

[14] *Amer. Jour. Sci.*, Sep., 1890, p. 199.

[15] *Amer. Jour. Sci.*, Mch., 1890, p. 201.

[16] Ib., 1880, p. 257.

corresponding to $H_2(MnFeCa)_5PO_4+4H_2O$. Reddingite is in pinkish-white masses, and in orthorhombic crystals with an octahedral habit. The axial ratio is $a:b:c=.8678:1:.9485$, and density 3.204. Their analysis yielded Mr. Wells:

P_2O_5	FeO	MnO	CaO	H_2O	Quartz.
34.90	17.13	34.51	.63	13.18	.13

a result expressed by the formula $(FeMn)_3(PO_4)_2+3H_2O$. Fairfieldite is in transparent foliated masses of a whitish or greenish-white color and a brilliant lustre, inclining to pearly on the perfect cleavage. Its composition agrees with the symbol $Ca_2Mn(PO_4)_2+2H_2O$. Dickinsonite is a bright green chlorite-like mineral with a micaceous structure and rhombic tabular habit.——The beautiful *chalcopyrite*[17] crystals from the French Creek Mines, Chester Co., Pa., occur together with pyrite[18] imbedded in byssolite, thuringite, and calcite in pockets in a magnetic iron ore. The principal type of the chalcopyrite is the sphenoid $\frac{\frac{3}{2}P}{2}$ often modified by a scalenohedron. All the faces are striated, and frequently they are so much rounded as to preclude measurements of their interfacial angles. Twinned crystals are quite common, the combination possessing an hexagonal habit.——The rare zeolite *mordenite* has been discovered by Pirsson[19] in the cavity of an amygdaloidal basalt, forming fragments in a breccia near Hoodoo Mt. in Western Wyoming. The mineral is in very small crystals, with a specific gravity lying between 2.119 and 2.179. Their analysis yields:

SiO_2	Al_2O_3	FeO_3	CaO	MgO	K_2O	Na_2O	H_2O
66.40	11.17	.57	1.94	.17	3.58	2.27	13.31

which is equivalent to $3RAl_2Si_{10}O_{24}+20H_2O$, in which R represents potassium, sodium, and calcium. The mineral differs from ptilolite in containing more water. In crystallization it is monoclinic, and is isomorphous with heulandite. Its habit resembles that of beaumontite. $a:b:c=.4010:1:.4262$, $\beta=88°\ 30.5'$. The plane of the optical axes is perpendicular to $\infty P\grave{\infty}$, and the extinction on this face is 15° to the clino-axis.——A careful examination of the *apophyllite* of the Seiser Alps indicates to Ploner[20] that the differences in the lengths of the crystallographic axes of specimens of the minerals from different localities, and occasionally even in different parts of the same individual, are due to variations in the positions of planes to which identical symbols have been given. The new forms detected on the crystals

[17] Penfield. *Amer. Jour. Sci.*, Sep., 1890, p. 207.

[18] Penfield. Ib., III., XXXVII., p. 209.

[19] Ib., Sep., 1890, p. 232.

[20] *Zeits. f. Kryst.* XVIII., 1890, p. 337.

examined are $\frac{1}{10}P$, $\frac{1}{5}P$, $\frac{2}{7}P$, ∞P, $P\infty$, $\frac{5}{3}P\infty$, $\frac{1}{2}P\frac{3}{2}$, $3P\frac{3}{2}$, $\infty P2$, and $\infty P3$, making ninety-seven forms now known to occur in the species.——Baumhauer[21] has discovered some small but good crystals of *cryolite* in a hand specimen from Evigtok, Greenland, so twinned that both individuals have their basal planes in common, and one appears to have been revolved about 88° 2′ around an axis normal to the base. ——The limestone of Villefranque and of Biarritz, France, contains long needles of quartz and crystals of dipyr and albite,[22] the first of which must have been formed contemporaneously with the limestone, while the last two were produced by the influence of an intrusive mass of diabase upon the enclosing rock.——Traube[23] ascribes the differences in the values of the axial ratios of different *sheelites* to the amounts of molybdenum occurring in them. Analyses of many specimens reveal the fact that white and light yellow varities contain but little of this element, while the dark varieties contain quite large amounts, (1–8%). The axial ratio of the purest scheelite is 1 : 1.5315, that of calcium molybdenate is 1 : 1.5458, and that of most scheelites between these limits.——In the pegmatite veins cutting granite near Meissen, Saxony, Sauer and Ussing[24] have found Baveno twins of *microcline* in which the gridiron structure is lacking. Lamellæ of albite are intergrown with the microcline, but sufficiently large areas of the latter mineral were found to allow of careful measurements of cleavage, angles, etc. The angle between the cleavage lines is 89° 30′, and the refractive indices for sodium light $\alpha = 1.5224$, $\beta = 1.5264$, $\gamma = 1.5295$. The optical angle is $2V = 83° 41'$.——A pure white *zinc sulphide* is mentioned by Mr. Robertson[25] as occurring at Galena, Cherokee Co., Kansas. It is associated with sphalerite, and is in a form suggesting the moist, freshly prepared substance. It is saturated with water bearing a trace of sulphuric acid. Its composition is: $Zn = 63.70$; $S = 30.77$; $Fe_2O_3 = 2.40$; Insol. = 2.52.——Rinne[26] gives some good illustrations of *microcline* structure in the feldspar of the Stockholm granite and of the Kyffhäuser gneiss, and suggests reasons for regarding it as a secondary phenomenon produced in non-striated feldspar.——The *phenacite* reported by Mr. Yeates[27] from

[21] Ib., XVIII., 1890, p. 355.

[22] Beaugey. Bull. Soc. Franc. d. Min., XIII., Feb., 1890, p. 59.

[23] *Neues Jahrb. f. Min.*, etc., B. B. VII., p. 232.

[24] *Zeits. f. Kryst.*, XVIII., 1890, p. 192.

[25] *Amer. Jour. Sci.*, Aug., 1890, p. 161.

[26] *Neues. Jahrb. f. Min.*, etc., 1890, II., p. 66.

[27] *Amer. Jour. Sci.*, Sep., 1890, p. 259.

Hebron, Me., turns out upon analysis to be apatite with a tabular habit.

New Minerals.—A new borate has been discovered imbedded in the form of small, colorless, transparent, or milky-white crystals in the pinnolite of Stassfurt, Germany. The crystals are monoclinic, with two perfect cleavages perpendicular to the plane of symmetry. One of these is assumed as the base, and the other as the orthopinacoid, when the axial ratio becomes $a:b:c = 2.1937:1:1.73385$; $\beta = 80°$ 12′. The forms observed are $\infty\bar{P}\infty$, ∞P, $-P$, $\frac{1}{2}P$, $\bar{P}\infty$, and $-3\bar{P}3$. Hardness is 4–5; density, 2.127. The plane of the optical axes is perpendicular to the plane of symmetry, and makes with c an angle of 7° in acute β. $A = b$. $2H_{na} = 104° 27'$. The composition of the substance, as found by Baurath, is:

B_2O_3	MgO	K_2O	Na_2O	Cl	H_2O
52.13	13.80	8.14	.39	.35	23.83

which corresponds to $H_4Mg_2K(BO_2)_9 + 6H_2O$. The name Hintzeite has been given it by Milch.[28] The same mineral is described under the name Heintzite by Leudecke.[30] According to this investigator, the mineral is easily soluble in hydrochloric and nitric acids. An analysis yielded results different from those above given, as follows: $B_2O_3 = 60.53$; $MgO = 12.23$; $K_2O = 7.39$; $H_2O = 19.85$. The axes chosen by Leudecke have the ratios $a:b:c = 1.2912:1:1.7572$ β: 57° 41′ 4. The principal cleavages are thus parallel to oP and to $\frac{1}{2}P\infty$. The refractive index for sodium light vibrating parallel to A is 1.354. The other optical properties coincide with those determined by Milch. Prof. Groth suggests that neither of the two names suggested for the mineral be accepted until it is found which analysis is correct.——*Powellite.*—In a weathered fragment of bornite from the Devil's Mining Region, in Idaho, Mr. Melville[30] has discovered a mineral resembling scheelite in external appearance, but differing from it in composition. The crystals are small, prismatic, greenish-yellow in color, with a hardness of 3.5, and a density of 4.526. They have a resinous lustre, and are semi-transparent and brittle. Measurements of angles indicate a tetragonal symmetry with $a:c = 1:1.5445$. The planes appearing oP, P, $P\infty$, and ∞P. The composition is:

MoO_3	WO_3	SiO_2	CuO	MgO	Fe_2O_3	Al_2O_3	CuO	S
58.58	10.28	3.25	25.55	.16	1.65	tr.	tr.	und.

[28] *Zeits. f. Kryst.*, XVIII., 1890, p. 479.

[29] Ib., p. 481.

[30] *Amer. Jour. Sci.*, Feb., 1891, p. 141.

The mineral bears the same relation to calcium molybdate as scheelite does to the corresponding tungstate.——An isotropic or weakly doubly refracting mineral occurs in the nepheline-syenite of a "massif" in the Kole Peninsula, Russia. Since its properties have not yet been fully determined, its discoverer, Ramsay,[31] has not yet assigned to it a name. The mineral is red and transparent. It fuses easily, and yields water. It is attacked by acids with difficulty, has a low index of refraction, $n_{na} = 1.5223$, and possesses no cleavage. Its density is 2.753, and composition:

SiO_2	$Al_2O_3Fe_2O_3$	MnO	CuO	MgO	Na_2O	K_2O	Loss
55.88	15.19	2.67	9.53	.53	9.06	1.57	6.04

——*Leverrierite*[32] occurs in small pseudohexagonal prisms that are twinned orthorhombic forms with a prismatic angle of 128°. They have a very perfect cleavage parallel to oP, so that they may easily be mistaken for mica. Often the prisms are twisted so that they resemble worm tubes to such perfection that they have been mistaken for organic markings, and have been described under the name *bacillarites*. According to Termier, all specimens of bacillarites examined by him are prisms of the new mineral whose composition is $H_{10}Al_4Si_5O_{21}$. The hardness of the substance is 1.5, and its density 2.3–2.4. The plane of its optical axes is $\infty\bar{P}\infty$, with a negative acute bisectrix normal to oP and an optical angle $2V = 45°–52°$. It may be distinguished from muscovite by its dark color, and from biotite by its weak pleochroism, and its weak double refraction. Leverrierite is found as a metamorphic constituent in carbonaceous clay slates, and in interstratified carboniferous eruptives.

[31] Ref. *Neues Jahrb. f. Min.*, etc., 1891, I., p. 98.

[32] Bull. Soc. Franc. d. Min., XIII., 1890, p. 325.

BOTANY.

Protoplasmic Physics.—Prof. Pfeffer, of Leipzig, has published[1] the results of his studies on the taking up and extrusion of solid substances by the plasmodia of Myxomycetes, especially of *Chondroderma difforme.* He concludes that, contrary to the more generally accepted view, the inclusion of solid bodies is due not at all to reaction to chemical or contact stimulus, but is a purely mechanical process due to the weight of the body, or to its resistance to the forward movement of the plasmodium. The plasma-membrane closes behind the included object like a film of oil from which a needle is withdrawn.

Indifferent or insoluble substances are not infrequently enclosed in vacuoles, from which they may pass back into the protoplasm; but substances which can furnish nutrient material to the protoplasm are never seen in vacuoles. In from one to four days all foreign bodies are thrown out, even such as are still capable of furnishing abundant nutritive material. Bodies enclosed in vacuoles are thrown out by the rupture of the vacuoles after they have migrated to the margin of the plasmodium. Extrusion of foreign bodies occurs only during the active movementof plasmodia, and is chiefly referable to their resistance to this movement. It is, as yet, wholly impossible to explain why one body follows the movements of the protoplasm, while others are thrown out. In the study of protoplasm within the cell-wall the author observed in the root-hairs of *Trianea bogotensis* that precipitates formed in the cell-sap by the action of methyl-blue were taken up by the protoplasm, as well as crystals of calcium oxalate, and he saw both sorts of bodies returned to the vacuoles. He considers that, in view of the interchange observed, it cannot be regarded as certain that a given element of the cell-contents has arisen where it is seen in any single case.

The same author concludes, in a paper following the last,[2] that vacuoles may arise anywhere in the cytoplasm, not necessarily by division, but independently, in spite of the views of the De Vries school. In the plasmodia of Chondroderma, he has observed all the intermediate conditions between pulsating and inactive vacuoles, and has succeeded by very ingenious experiments in producing vacuoles artificially. This was done by placing a plasmodium in a saturated aqueous solution of asparagin, or some other suitable substance, which contained some

[1] Ueber Aufnahme und Ausgabe ungelöster Körper. Abhandl. d. Math.—Phys. Cl. d. Sächs Ges. de Wissensch. Bd. XVI., p. 149. (Bot. Centralbl., XLIV., 180.)

[2] Zur Kenntniss der Plasmahaut und der Vacuolen, etc.; *l. c.* p. 185. (Bot. Centralb., *l. c.*)

undissolved granules of the same substance. After it had taken up some of these granules the plasmodium was removed to pure water, when a vacuole was slowly formed about each granule, in consequence of its gradual evolution. These artificial vacuoles differed in no respect, except in size, from the natural ones, but even showed, in some cases, slight pulsations. They were seen to divide and to fuse with each other and with pulsating vacuoles, and were formed even in chloroformed plasmodia. It is evident that these vacuoles cannot be dependent on a special organ, the tonoplast of De Vries, for their formation.

Pfeffer considers the hyaloplasm and the granular plasma of the cell protoplasm to be essentially the same, and to differ merely in the presence or absence of granules of most various composition, some of which are foreign substances. He has seen the change from one to the other condition, and has observed the formation of vacuoles in both granular and hyaline plasma. He considers the existence of a plasma-membrane, distinct from the remaining cytoplasm, very probable, in view of the peculiar osmotic phenomena presented by the cytoplast. It is uncertain whether this membrane owes its origin to a definite surface stretching or whether the contact of water is also necessary. Vital activity does not appear to be essential either to its formation or to the manifestation of plasticity in the protoplast.—J. E. HUMPHREY, *Amherst, Mass.*

Alcoholic Material for Laboratory Work in Systematic Botany.—It is now generally recognized that laboratory practice or field work is indispensable to effective instruction in all the natural sciences. Botany deals with material that is especially adapted to training the powers of observation. The translation of the characters of a stem, leaf, or flower into appropriate language will give the student a habit of careful investigation, as well as facility in description.

Plants direct from the field are generally considered to be in the best possible condition for use in the laboratory. It is a difficult matter sometimes, however, to shape courses of instruction so as to have plants in flower just at the time when they are needed. During the spring there is an abundance; but in the fall and winter, how shall material be provided? To furnish a class of thirty or more from a greenhouse is too expensive; moreover, plants will not always blossom in the greenhouse just when desired. The plan is sometimes adopted of pressing enough specimens to supply each member of the class with a specimen of the species to be studied. There are serious objections, however, to this plan. In the first place, specimens collected in such a wholesale way are not apt to be satisfactory. All specimens should be as complete as possible when they are to be used by students. Second, dry material is very difficult to dissect. Soaking in water will soften the tissue, but renders it too soft and pulpy to dissect nicely. A third objection to this plan is the expense of collecting so large an amount of material every year, for, in most cases, at least one specimen will be used up by a student in a single study.

Having experienced the above difficulties in the laboratory, we have been trying in various ways to overcome them. The work of the winter in the laboratory is to make a study of typical species of several orders, among which are the Rosaceæ, Ranunculaceæ, Nymphæaceæ, and Leguminosæ. This work has been preceded by similar studies in the orders Compositæ, Gramineæ, and Cyperaceæ in the fall, and by general work in plant analysis during the previous spring term. The course is accompanied by lectures. Now, instead of pressing as many specimens of each species as is intended for study each year, we pursue the following plan: The species to be studied are selected. As many specimens of each species as there will be students in the laboratory at each session are pressed, taking great pains to have each specimen as complete as possible, and also pressing and drying them promptly, so as to preserve the colors. These specimens are mounted on heavy card-board sheets. A convenient size for the sheets is 14x22 inches. The specimens are fastened to the card-board with fish-glue, or may be fastened with narrow strips of gummed paper; I think the fish-glue is preferable. The mounted specimen shows the whole plant if possible. The fruit is also shown. When the plant is too large to press entire the flower, fruit, various forms of leaves, and a piece of the root and stem are mounted. If the plant has medicinal properties, the part which is medicinal is shown as it appears in commerce. If any part of the plant be of economic importance, as the fibre of flax or the bast of basswood, these are shown.

Such a set of permanent, mounted specimens duplicates plants growing fresh in the field sufficiently for the purposes of systematic study. The cards, when in use, are suspended from an arm by "bull-dog hooks," which may be obtained at any bookstore. The arms are about one foot long, and, as the tables are arranged in our laboratory, can be fastened to the window casing. Very nice horizontal arms with attachment can be obtained of furniture dealers.

To go along with these mounted specimens a sufficient quantity of flowers and young fruits for dissection to supply the class is collected and preserved in alcohol until they are to be used. So far, our experience has been that alcohol is the best preservative for this tissue, as well as for tissue designed for histological purposes. The fresh material is put in 50 per cent. alcohol, and then the strength of the alcohol is gradually increased until it is at least 80 per cent. A very effective way of hardening is to place the material in a straight glass vessel, such as a straight beaker having a membrane of chamois-skin for a bottom. This is placed in another jar. This makes a vessel within a vessel. The outer one contains 95 per cent. alcohol; the inner contains the material and just sufficient 50 per cent. alcohol to cover it. Gradually the alcohol in the inner vessel will become stronger, until it is sufficiently strong to preserve the tissue. This is Schultze's apparatus. Hardening in this way saves alcohol and time. Where material is changed from weaker to stronger there is always left over a considerable quantity of alcohol too weak to use for permanent storage. Where the Schultze apparatus is used, the spirit in which the material is when hardened is strong enough to preserve it indefinitely. We store our hardened material in ordinary fruit jars. It is perfect in all respects except color, the loss of which is more of an advantage than disadvantage. The tissue is clear and cuts smoothly. By keeping it slightly moistened with the preserving fluid while dissecting, it preserves its shape as long as desired. It is less pulpy than fresh tissue, and much more manageable than dry.

The sets of mounted specimens are permanent, and with careful usage will last a long time. The supply of alcoholic material can be replenished from time to time at slight expense.

It is of great value to have a set of microscopical slides on which are mounted sections of the ovary so cut as to show the insertion of the ovules; also their parts and their arrangement. This is a subject of much importance in the study of systematic botany, and one involved in considerable difficulty. The fresh tissue of ovules is delicate, and by hardening in alcohol, imbedding, and making permanent microscopical mounts, a very profitable and interesting course of study may be arranged. If any teachers have occasion to use specimens for study during the season when flowers are not in bloom, they will find this method worth trying.—W. W. ROWLEE, *Cornell University*.

A Field Manual of Botany.—It is announced again that there will soon be issued a special edition of Gray's Manual for field use. It will be printed on thin French paper, with narrow margins. It will be bound in full leather, limp, and cut flush, very much like a foreign guide-book. The price will be two dollars, which is but a trifle more than for the ordinary edition. It will prove a useful book to students and collectors.—CHARLES E. BESSEY.

ZOOLOGY.

Reproduction of Urnatella.—Statoblasts have not hitherto been found in this curious type of the Polyzoa, first described by Leidy. Mr. Edward Potts has lately succeeded in having the animal reproduce itself by germination from the jointed stems which remain after the polyp-heads have died down. "About the middle of September last I gathered from the bed of the Schuylkill canal, below Flat Rock Dam, some sticks bearing colonies of Leidy's Urnatella. The heads as usual soon died; but as no statoblasts have yet been discovered to be produced by this polyzoon, I kept the jointed stems under the impression that they took the place of gemmules and would reproduce themselves in the spring. On February 1st I found them thus rejuvenating themselves, and I now have a good stock of Urnatellas." The preceding is an extract from a note by Mr. Potts to one of the associate editors.—R.

The Growth of Corals.—Alexander Agassiz has figured some specimens of coral, natural size, taken from the shore end of the international cable laid between Havana and Key West. As this portion of the cable was repaired in 1881, these specimens represent a seven years' growth. *Orbicella annularis* shows a greater increase than estimated by Verrill. *Manicina areolata* and *Isophyllia dipsacea* show very rapid increase. (Bull. Harvard Mus. Comp. Zool., Vol. XX., No. 2.)

The Changes of the Salamander Diemyctylus viridescens.—I have now demonstrated the following facts with reference to this Amphibian: 1. The eggs are internally fertilized. 2. The larvæ have the form and coloration of the adult aquatic ones. 3. When the gills are lost the animal becomes terrestial, and changes it viridescent color for red. 4. At maturity the red terrestial form goes into the water, and assumes a viridescent coloration. 5. In aquatic forms, whether adult or larval, the epithelium of the mouth is stratified and non-ciliated. 6. In the terrestrial forms the oral epithelium is ciliated.—SIMON H. GAGE.

EMBRYOLOGY.[1]

On the Fœtal Membranes of Testudinata.—Dr. K. Mitsukuri has published an elaborate paper in the Journal of the College of Science, Imperial University of Japan (Vol. IV., pt. 1), on the fœtal membranes of the turtle. The contribution is a paper of fifty pages, with ten excellent plates. The amnion arises from an anterior and two lateral folds,—there is no posterior fold,—and these extend gradually from before backwards. The lateral folds meet above the embryo, but their cavities do not unite across, so that a connection between the amnion (proper) and the serous envelope—sero-amniotic connection—always remains along the line of union. The backward growth of the amniotic folds over the embryo does not stop at the posterior end, but continues to grow backward, although diminished in width, until finally there is produced a tube extending from the posterior end of the embryo, reaching a length as great as the embryo itself, and placing the cavity of the amnion into communication with the exterior.

In the Testudinata the allantois arises as a diverticulum from the posterior region of the midgut, and is from the first continuous with it. The later stages of the fœtal membranes are more complicated. The allantois is obstructed in its growth over the embryo by the sero-amniotic connection. Ultimately the allantois surrounds the yolk by means of its three lobes. "There is always, even in very much advanced eggs, a small mass of the white just at the point where the three lobes of the allantois meet at the lower pole." It seems that we have here, in a very primitive condition, the structure described by Duval as the placenta of birds. The yolk-sac passes into the interior of the body in hatching, where it lies for a long time, and may be found in young tortoises late in the spring of the year following.

Mitsukuri thinks that if the embryology of the groups of reptiles and birds are carefully gone over again many structures which are highly significant in the light of facts now obtained will be found to have hitherto escaped notice; for instance, the sero-amniotic connection and the posterior tube of the amnion. The amnion was probably developed originally by mechanical causes. In Testiudinata, when the head fold is produced, there are two reasons why it should sink into the yolk; "first, the yolk is very large and liquid, especially beneath the blastoderm; and, in the second place, the white disappears from over

[1] Edited by Thomas H. Morgan, Johns Hopkins University, Baltimore, Md.

the blastoderm, which then adheres firmly to the shell-membrane, hence there is no space for the head fold to grow, except towards below."

The Placenta of Rodents.—Duval has published a paper in the *Journal de l'Anatomie*[2] giving a clear and interesting account of the discovery of the "inversion" of the germ-layers of rodents, adding a theory of the method by which this curious process has been brought about, and illustrating the whole by an admirable series of diagrams.

With Bischoff (1842) the problem of the inversion originated, and its solution has gradually, since then, been worked out. We may pass through a series of forms showing the condition of inversion in its various stages,—in the hare, where it is simplest, through the field-mouse, rat, and mouse, to the guinea-pig, where it is most complicated. Unfortunately the early investigators began with the last form, and it is rather surprising they made as much as they did out of the process; indeed, Duval believes that, although often in error, Bischoff guessed the fundamental meaning of the phenomenon, and had a better knowledge of the process than some of the investigators that came after him.

Primarily the sinking of the blastodermic portion of the embryonic vesicle has been the cause of the inversion of the layers. This was closely connected with the formation of the ectodermic amnion which arches up over the embryo as the latter sinks into the vesicle. By the closure of the amnion above there is formed a cavity lined by ectoderm, which, owing to the sinking of the embryo, lies, as it were, in the center of the vesicle, but still *above* the embryo. This process takes place in its simplest form in the hare, but in the other rodents it takes place by an abbreviated condition; for the amniotic (ectodermic) space first appears as a *split* in the thickened ectoderm above the blastoderm. Subsequently the cavity of the amnion is divided into two parts, an upper and a lower, by a constriction formed in the middle. This division the author believes primarily to have taken place by the early development of the allantois in order that it might spread out under the upper (attached) pole of the embryo. In many forms the amnion divides into its two parts before the appearance of the allantois, and this is but a *precocious* process, caused in the first instance by the growth of the allantois.

On the Morphology of the Bilateral Ciliated Bands of the Echinoderm Larvæ.[1]—In a previous work (Die Entwickelung

[2] XXVI. Anne., No. 6, 1891.

[1] R. Semon, *Jenaische Zeitschrift*, XXV. (N. F., XVIII.), 1890.

der Synapta digitata (*Jen. Zeit.*, XXII.) the author refers to the preoral ciliated band as arising from the adoral band (surrounding the mouth), and not from the other ciliated band, from which it is entirely separated, thus opposing the older view of Gegenbaur, adopted by Korschelt and Heider in their Lehrbuch.

But the author's present work, begun in April, 1890, at Helgoland, shows that the adoral band arises without connection with the preoral band, and that the union of their edges is secondary. Thus ontogenetically is given striking proof of the correctness of Gegenbaur's supposition.

The stage where but a single ciliated band is present is called the Auricularia stage of the Bipinnaria.

In older larvæ the postoral and preoral portions of the longitudinal (circumoral) ciliated band unite at the preoral apical pole, and form a median unpaired stripe. Later, on a plane parallel to the ventral surface, this median unpaired stripe divides, and thus forms the preoral and postoral ciliated bands of the Bipinnaria.

The ciliated bands are formed by a loss of cilia and flattening of the cells over the rest of the body, thus leaving the bands as the only ciliated part. This process begins on the ventral side; the cilia disappear last at the apical pole.

The adoral ciliated band is formed in a similar way, and at its anterior part comes into close relation, secondarily, with the preoral band.

Thus is solved the only difficulty to Joh. Müller's plan to derive the body form and arrangement of the ciliated bands for all Dipleurula larvæ from a fundamental type, since it is shown that the Asterid larva passes through an Auricularia stage, and that the preoral ciliated band is separated from an ancestral single ciliated band. This stage with a single ciliated band is the typical form, ontogenetically reproduced in sufficiently young larvæ of all classes of Echinoderms.

The author notes as an interesting fact that in Joh. Müller's comparison the Ophiurid pluteus, by the increase of the posterior dorsoventral bendings (auriculæ of the Auricularia and Bipinnaria), to long and characteristic projections, in this important point stands nearer the typical form than the Echinid pluteus to which in other respects it is more comparable.

He points out the close relation existing in all larvæ between the upper transverse border of the preoral band and the adoral ciliated band. He believes that the Dipleurula larva cannot be traced back to the *typical trochophore* with *preoral ciliated rings;* probably not to the *mesotrochal* larva; possibly it may be compared to a *telotrochal* larva, but it must be shown that the bands arise in a similar way in each. This is only a tentative suggestion.

In Tornaria the arrangement of two longitudinal ciliated bands agrees throughout with the Asterid larva, as does also its internal development (cœlom sacks). Still, on account of the differences in the mature animals, it is difficult to show more than a very distant genetic relationship.

As a result of these observations, we believe that the Dipleurula larva, including Tornaria, are separated from the cilia-bearing larvæ of the higher and lower worms, as well as molluscs. An homologizing of the circumoral ciliated bands of Echinoderms with the cilia apparatus of the other larval types cannot be carried out. They probably are structures independently arising. The results on the nervous system of Asterid and Echinid larva were negative.

The author speaks of a bilateral fibre-system, united by a cross commissure, lying in the dorsal skin under the epithelium. It seems to take the place of a nervous system, and its structure recalls that of nervous tissue. The thicker fibres cannot be distinguished from the muscle fibres of the foregut, perhaps a little less transparent and certainly more branched. This may be regarded as a well-developed dermal musculature.—GEORGE W. FIELD.

PSYCHOLOGY.

Note on Imperfect Instinct in Animals.—On a number of occasions I have observed that the instinct of animals is sometimes shown to be imperfect, and reading Mr. George J. Romanes's book on "Mental Evolution in Animals," where mention is made of "imperfection of instinct" (page 167), his illustrations quoted recall to my mind some original observations which might add still further to the interest of this subject. Regarding insects, on July 4th, 1887, I noticed among the fireworks displayed upon an open stand, on the corner of a vacant lot in Chicago, a number of bunches of different-sized fire-crackers with their bright crimson covers conspicuously distributed among the other pieces of similar explosives. While I was standing close by a pretty, bright, reddish-brown butterfly, with silver spots on the under surface of the wings, which I supposed to be the larger species of Argynnis, came flying along near the ground from the north. When nearly opposite, attracted by the bright color, it changed its course quickly and flew directly to the fire-crackers, trying one bunch and then another, as I have noticed the same species of butterfly do in a field at Hyde Park while feeding, going from one bright red flower to another. Then suddenly recovering itself, and as if coming to a point of realization of a mistake, the insect continued its headlong journey southward until lost to view. I find in my diary on June 24th, 1884, while I was standing on a street corner in Chicago waiting the arrival of a car, an Alypian moth (*Alypia octomaculata*) was attracted by the clothes which I wore at that time. The specimen was a beautiful male, and when I stood still it flew about my body in the air repeatedly, and persistently alighted on my clothes, although it was gently brushed away several times with my hand. The black and white on the moth coincided closely with the small checks of the same in my suit, the significance of which impressed me strongly at the time. Last summer (1890) I noticed several times that small white butterflies were attracted by bits of white pieces of paper which had been carelessly thrown upon the ground. An instance bearing upon this point is recorded in the AMERICAN NATURALIST (Vol. XX., page 976), in which many Ajax butterflies (*Papilio ajax*), which are wary and ordinarily captured with great difficulty, became attracted by dead specimens of the same species which I pinned upon the ends of twigs and stuck in the ground to serve as decoys. I was allowed to increase my collection with a number of additional specimens in this way by the use of a net, which could not have been otherwise taken.

In the matter of birds, it is an every-day experience of hunters to attract wild ducks and some other birds within gun-range by artificial decoys placed at a point where the birds can see them in passing over on the wing, and I have myself shot American golden plover frequently which were attracted by flat tin pieces which I had painted in imitation and cut in the shape of these birds, and stuck upon sticks which elevated them from the ground. In the latter case almost every individual in a flock of twenty to thirty have been shot in this way; and imitating their call-note would again and again call them back, although each time a number shot from the flock would fall to the ground, which were probably noticed by the birds that escaped the fire, for they sometimes dove down from above in the direction of the falling birds. It is interesting, although digressing a little from the subject in hand, to note that in localities where these birds frequented by thousands in their migrations some years ago, but few are seen now, and are fast following in the path of the Carolina paroquet and wild pigeon, owing in a great measure to their inability to adapt their imperfect and limited instinct to the sudden encroachment of civilized man. I once attended a great fire which consumed a number of large warehouses and a great quantity of lumber. The fire occurred in the dead of the night, lighting up the surrounding vicinity brightly, and the heat was intense. While thus gazing at this spectacle I noticed dozens of tame doves and English sparrows, irresistibly drawn by the intense light, fly directly into the flames, and hundreds were consumed in less time than it takes to relate the observation. Similarly, on July 7th, 1890, I noticed in front of my office, where an electric light hung to light up the corner at night, numerous insects, some of the most grotesque forms of moths, among them such as I had never observed before, and a number of different species of beetles heedlessly plunging into the globe that surrounds the light, and were destroyed. Mr. Romanes says (page 174) that under the general heading of "Imperfection of Instinct" "we may include two very distinct classes of phenomena; for instincts may be imperfect because they have not yet been completely developed, or they may appear to be imperfect because not completely answering to some change in those circumstances of life with reference to which they have been fully developed." To which of the two phenomena the above notes will belong requires but little reflection on the part of the reader.—Dr. Joseph L. Hancock.

An Instance of the Black Snake Attacking Man.—In the autumn of 1867 I was residing at Stamford, Conn., being at that time about seventeen years of age. Apart from my college studies, my entire time was given over to the subject of biology and the formation of collections of various animals. The country about Stamford was admirable ground for the collecting naturalist, and by the writer its advantages were not neglected. One day, during the time above mentioned, I was hunting in a piece of heavy hemlock timber about three miles from the town, and upon passing under a tall tree my attention was attracted by a swinging, rope-like object that hung suspended from its lower limb, immediately overhead. In an instant I recognized it as a large black snake (*B. constrictor*), and he was holding on by a coil or two of his tail, while his head was several feet above the reach of my outstretched arm and hand. His body was straightened out as straight as could be. It took but an instant for me to appreciate this extraordinary behavior on the part of a species of snake with which I was quite familiar. I was about to reach up and strike him with my gun-barrels, when in a twinkling he let go his hold, and in falling fell all in a loose coil on my head and shoulder, but as quick as a flash twined himself about my neck, with the hinder third of his body twisted about my arm at the arm-pit. Rearing his head within a few inches of my face, and rapidly quivering his tongue at me, he was quite a picture to behold. It required but a moment or two, however, for me to demonstrate to this hardy and soot-tinted representative of the reptilian race that he had attacked a quarry entirely too big for his powers,—though I confess he warped down his constricting coils in a manner not to be despised as coming from so small a snake. Seizing him near the head, and leaning my gun against a tree, by three or four vigorous pulls I soon disengaged him, and his disappointed snakeship was taken home alive. He measured something less than six feet.—R. W. SHUFELDT, *Takoma, D. C., February 24th, 1891.*

ARCHEOLOGY AND ETHNOLOGY.[1]

International Congress of Anthropology and Prehistoric Archeology.—*Tenth Session, Paris, August 19 to 27, 1889.*—This congress grew out of the meeting at Spezzia, in Italy, in September, 1865, of four gentlemen of high reputation in connection with studies relative to prehistoric anthropology: Capellini, of Bologna; Gabriel de Mortillet, of Paris; Steenstrup, of Copenhagen; and Stoppani, of Italy. To further the organization, a meeting was agreed upon to be held at Neuchatel, in Switzerland, in the year following, 1866, and the organization was completed and the congress established at the meeting in Paris in 1867. The subsequent meetings were as follows: 1868, London and Norwich; 1869, Copenhagen; 1871, Bologna; 1872, Brussels; 1874, Stockholm; 1876, Budapest; 1878, Paris; 1880, Lisbon. Subsequent meetings were arranged for Rome and Athens, but were defeated by rumors of pestilence and war. The tenth session was organized to be held at Paris in the year 1889, thereby taking advantage of the French exposition and the many opportunities for study afforded, as well as the number of foreigners who would be in attendance.

The meetings were well attended, and brought together the most illustrious scientists of various nations. The influence of the congress was highly beneficial, and it deserved support. Not only did distant anthropologists and prehistoric archæologists become acquainted with

[1] Edited by Dr. Thomas Wilson, Smithsonian Institution, Washington, D. C.

each other, but they had a chance there to present new discoveries and announce new theories. The congresses act as an international clearing-house, and enable the scientists of the world to compare notes, and, if needs be, correct their errors. That the importance of these congresses has been recognized by the European anthropologists is demonstrated by the numbers in attendance, the average of which has been 588 members, while the session at Stockholm counted 1,642 adherents. The foreigners usually number about one-half the attendance. The average representation, stated by countries or nations, has been as follows: France, 126; Sweden, 115; Great Britain, 70; Belgium, 68; Italy, 45; Denmark, 41; Austria-Hungary, 35; Germany, 20; Portugal, 10; Russia, 8; Netherlands, Norway, and Finland, each 6; Switzerland and Roumania, each 5; United States of America, 4; Luxemburg, 2; Brazil, Greece, Turkey, Argentine Republic, each 1; all other nations taken together, 4.

A permanent council had general supervision of the affairs of the congress, but a committee of organization was charged with the duty of preparation.

The program for this session, as agreed upon by this committee and published in advance, was as follows: Monday, August 19th, 1889, 2 o'clock P.M. Address of the president. Report of the secretary-general. Election of the bureau and council. Additional by-laws.—Tuesday, August 20th, 1889, 9.30 A.M. Visit to the Museum of Natural History in the galleries of anthropology and paleontology. 2.00 P.M., regular meeting in the amphitheatre of the College of France.—Wednesday, August 21st, 1889, 9.00 A.M., meeting at College of France. 1.00 P.M., reception of the members of the congress by the municipality of Paris at the Hotel de Ville at 4.00 P.M.—Thursday, August 22d, 1889. Visit to the colonial display at the exposition. Rendezvous on the Esplanade des Invalides at the Tunisian Pavilion, 9.30 A.M. Visit to the exposition, section of anthropology, 2.00 P.M., and afterwards to the Museum of the Trocadero.—Friday, August 23d, 1889. Meeting at College of France, 9.00 A.M. and 2.00 P.M.—Saturday, August 24th, 1889. Excursion to Saint-Germain by steamer on the Seine, and visit to the museum.—Sunday, August 25th, 1889. Meeting at College of France, 9.00 A.M., and closing session at 2.00 P.M.—Monday, August 26th, 1889. Excursion by rail to Chelles, the great paleolithic station.

The questions proposed by the committee for discussion before the congress were as follows: 1. Denudation and filling of the valleys, filling of the caverns, and their relations to the antiquity of man. 2.

The periodicity of glacial phenomena. 3. Art and industry in the alluvial and in the caverns. Paleontologic and archeologic classifications, and their value as applied to the Quaternary period. 4. The chronological relation between the civilization of the ages of stone, of bronze, and of iron. 5. The relation between the civilizations of Hallstadt and similar Danubian prehistoric stations, and the civilization of Mycenæ, of Tiryns, of Hissarlik, and of the Caucasus. 6. A critical examination of the skulls and bones of the prehistoric man belonging to the Quaternary period discovered within the past fifteen years. The ethnic elements properly belonging to the ages of stone, bronze, and iron in Central and Western Europe. 7. Ethnographic survivals which may throw light upon the social state of primitive populations of Central and Western Europe. 8. How far do the analogies of archæology and ethnography authorize or sanction the hypothesis of relations between the peoples, and how far of prehistoric migration?

There were 450 members of the congress enrolled, though not all were present.

Twenty-seven countries were represented, of which nineteen were European, six of the two Americas, and one each from Asia and Oceanica. The congress at Lisbon was nearly as large as that at Paris. It had 417 enrolled members, of which 330 were foreigners to that country.

Monsieur de Quatrefages, the president, opened the congress by an address of welcome, and recalled to his hearers, in a few words, the history of the work of Forchammer, Worsaae, and Steenstrup in 1847, making a happy accord of natural history and archeology. These were founded upon modern sciences regarded up to that time as having a relation together, but which were nevertheless united by an alliance that has become more and more fruitful. From this the past of the human race plunged in an immense unknown, far beyond the reach of history or even the most obscure legends, and embracing only the geologic times with which their investigations had to deal. These investigations were published, and soon it was recognized that one branch more had been developed on the tree of human knowledge.

M. de Quatrefages followed the International Congress of Anthropology and Prehistoric Archeology from its foundation and commencement in 1865 or 1867 through each one of its sessions. The session then opened at Paris had among the others an extreme importance. The first question on the program, "The Geology of Prehistoric Times," was a declaration of our profession of faith. In adopting the sixth question, "Our Notions Anthropologic," the congress testified that one of its subjects of investigation is attached to antiquity, which becomes an object essential to its studies, and one to be followed in all paths of the science. Comparative ethnography throws light on our primitive ancestors, while geography comes in as an important and efficient aid.

The congress in dealing with the question of fossil man would not sustain on the one part dogmatism, nor on the other philosophy. This will explain its triumphs in the different countries in which it has met.

The secretary-general, Dr. Hamy, then told of the steps which had been taken in order to protect this meeting of the congress against the difficulties encountered at Lisbon, and augmented by the death of the late secretary-general. He described step by step the action taken by the officers and original founders, and it was at last decided that M. de Quatrefages would be the president. He then named the committee of organization, and announced the bureau and council as follows:

President, M. A. de Quatrefages; vice presidents, MM. Belucci (G.), Beneden (J.-L. van), Bertrand (Alex.), Bogdanoff, Delgado (N.), Evans (J.), Hilderbrand (H.), Gaudry (Alb.), Mason (Otis T.), Muller (Soph.), Schliemann (H.), Vilanova; secretary-general, Hamy (E. T.); secretaries, MM. Boule (M.), Cartailhac (Em.), Deniker (J.), Fraipont (J.), Vasconcellos-Abreu Verneau (Dr.); council, MM. Benedikt, Cotteau, Gosse (Dr.), Hovelacque, Lumholtz, Netto (Ladislas), Odobesco, Riedel (J. F.), Schmidt (Valdemar), Szabo (de).

The first question proposed by the committee of organization was: "The Cutting and Filling of the Valleys, the Filling of the Caverns, and These in Their Bearing upon the Antiquity of Man."

M. Gaudry was the reporter. "It is not certain," said he, "that in our country man has lived a long enough time that the contemporaneous animals of his antiquity should produce the notable transformation which would serve as datum points. The savants having the greatest experience with the objects made and used by early man are not in entire accord." A good thing from which to determine successive stage of man during the prehistoric times is stratigraphic geology. There are three points in the Plistocene geologic period which are particularly important to establish the age of the strata which contains the traces of man:

1. The glacial and interglacial formations; example, Rixdorf. The observations in divers places in Germany and in England demonstrates that there have been several interglacial formations.

2. The great Glacial age. In England and in Norfolk the boulder clay, that is evidence of the grand Glacial epoch, is above the forest beds. In consequence, the depots at Chelles and Montreuil, which contain the animals of a warm temperate climate, do not correspond with the earlier epoch of Plistocene that followed the age of the forest bed. M. Gaudry supposed this to be a depot of the interglacial age of Rixdorf; and that it is, in any event, a Plistocene deposit, not relatively of antiquity.

3. The cutting of the valleys. The theory of Prestwich was that the Plistocene deposits, the most elevated, are the most ancient. In general this ought to be true in France. The locality of Vaucresson, 150 metres above the sea, of Montreuil-sous-Bois, 100 metres, both of a Quaternary period, very ancient, contemporaneous with the grand glaciers of the north of Europe, and characterized by abundant remains of reindeer, mammoth, and the wooly rhinoceros associated with chipped flints, are illustrations. The Chellèen of Bas Montreuil, and of Chelles with deer, *Rhinoceros merkii*, *Elephas antiquus*, are grand interglacial depots, during which the climate became warmer, and the melting of the gigantic masses of glacial ice produced immense erosion. Finally, M. Gaudry believed that the alluvium of the lower level, where they find the mammoth, reindeer, and the *Rhinoceros tichorhinus*, represents a return of the cold.

It was contested that if the valley of the Seine was cut in the beginning of the Quaternary epoch, the Chellèen ought to be more ancient than the depot of Haut-Montreuil. It was necessary that the stratigraphic geologist should mark in a precise and indisputable manner the age of the cutting and the depots of our valleys of the Seine.

Professor Geikie, the Scotch geologist, sent a paper on this subject, which was read. The relative positions of the fluvial strata of a valley do not necessarily indicate their antiquity, and the elevated strata are not necessarily the most ancient. In certain cases there have been grave exaggerations of fluvial cutting accomplished during the Pleistocene times. Our grand valleys in Scotland were cut before the Glacial period, and at an epoch which M. Geikie does not dare to fix with precision. These valleys continued to be cut during the Pleistocene period. Those which are in the region covered by the glaciers have naturally escaped this action. As for the levels of the gravels, the inferior or lower ones simply indicate a normal state of the water-course, as the superior or higher ones testify to the torrential action of the river. We do not possess any serious or certain knowledge that will permit us to calculate the degree of cutting operation in the valleys of the northwest of Europe during the time these regions were occupied by paleolithic man. We can only affirm that the cutting is the result of alluvial action very much prolonged.

Mr. Geikie sent a second paper on the periodicity of glacial phenomena. He did not enter into the question as an argument. He simply referred to his two works in which the question had been argued at length: "The Great Ice Age," and "Prehistoric Europe," and said he was content with conclusions he had therein announced in favor of that periodicity.

M. Adrien de Mortillet was of the opinion that the theory of the three levels, the higher, the middle, and the lower of Prestwich, came from Belgrand. This theory was not affected by the fact that there had been found at the bottom of the gravel the bones of the *Rhinoceros merkii* and fossil animals which belonged to the Chellèen epoch of the Paleolithic age. Monsieur van den Broeck refused his adhesion to the last conclusion, and declared that if true it revoked the laws of nature. He said if these lower deposits contained the ancient fossils they must have been redeposited, and these, therefore, were valueless as to the question of their antiquity. He insisted upon the importance, for the purposes of study of primitive archeology, and for the determination of the age of the objects of human industry found in the alluvial deposits, of the superficial strata of the soil and the infiltration of the water to the lower strata, by which the latter were changed in their character and appearance.

Dr. Gosse presented certain Chellèen implements, the first of this type found in Switzerland, and with them charts of the Lake of Geneva, which showed successive stages by which the alluvium was deposited, and which corresponded in the level with others in which had been gathered the mammoth, reindeer, and below all, Roman antiquities.

M. Cartailhac doubted whether this implement was Chellèen.

Mr. John Evans visited, now thirty years ago, Saint Acheul, in company with Prestwich, and he adopted with all his heart that which had been said by that great geologist. The paleontologic evidences are uncertain and sometimes founded in error. At Norfolk, for example, there is in one stratum *Elephas antiquus*, in the same the *primigenius*, and it is impossible to establish in the stratum a proper division.

M. Gabreil de Mortillet defended the geologists against the reproach of neglect in investigations into the prehistoric. The cutting of the valleys is a question difficult to solve. The wisest man with the most extensive knowledge seems unable to harmonize all the facts of geology.

It can only be done by extensive acquaintance with facts. The Tertiary plateau of Paris at the beginning of the Miocene was horizontal and intact and 170 metres in elevation. It was profoundly affected by the Seine during the Tertiary, which made a colossal cutting compared with that of the Plistocene, which in Paris is only 40 metres in elevation. The movements of the soil explain perfectly the conclusions as to the filling of the valleys at the periods of depression, and of cutting during the periods of elevation.

Monsieur Mourlon, of Brussels, said that diversity of views and differences of opinion proved that the solution of this problem is yet far distant. He recommended that each person should take up his own proper study in his own country, and pursue it without any preconceived ideas or opinions. He explained the situation at Mons and Ixelles as identical with that of Igtham presented by Mr. Prestwich, and said that the deposits were doubtless Pliocene, yet they found chipped flints of the Moustier type.

M. Marellin Boule said that he had studied the fossil bones of Ixelles at the museum, and that all the species belong to the fauna of the *primigenius*. The deposit at Ixelles is probably not older than the commencement of the Plistocene as we know it in France. In any event, it does not belong to the Pliocene.

Gosselet, of Lille, objected that Mr. Prestwich was too uncertain. He always said "It is perhaps" pre-Glacial, etc. Yet M. Gosselet was opposed to M. Mourlon in his opinion that the deposits at Mons were anterior to the Plistocene.

M. Max Lohest said that none of the numberless depots yet discovered in the caverns were characteristic of any determined geologic epoch. Fauna of the mammoth and *Rhinoceros tichorhinus* are found as well in the red plastic clay, the rolled pebble, and the stratified mud as in the clay full of sharp stones which came from the roof of the cavern. He attacked the theory of M. Dupont, and declared that the height of elevation of a cavern above the level of the river was not evidence of its antiquity, and that the formation of the Belgium valleys had begun anterior to the Cretaceous epoch. The clay of the plateaux in the east of Belgium that came from the cutting of the valleys was deposited probably anterior to the age of the mammoth. On the arrival of man the face of the country presented much the same appearance as now.

Monsieur van den Broeck, of Belgium, responded to his colleagues, MM. Mourlon and Max Lohest. In his opinion the Belgium valleys were not cut until after the Pliocene, because we found the sediment of that epoch crowning the hills and plateaux in the neighborhood of the valley. In the valley of the Meuse, M. van den Broeck cited evidence to prove that the lower levels were much more recent than the high levels. Localities cited by M. Mourlon were not pre-Plistocene, because both were situated on the flank of the valley, and not on the Plistocene of the plateaux. The fauna of a cavern could only be the same as that of the valley.

Mr. John Evans was in accord with those who said that the great valleys had been cut before the Plistocene, but we should not forget that there may be valleys of all epochs. He approved the opinions and conclusions of Prestwich, but only in regard to that which concerns the Plistocene, and said that neither himself nor other geologists of England could follow Mr. Prestwich in his theory of the worked flint being pre-Glacial. In his opinion the deposit of the worked flint at Igtham was a superposition well established.

Mr. Thomas Wilson said a few words upon the progress made by American geologists on the subject of the Plistocene period and the antiquity of man. He spoke of the interest in that subject in his country. He showed to the congress some of the quartzite and argillite implements which belong to the paleolithic period, and had been discovered on the surface in his country, as had been those Chellèen implements found by Mr. Prestwich at the locality of Igtham in Kent. On the subject of the cutting of the valleys and their subsequent filling, he remarked that the rivers of France and England especially were of such short length that it was possible the operation may not have been carried out to its conclusion by the courses of nature, and he invited the geologists of Europe who were interested in studying this question not to neglect the opportunity of visiting the United States upon the occasion of the next geologic congress, to be held in 1891, that they might investigate our rivers; those flowing from the mountains to the Atlantic seaboard, some of them passing through the glacial moraine, like the Connecticut, Hudson, and Delaware, others others coming from mountains unaffected by the glaciers, as the Susquehanna, Potomac, and James; or go to the west, where were to be found rivers from 1,000 to 4,000 miles in length, as the Ohio, Cumberland, Tennessee, Mississippi, and Missouri, on the banks of which are to be found cut the same kind of caverns as those of Belgium, as were also the terraces of the high, low, and middle levels of Prestwich, Belgrand, and Mortillet; they were thus to be found, not in isolated positions, but stretched out for hundreds of miles. The earth cut from one place would be carried to another further down, and so deposited and redeposited many, many times before reaching the ocean.

Monsieur Judge Piette described at length the position, condition, and geologic formation of the great cavern of Mas d'Azil, Ariege; how it was found in a tunnel made under or through the mountain by the passage of the river l'Arize, and how it had been inhabited by prehistoric man during all epochs. He had visited this cavern, which is a stupendous and wonderful work of nature, his interest being correspondingly excited because in it were to be found in great quantities and great thickness, in different parts of the caverns the evidence of the occupation by prehistoric man in all his epochs; the paleolithic, the earliest cavern epoch, down to and including the neolithic and even bronze age.

M. Chambrun de Rosemont and Madame Clemence Royer gave their opinions. Monsieur Gosselet confined himself to the question which was being discussed, and gave it as his opinion that there were to be found the following phenomena in the cutting of the valleys: 1. A first cutting anterior to the deposit of the lower or earliest Plistocene. 2. A second cutting posterior to the deposit of the yellow clay, but anterior to the upper diluvium. These repose indifferently on the strata of the lower Plistocenc, and which may have been more or less eroded. Sometimes the gravels of the two epochs are superposed. 3. A third cutting posterior to the Plistocene period. Sometimes this finds the Plistocene in the valleys; but it is not infrequent to find the Tertiary and even the secondary deposit exposit exposed by the cutting. 4. After this last cutting the water of the rain and the rivulets produced a heterogeneous clayey deposit that covered the slopes and descended even to the bottom of the valleys. In this one can find the *débris* of the age of polished stone, of Roman objects, and others similar. The relations of the divisions in the fauna and the human industry of the Plistocene epoch have not been determined.

M. de Szabo described the Plistocene formations in Hungary.—THOMAS WILSON. (*To be continued.*)

The Munich Association for the study of anthropology, ethnology, and prehistorics is publishing its transactions in an organ called *Beiträge zur Anthropologie und Urgeschichte Bayerns*, which has now reached its ninth volume. Professors J. Ranke and N. Rüdinger are the editors, and a series of most important papers have filled its pages since publication began.

The fourth number of Volume VIII., which is now before us, contains an elaborate inquiry into the racial groups now forming the population of the Bavarian province Oberfranken, northeastern part, composed by Ludwig Zapf. The article is accompanied by a map showing that the district where the rustics have preserved the customary *wendic dress* is in part identical with the district embracing the dark-hued color of the eyes, though this extends somewhat further to the south. The author bases his ethnographic division upon the linguistic facts observed there, *four* dialects being spoken in that section.

In the same number Dr. Höfler discusses Bavarian dialectic terms for diseases and for the parts of the human body, and Hugo Arnold gives an illustrated report on recent excavations made at Pfünz and Faimingen, which resulted in the discovery of Roman temples erected for the worship of Jupiter Dolichenus and of idols representing this deity.

The numbers 1 and 2 of Vol. IX. of the *Beiträge* are united in one fascicle, and contain in eighty-five pages much that is of interest, though the contents refer more to local than to general topics of archeology and ethnology. Ten plates illustrate the articles, of which may be mentioned as the most likely to attract attention: Oldest Inhabitants of Southern Bavaria, by Sopp; Prehistoric Sketches from the Tract between Inn and Salzach Rivers, by Weber; The Home of the Bajuwarian Landholder, by Tresel; On the Difference of Age in Population Statistics, by G. von Mayr; Hill Tomb near Dechsendorf, by A. Erhard; New Prehistoric Discoveries in Bavaria, by Weber. The appendix of thirty-four pages gives the minutes of the transactions of the Anthropologic Society of the Bavarian capital during the earlier months of 1889.

The Map of Prehistoric Bavaria, in fifteen sheets, the laborious work of Prof. F. Ohlenschlager, is now completed, for the last three sheets have just been distributed with the third number of Vol. IX. to the subscribers. The official removal of the author from Munich, the capital, to other functions in a Rhenish province of the same kingdom has retarded the completion of the map for more than two years, and the publication of the whole map was effected in the period from 1879 to 1890. The important discoveries made during the latest years made it possible for archeologists to establish a relative chronology for the objects of the Hallstatt and La Tène epoch, and this circumstance has largely enhanced the value of the map, the study of which is facilitated by copious indexing. The colored signs pointing to the places of discovery are twenty-three in number. The topographic data are all entered upon the military survey map of Southwestern Germany.

MICROSCOPY.[1]

The Pycnogonids.[2]—Three genera of Pycnogonids, each with a single species, are to be found at Wood's Holl,—viz., *Pallene empusa, Phoxichilidium maxillare* Smith (*Anoplodactylus lentus* Wilson), and *Tanystylum orbiculare*. During July, August, and September these are found with eggs. Pallene inhabits the hydroids (Tubularia, Pennaria) on the piles of the wharves, and is also common on the red sea-weeds below low-tide mark. The hydroids or sea-weeds as soon as collected were brought into the laboratory and worked over piece by piece. Each bunch was in turn swished rapidly backward and forward in a dish containing a small amount of water, so that the Pycnogonids were shaken loose and could be easily picked out. The other genera were more easily found, and on separating the masses of hydroids, etc., could be readily seen clinging to the stems. The males of Pallene carry on each pair of ovigerous legs a small bunch of eggs. Each bunch contains from one or two to fifteen or twenty eggs. The eggs of Phoxichilidium and Tanystylum are individually much smaller than the last, but are very numerous, so that the bunches are much larger, especially so in the former. Phoxichilidium carries several bunches strung along on the ovigerous legs; the bunches are white, and very conspicuous against the purple color of the adult. Tanystylum has smaller bunches of eggs, with the individual eggs larger than the former, and the masses are carried so that they form a circle of clusters held against the ventral side.

The adults with eggs were put into alcoholic picro-sulphuric acid for several hours, and then gradually carried through different grades of alcohol. Other methods of hardening gave far less satisfactory results, —*i.e.*, boiling water or Flemming's solution.

To prepare the eggs and embryos for study they were passed through absolute alcohol (one hour), turpentine (two to four hours), soft paraffine (one hour), hard paraffine (one to two hours). They were cut in paraffine, and fixed to the slide with albumen fixative; then back again through turpentine, alsolute alcohol, ninety-five per cent., eighty per cent., seventy per cent. alcohol to Kleinenberg's hæmatoxylin, where they were left for a very long time (twelve to forty-eight hours); then washed fifteen minutes in acid alcohol, and up again

[1] Edited by C. O. Whitman, Clark University, Worcester, Mass.

[2] T. H. Morgan. Studies Biol. Lab., V., 1, 1891, pp. 2, 3.

through the alcohol to turpentine and into balsam. In Pallene each egg was in many cases pricked with a very sharp needle before going into absolute alcohol. It is necessary to do this under a dissecting microscope. By these methods very excellent results were often obtained, aud after many failures of other methods was found to be the only satisfactory one. In Pallene the larger size of the egg makes a study of the earlier stages much easier, but the other genera have a much simpler development.

Method of Rendering Opaque Nemertean Eggs Transparent.—The eggs of Nemerteans which have a direct development are opaque, and cannot be rendered transparent by ordinary reagents. This difficulty was overcome by Barrois[3] by the use of carmine and glycerine. The mixture must be allowed to act gradually, otherwise it causes deformations. Three mixtures, containing glycerine in increasing proportions were used, the first consisting of one part glycerine to four parts water; the second, equal parts of glycerine and water; the third, three parts of glycerine to one of water. Enough carmine was added to give the mixture a wine color. Each mixture was allowed to act some minutes, and then the eggs were examined under slight compression.

Method of Narcotizing Hydroids, Actiniæ, etc.—In order to kill Hydroids, Actiniæ, and similar forms in an expanded condition, a little expedient may be recommended which the writer has tried in many places and on many forms, and has uniformly found of value. The animals to be killed are left in a small quantity of the salt water in which they were brought in, until this becomes rather warm and stale, or until, in fact, they are weakened by the narcotizing effect of impure water. This manifests itself in one or two ways; some forms draw themselves completely together, while others hang half expanded and limp in the water. They are then transferred in colonies or in large groups into *fresh salt water* which is at the same time cool. The effect of a mass of cool, pure water is such as to cause the animals to expand fully and promptly. Immediately as the expansion is seen to reach its maximum, in the course usually of a few seconds, they are transferred by a quick motion to some rapid killing reagent. After the long narcosis in poor water, the polyps appear to lack energy enough to contract forcibly, as is usually the case. As killing reagents, alcoholic corrosive sublimate and picro-nitric acid have given the most uniformly good results. In this way the most susceptible

[3] Recherches sur l'embryologie des Némertes. Lille., 1877, p. 101.

Actiniæ may be easily preserved expanded and intact, and Hydroids of all genera yield good specimens. The transfer to fresh sea-water is the only point requiring care. No time limit can be given, as the factors are too variable; but a little practice is sure to show the character and advantages of this method.—H. B. WARD, *Cambridge, Mass.*

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Boston Society of Natural History.—December 3d, 1890.—Dr. J. Walter Fewkes spoke of "The Summer Ceremonials of the Zuñi Indians: a Study of Aboriginal Religion."

December 17th.—Prof. A. E. Dolbear read a paper on "The Physics of Crystalline and Cellular Structure." A communication on "Kame Ridges and Hillocks of Hingham," by Mr. T. T. Bouvé, was also presented.

January 7th, 1891.—Business: Election of members. Final action on the proposed new by-laws was taken by the society. Mr. J. G. Owens read a paper on "A Few Games of the Zuñi Indians."

January 21st.—Prof. A. E. Dolbear read a paper on "The Physics of Crystalline and Cellular Structure."

February 4th.—Mr. G. H. Barton described "The Hawaiian Islands: Their Natural History and Inhabitants." The paper was illustrated with a stereopticon. Mr. J. H. Emerton exhibited a new model of Oahu, which he has lately made for the museum of the society.

February 18th.—Mr. Warren Upham spoke of "Walden, Cochituate, and other Lakes Enclosed by Modified Drift." Prof. W. H. Niles presented a paper on "Notes upon Asphaltum Deposits in California."

March 4th.—Prof. W. M. Davis presented a paper entitled "Illustration of the Faulted Monoclinal Structure and Topographic Development of the Triassic Formation of Connecticut by a Working Model." Prof. N. S. Shaler spoke on the "Antiquity of the Glacial Period." Prof. Shaler called the attention of the society to the Dorkin photographs.

March 18th.—Dr. G. Baur read a paper on "The Importance of a Scientific Investigation of the Galapagos Islands." Prof. W. O. Crosby made a communication "On the Colors of Soils."

April 1st.—Dr. H. C. Ernst spoke on the latest developments in the "Germ Theory of Disease," illustrated by stereopticon and exhibition of tube-cultures.—J. WALTER FEWKES, *Secretary.*

Biological Society of Washington.—December 13th, 1890.—The following communications were read: The Occurrence of an Asiatic Cuckoo on the Pribylov Islands; Mr. William Palmer. New Notes on the Genus Phylloxera; Prof. C. V. Riley. The Teeth of the Muskrat; Mr. F. W. True. The Wing of Metopidius; Mr. F. A. Lucas.

December 27th.—The following communications were read: A Preliminary Study of Ticks in the United States; Dr. Cooper Curtice. Exhibition of a New Rabbit from the Snake Plains of Idaho; Dr. C. Hart Merriam. On the Topography of Florida, with Reference to Its Bearing on Fossil Faunas; Mr. W. H. Dall.

February 7th, 1891.—The following communications were read: Discovery of Vertebrate Life in Lower Silurian (Ordovician) Strata; Mr. C. D. Walcott. A Review of the Discovery of the Cretaceous Mammalia; Prof. Henry F. Osborn.

March 7th.—Communications: Exhibition of Young Hoatzins; A Specimen of *Bison latifrons* from Florida; Mr. F. A. Lucas. The Fishes of Great South Bay, Long Island; Dr. T. H. Bean. A New Aster from Southern California; Mr. J. N. Rose. Color and Odor of Flowers in Attracting Insects; Mr. Geo. B. Sudworth. Embryo of a Chick with Two Protovertebræ; Mr. J. M. Stedman.

March 21st.—Dr. W. H. Dall spoke upon the "Age of the Peace Creek Bone-Beds of Florida." Reference was made to the discovery of bones of various sorts by the Coast Survey and other exploring parties, while the recent explorations for phosphates have brought many more to light. In some counties the sticky clay containing the bones occurs in cavities of Eocene and Miocene rocks. The occurrence of bones in these localities indicates that the animals had become mired in attempting to cross swampy ground; and their appearance indicates that they had been gnawed by carnivorous animals. Evidences of fire are also present, but it was considered that lightning, and not man, was the probable cause. Some authors called the strata containing the bones Miocene, some Pliocene, and some Quaternary.

The bones found are those of the Elephas, Rhinoceros, Mastodon, Llama, Deer, Hippotherium, Equus, Tiger, Tapir, Buffalo, Megatherium, Megalonyx, Glyptodon, Porpoise, and Alligator, besides many fish fragments. Professor Cope had made a comparison between the Florida remains and those of the west, particularly the Loup Fork beds, of Miocene age. Some forms, however, were similar to those of the Equus beds, of Pliocene age. The Florida remains were, Cope thought, of an epoch between the Loup Fork and the Equus beds.

Dr. Dall stated that he had lately visited the Peace Creek locality for the special purpose of settling the age of the deposit. He explained the method of dredging for the phosphate in the river, stating that 200 tons per day were obtained. It is mostly in the form of pebbles about the size of marbles. Above Arcadia he found a section along the river bank which showed a bed with the bones *in situ*. The layer was about 1½ feet thick, overlying strata of Pliocene age (as shown by marine shells); and the bone bed was in turn overlain by a deposit of phosphatic material. The bones, therefore, could not be older than the Pliocene, and as the marl above them was covered in turn by a stratum which also contains Pliocene marine fossils, the conclusion was inevitable that the bone beds of that locality, at least, were of Middle Pliocene age.

Dr. R. W. Shufeldt read a paper "On a Collection of Fossil Birds from the Equus Beds of Oregon," from the collection of Prof. E. D. Cope. He first described the features of Silver Lake, a beautiful sheet of water frequented by great numbers of water birds. "Fossil Lake" was the bed of a dried-up lake, not many miles distant; and in the fine silt of this locality many bird remains had been discovered by Prof. Condon and Prof. Cope. He thought there were at least twenty undescribed extinct species. Indian relics, implements of obsidian, were found in the same bed as the bird remains, though it could not be asserted positively that the two were contemporaneous.

Mr. F. A. Lucas spoke of the anatomy of Hesperornis, the gigantic, extinct, toothed bird. He compared it with various living birds, and concluded the evidence indicated a foot patterned after that of the grebe, but more highly specialized. With Marsh he did not think it was a land bird, or that it used its wings in swimming, but that it was a highly specialized aquatic.

Mr. F. H. Knowlton discussed the function of cypress knees. He referred to the idea advanced in 1848 that these knees, which vary in height from one inch to two, four, and even ten feet, performed the function of aëration. This idea had been later on fully elaborated by Prof. N. S. Shaler. Another theory, advanced by Dr. Lamborn, is that the knees buttress the trees, and so prevent violent winds from uprooting them. The latter idea seemed very plausible, as it was an undoubted fact that no one had ever seen an uprooted cypress tree. Prof. Shaler had contended that when the knees were submerged the tree invariably died, but this was stated not to be the case.

Prof. L. F. Ward, in discussing the paper, expressed his disbelief in the theory that the knees were for the purpose of increasing the areating surface. He described the appearance they presented, and stated his belief that they certainly furnished support to the tree in many cases. He questioned the fact of this being their original purpose, but thought it might be the after result. He mentioned a tree planted by Bartram, near Philadelphia, which grew in dry ground, and had knees 100 yards from the trunk. This tree was probably one hundred years old, and had never grown in or near the water. He advanced the idea that the knees were only aborted shoots, thrown up from the roots like the suckers of the silver poplar and ailanthus. Water he did not consider necessary for the growth of the knees. He had not seen any tree actually arising from a knee and so connected with the parent, but he believed investigation would show that the knees were of the nature of aborted sprouts.—JOSEPH F. JAMES.

Proceedings of the Natural Science Association of Staten Island.—November 8th, 1890.—This being the annual meeting, reports of officers for the past year were read and accepted. The treasurer reported an income of $168.08 and expenses amounting to $116.83, leaving a balance of $51.25 in the treasury.

The election of officers for the ensuing year resulted as follows: President, Dr. N. L. Britton; treasurer, Eberhard Faber; recording secretary, Chas. F. Simons; corresponding secretary, Arthur Hollick; curator, Jos. C. Thompson.

Dr. Britton alluded to his recent proposition (see Bulletin Torrey Botanical Club, Vol. XVII., p. 121) to recognize plants which, with greater or less frequency, bear flowers of a color other than the normal hue under the rank of "forms," the difference not being sufficient to class them as varieties. Thus the common salt-marsh pink (*Sabbatia stellaris*), whose flowers are normally red, occasionally produces them of a pure white color, and this albino condition was therefore described under the name *Sabbatia stellaris* forma *albiflora*. This form has recently been collected in considerable quantity in the meadows back of South Beach, where it grows with the ordinary red-flowered form, and in certain patches is equally abundant. Another salt-marsh species of this genus (*S. dodecandra*), observed by Mr. Eadie at Old Place, and by Mr. Hollick at Kreischerville, has not yet been reported in the albino form from our region, but has been noticed in New Jersey.

The painted cup (*Castilleia coccinea*), which formerly grew in large quantities in the Cove Lake swamp, but is now to a considerable extent obliterated there, usually produced some plants with orange or yellow bracts, their ordinary color being scarlet. The same occurrence has been reported in other districts.

Some years ago Mr. Hollick collected a plant of the New England aster (*Aster novæ-angliæ*) at West New Brighton, which, instead of having the ordinary purple rays, had them rose-colored. This had been described by Dr. Gray as var. *roseus*, but it manifestly falls into the rank here alluded to as "forms," and I should propose to call it *A. novæ-angliæ* forma *roseus* Gray.

Mr. Hollick exhibited specimens of lignite and pyrite from the recently opened fire-clay beds at Green Ridge. This clay has been mined in this locality to a depth of about thirty feet. It is covered by from six to ten feet of drift, and is undoubtedly of Cretaceous age, the same as the Kreischerville clays, the two no doubt being continuous. About three-fourths of a mile to the eastward, at Fresh Kills, drift clay is being mined to as great a depth, but there is as yet no indication of the Cretaceous clay being near at hand. Both these localities were visited on election day on the occasion of the annual field day with the Torrey Botanical Club and Brooklyn Institute, at which time the specimens were collected. Mr. Hollick also reported that on the same day a new locality was discovered for wintergreen (*Gaultheria procumbens*), near Giffords, where there was a large patch full of berries.

March 14th, 1891.—A paper was read by Mr. Charles W. Leng, "Notes on Some Species of Donacia," as follows:

It has been my task during the past few months to make a revision of the genus Donacia, in the prosecution of which I have, with the assistance of my fellow coleopterists, Messrs. Davis and Thompson, collected considerable numbers of those species inhabiting Staten Island. Their specific identity has thus become known to me, and certain facts respecting their habits which have not been elsewhere definitely recorded seem to be proper matter for these proceedings.

There are about twenty species inhabiting the United States and Canada, of which five only are known to occur here. It is possible, however, that additional species may be found by sweeping damp meadows with a net in June and July, a method not adopted by us last year.

The genus is quite homogeneous, and the species are indeed so much alike that most collections are in some confusion. The body beneath is more or less flattened and densely clothed with decumbent hairs, lustrous and resembling silk or satin, according to the fancy of the describer. These hairs serve as a protection against the moisture to which their pond-frequenting habits expose the insects. The color above varies from coppery bronze to testaceous, more or less mottled with metallic green. The length is about half an inch. The antennæ and legs are comparatively long, and the variation in the length of the joints of the one and in the spinous processes which adorn the other afford the most convenient characters, combined with the form of the elytral apices, for the separation of the species. They may be known as follows:

Prothorax not tuberculate, scarcely punctulate;
    Third joint of antennæ little, if any, larger than second;
        Elytra squarely truncate, *lucida.*
    Third joint of antennæ at least twice as long as second;
        Elytra squarely truncate, *palmata.*
        Elytra more convex, subtruncate, *piscatrix.*
Prothorax not tuberculate, coarsely, densely punctate;
    Third joint of antennæ little longer than second;
        Elytra squarely truncate, *subtilis.*
Prothorax evidently tuberculate, scarcely punctate;
    Third joint of antennæ little longer than second;
        Elytra more convex, subtruncate, *tuberculata.*

In addition to the above, the sexual characters assist in separating the species. All the males have the last dorsal segment, called the pygidium or podex, short and truncate; the females have the same part longer and rounded at apex. The male of *lucida* has the posterior femora spinose, often armed with two or three spines; the female has but one spine. The sexes of *palmata* and *piscatrix* differ similarly in the femora; the male *palmata* is further distinguished by a dilation of the first joint of the anterior tarsi, and the male of *piscatrix* by an excavation of the first ventral segment. The sexes of *subtilis* differ but little; both have the posterior femora unidentate. The male of *tuberculata* has but one spine, but the female is without any.

From the results of last season's collecting I am satisfied that the above-described species affect different aquatic or subaquatic plants; the first three appertaining to the water-lilies, *subtilis* to the rushes growing at the pond margin, and *tuberculata* to the Sagittaria. The evidence I have is as follows: Our collections were made principally at Britton's ice pond, at the small pond on top of Todt Hill, and at Butler's or Galloway's pond near Garretson station. In all of them the yellow water-lily grows abundantly, mingled with the white water-lily, but only at Butler's pond do gradually shelving banks afford the marshy stretch necessary to a free growth of the rushes. At all of these ponds the first three species of Donacia were abundant, but only at Butler's did we find *subtilis*. At that pond were many specimens, some resting on the lily pads, but the greater number on the stalks of the rushes. (Identified by Mr. Arthur Hollick as *Juncus effusus* L.) Mr. C. M. Weed, in the Bull. Ohio Ex. Sta., Oct., 1889, describes the abundance of *subtilis* in a similar situation near Columbus. My friend, Mr. E. M. Hulbert, tells me it is abundant near New Britain on sweet flag, and "no water-lilies within a mile, and no other species found."

In regard to *lucida*, *palmata*, and *piscatrix*, all three have been taken often on the leaves of the lilies and within the flowers, and there is a further confirmation of their lily-frequenting habits derived from an observation of the roots of that plant. In the operation of cleaning the ponds for winter, the icemen drag out the ranker growth of lilies and throw them, roots and all, on the banks. I have found in November oval cases of a thin but tough material attached to these roots and containing Donaciæ in the imago and larval stages. These cocoons are waterproof, and enable the beetle to pass the winter under two or three feet of water, or perhaps, when near the bank, imbedded in ice.

The larvæ of our American Donaciæ have not been described, and though I have dried specimens I cannot venture to make a complete description. They appear to be whitish grubs, about half an inch in length, with the head darker, but not otherwise conspicuous. The body appears to taper slightly beyond the head.

I have searched about the plants inhabited by *subtilis* for similar cocoons, but hitherto unsuccessfully. Many of the stems are now eaten, possibly by its larva, and among the roots are empty cases, but these might have been washed up from the pond.

The last species, *tuberculata*, is known to us on Staten Island by a single specimen taken on Sagittaria. It was however, taken in numbers by Mr. Davis and myself in the cranberry bog at Jamesburg, N. J., on the same plant. Water-lilies occurred a few hundred yards away, and on their leaves were a few specimens of *lucida*, but on the Sagittaria only *tuberculata*.

The life-history indicated by these observations is certainly a curious chapter in coleopterology. The parent beetles hover about the food plant proper for their offspring. They lay thereon their eggs, and the larvæ hatching, eat and grow fat until the approach of winter warns them to prepare the waterproof case for their coming transformation, within which the perfect insect develops and lies dormant until the following summer, when he emerges to repeat the cycle. It is, of course, no more than all the butterflies do, but possesses a special interest from the accompanying adaptation to an aquatic career.

Mr. Arthur Hollick presented a specimen of soapstone rock from the Clove road outcrop, showing well preserved glacial striations, or possibly "slickenside" markings, neither of which had been previously noted from such rock, probably on account of its being so soft and easily weathered.

January 10th, 1891.—Mr. Arthur Hollick read the following notes upon additions to the flora of the Island, illustrated by specimens:

Since the last appendix to the "Flora of Richmond County" was published, about two years since, a number of important finds have been made. Some of these are of plants not previously found on the Island, others are of plants which had been previously reported but not verified by specimens, while others are of importance as new localities for rare species. I take pleasure in acknowledging our indebtedness to the members of the Torrey Botanical Club, who are responsible for seven of the finds, discovered during several field-day excursions to the Island.

Ranunculus lacustris Beck and Tracy. Abundant in a pond on Ocean Terrace, near the Vanderbilt mausoleum; only known previously from a pond near Court House Station.

Tilia americana L. Richmond (Wm. T. Davis.) These trees were discovered May 30th, 1888, but it was not until the following year that the flowers were obtained and the species positively identified. The trees are few in number, and grow in the woods near the defunct North and South Shore R. R. So far as we know, they are the only native lindens on the Island.

Euonymus europæus L. Escaped along a roadside near Richmond Valley.

Eupatorium hyssopifolium L. Pleasant Plains.

Aster radula Ait. Arlington. (Dr. R. G. Eccles.)

Hieracium aurantiacum L. Rossville; in grassy ground, near the shore.

Veronica chamædrys L. Prince's Bay. (Mrs. N. L. Britton.)

Salix purpurea L. Abundant along roadsides near Rossville. Probably the relics of old basket-willow plantations.

Habenaria ciliaris (L.) R. Br. Old Place (Wm. T. Davis) and Bogardus's Corners.

Habenaria blephariglottis (Willd.) Torrey. Arlington. (Dr. R. G. Eccles.)

Microstylis unifolia (Michx.), B. S. P. Near Egbertville (Mrs. N. L. Britton), and Ocean Terrace, near Four Corners. This inconspicuous little orchid has recently been found in comparative abundance at both localities, and may probably be looked for in similar situations elsewhere. It was admitted into the original "Flora of Richmond County," published in 1879, upon the strength of a single rather poor specimen found by Judge Addison Brown "in a glen near New Dorp," and until another specimen was found by Mrs. Britton about three years ago this was the only voucher which we had to show as evidence of its occurrence here.

Liparis lœselii (L.) Rich. Garrettson's; one specimen only. (Miss Millie Timmerman.) This species was admitted into the original catalogue on the authority of I. H. Hall, in the Bulletin of the Torrey Botanical Club for April, 1874, where there is a note to the effect that it was found "on Staten Island, in the gravelly bank of a railroad cutting."

Cypripedium acaule Ait., forma *alba*. A single specimen of this albino was found by Mrs. Edward Heylyn. The exact locality is not known to me.

Belamcanda chinensis (L.) Red. Tottenville; along a brook.

Tradescantia virginica L. Bogardus's Corners; evidently spreading.

Eleocharis palustris (L.) R. Br., var *glaucescens* (Willd.) Gray. Common.

Scirpus olneyi Gray. New Dorp.

Glyceria distans (L.) Wahl. New Dorp.

Panicum miliaceum L. Todt Hill road, near Moravian Church.

Association of American Anatomists.—The next meeting will be held at Washington, D. C., in September, 1891, at or about the time of meeting of the Congress of American Physicians and Surgeons. The officers for that meeting are as follows: President, Joseph Leidy; vice presidents, Frank Baker, F. D. Weisse; secretary and treasurer, D. S. Lamb; executive committee, Harrison Allen, Thomas Dwight, and B. G. Wilder.

SCIENTIFIC NEWS.

The Royal Society of Canada announces its annual meeting in Montreal, May 27th, the session lasting one week. In the words of the preliminary circular, which has been mailed to us, it is anticipated that the meeting will be attended by many distinguished persons, eminent in literature and science, from Europe and the United States, as well as from the Dominion of Canada. The ordinary sessions of the society will be held in the buildings of the McGill University, and the popular evening lectures will be delivered in the Queen's Hall on St. Catherine Street. The museums and art galleries, with the educational, industrial, and other institutions of the city will be opened to visiting members and associates. Local excursions to places of interest in the neighborhood will be arranged for, and receptions, garden parties, and entertainments of various kinds will also be provided. It is also proposed to keep a directory, wherein the names and addresses of all those attending the meeting will be registered, and thus members and associates will be enabled to communicate one with another without delay. The committee are engaged in the preparation of a hand-book, for gratuitous circulation among intending visitors, which will include an historical account of the society, together with other interesting scientific and local information, a copy of which will be sent on application. Sir Donald A. Smith is chairman, and J. A. Beaudry, C.E., and W. J. Smyth, Ph.D., honorary local secretaries. All persons interested in literature and science may become associates for this meeting, and are cordially invited by the local committee to be present thereat.

Joseph Leidy, M. D., Professor of Human Anatomy in the University of Pennsylvania, and president of the Academy of Natural Sciences of Philadelphia, died April 30th. He was born in Philadelphia, September 9th, 1823. His father, Philip Leidy, was a native of Montgomery county, Pa., and his ancestors on both sides were Germans from the valley of the Rhine.

His taste for natural history was exhibited at a very early age, and received judicious encouragement from the master of the school where he acquired the rudiments of an English education. At the age of sixteen he left school with the intention of becoming an artist, as his father proposed.

In the meantime, however, much of his leisure had been passed in a wholesale drug store near his home. His time here was so well spent that the proprietor did not hesitate, when an opportunity offered, to recommend him as competent to take temporary charge of a retail drug store belonging to a customer. He was encouraged by his success in filling the trust thus reposed in him to study the properties and art of compounding drugs as a profession. His study of nature, while thus occupied, had not been neglected. To botany and mineralogy he had added comparative anatomy, his first practical studies in that branch having been made on a barn-door fowl and a common earthworm. So absorbed did he become in his anatomical studies that, at the suggestion of his mother and with the consent of his father, he gave up all intention of becoming either artist or apothecary, and resolved to devote himself to that profession which would afford him the best opportunity for pursuing those studies from which it was now evident he could not easily withdraw himself. In the autumn of 1840, therefore, he began the study of medicine, devoting his first year to practical anatomy.

Having entered the office of Dr. Paul B. Goddard, he attended three full courses of lectures in the University of Pennsylvania, presented a thesis on "The Comparative Anatomy of the Eye of Vertebrated Animals," and graduated as doctor of medicine in the spring of 1844. Immediately after receiving his degree his first work in connection with the university was as assistant in the chemical laboratories of Drs. Hare and James B. Rogers. He began the practice of medicine in the fall of 1844, and continued it for two years, when he resolved to devote himself entirely to teaching. He was elected Professor of Anatomy in the University of Pennsylvania in 1853. In 1871 he was appointed Professor of Natural History in Swarthmore College. In 1845 he was elected a member of the Philadelphia Academy of Natural Sciences, and in 1846 the chairman of its board of curators. In 1882 he became its president.

Dr. Leidy's work covered a wide range of subjects. He was a good mineralogist, botanist, and zoologist. His original work was done in zoology and in the paleontology of the Vertebrata. He first determined the identity of the *Trichina spiralis* of man with that of the hog, and discovered many new forms of Entozoa. His early researches into the anatomy of insects and of other invertebrates are well known. His later work was in the field of vertebrate paleontology, of which science in America he laid the foundations. His most important work outside of this field is his Monograph of the Fresh-Water Rhizopoda of North

America, which is especially valuable for its admirable illustrations, drawn and colored by himself.

Dr. Leidy received the Walker prize of the Boston Society of Natural History, and the Lyell medal of the Geological Society of London. He received the degree of LL.D. from Harvard University. At the time of his death he was president of the faculty of the Wagner Free Institute of Science, and of the Department of Biology of the University of Pennsylvania; also of the American Anthropometric Society, to which body his brain has been committed for examination and report.

Professor Leidy was a man of fine presence, and was possessed of a sonorous voice. He was an admirably lucid lecturer, and had excellent artistic skill. In his disposition he was retiring and even timid, and his sympathies were easily roused. His interest was readily enlisted on behalf of "the under dog in the fight"; and the person who appealed to this side of his character was rarely disappointed. From an intellectual point of view, he was an acute and accurate observer, and a tireless investigator. Of the systematic and generalizing faculties he possessed little, and for this reason he was no organizer of men. In fact, he was indifferent to this aspect of human relations, being an "individualist" in this respect, as he was in his scientific pursuits.

American science has sustained a severe loss in the death of Leidy. His life has been a stimulus to the progress of intellectual pursuits in this country, and it will produce much fruit in the future, as it has in the past. Honors came to him and his fellow-citizens will honor themselves by erecting to him a permanent memorial in some conspicuous part of the city of his birth.

WE regret to announce the sudden death, on February 13th, at the age of 77 years, of **Mr. William Davies**, F.G.S., for forty years of the Geological Department of the British Museum, from which he retired as senior assistant some two or three years ago. This veteran paleontologist was widely known and highly esteemed by scientists of all countries for his great knowledge of the fossil back-boned animals, and for the genial readiness with which he imparted it to students and inquirers. His official duties necessarily brought him into frequent contact with the numerous distinguished pilgrims from all parts of the world to the great shrine of natural history in London. His recollections went back to the days of Dean Buckland, Agassiz, Owen, Mantell, Phillips, Hugh Miller, and other great pioneers and founders of the sciences of geology and paleontology. No one, perhaps, regretted more than he did the removal of the natural history collections from the historic galleries in Bloomsbury. It is certain none labored more strenuously to effect their safe transfer to their new home at South Kensington, and the arrangement of the gallery of fossil fishes, containing the finest collection of fossil fishes in the world, was his especial pride and care. Mr. Davies was remarkable for his unaffected simplicity of manner and modesty of character. He occupied the somewhat rare position in these scribbling days, of knowing more than he wrote, instead of writing more than he knew. Nevertheless, Mr. Davies contributed several instructive and interesting papers to the *Geological Magazine*. In one, "On the Omosaurus," he described the removal to the museum workshops of the huge septarian nodules from the Kimmeridge clay of Swindon, Wiltshire, and the subsequent development therefrom of the remains of "that gigantic British dragon of old time," the *Omosaurus armatus* of Owen, one of the finest specimens of its class in the National Museum. The descriptive catalogue of the Plistocene mammalian remains from Ilford, Essex, of Sir Antonio Brady's collection in the British Museum, was also from his pen.

Some rather sensational journalistic articles were published at the time about this fine collection, comprising the remains of parts of the skeleton of a considerable number of individual specimens of various Rhinoceri (*R. leptorhinus*), primeval oxen (*Bos primigenius*), deer, and especially of the mammoth (*Elephas primigenius*) from the Pleistocene deposits of the valley of the Thames. Mr. Davies used to relate that for some time afterwards people came to the museum and inquired anxiously for the British elephants, and went away quite angry and disappointed when they were shown the series of detached bones, not in the least realizing that a *single* bone often sufficed an anatomist for the reconstruction of an individual animal. They really seemed to expect to see the one hundred and fifty Essex elephants set up all in a row.

Mr. Davies was a great lover of nature, and enjoyed many a botanical ramble over the South Downs; but even when out for a holiday it was not easy to keep him long out of a museum. Then nothing delighted him more than to pore over a nondescript heap of old bones that every one else had given up as hopeless. It was marvelous to watch the patience and skill with which he would select and fit such rough fragments together, and finally build up the limb bone of a rhinoceros or or the spinous processes of the vertebra of an Iguanodon. Mr. Davies will be sincerely regretted by his former chiefs and colleagues, and by many friends. His end was doubtless hastened by anxieties concerning the illness of his only son, Mr. Thomas Davies, F.G.S., senior assistant of the Mineralogical Department of the British Museum.—AGNES CRANE.

Dr. John LeConte, Professor of Physics in the University of California, died April 29. He belonged to a distinguished scientific family. His father and uncle were both naturalists. His younger brother is a prominent geologist and chemist, and his nephew was an explorer and naturalist and served as chief clerk in the United States mint in this city for the five years preceding his death.

John LeConte was born in Liberty county, Georgia, on the 4th day of December, 1818, graduated at Franklin College, University of Georgia, in 1838, and studied medicine at the College of Physicians and Surgeons of New York, where he graduated in 1841. He settled in Savannah, Ga., in 1842, and there began the practice of his profession, but in 1846 was called to the chair of Natural Philosophy and Chemistry in Franklin College, which he held until 1855. He lectured on chemistry at the College of Physicians and Surgeons, New York, in 1855–56, and in 1856 became Professor of Natural and Mechanical Philosophy in South Carolina College, at Columbia. In 1869 he was appointed Professor of Physics and Industrial Mechanics in the University of California, and after holding the office of president of the university, in addition to his chair, from 1876 until 1881, he retired to the chair of Physics, which he retained up to the time of his death. His scientific work extended over fifty years.

NOTICES.

Notices for scientific societies and private individuals inserted under this head free of charge. For business houses, two cents per word.

The American Geologist for 1891.

EDITED BY

PROF. S. CALVIN, University of Iowa; DR. E. W. CLAYPOLE, Buchtel College; JOHN EYERMAN, Lafayette College; DR. PERSIFOR FRAZER, Franklin Institute; PROF. F. W. CRAGIN, Washburn College; PROF. C. L. HERRICK, Cincinnati University; PROF. A. LAKES, Colorado School of Mines; DR. ANDREW C. LAWSON, late Geological Survey of Canada; E. O. ULRICH, Illinois Geological Survey; PROF. I. C. WHITE, University of West Virginia; DR. ALEX. WINCHELL, University of Michigan; PROF. N. H. WINCHELL, University of Minnesota.

SPECIAL OFFERS TO NEW SUBSCRIBERS.

For the year 1891 the subscription rate for the GEOLOGIST will remain at $3.50. Any old subscriber who remits that sum with the name of a new subscriber will be entitled to have his own subscription extended six months. The cost of the numbers for 1888, after January 1st, 1891, will be $3.50; those of 1889, $2.50, and of 1890, $2.50. New subscribers *who remit to us cash in advance* will receive all back numbers and the subscription for 1891, for $11.00, but this will debar them from the privilege of the following premiums.

Any new subscriber *who remits to us cash in advance* may select from the following premium list, by which he will receive the selected book and the GEOLOGIST at a considerably less rate than he could obtain both separately. These are special offers for this specific purpose, for which we have made favorable arrangements with the various publishers. The works here listed are such as every geologist would desire to have in his library.

North American Geology and Paleontology. By S. A. MILLER. Recently published; 664 pp., Royal octavo, 1194 illustrations. Regular price, $5.00; with the GEOLOGIST for 1891, $7.00.

Rand & McNally's Standard Atlas of the World. One large volume of 196 pp, elegantly illustrated, substantially bound, with gold side stamp, revised to 1890. Indispensable to every student. Size of atlas closed, 11x14 inches. Regular price, best English cloth binding, $4.50. With the GEOLOGIST for 1891, $5.00.

Pre-Adamites; or a Demonstration of the Existence of Man before Adam. A study of their condition, antiquity, racial affinities and progressive dispersion over the earth. With charts and other illustrations. By ALEXANDER WINCHELL, LL.D. 3d ed., 1 vol., 8vo, cloth. Regular price, $3.50; with the GEOLOGIST for 1891, $4.75.

World Life. A study of the formation, growth and decay of worlds, from their earliest existence as nebulous masses diffused through space to their development in sun and world systems, and their final dissolution. By ALEXANDER WINCHELL, LL.D., 1 vol., illustrated 12mo., cloth. Regular price, $2.50; with the GEOLOGIST for 1891, $4.25.

Sparks from a Geologist's Hammer. A series of geological essays. By ALEXANDER WINCHELL, LL. D. Second edition, illustrated, 12mo. Regular price, $2.00; with the GEOLOGIST for 1891, $4.00.

Leibnitz' New Essays Concerning the Human Understanding. A critical exposition. By PROF. JOHN DEWEY, PH. D. 16mo, 289 pp. Regular price, $1.25; with the GEOLOGIST for 1891, $3.75.

CLUBBING LIST.

The publishers offer to send the NATURALIST, together with any one of the following periodicals, at the prices named for both. If any not on the list are wanted, or if two or more are selected from the list, the publishers will be pleased to quote low prices on application.

	Regular subscription price	Regular price of both.	Our price for both.
Popular Science Monthly,	$5 00	$ 9 00	$ 8 00
The American Journal of Science,	6 00	10 00	8 75
American Meteorological Journal,	3 00	7 00	6 40
American Geologist,	3 50	7 50	7 00
School of Mines Quarterly,	2 00	6 00	5 50
The Microscope,	1 00	5 00	4 50
The Scientific American,	3 00	7 00	6 50
The American,	3 00	7 00	Old, 6 50 New, 6 00
Lippincott's Magazine,	3 00	7 00	6 00
Cosmopolitan,	2 40	6 40	5 40
Belford's Magazine,	2 50	6 50	5 75
Scribner's Magazine,	3 00	7 00	6 40
Century Magazine,	4 00	8 00	7 50
St. Nicholas,	3 00	7 00	6 50
Atlantic Monthly,	4 00	8 00	7 00
Harper's Magazine,	4 00	8 00	7 00
Harper's Weekly,	4 00	8 00	7 00
Harper's Bazar,	4 00	8 00	7 00
The Nation,	3 00	7 00	6 50
Outing,	3 00	7 00	6 25
Cassell's Family Magazine,	1 50	5 50	5 00
American Garden,	2 00	6 00	5 40
North American Review,	5 00	9 00	8 00
Forum,	5 00	9 00	8 00
Country Gentleman,	3 00	7 00	6 00
Vick's Magazine,	1 25	5 25	4 75
America,	3 00	7 00	6 00
New York Observer,	3 00	7 00	6 00
Public Opinion,	3 00	7 00	6 52

Orders from this list must in all cases be accompanied by the cash or its equivalent,—*i.e.*, drafts on New York or Philadelphia, money orders or postal notes.

FERRIS BROS., Publishers,
Sixth and Arch Sts., Phila.

To Scientific Investigators.

ONE of the greatest needs of American science at the present time is a convenient medium in which brief preliminary notices of the results of investigation can be published. A considerable length of time of necessity elapses between the conclusion of any series of observations and their appearance in print, and it is of great advantage to the observer, and still more to his fellow-workers, to have the results made known as soon as possible, thus insuring priority of discovery to the one, and allowing the others to keep more perfectly posted with what is going on in the scientific world around them.

A preliminary notice should be published *at once* to be of value, and hitherto there has been no scientific periodical in this country, published at sufficiently brief intervals, and open to all investigators, which has specially opened its columns to the publication of such notices, and has undertaken to make them public with as little delay as possible. This the NATURALIST proposes to do, and invites the coöperation of all investigators in an attempt to inaugurate a department for the prompt and satisfactory publication of preliminary notices of the results of scientific investigations.

NOTICE TO CONTRIBUTORS
TO THE
AMERICAN NATURALIST.

Send Contributions to the EDITORS ONLY.

Send to the PUBLISHERS ONLY:

All Orders for Extra (or Reprint) Copies.
All Proofs of Texts and Engravings.

NOTE.—All orders for reprint or extra copies must be given before the number containing the article goes to press; otherwise none will be furnished.

$4.00 per Year. 40 cts. per Copy.

THE AMERICAN NATURALIST.

A MONTHLY JOURNAL
DEVOTED TO THE NATURAL SCIENCES
IN THEIR WIDEST SENSE.

Vol. XXV. MAY, 1891. No. 293

CONTENTS.

PHILADELPHIA:
FERRIS BROS., PUBLISHERS
SIXTH AND ARCH STREETS

To Scientific Investigators.

ONE of the greatest needs of American science at the present time is a convenient medium in which brief preliminary notices of the results of investigation can be published. A considerable length of time of necessity elapses between the conclusion of any series of observations and their appearance in print, and it is of great advantage to the observer, and still more to his fellow-workers, to have the results made known as soon as possible, thus insuring priority of discovery to the one, and allowing the others to keep more perfectly posted with what is going on in the scientific world around them.

A preliminary notice should be published *at once* to be of value, and hitherto there has been no scientific periodical in this country, published at sufficiently brief intervals, and open to all investigators, which has specially opened its columns to the publication of such notices, and has undertaken to make them public with as little delay as possible. This the NATURALIST proposes to do, and invites the coöperation of all investigators in an attempt to inaugurate a department for the prompt and satisfactory publication of preliminary notices of the results of scientific investigations.

THE

AMERICAN NATURALIST

VOL. XXV. MAY, 1891. 293.

THE HELIOTROPISM OF HYDRA.[1]

BY EDMUND B. WILSON.

I. *Introductory.*—Every observer of Hydra is familiar with the fact that the animal possesses considerable power of locomotion, and under certain circumstances may creep restlessly about the aquarium; it is not so generally known that its wanderings, which on superficial examination seem vague and meaningless, are in reality directed towards a definite end, and play an important part in the life of the animal. Trembley observed as long ago as 1791 that the movements of *Hydra viridis* show a definite relation to the source of light (heliotropism), the animal manifesting a marked tendency to collect on the illuminated side of the aquarium. Although this heliotropism is now well known, it has not received the attention it deserves; as far as I know, indeed, nothing has been added to Trembley's account by later observers. I find no mention of the subject in any of the more recent papers on heliotropism, except in Loeb's very interesting work,[2] and this gives no more than a brief review of Trembley's results. The subject is, however, one of considerable interest for several reasons. Hydra is not known to possess any kind of differentiated visual apparatus; the animals can be kept under observation for a long time and their behavior closely studied; the comparison of *H. fusca* with *H. viridis* enables us to determine how the

[1] Read before the American Morphological Society, December, 1890.

[2] Heliotropismus der Thiere. Würzburg, 1890.

movements are affected by the presence of chlorophyll; on account of their slowness, the movements may be accurately followed step by step.

Although the observations recorded in the following pages have occupied my attention at intervals for several years, they are still far from exhaustive, and I offer them only as a beginning. They indicate, however, that the purpose of the creeping movements and the stimuli that call them forth have not hitherto received any satisfactory explanation, and that a number of very interesting physiological questions connected with them have in consequence been overlooked. Since the heliotropic movements are complicated by other actions, I will first describe the general character of the movements as a whole.

II. *General Character of the Movements.*—Marshall has given a very good account of the mode of locomotion of Hydra,[3] though he makes no attempt at an accurate analysis of the movements, and does not mention heliotropism. I shall therefore treat only of the general character of the movements. The following account applies both to *H. viridis* and to *H. fusca*, unless otherwise stated. In a light of moderate intensity (in a north room) the animals, after wandering more or less irregularly about, gradually collect on the side turned towards the window, usually not far from the surface of the water, though here and there a straggler lags in the background or along the sides of the aquarium. The movements then become less active; the animals may remain for a considerable time with only slight changes of position, and, if the food be abundant, rapidly increase in number by growth and budding. It appears, therefore, that in moderate daylight Hydra is positively heliotropic, and its behavior is the same with lamplight, even if it be of very low intensity. If the intensity of the light be increased, a point is ultimately reached at which the action is reversed and the animals move away from the light (*i.e.*, the heliotropism becomes negative), though this action is less striking in its results than the advance movement, since the animals do not collect on the side opposite to the light, but move into the shadow of leaves, etc., or seek the

[3] *Zeitschrift für Wiss. Zoologie*, XXXVII., 1882.

bottom. It is, however, difficult to determine the precise character of the negative heliotropism, since it only occurs at an intensity that is unfavorable to the general condition of the aquarium, and thus indirectly injures the Hydras.

Up to this point there is no essential difference in the behavior of the two species, although, as many observers of Hydra have pointed out, the movements of *H. viridis* are more rapid than those of *H. fusca*, so that the former species almost invariably leads the march towards the light. If now the aquarium be allowed to stand for a long time undisturbed (the water remaining unchanged, but maintained at a constant level), until the food supply of Daphnia, Cypris, etc., becomes scanty, a very interesting series of movements may be observed in *H. fusca*. (They are only occasionally performed by *H. viridis*, and never, so far as I have observed, with the same regularity as in the former species.) After a prolonged stay near the surface the animal detaches itself from the the glass, and with tentacles widely outstretched sinks slowly to the bottom, often floating for a time at the surface before the descent. Arrived at the bottom, it slowly crawls once more to the light side, gradually, and with many deviations from the straight course, reascends to the surface, ultimately sinks again to the bottom, and so on. Thus the movements pass through a cycle, extremely variable in its details, but on the whole maintaining the character of a slow and regular rotation. The duration of the cycle is extremely variable; it may be only one or two days, or it may be as many weeks.[4]

What is the use of these movements, and by what stimuli are they called forth?

III. *Purpose and Cause of the Movements.*—It appears to be commonly assumed that Hydra moves towards the source of light "for the sake of warmth,"—*i. e.*, that within suitable limits a higher temperature is more agreeable to the animal or more

[4] In order to realize the truth of this description it is necessary to have under observation a large number of individuals in a large aquarium, to which they have become thoroughly accustomed by a residence of weeks or months. Many of my observations have been made on a fraternity of Hydras from five hundred to a thousand strong, all of which had arisen in the aquarium from a group of three or four progenitors, in the course of about two months. In this fraternity the cyclical character of the movements was very marked, and the descent of the animals might be observed almost at any time.

favorable to its physiological processes. Whether the animal has any "preferences" or exercises any conscious choice is an open question; but this question aside, the assumption that it is stimulated to move towards the light by the invisible heat-rays is clearly without foundation. The light, before impinging upon the animal, must as a rule traverse a considerable thickness of water, by which the heat-rays are almost wholly absorbed, and thus rendered inoperative. Experimentally the same result is given as follows: If in the winter season an aquarium be placed close to a north window, in a warm room, the animals collect as usual on the light side, although, as shown by a thermopyle, the other sides may receive a much greater supply of heat-rays. Experiments with Bunsen flames or heated objects placed close to the aquarium and kept in a fixed position for days show no perceptible movement of the Hydras towards the source of heat, provided no luminous rays are given off from it. The most convincing evidence is afforded by the behavior of Hydras towards rays that have passed through water as compared with rays that have passed through liquids absorbing the same amount of heat but transmitting fewer light-rays. Thus it is easy to arrange an apparatus such that a group of Hydras is offered the choice between rays that have passed through water (transparent to the visible rays, but nearly impervious to heat-rays) and a strong solution of iodine which, as shown by the thermopyle, is practically the same as water in respect to the transmission of heat-rays, but absorbs a large proportion of the visible rays. Under these circumstances the Hydras invariably move in the direction of the rays that have traversed the water, thus proving that the attractive influence must be exerted by the visible rays.

It is certain, therefore, that notwithstanding their complete lack of definite visual apparatus, both species of Hydra are not only very sensitive to the visible rays, but perform definite actions in response to the stimuli afforded by them. It seems certain, also, that the heliotropism cannot have the same part to play as in the life of green plants, since it is not peculiar to the green Hydra. In this regard Hydra differs strikingly from the Protozoa, in which, as a rule, it is only the chlorophyll-containing forms that seek the light.

The main purpose of the heliotropic movements, as I am convinced, is simply to place the animals in the position of maximum food supply, and the entire cycle of movements of which heliotropism is a factor may be explained on the same basis. The favorite and usual food of Hydra consists of various minute Crustacea,—Daphnia, Cypris, and other Entomostraca, especially the first named,—though it will readily devour insect larvæ and many other small animals. It is a well-known fact that Daphnia and related forms manifest in a high degree a heliotropism of the same character as that of Hydra,—*i. e.*, positive in moderate light, negative in strong light,—and it must result from this that so far as the movements of the two animals are determined by light the tendency will be, in the long run, for the Hydras to collect in the localities most frequented by their prey. It is impossible to study an aquarium well stocked with the two animals without being struck by the immense advantage secured to the Hydras by their position on the illuminated side near the surface. In this region the Crustacea often swim in swarms, darting about through a forest of outstretched Hydras, many of which are gorged with food and actively budding, while in other parts of the aquarium both animals are far less abundant. The power of seeking the light, or of avoiding it when too strong, thus confers upon the blind, sluggish Hydra a means of pursuing and capturing its active and highly organized prey, and a vague, diffused sensibility to light becomes in this way of vital importance to its possessor, and may be brought under the action of natural selection. It cannot be doubted that individuals possessing a sensibility higher than the average will have a distinct advantage over the others, so that natural selection will tend to perpetuate them. An interesting feature of the case is that the increased food supply directly increases the rate of reproduction,—*i. e.*, by budding,—so that, in the long run, individuals of high sensibility will multiply more rapidly than those of low sensibility, and leave a larger number of descendants in increasing proportion from generation to generation. It may be noted, further, that the add that *H. viridis* is far more hardy than *H. fusca*, being able to live for many days or weeks in foul water that would quickly prove fatal to the latter species. This power of endurance may be due to the liberation of oxygen through the assimilative action of the chlorophyll.

En résumé, the movements of Hydra may be resolved into three actions, which, taken together, insure to the animal a supply of food and air. These are (1) heliotropism, (2) aërotropism, and (3) detachment from the support; and the three are so combined as to form on the whole a cycle. Each movement appears to be called forth by a particlar stimulus,—the first by light-rays, the second by dissolved air, the third apparently by diminished food supply of a certain kind. The entire series of movements is useful to the animal, is in large part even of vital importance, and at first sight gives the general impression of consciousness and design; yet a careful analysis of the action weakens this impression, and indicates that it may be regarded as a series of rather complex reflexes, into which the element of consciousness, and *a fortiori* intelligence, need not enter at all.

We may perhaps push the matter a step further back. Granting that the heliotropism of Hydra has been acquired because of the similar heliotropism of Daphnia, we may next seek an explanation of the latter action. The explanation lies close at hand, though I have never seen it stated. There can be little doubt that Daphnia, like Hydra, seeks the light because it there finds the maximum food supply. It is well known that a large number of microscopic green plants possess a considerable power of locomotion, and that they are positively or negatively heliotropic according to the intensity of the light, This is true, for instance, of the zoöpores of numerous species of fresh-water algæ, of many desmids, and other forms. These plants form a part—probably an important part—of the food of Daphnia, and the animal would accordingly gain a great advantage by acquiring a similar heliotropism. Lastly, the heliotropism of the plants is no doubt a provision for placing them in the optimum position for assimilation. It appears, therefore, that the ultimate reason for the heliotropism of Hydra may lie in the mode of assimilation in green plants, and the case seems to me an interesting one, as illustrating both the correlations between associated organisms, and the nature of the conditions that may enable natural selection to operate at or near the beginning of a series of physiological and morphological modifications.

IV. *Color Discrimination.*—Like many other heliotropic forms, Hydra is chiefly affected by the blue rays. If strips of glass of various colors be fastened to the illuminated side of an aquarium, both species of Hydra show a very marked tendency to collect under the blue, and an equally marked avoidance of the red, green, yellow, or any combination of colors containing no blue. This preference for the blue is (within rather wide limits) independent of intensity. This is strikingly shown by the comparison of a light "yellow" glass with a dark blue cobalt glass,[7] the former being of high, the latter of low, intensity. If equal areas on the light side of an aquarium be covered (see Table II.) (*a*) with yellow, (*b*) with blue, (*c*) with an opaque screen, and a fourth area (*d*) be left uncovered, the result is invariably that in the course of a few days the greatest number of Hydras will be found under the blue (allowance being of course made for the initial differences): the uncovered area stands next, and the shaded and yellow areas contain fewest, with no constant difference between them. That is, the areas compare as follows, as regards:

	Highest.		Lowest.	
Intensity,	(*d*) White,	(*a*) Yellow,	(*b*) Blue,	(*c*) Dark,
Attractiveness,	(*b*) Blue,	(*d*) White,	{ (*a*) Yellow, (*c*) Dark.	

[7] The colors of the glasses used in the experiments, as tested by the spectroscope, were as follows:

Red.—Transmits red and a little orange. Complete absorption of the upper end down to a little beyond the D line. Lower end just perceptibly shortened.

Yellow.—Transmits all but the blue, indigo, and violet. With one layer, complete absorption of upper end down to *b* in the green. Red end very slightly shortened. Two layers cut out of the upper end as far as E, but still transmit some green. Three layers produce nearly complete absorption of the green.

Green.—Transmits green and yellow. Upper end absorbed down to just below F. Red end nearly absorbed, but a faint band transmitted between B and C.

Blue.—Transmits blue, indigo, and violet, and a very little green and red. In a single layer upper end transmitted as far as F. Very faint transmission of green between E and F, and a slightly brighter but narrow band to the left of E. A broad but only barely visible band transmitted in the red. Two layers extinguish the red completely and the green nearly. With three or four layers nothing is visible below F.

The same result is reached if two or even three layers of blue glass are used (see Table II.), although in the last case the blue color is so dark that at a short distance it appears nearly opaque to the eye. It is, moreover, immaterial whether the four (three) areas constitute the only source of light (the top and other sides being in this case covered with black paper) or the diffused light of the room enter from behind and above; the result remains the same. Red and green glass agree nearly with yellow, the Hydras treating them practically as if they were opaque. (This statement will require some modification hereafter.)

The result thus obtained is rendered still more striking if the yellow and blue glasses be interchanged. Within an hour or two the Hydras begin to move out of the yellow light and into the blue, and in a day or two, more or less according to circumstances, the numbers under the blue are far in excess. Thus the Hydras may be driven from one area to another and back again by interchanging the glasses, as often as may be desired (see Table III.). For further details the reader is referred to the explanation of the tables and the chart.

TABLE I.—*Hydra fusca.*

Date.	Hour.	Weather.	Temperature, F.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
Areas				I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
Arrangement of the Colors					Y2		B2		R2		G2	
March 9,	10.30 A.M.	Bright.		11	17	19	18	9	27	11	25	16
" 9,	12.30 P.M.	"		10	15	18	19	19	17	24	16	22
" 10,	10.30 A.M.	Cloudy.	67°	14	8	21	22	23	10	27	9	33
" 10,	4.30 P.M.	"	75°	15	7	21	35	24	7	30	7	37
" 11,	9.30 A.M.	"		14	4	23	30	27	9	25	9	32
" 12,	10.30 A.M.	Bright.	74°	21	11	15	34	29	14	28	5	35
" 13,	10.30 A.M.	Cloudy.		26	6	21	41	20	13	33	8	43
" 14,	12.30 P.M.	"	72°	33	8	25	30	31	7	30	5	46
Rearrangement of the Colors					B3		B4		B2		B1	
March 15,	9.30 A.M.	Cloudy.	70°	21	16	22	21	21	27	18	25	26
" 15,	3.30 P.M.	Bright.	70°	15	27	15	26	20	30	11	33	26
" 16,	11.30 A.M.	"	62°	17	23	18	22	23	38	15	41	25
" 17,	10.30 A.M.	"	70°	21	25	23	17	27	41	20	47	21
" 18,	11.30 A.M.	"	68°	13	36	20	22	15	43	14	50	18
" 18,	5.00 P.M.	"	68°	13	39	10	21	18	45	14	52	21
Rearrangement of the Colors							Y		G2		R	
March 19,	Noon.	Cloudy.	66°			29	7	34	17	39	24	42
" 19,	3.45 P.M.	"				35	6	33	20	38	17	43
" 20,	10.00 A.M.	Bright.	72°			36	10	31	19	33	27	53
" 20,	3.45 P.M.					39	11	35	14	42	21	63
" 21,	9.45 A.M.	Foggy.	70°			33	10	41	13	38	20	65
" 22,	1.00 P.M.	"	66°			35	8	48	17	52	18	64
" 23,	10.00 A.M.	Cloudy.	64°			34	14	33	25	35	24	58

EXPLANATION OF TABLE I.

The areas marked I.–IX. were vertical parallelograms of equal size (34 by 125 mm.), extending from the bottom to the surface, consecutively placed on the side of a large square aquarium, which was placed at a distance of fourteen feet from a window three feet wide and eight feet high, facing the northeast, so that direct sunlight never fell upon the aquarium. The top of the aquarium was covered, the ends and rear side uncovered, so as to admit the diffused light of the room. Area IX. extended to within nine mm. of one end of the aquarium. I. was nearly in the middle. The Hydras had lived for about two months in the aquarium, and were very large and vigorous, many of them actively budding. Throughout the experiment there was a moderate supply of crustacean food, but the animals nevertheless often descended to the bottom and filled themselves with sediment. The alternate areas II., IV., VI., VIII., were first covered with double layers of colored glass (for the color-test see page 421), as in the table, and these were allowed to remain for five days. The results were as follows: The total number of Hydras increased from 153 to 215,—*i. e.*, 40 per cent. The record of the colored areas (taking the mean of the first two and the last two observations) was:

Yellow	decrease (per cent.)	56
Red	" "	55
Green	" "	70
Blue	increase "	92

The record of the light areas was:

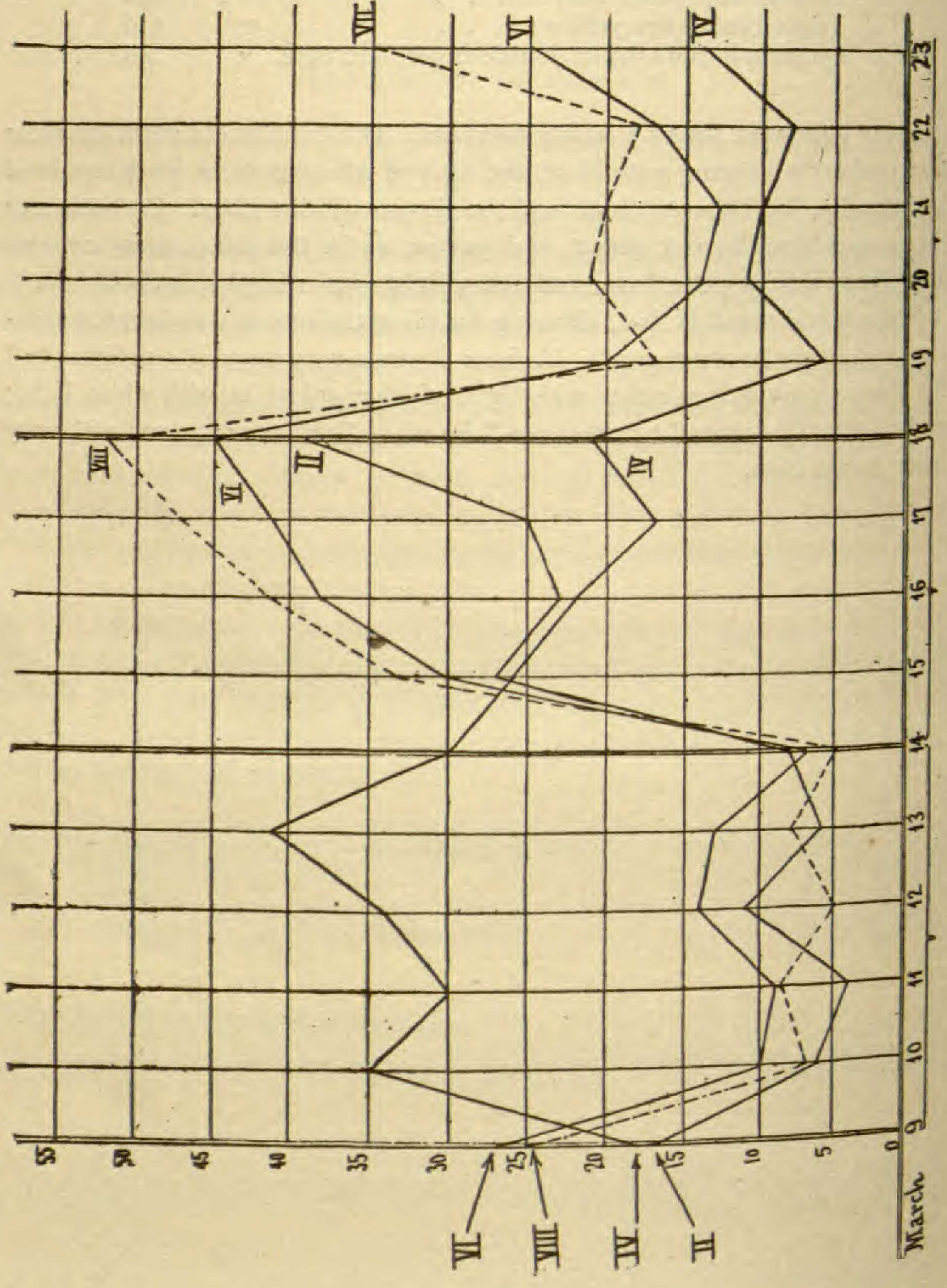
I.	increase (per cent.)	185
III.	" "	24
V.	" "	89
VII.	" "	80
IX.	" "	134

Thus all of the colors except the blue show a large decrease; the blue and all of the light areas a large increase. The increase in the blue is more than double the general rate of increase, but less than that of the two end areas, I. and IX. The colors are now rearranged, one layer of blue being substituted for the green, two layers of blue for the red, three layers of blue for the yellow, and four layers of blue for the former two layers of area IV. Results, after four days, as follows (taking, as before, the mean of the last two observations):

Total increase 215 to 233,—*i.e.*, eight per cent.			
Single blue (after green), . . .	increase	(per cent.)	692
Double blue (after red)	"	"	340
Triple blue (after yellow) . . .	"	"	436
Quadruple blue (after double blue),	decrease	"	40

Every light area shows a heavy decrease. The experiment seems to show that under the existing conditions the limit of attractiveness, as determined by intensity, lies between three and four layers of blue glass. On replacing the various blues by red, green, and yellow, as in the table, every colored area shows a heavy decrease, and every light area a large increase.

The general result is that, allowing for all variations of weather, temperature, and irregular movements, *H. fusca* shows a very marked "preference" for blue in comparison either with light of other colors or with white light; and an equally marked "preference" for white light as compared with any color except blue.



The above diagram shows in graphic form the same results set forth in Table I. Vertical distances from the base denote the number of Hydras; horizontal distances to the right of the left-hand vertical line denote the date (see Table I.) The colors were changed at the vertical double lines.

The curves show very strikingly, along with the indefinite diurnal fluctuations, the immediate fall in the number of Hydras when placed under any color except blue. The curve IV., as compared with that of II., shows that the attractive influence of blue, under the conditions of the experiment, ceased when the intensity of the blue was diminished beyond three layers of glass.

The comparison of curves II., VI., and VIII. shows a remarkable similarity between them, and indicates that, under the conditions of the experiments, the actions of red, green, and "yellow" did not materially differ.

EXPLANATION OF TABLE II. (page 428.)

This experiment gives a comparison of blue, yellow, white, and the shadow of an opaque screen (II.), and shows the amount of fluctuation from day to day. The general arrangement is the same as in Table I., the same aquarium, Hydras, position, and areas being used as before, but the areas are increased in number, so as to extend over nearly the whole illuminated side, area I. being three mm. from one end, and area XVI. nine mm. from the other. The comparison is made between the first and last observations.

Total increase, 421 to 674,—*i.e.*, 60 per cent.
Blue, increase . . . . 327 per cent.
Yellow, decrease . . . . 30 "
Dark screen, decrease . . . . 37 "
Light (a mean of V., VI., VII., increase . 30 "

An inspection of the table shows that although these figures express the broad general result with sufficient accuracy, they are not to be taken to mean more than this, since there is a wide margin of apparently fortuitous variation from day to day. The table shows a marked "preference" for the blue, and a much less marked but still distinct "preference" for ordinary daylight, as compared with the light of diminished intensity behind the opaque screen. The yellow glass acts practically as if it were opaque.

TABLE II.—*H. fusca.*

Areas	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.
Arrangement			B			L			D					Y		
March 28, 4.30 P.M.	24	14	15	19	26	27	14	22	19	29	24	33	29	34	32	60
" 29, 10.30 A.M.	24	14	29	11	25	26	16	25	16	29	25	29	31	17	45	62
" 29, 4.00 P.M.			28			29			15					22		
" 30, 9.45 A.M.	17	13	28	13	24	22	25	24	16	29	27	34	34	12	50	73
" 31, 9.30 A.M.	23	13	34	16	22	29	22	30	10	24	33	34	34	16	47	84
April 1, 10.00 A.M.	21	21	34	12	26	27	17	30	14	23	29	34	31	24	55	65
" 2, 11.00 A.M.	18	17	42	19	30	23	22	30	14	22	24	27	43	24	54	73
" 3, Noon.	19	26	42	23	32	27	20	14	19	21	29	31	35	23	53	83
" 4, 10.00 A.M.	14	22	46	25	37	33	14	26	11	19	33	31	45	17	46	78
Rearrangement			B2						D					G2		
April 4, 1.00 P.M.			52						10					22		
" 4, 4.00 P.M.			56			34			7					21		
" 4, 8.00 P.M.			54						9					24		
" 5, 10.00 A.M.	21	29	49	28	44	35	17	27	15	18	29	38	47	28	54	77
			B3													
" 5, 4.00 P.M.			50			36			13					24		
" 6, 10.00 A.M.	15	39	46	28	39	41	23	38	6	22	23	28	50	19	45	88
			B4													
" 8, 1.00 P.M.	37	43	38	32	50	39	30	41	9	25	24	38	37	23	53	100
														Y		
" 9, 4.30 P.M.	40	50	34	37	48	39	33	44	11	21	23	35	44	17	71	83
			B3													
" 10, 9.30 A.M.			49			46			9					18		
" 15, 11.00 A.M.	59	52	64	17	25	30	33	43	12	33	31	33	43	24	81	94

TABLE III.—*Hydra viridis.*

Areas	I.	II.	III.	IV.	V.	VI.	VII.
Arrangement	G		B		Y		R
March 24, 5.30 P.M.	1	0	6	2	8	2	2
" 24, 8.30 P.M.	1	1	7	6	5	5	1
" 25, 11.45 A.M.	0	0	14	0	0	7	0
Rearranged	G.		Y		B		R
March 25, 2.00 P.M.	0	3	4	5	5	4	0
" 25, 5.00 P.M.	0	5	1	6	6	4	0
" 26, 5.00 P.M.	0	7	3	3	6	6	0
" 27, 4.00 P.M.	0	3	0	4	9	6	2
" 28, 4.00 P.M.	0	3	0	5	9	6	2
" 29, 3.00 P.M.	0	3	0	2	15	4	0
Rearranged	G		Y		R		B
March 29, 9.45 P.M.	0	4	0	9	6	8	2
" 30, 9.45 A.M.	0	4	0	10	1	6	8
" 31, 9.00 A.M.	0	4	0	12	0	5	9
Rearranged			B.		B		
March 31, 12.30 P.M.	1	1	7	4	6	6	4
April 1. 9.30 A.M.	5	1	11	2	9	4	4
Rearranged			B2		B1		
April 2, 10.00 A.M.	5	5	10	0	13	7	6
" 2, 9.00 P.M.	3	2	7	2	19	2	6
" 3, 11.00 A.M.	6	3	3	5	14	6	5

Explanation of Table III.

General conditions of the experiment, as in Tables I., II., but the animals were in a cylindrical aquarium, eight inches in diameter, and the areas were much smaller (colored areas, 20 by 70 mm.; light areas, 10 by 70 mm.). The middle area (IV.) was turned towards the window. The end areas (I., VII.) would therefore tend to receive any Hydras advancing towards the light around the sides.

The results show a complete avoidance of all colors except blue, and a marked "preference" for blue as compared with ordinary daylight.

The results obtained by the use of colored glasses are confirmed by tests with the actual spectrum.[8] If a spectrum produced by passing a beam of light from an Argand lamp through a prism be thrown upon a group of Hydras, they show a very marked tendency to collect in the lower blue. It is

[8] For this purpose I have used an Argand gas-burner, the light from which was passed first through a narrow slit, then through a biconvex lens to render the rays approximately parallel, and finally through a large prism (bisulphide bottle). The spectrum thus obtained was projected upon the side of a square aquarium ruled in small squares, and at

difficult to fix exactly the limit of the attractive rays. As nearly as can be determined they extend over the lower third of the blue end,—*i. e.*, from G nearly to F,—and for a short distance into the green.

The results of these experiments leave no doubt that, irrespective of intensity, Hydra prefers[9] blue light to all other colors and to white light (ordinary daylight). My observations indicate further that, although the blue rays are by far the most efficient, a slight attractive influence is also exercised by the green. Under ordinary circumstances—*i. e.*, when diffused daylight is not cut off from behind or above—Hydra appears to be as indifferent to green as to red or to an opaque screen. If, however, the animal be enclosed in an aquarium so arranged as to offer it the choice between green and either red or "yellow," a distinct though slight preference is shown for the green, and the animals very gradually accumulate behind it. The green glass used in this experiment shows no trace of blue under the spectroscope. If the choice be offered between red or "yellow" (the latter = red + yellow + green), no perceptible preference is shown, even if the experiment be continued for weeks. This result is of some interest, for it seems to show that the slight attractive influence of green is nullified by the admixture of red and yellow, just as the attractiveness of blue is diminished by the admixture of the other colors, as has been shown.

The preference of Hydra for blue as compared with white light is a very remarkable fact; for the animal can never have had any experience of pure blue, but only of white, light,—*i. e.*, blue plus the other colors of the spectrum. Neither can the preference for blue glass be due simply and solely to the attractive influence of the blue rays, for the ordinary daylight entering the aquarium contains at least as many blue rays as the same

the distance adopted (about two feet from the prism) was about three inches in length. The apparatus was placed in a perfectly dark underground room, and every pains was taken, by the use of suitable screens, etc., to exclude from the aquarium all light excepting that proceeding from the prism.

[9] The word "prefer" is perhaps objectionable as implying an act of consciousness on the part of Hydra. I do not wish to make such an implication, however, and use the word only for the sake of brevity.

light after its passage through the blue glass. The conclusion would seem to be inevitable that the lower rays exercise an injurious or repellant action, and thus tend to produce negative heliotropism, or to counteract the effect of the blue rays. It is a tempting hypothesis to suppose that the blue rays are most efficient in light of low intensity, and the lower rays most efficient in high,—a view which would explain in the clearest manner the reversal of heliotropism with the change in intensity. Experiment, however, does not sustain this conclusion, but indicates that the animal is wholly indifferent to the lower rays. Hydras supplied only with light that has passed through red or yellow glass do not noticeably move either away from or towards it, but behave as though the glass were opaque. Tested with the actual spectrum, they appear to be quite indifferent to all of the rays except the lower blue and the upper green. I have also tested this question by the comparison of nearly pure blue glass with purple (aqueous solutions of methyl-violet of various intensities), which is a mixture of blue and red. Any repellant action on the part of the red might reasonably be expected to counteract more or less completely the attractiveness of the blue. Experiment shows, however, that purple is as attractive as pure blue, —neither more nor less, as far as can be determined.

It appears, therefore, to sum up, that although the lower rays are without any perceptible action on Hydra, by themselves or when mixed singly with the upper rays (as in purple), yet they partially counteract the attractiveness of the blue rays when mixed with them as they are in ordinary daylight, and of the green rays when mixed with them so as to form yellow (*i. e.*, white light minus blue). This paradoxical result I am at present unable to understand, but the problem is undoubtedly worthy of the most careful investigation.

Why the blue-green rays alone should be operative it is impossible to say. The recent works of Loeb and Groome upon animal heliotropism, and the earlier work of Sachs, de Bary and others upon plants, show that in all probability the blue rays are the effective ones in all cases of heliotropic action, whatever its purpose or mode of origin, whether in plants or animals, whether guided by differentiated visual organs or not. If this conclusion be well founded, the efficiency of the blue rays must depend upon some fundamental characteristic of protoplasmic action, and the sensibility to the lower rays, as manifested by differentiated visual end-organs in higher forms, has probably been secondarily acquired by an extension of the original blue-sensibility.

It seems hardly necessary to point out that this conclusion by no means implies that all forms of heliotropic action have the same physiological meaning. It relates solely to the *mode of stimulus*, not to the purpose of the actions called forth by the stimulus. Sneezing and winking may both be produced by a sudden visual stimulus, but we do not for this reason conclude that these actions must play the same physiological *rôle*.

To the ultra-violet rays the animals, as far as can be determined, are as indifferent as to the ultra-red.

V.—The last point to be considered relates to the mode in which the stimulus acts,—a question of greater importance than appears at first sight. There seems to be no doubt that blue rays impinging upon Hydra exert a directly attractive influence; for if an aquarium be supplied with blue light only (entering through a small window) the animals move pretty directly towards it, and do not simply wander aimlessly about until they reach the blue by accident. The case is different when a number of the animals, already situated on the illuminated side of a square aquarium, are offered the choice between a number of differently colored slips fastened to that side.

Under these conditions, as has been shown, the animals decrease under the red, yellow, and green glasses, and steadily accumulate under the blue, although no unmixed blue light impinges upon those individuals not actually behind the blue glass. The lower rays, however, exert no repellant action in themselves, and we must therefore assume that the animals tend to wander irregularly about until the blue areas are accidentally discovered. Observation shows, moreover, that the tendency to wander exists under every condition of illumination. By marking off the side of an aquarium into small squares it is easy to follow and accurately record the individual movements of a group of Hydras for a long time. The results show that even after the animals have thoroughly established themselves in the usual position on the illuminated side they are to some extent continually on the march, and seldom remain in one spot more than a day or two, and the time is usually much less than this. I cannot make out that the movements are more active under the red, yellow, or green, or in darkness, than in daylight or under blue, though a *sudden change*, whether of color or of intensity, is apt to stimulate the movements for a time. This latter fact probably explains the comparatively rapid dispersal of the animals upon the substitution of a neutral color for blue (see tables), which at first sight seems to point to a direct repellent action.

On the whole, the facts seem to warrant the conclusion that Hydra has an innate (automatic?) tendency to wander, and that light and oxygen operate not so much by calling forth new movements as by the modification of indefinite movements that tend continually to recur irrespective of external stimuli. If this be so, the case shows an interesting analogy to the movements of plants, many of which (including heliotropism), as Darwin has so strikingly shown, have arisen through the modification by special stimuli of an innate circumnutatory movement. Some of these movements in plants, though no doubt unconscious, have an extraordinary likeness to purposive, intelligent acts. It would be difficult to say in what lies the superior claim of Hydra to recognition as a conscious, not to say intelligent, being.

Bryn Mawr, Pa., April, 1891.

guided by differentiated visual organs or not. If this conclusion be well founded, the efficiency of the blue rays must depend upon some fundamental characteristic of protoplasmic action, and the sensibility to the lower rays, as manifested by differentiated visual end-organs in higher forms, has probably been secondarily acquired by an extension of the original blue-sensibility.

It seems hardly necessary to point out that this conclusion by no means implies that all forms of heliotropic action have the same physiological meaning. It relates solely to the *mode of stimulus*, not to the purpose of the actions called forth by the stimulus. Sneezing and winking may both be produced by a sudden visual stimulus, but we do not for this reason conclude that these actions must play the same physiological *rôle*.

To the ultra-violet rays the animals, as far as can be determined, are as indifferent as to the ultra-red.

V.—The last point to be considered relates to the mode in which the stimulus acts,—a question of greater importance than appears at first sight. There seems to be no doubt that blue rays impinging upon Hydra exert a directly attractive influence; for if an aquarium be supplied with blue light only (entering through a small window) the animals move pretty directly towards it, and do not simply wander aimlessly about until they reach the blue by accident. The case is different when a number of the animals, already situated on the illuminated side of a square aquarium, are offered the choice between a number of differently colored slips fastened to that side.

Under these conditions, as has been shown, the animals decrease under the red, yellow, and green glasses, and steadily accumulate under the blue, although no unmixed blue light impinges upon those individuals not actually behind the blue glass. The lower rays, however, exert no repellant action in themselves, and we must therefore assume that the animals tend to wander irregularly about until the blue areas are accidentally discovered. Observation shows, moreover, that the tendency to wander exists under every condition of illumination. By marking off the side of an aquarium into small squares it is easy to follow and accurately record the individual movements of a group of Hydras for a long time. The results show that even after the animals have thoroughly established themselves in the usual position on the illuminated side they are to some extent continually on the march, and seldom remain in one spot more than a day or two, and the time is usually much less than this. I cannot make out that the movements are more active under the red, yellow, or green, or in darkness, than in daylight or under blue, though a *sudden change*, whether of color or of intensity, is apt to stimulate the movements for a time. This latter fact probably explains the comparatively rapid dispersal of the animals upon the substitution of a neutral color for blue (see tables), which at first sight seems to point to a direct repellent action.

On the whole, the facts seem to warrant the conclusion that Hydra has an innate (automatic ?) tendency to wander, and that light and oxygen operate not so much by calling forth new movements as by the modification of indefinite movements that tend continually to recur irrespective of external stimuli. If this be so, the case shows an interesting analogy to the movements of plants, many of which (including heliotropism), as Darwin has so strikingly shown, have arisen through the modification by special stimuli of an innate circumnutatory movement. Some of these movements in plants, though no doubt unconscious, have an extraordinary likeness to purposive, intelligent acts. It would be difficult to say in what lies the superior claim of Hydra to recognition as a conscious, not to say intelligent, being.

Bryn Mawr, Pa., April, 1891.

REMARKS ON THE REPTILES GENERALLY CALLED DINOSAURIA.

BY G. BAUR.

THE name Dinosauria was proposed by Prof. Richard Owen (1), in a paper on "British Fossil Reptiles," read before the ninth meeting of the British Association, at Birmingham in 1839. In this order were placed the genera Megalosaurus, Hylæosaurus, and Iguanodon. Already in 1830, however, Hermann v. Meyer (2) had placed Megalosaurus and Iguanodon in a peculiar group of the fossil saurians, with "Extremitaeten wie bei den schweren Landsäugethieren." Kaup (3) follows H. v. Meyer, and calls the order containing Iguanodon and Megalosaurus: *Rieseneidechsen, Megalosaurier*.

Owen gave the following characters for the group he had called Dinosauria (*l. c.*, p. 102, 103):

DINOSAURIANS.

"This group, which includes at least three well-established genera of saurians, is characterized by a large sacrum composed of five anchylosed vertebræ of unusual construction, by the height and breadth and outward sculpturing of the neural arch of the dorsal vertebræ, by the two-fold articulation of the ribs to the vertebræ, viz., at the anterior part of the spine by a head and tubercle, and along the rest of the trunk by a tubercle attached to the transverse process only, by broad and sometimes complicated coracoids and long and slender clavicles, whereby crocodilian characters of the vertebral column are combined with a lacertilian type of the pectoral arch; the dental organs also exhibit the same transitional or annectent characters in a greater or less degree. The bones of the extremities are of large proportional size, for saurians; they are provided with large medullary cavities and with well-developed and unusual processes, and are terminated by metacarpal, metatarsal, and phalangeal bones, which, with the exception of the ungual phalanges, more or less resemble those of the heavy pachydermal mammals, and attest, with the hollow, long bones, the terrestrial habits of the species. The combination of such characters, some as the sacral ones, altogether peculiar among reptiles, others borrowed, as it were, from groups now distinct from each other, and all manifested by creatures far surpassing in size the largest of existing reptiles, will, it is presumed, be deemed sufficient ground for establishing a distinct tribe or suborder of saurian reptiles, for which I would propose the name of Dinosauria" (p. 103).

A few years later, in 1843, Fitzinger (4) placed Megalosaurus in the family "Megalosauri," among the Loricata; Iguandon we find under the family name "Therosauri," among the order Sauri.

In 1845 H. v. Meyer (5) introduced the name Pachypodes for the group he had established in 1830, including Iguanodon, Hylæosaurus, Megalosaurus, Plateosaurus.

Paul Gervais (6) established the families Megalosauridæ and Iguanodontidæ in 1853, without giving definition.

In 1866 Owen (7) characterized the Dinosauria thus:

"Cervical and anterior dorsal vertebræ with par- and diapophyses, articulating with bifurcated ribs; a few anterior vertebræ, more or less convex in front and cupped behind, the rest with flat or slightly concave articular ends; dorsal vertebræ with a neural platform; sacral vertebræ exceeding two in number; body supported on four strong ambulatory unguiculate limbs. Skin in some armed by bony scutes. Teeth confined to upper and lower jaws, implanted in sockets." He names the genera: Iguanodon, Scelidosaurus, Megalosaurus.

In the same year Haeckel (8) and Cope gave the first classification of the Dinosauria.

Haeckel considers the Dinosauria a subclass, which he divides in two orders:

"Erste Ordnung der Dinosaurier: Harpagosauria H.; Carnivore Lindwürmer. Zweite Ordnung der Dinosaurier: Therosauria H.; Herbivore Lindwürmer."

Haeckel uses the same name as Fitzinger for the herbivorous forms represented by Iguanodon.

The Harpagosauria are represented by Megalosaurus, Hylæosaurus, Telorosaurus.

Cope's first note on the classification of the Dinosaurs was published in the Proc. Acad. Nat. Sci., Phila., 1866, p. 317. He distinguishes Orthopoda with the genera Scelidosaurus Ow., Hylæosaurus Mont., Iguanodon Mont., Hadrosaurus Leidy; and Goniopoda with the genera Lælaps Cope and Megalosaurus Buckl.

In 1870 Cope (9) characterized these in the following way:

ORTHOPODA.

"Cope, Proc. Ac. Nat. Sci., Phila., 1866, 317. Therosauria Haeckel, 1866. Proximal tarsal bones distinct from each other and from the tibia, articulating with a tibia and with a terminal face of a well-developed fibula. The ilium with a massive, narrowed, anterior prolongation. Hadrosauridæ, Iguanodontidæ, Scelidosauridæ."

GONIOPODA COPE.

"Proc. Ac. Nat. Sci., Phila., 1866, 317. Harpagosauria Haeckel, 1866. Proximal tarsal bones distinct from tibia; the latter closely embraced by the much-enlarged astragalus, on its inferior and anterior faces, forming an immovable articulation. Astragalus with an extensive anterior articular condyle below, above in contact with the fibula, which is much reduced, especially distally. Anterior part of the ilium dilated and plate-like. Lælaps, Poecilopleuron, Megalosaurus, Cœlosaurus, and perhaps Bathygnathus and Aublysodon."

In the same paper a third group, SYMPHYPODA, is established, with the genera Compsognathus and Ornithotarsus and the following characters:

"First series of tarsal bones confluent with each other and with the tibia. Fibula distally much reduced. Anterior part of ilium dilated, plate-like."

Later it was found that Ornithotarsus belonged to the Orthopoda, Compsognathus to the Gonipoda.

Huxley (10) gave the first characteristic of the Dinosauria in 1869. "The bony exoskeleton is sometimes more highly developed than in the Crocodilia, and sometimes absent. The centra of the posterior dorsal vertebræ are flat or slightly concave at each end, and they have crocodilian transverse processes and ribs. The centra of the anterior dorsal and of the cervical vertebræ are sometimes concave behind and convex in front (opisthocœlous). There are four or more vertebræ in the sacrum. The pelvis and bones of the hind limb are in many respects very like those of birds. No clavicles have been observed, and the fore limb is sometimes very small in proportion to the hind limb."

One year later Prof. Cope (11) gave the following characters: "Limbs ambulatory or prehensile. Ilium horizontal, supporting a long sacrum of five or six vertebræ, the anterior derived from the lumbar series. The acetabulum thrown forwards, and not complete, but perforate. Ischium long, longitudinal, posterior, supporting the parts, in front of a process. Ribs free, double-headed. Neural arches united by suture; chevron bones present."

The next paper is Prof. Huxley's (12) well-known memoir on the classification of the Dinosauria. The order Ornithoscelida is created, with two suborders:

"I. Dinosauria, with the cervical vertebræ relatively short, and the femur as long as or longer than the tibia.

II. The Compsognatha, with the cervical vertebræ relatively long, and the femur shorter than the tibia."

The Dinosaurs are now characterized fully:

"1. The dorsal vertebræ have amphicœlous or opisthocœlous centra They are provided with capitular and tubercular transverse processes, the latter being much the longer.

2. The number of the vertebræ which enter into the sacrum does not fall below two, and may be as many as six.

3. The chevron bones are attached intervertebrally, and their rami are united at their vertebral ends by a bar of bone.

4. The anterior vertebral ribs have distant capitula and tubercula.

5. The skull is modeled upon the lacertilian, not on the crocodilian, type. There is a bony sclerotic ring.

6. The teeth are not anchylosed to the jaws, and may be lodged in distinct sockets. They appear to be present only in the premaxillæ, maxillæ, and dentary portions of the mandible.

7. The scapula is vertically elongated; the coronoid is short, and has a rounded and undivided margin. There is no clavicle.

8. The crest of the ilium is prolonged both in front of and behind the acetabulum, and the part which roofs over the latter cavity forms a wide arch, the inner wall of the acetabulum having been formed by membrane, as in birds.

9. The ischium and pubis are much elongated.

10. The femur has a strong inner trochanter; and there is a crest on the ventral face of the outer condyle, which passes between the tibia and the fibula, as in birds.

11. The tibia is shorter than the femur. The proximal end is produced anteriorly into a strong crest, which is bent outwardly, or towards the fibular side.

12. The astragalus is like that of a bird; and the digits of the pes are terminated by strong and curved ungual phalanges."

The Dinosaurs are divided by Huxley into three families:

I. Megalosauridæ; Teratosaurus, Palæosaurus, Megalosaurus, Poikilopleuron, Lælaps, and probably Euskelosaurus.

II. Scelidosauridæ; Scelidosaurus, Thecodontosaurus, Hylæosaurus, Polacanthus (?), Acanthopholis.

III. Iguanodontidæ; Cetiosaurus, Iguanodon, Hypsilophodon, Hadrosaurus, and probably Stenopelyx.

With 1877 begin the publications of Prof. O. C. Marsh, based on the extensive collections brought together by his collectors.

In 1877 a new order of reptiles is named Stegosauria, but no characters are given (13).

The year following the order Sauropoda of the Dinosauria is established (14), to contain the very large reptiles, named by Marsh Atlantosaurus, Apatosaurus, Morosaurus, and Diplodocus, and by Cope Camarasaurus, Amphicœlias, etc. The characters of this order are:

SAUROPODA.

"1. The fore and hind limbs are nearly equal in size.

2. The carpal and tarsal bones are distinct.

3. The feet are plantigrade, with five toes on each foot.

4. The precaudal vertebræ contain large cavities, apparently pneumatic.

5. The neural arches are united to the centra by suture.

6. The sacral vertebræ do not exceed four, and each supports its transverse process.

7. The chevrons have articular extremities.

8. The pubes unite in front by ventral symphysis.

9. The third trochanter is rudimentary or wanting.

10. The limb bones are without medullary cavities."

Cetiosaurus, a member of this group, had always been considered as one of the Crocodilia, and Owen (15) had placed it in a special group, Opisthocœlia.

In this Owen was followed by Haeckel, but not by Huxley, who placed Cetiosaurus among the Iguanodontidæ. Seeley introduced the name Cetiosauria in 1874.

Another new order of reptiles was created by Marsh (16), under the name Cœluria, without characters, in 1881.

In the same year the first classification of the Dinosauria is given by Marsh (17).

The Dinosaurs are considered an order, and divided in five suborders: Sauropoda, Stegosauria, Ornithopoda, Theropoda, Hallopoda, Cœluria. The diagnoses are thus given:

Order DINOSAURIA Owen.

"1. Suborder Sauropoda (lizard foot). Herbivorous. Feet plantigrade, ungulate; five digits in manus and pes. Pubes united in front by cartilage. No postpubis. Precaudal vertebræ hollow; limb bones solid. Family, Atlantosauridæ; genera, Atlantosaurus, Apatosaurus, Brontosaurus, Diplodocus, and Morosaurus.

2. Suborder Stegosauria (plated lizard). Herbivorous. Feet plantigrade, ungulate; five digits in manus and pes. Pubes free in front. Postpubis present. Vertebræ and limb bones solid. Family, Stegosauridæ; genus, Stegosaurus.

3. Suborder Ornithopoda (bird foot). Herbivorous. Feet digitigrade; four functional digits in manus and three in pes.

Pubes free in front. Post pubis present. Vertebræ solid; limb bones hollow. Family, Camptonotidæ; genera, Camptonotus, Diracodon, Laosaurus, and Nanosaurus.

4. Suborder Theropoda (beast foot). Carnivorous. Feet digitigrade; digits with prehensile claws. Pubes coösified in front. Post-pubis present. Vertebræ more or less cavernous; limb bones hollow. Family, Allosauridæ; genera, Allosaurus, Creosaurus, and Labrosaurus.

5. Suborder Hallopoda (leaping foot). Carnivorous (?). Feet digitigrade, unguiculate; three digits in pes. Metatarsals much elongated; calcaneum much produced backward. Two vertebræ in sacrum. Limb bones hollow. Family, Hallopodidæ; genus, Hallopus.

DINOSAURIA (?)

6. Suborder Cœluria (hollow tail). Carnivorous (?). Family, Cœluridæ; genus, Cœlurus."

The year following, 1882, the Dinosauria are placed in a subclass, with five orders (18).

a. Sauropoda. *b*. Stegosauria. 3. Ornithopoda. 4. Theropoda.
1. Suborder Cœluria. 2. Suborder Compsognatha. 5. Hallopoda.

The subclass Dinosauria is characterized in the following words: "Premaxillary bones separate; upper and lower temporal arches; rami of lower jaw united in front by cartilage only; no teeth on palate. Neural arches of vertebræ united to centra by suture; cervical vertebræ numerous; sacral vertebræ coössified. Cervical ribs united to the vertebræ by suture or anchylosis; thoracic ribs double-headed. Pelvic bones separate from each other, and from sacrum; ilium prolonged in front of acetabulum; acetabulum formed in part by pubis; ischia meet distally on median line. Fore and hind limbs present, the latter ambulatory and larger than those in front; head of femur at right angles to condyles; tibia with procnemial crest; fibula complete. First row of tarsals composed of astragalus and calcaneum only, which together form the upper portion of ankle joint."

After this Cope (19) established the following system, considering the Dinosaurs an order, with four suborders.

"Feet ungulate; pubis projecting and connected in front; no postpubis. *Opisthocœlia.*
Feet ungulate; pubes projecting free in front; postpubis present. *Orthopoda.*
Feet unguiculate; pubes projecting downwards and coössified distally; calcaneum not produced. *Goniopoda.*
Feet unguiculate; calcaneum much produced backwards; (?) pelvis. *Hallopoda.*"

In 1884 Marsh (20) again published another classification. He divided the sub-class Dinosauria into four orders and three sub-orders:

1. Order Sauropoda.
2. " Stegosauria.
3. " Ornithopoda.
4. " Theropoda.
   Suborder Cœluria.
   " Compsognatha.
   " Ceratosauria.

The Hallopoda are now considered an order of reptiles, not placed within the Dinosaurs.

In 1885 Cope (21) placed the Crocodilia among the Dinosauria, and gave the following character: "Os quadratum immovably articulated, capitular and tubercular rib articulations distinct. Ischium and pubis distinct, the latter directed forwards, backwards, or downwards; two posterior cranial arches; limbs ambulatory; no procoracoid."

In 1887 (22) Baur divided the Dinosauria in three groups:

"A. Carnivorous Dinosaurs, Harpagosauria Haeckel, 1866.
   I. Goniopoda Cope, 1886 (Theropoda Marsh, 1881).
B. Herbivorous Dinosaurs, Therosauria Haeckel, 1866.
   II. Orthopoda Cope, 1866.
      1. Ornithopoda Marsh, 1881.
      2. Stegosauria Marsh, 1877.
C. Crocodilian-like Dinosaurs, Sauropoda Marsh, 1878.
   III. Opisthocœlia Owen, 1859."

In the same year Prof. Seeley (23) gave a new classification.

He reached the result "that the Dinosauria has no existence as a natural group of animals, but includes two distinct types of animal structure." These two orders are called Ornithischia and Saurischia.

ORNITHISCHIA.

"In this order the ventral border of the pubic bone is divided so that one limb is directed backward parallel to the ischium, as among birds, and the other limb is directed forward. Neither of these limbs of the pubis appears to form a median symphysis. The ilium is prolonged in front of the acetabulum as a more or less slender processor bar. The vertebræ are solid, and the skeleton is not pneumatic. The basicranial structure is distinctive differing from that of crocodiles and lizards. The body and limbs are frequently covered with scutes, which many form a complete shield or be reduced so as to be unrecognizable. The digits vary from three to five."

SAURISCHIA.

"In this order the pubis is directed forward from its symphysis with the ischium, and no posterior limb of the bone is developed. Both pubis and ischium appear to meet by a median symphysis, so that the arrangement and relation of the bones are lacertilian. The anterior prolongation of the ilium has a vertical expansion. The vertebræ are more or less pneumatic or cavernous, and in the dorsal region the neural arch is commonly elevated. The basicranial structure is sub-lacertilian. No armor has been found. The digits vary in number from three to five."

In 1889 Marsh (24) admits four orders of Dinosauria: Sauropoda, Stegosauria, Ornithopoda, Theropoda; Ceratosaurus, Hallopus, and Compsognathus being placed among the Theropoda.

Cope (25) admits, partially at least, Seeley's classification, but he keeps the order Dinosauria, which he divides in two suborders: Saurischia and Orthopoda; the first with the inferior pelvic elements directed downwards, the second with the pelvic elements directed backwards.

Lydekker (26) divides the order Dinosauria in three suborders: Sauropoda, Theropoda, Ornithopoda. In the Ornithopoda he includes the Stegosauria of Marsh.

In 1889 he keeps this arrangement and divides the suborders in the following families (27):

I. Ornithopoda.—Trachodontidæ, Iguanodontidæ, Scelidosauridæ, Stegosauridæ, Ceratopsidæ.

II. Theropoda.—Anchisauridæ, Megalosauridæ, Compsognathidæ, Cœluridæ.

III. Sauropoda.—Atlantosauridæ, Diplodocidae, Cetiosauridæ.

In 1890 Prof. Marsh (28) separated the Hallopoda from the Dinosauria with query, and placed them in a special order; at the same time he gave the family Ceratopsidæ, which he had established in December, 1888 (*Am. Journ. Sci.*), the rank of a suborder, with the name Ceratopsia.

After this Baur (29) expressed the opinion that Hallopus is nearly related to Compsognathus, and that it is unnatural to place the Ceratopsidæ in a special suborder.

In the latest paper on the subject Prof. Marsh (30) has given up the suborder Ceratopsia, considering the Ceratopsidæ a family only.

Prof. Zittel (31) retains the order Dinosauria, which he divides in this way:

I. Unterordnung Sauropoda. Families: 1. Cetiosauridæ. 2. Atlantosauridæ. 3. Morosauridæ. 4. Diplodocidæ.

II. Unterordnung Theropoda. Families: 1. Zanclodontidæ. 2. Megalosauridæ. 3. Ceratosauridæ. 4. Anchisauridæ. 5. Cœluridæ. 6. Compsognathidæ. 7. Hallopidæ.

III. Unterordnung Orthopoda. A. Stegosauria. Families: 1. Scelidosauridæ. 2. Stegosauridæ. B. Ceratopsia. C. Ornithopoda. Families: 1. Camptosauridæ. 2. Iguanodontidæ. 3. Hadrosauridæ. 4. Nanosauridæ. 5. Ornithomimidæ.

After this review of the general classification of Dinosaurs we see that there are quite a number of different ideas. Leaving the older views aside, we have to-day the following principal opinions, taking the latest views of the different authors.

A. *The Dinosauria are a Natural Group.*—1. The Dinosauria form a subclass of reptiles, containing four orders: 1. Sauropoda. 2. Stegosauria. 3. Ornithopoda. 4. Theropoda (Marsh).

2. The Dinosauria form an order of reptiles, containing three suborders: Sauropoda, Ornithopoda, Theropoda (Lydekker); Sauropoda, Orthopoda, Theropoda (Zittel).

3. The Dinosauria form an order of reptiles, containing two suborders: Saurischia, Orthopoda (Cope).

B. *The Dinosauria are not a Natural Group.*—The reptiles generally called Dinosauria belong to two distinct orders: Ornithischia and Saurischia (Seeley).

The first question to decide is, Do the Dinosauria represent a natural group or not? To examine this we will proceed to study a member of each of the three groups, Sauropoda, Orthopoda, and Theropoda, and compare these members among themselves. Of the Orthopoda especially we will take as a type Iguanodon, the structure of which is best known through the different publications of Dollo in the Bull. Musée Royal d'His. Nat. de Belgique; of the Sauropoda we will take Diplodocus, described by Marsh; and of the Theropoda, Ceratosaurus, also made known by Marsh. We begin with the skull, then treat the vertebræ, the shoulder girdle, the pelvis, the fore and hind limbs, the abdominal ossicles, and the dermal ossification so far as necessary.

I. THE SKULL.

Iguanodon.—All that I have to say about Iguanodon is based on the careful descriptions of Dollo (32).

1. The brain-case is completely ossified; a very strong alisphenoid being present.

2. The premaxillaries are separate, and there is a strong process extending between the nasals and mandibles, excluding the maxillaries from the nasal opening.

3. No epipterygoid (columella).

4. The jugals are fixed to a special process of the maxillaries; they are not placed in the same level with the alveolar border, but a considerable distance outside of it. They do not reach the end of the dental series. They are in connection with the lachrymals, postfrontals, quadratojugals, and maxillaries. They bound the orbits inferiorly, and also somewhat posteriorly.

5. The quadratojugals are placed between quadrate and jugal, but do not touch the squamosal.

6. The squamosals do not send down a process to join the quadratojugal.

7. The quadrate is very elongate, with its lower end directed forwards; there is a well-developed pterygoid process.

8. The mandible has a distinct predentary line.

9. The dentary has a greatly developed coronoid process.

10. The external nasal openings are limited by the premaxillaries and nasals.

11. The prelachrymal fossæ are small, and limited by the maxillaries, prefrontals, and lachrymals.

12. The orbits are limited by the supraorbitals, lachrymals, jugals, and post-fronto-orbitals.

Diplodocus.—These notes on Diplodocus are based on the figures of Prof. Marsh, which, however, are not quite correct, as I found from the study of the original specimens.

1. The brain-case is completely ossified; a very strong alisphenoid being present.

2. The premaxillaries are separate, and there is no process extending between the nasals and maxillaries, excluding the maxillaries from the nasal opening.

3. No epipterygoid (columella).

4. The jugals are placed in the same level with the alveolar border of the maxillaries. They do not reach the end of the dental series. They are in connection with the lachrymals, postorbitals, quadratojugals, and maxillaries. They bound the orbits only pre-inferiorly.

5. The quadratojugals are placed between the quadrate and maxillary, but do not touch the squamosal.

6. The squamosals do not send down a process to join the quadratojugals.

7. The quadrate is elongate with its lower end strongly directed forward. There is a very large pterygoid process.

8. The mandible has no predentary bone.

9. The dentary is without coronoid process.

10. The external nasal openings are limited by the premaxillaries, maxillaries, and nasals.

11. The prelachrymal fossæ are large, limited by the maxillaries, prefrontals, lachrymojugals. (The suture between jugals and lachrymals seems to be very indistinct.)

12. The orbits are limited by the post-fronto-orbitals, and lachrymojugals.

Ceratosaurus.—Mostly after Marsh. 1. The brain-case is not ossified in front; there are no strongly ossified alisphenoids; this region like Sphenodon.

2. The premaxillaries are separate; there is no process extending between the nasals and maxillaries, excluding the maxillaries from the nasal opening.

3. An epipterygoid (columella).

4. The jugals are placed in the same level with the alveolar border of the maxillaries, and reach the end of the dental series. They are in connection with the lachrymals, postorbitals, quadratojugals, and maxillary.

5. The quadratojugal is placed between quadrate and jugal, and seems to touch the squamosal.

6. The squamosal sends down a small process to join the quadratojugal.

7. The quadrate is very much like that of Sphenodon, with a foramen between quadratojugal and quadrate, and directed backwards with its distal end. There is a very large pterygoid process.

8. Mandible without predentary bone.

9. Dentary without coronoid process.

10. The external nasal openings are limited by the premaxillaries, nasals, and maxillaries.

11. The prelachrymal fossæ are large, limited by the prefrontals, lachrymals, jugals, and maxillaries.

12. The orbits are limited by the prefrontals, frontals, post-fronto-orbitals, jugals, and lachrymals.

By comparing these three forms it is evident that Iguanodon stands quite isolated. It shows the peculiar lower jaw, the peculiar nasal openings from which the maxillaries are excluded,[1] and the peculiar maxillary with the free posterior dentary end.

From the study of the skulls alone it is evident that Iguanodon has to be separated entirely from Diplodocus and Ceratosaurus; that there is no affinity whatever among these animals, which could permit us to place them in a common group may it be called a subclass or an order of reptiles.

But I have to say exactly the same in regard to Diplodocus and Ceratosaurus. Diplodocus is of a crocodilian pattern, showing a well-developed alisphenoid; Ceratosaurus, however, is typically Rhynchocephalian or Proganosaurian in nearly every detail, and it is certainly very much more related to these groups than to any other group of the so-called Dinosauria. The study of the skull alone would be sufficient to show that the Dinosauria is an absolutely unnatural group without any right of existence; it shows that the three members, Iguanodon, Diplodocus, and Ceratosaurus belong to three distinct groups of Monocondylia, with very little relation to each other.

II. THE VERTEBRÆ.

The vertebræ are of the character of the Archosauria, the dorsals having well-developed transverse processes. As is well known from the study of the Testudinata and Crocodilia, the character of the articular faces of the centra of the vertebræ is of very little value in tracing the phylogenetic relation of groups. The sacrum, however, shows peculiarities.

Iguanodon.—In Iguanodon the sacral ribs are placed more or less between the centra of the sacral vertebræ. They are united to distinct diapophyses of the neural arches and to the centrum; the diapophysis may extend in some forms (Agathaumas) as far as the end of the sacral rib, but it is never separated from it. In other words, in Iguanodon the ilium is separated by sacral ribs, which are placed between the centra and to which diapophyses of the neural arches are suturally united or coössified.

[1] This condition resembles very much that seen in mammals, in which we also have a process of the premaxillary extending between nasal and maxillary. In birds the maxillary is excluded from the nasal opening by the descending branches of the nasal. A somewhat intermediate condition is seen in Aëtosaurus.

Diplodocus.—In Diplodocus and its allies the sacral ribs are not intervertebral, but are connected with the centra of the vertebræ only, without diapophyses.

Ceratosaurus.—In Ceratosaurus and its allies the sacral ribs are intervertebral, but entirely free from the well-developed diapophyses, which also support the ilium. The diagrammatic figures show these relations. We see also that the structure of the sacrum shows greater differences than we find in a natural group, and also shows that the Dinosauria must be given up.

III. THE SHOULDER GIRDLE.

In the shoulder girdle we find, as in all Archosauria, a simple coracoid and an elongate scapula. So far no clavicles have been found, and I think that these elements are absent in Iguanodon and Diplodocus and the allied forms, but I should not be surprised at all if further discoveries would demonstrate the presence of clavicle and interclavicle in the megalosauroid forms.

IV. THE PELVIS.

Iguanodon.—The pubis of Iguanodon and its allies at once distinguishes it from all the other groups. As is well known and now shown without doubt, the ectopubis or pectineal process in this form is exceedingly developed; the entopubis or true pubis being directed backwards This character alone is sufficient to separate Iguanodon far from Diplodocus and Ceratosaurus. In the highest specialized members of the Iguanodon group—Agathaumas (Triceratops), for instance—the ectopubis is enormously developed, the entopubis being quite rudimentary.

Diplodocus.—Here we have the pubis directed forwards, and pierced by the obturator foramen, all the bones of the pelvis being very massive.

Ceratosaurus.—Also in this form the pubes are directed forwards, but are closely united at the distal two-thirds, appearing like a chevron bone when seen from front; also the ischia are united at the distal end; the elements of the pelvis being slender.

It is evident that Diplodocus and Ceratosaurus resemble each other very much more in the structure of the pelvis than they do in comparison with Iguanodon. The pelvis of these two forms can be reduced to the type seen in the Rhynchocephalia and Squamata.

V. THE FORE AND HIND LIMBS.

The structure of the limbs is of very great taxonomic value in a definite animal group of forms; but if we would take the limbs alone to establish a system we would be led to the most absurd results. The order Enaliosauria was established for the Ichthyosaurs, and Plesiosaurs which are provided with paddles. But this is only a parallelism in structure. The Plesiosauria have no relations whatever to the Ichthyosauria. The same we may say in regard to the Dinosauria. The Iguanodon-like forms resemble very much the Megalosaurus-like forms; but there cannot be the slightest doubt that this resemblance does not mean affinity, but parallelism.

VI. ABDOMINAL OSSICLES.

So-called abdominal ribs were present in the megalosauroid forms, as shown by Deslongchamps. They have not been discovered yet in Iguanodon and Diplodocus, and it is impossible to determine with our present knowledge whether they were present or not.

VII. DERMAL OSSIFICATIONS.

Dermal ossifications are known in the Iguanodon-like forms, especially in the highly developed Stegosauridæ and Agathaumidæ; they seem to be absent in the Diplodocus and Ceratosaurus forms. I do not consider such ossifications of great taxonomic value, especially not for ordinal characters.

If we now recapitulate, we have found that the structure of the skull and sacrum of Iguanodon, Diplodocus, Ceratosaurus, make it sure that these three animals are in no near relation to each other; that they doubtless are the representatives of three different groups; that the Dinosauria have to be given up. The question now comes up, What names shall we apply to the three groups of archosaurian reptiles represented by Iguanodon, Diplodocus, and Ceratosaurus?

Iguanodon belongs to the group which has been called Therosauri by Fitzinger, 1843; Therosauria by Haeckel, 1866; Orthopoda by Cope, 1866; Ornithopoda and Stegosauria by Marsh, 1881; Ornithischia by Seeley, 1887. Of all these names that of Therosauri or Therosauria has the priority. But I do not believe that this name will be favored. I think it best to introduce a new significant name for this group of archosaurian reptiles: *Iguanodontia*,—like Crocodilia, Plesiosauria, Ichthyosauria, Aëthosauria, etc., the most typical representative of this group being Iguanodon. To this group belong the families, Iguanodontidæ, Hypsilophodontidæ, Hadrosauridæ, Ornithomimidæ (?), Scelidosauridæ, Stegosauridæ, Agathaumidæ.[2]

Diplodocus belongs to the group which has been called Opisthocœlia by Owen, 1859; Cetiosauria by Seeley, 1874; Sauropoda by Marsh, 1878. I think it best to use the name *Cetiosauria* introduced by Seeley, Cetiosaurus being the oldest member of the group, and doubtless synonymous with one and probably more of the American genera. Of this group there is evidence so far of only one family, the Cetiosauridæ.

Ceratosaurus is a member of the group which has been called Megalosauri by Fitzinger, 1843; Harpagosauria by Haeckel, 1866; Goniopoda by Cope, 1866; Theropoda by Marsh, 1881; I propose to use the name *Megalosauria* for this group. It is the oldest name used, and Megalosaurus is the oldest genus known, and there is no doubt that one or more of the American generic names will prove to be synonyms of it.

In this group the following families can be distinguished: Zanclodontidæ, Anchisauridæ, Megalosauridæ, Compsognathidæ, Cœluridæ.[3]

As the result of this paper I may state this:

1. The group generally called Dinosauria is an unnatural one, which is composed of three special groups of archosaurian rep-

[2] Ceratops Marsh is the same as Monoclonius Cope, as I know from actual study of the types. That Agathaumas Cope is the same as Triceratops Marsh will be admitted by everybody who will compare the original plates of the sacrum, dorsal vertebræ, and the ilium of Agathaumas, by Cope, with those of Triceratops, given by Marsh.

[3] I think that Macellognathus Marsh, which has nothing whatever to do with the Testudinata, belongs to this family and to Cœlurus.

tiles, without any close relation between each other. The Dinosauria do not exist.

2. The so-called Dinosauria contain three groups of reptiles, which ought to be called Iguanodontia, Megalosauria, and Cetiosauria.

The distinctive character of these three groups are:

IGUANODONTIA.

Brain-case complètely ossified; a well-developed alisphenoid; no epipterygoid (columella); premaxillaries with a posterior outer process extending between nasals and maxillaries, excluding maxillaries from nasal openings; jugals fixed to a special process of the maxillary outside the alveolar border; posterior alveolar end of maxillàries free; not connected with jugals or quadratojugals; quadrate directed forward; mandible with a distinct predentary bone; dentary with greatly developed coronoid process; sacral vertebræ with ribs and diapophyses united, intervertebral; pubis consisting of two branches; the anterior one ectopubis (pectineal process, prepubis) greatly developed: the entopubis directed backwards, well developed or rudimentary; ilium very much extended in front and also behind.

CETIOSAURIA.

Brain-case completely ossified; a well-developed alisphenoid; no epipterygoid (columella); premaxillaries not excluding maxillaries from nasal opening; jugal and quadratojugal forming a continuation of the posterior border of the maxillary in the same plane; quadratojugal in connection with maxillary; quadrate directed forwards; mandible without predentary bone; dentary without coronoid process; sacral vertebræ with ribs only vertebral; pubis consisting of one branch, the entopubis only, directed forwards.

MEGALOSAURIA.

Brain-case not ossified in front; no ossified alisphenoid; an epterygoid (columella); premaxillaries not excluding maxillaries from nasal opening; jugal connected with alveolar end of maxillary, on the same plane; quadratojugal free from maxillary; quadrate directed backwards; mandible without predentary bone; dentary without coronoid process; sacral vertebræ with ribs intervertebral; and diapophyses without connections with ribs; pubes directed forwards, and strongly united at the ends.

The Iguanodontia appear in the Lias with all characters (Scelidosaurus), and form an absolutely isolated group so far. The nearest relations seems to be with birds rather than with any other groups of the Monocondylia. Whether the peculiar condition of the premaxillaries and the relations of the jugal to the maxillary, which remind us of the arrangement in mammals and some Theromora, indicates affinity to the ancestral forms of these groups, I am unable to say; but the fact that in mammals the pubis is also turned back has to be noticed.

The Iguanodontia reach to the Upper Cretaceous, and show in Agathaumas and Diclonius their highest specialization.

The Cetiosauria are confined to the Jurassic, Wealden, and Cretaceous (Cambridge Greensand).[4] They seem to have their nearest relatives in the Belodontidæ. The Crocodilia, with their peculiar pelvic arch, seem to be also related to this group.

The Megalosauria extend from the Triassic to the Cretaceous. The skull is of the pattern of Paleohatteria of the Proganosauria and the Rhynchocephalia, and it seems very probable to-day that the Megalosauria have developed from the Rhynchocephalia. Protorosaurus seems to be in this line.

The earliest reptiles doubtless go back to the Carboniferous, from which formation we do not know a single reptile so far. This is made probable by the existence in the Permian and Lower Triassic of different groups of Reptilia. It is very likely that birds began to be branched off already in the Lower Triassic, probably from a group which gave also origin to the Iguanodontia; but to decide this question is not possible to-day. I still believe with Hitchcock that a great number of the tracks in the Connecticut Triassic sandstone are the tracks of true birds, not of any of the Megalosauria known to-day. All Megalosauria known have a long tail, and we ought

[4] The metatarsals figured by Seeley of a Dinosaur from the Cretaceous Greensand cannot be distinguished from those of Morosaurus.

to expect to find impressions of a tail, with the impressions produced by the hind limbs, but this we do not. The impressions, therefore, seem to be produced by an animal having a short tail. Some characters of birds remind us of the Megalosauria; but the fact remains that we know hardly anything about the actual ancestors of this branch of the Monocondylia. The birds have a well-ossified alisphenoid, no epipterygoid, and there seems to be little doubt that the avian ancestors of the birds of to-day had already this character; but the ancestors of these must have had the brain-case open in front, no ossified alisphenoids, but an epipterygoid; and here, again, we reach a form like the Proganosauria and Rhynchocephalia.

Clark University, Worcester, Mass., Feb. 11th, 1891.

AUTHORITIES CITED.

1. OWEN, R.—Report on British Fossil Reptiles. Brit. Asso. Rep., London, 1840, pp. 102, 103.

2. MEYER, H. v.—Über fossile Saurier. Isis, 1830, pp. 517–519. Also in his Palaeologica zur Geschichte der Erde und ihrer Geschopfe. Frankfurt, a. M., 1832, p. 201.

3. KAUP, J. J.—Das Thierreich in seinen Hauptformen systematisch qeschrieben. Vol. II., Part 2, p. 18, Darmstadt, 1836.

4. FITZINGER, LEOPOLDUS.—Systema Reptilium. Fasciculus Primus: Amblyglossæ. Vindobonæ, 1843, p. 12.

5. MEYER, H. v.—System der fossilen Saurier. *Neues Jahrb. Min.*, 1845, pp. 278–285.

6. GERVAIS, P.—Observations relatives aux reptiles fossiles de la France, Paris, Compt. Rend., XXXVI., 1853, p. 471.

7. OWEN, R.—On the Anatomy of Vertebrates. Vol. I., London, pp. 14–18.

8. HAECKEL, ERNST.—Generelle Morphologie der Organismen. Berlin, 1866, Bd. II., p. 136.

9. COPE, E. D.—Synopsis of the Extinct Batrachia, Reptilia, and Aves of North America. Trans. Amer. Philos. Soc., Vol. XIV., 1870, p. 90, 99.

10. HUXLEY, T. H.—An Introduction to the Classification of Animals. London, 1869, pp. 110–111.

11. COPE, E. D.—Synopsis of the Extinct Batrachia and Reptilia of North America. Trans. Amer. Philos. Soc., Phila., 1870, pp. 26–53.

12. HUXLEY, T. H.—On the Classification of the Dinosauria, with Observations on the Dinosauria of the Trias. *Q. J. G. S.*, Vol. XXVI., pp. 32–36.

13. MARSH, O. C.—A New Order of Extinct Reptilia (Stegosauria) from the Jurassic of the Rocky Mountains, *Am. Jour. Sci.*, Vol. XIV., Dec., 1877, p. 513.

14. MARSH, O. C.—Principal Characters of American Jurassic Dinosaurs. *Am. Jour. Sci.*, XVI., Nov., 1878, p. 412.

15. OWEN, R.—On the Orders of Fossil and Recent Reptilia, and their Distribution in Time. Brit. Assoc. Rep., 1859, p. 164.

16. MARSH, O. C.—A New Order of Extinct Jurassic Reptiles (Cœluria). *Amer. Jour. Sci.*, Vol. XXI., April, 1881, p. 340.

17. MARSH, O. C.—Principal Characters of American Jurassic Dinosaurs. Part V. *Am. Jour. Sci.*, XXI., May, 1881, p. 423.

18. MARSH, O. C.—Classification of the Dinosauria. *Am. Jour. Sci.*, Vol. XXIII., January, 1882, pp. 81–86.

19. COPE, E. D.—On the Characters of the Skull in the Hadrosauridæ. Proc. Acad. Nat. Sci., Phil., June, 1883, p. 98.

20. MARSH, O. C.—On the Classification and Affinities of Dinosaurian Reptiles. Brit. Asso. Rep., 1884, Montreal. London, 1885, pp. 763–766.

21. COPE, E. D.—On the Evolution of the Vertebrate, Progressive and Retrogressive. AM. NAT., March, 1885, pp. 245–247; April, 341–344.

22. BAUR, G.—On the Phylogenetic Arrangement of the Sauropsida. *Jour. Morph.*, Vol. I., No. 1, Sept., 1887.

23. SEELEY, H. G.—On the Classification of the Fossil Animals Commonly Named Dinosauria. Proc. Roy. Soc., Vol. XLIII., Nov. 24, 1887, pp. 165–271.

24. MARSH, O. C.—Comparison of the Principal Forms of the Dinosauria of Europe and America. *Am. Jour. Sci.*, Vol. XXXVII., April, 1889, pp. 323–331.

25. COPE, E. D.—Synopsis of the Families of Vertebrata. AM. NAT., Oct., 1889 (published March 12, 1890), p. 849.

26. LYDEKKER, R.—Catalogue of the Fossil Reptilia and Amphibia. Part I., London, 1888.

27. LYDEKKER, R., and H. A. NICHOLSON.—A Manual of Paleontology. Vol. II., 1889.

28. MARSH, O. C.—Distinctive Characters of the Order Hallopoda. Additional Characters of the Ceratopsidæ, with Notice of New Cretaceous Dinosaurs. *Am. Jour. Sci.*, XXXIX., May, 1890.

29. BAUR, G.—AM. NAT., June, 1890, p. 569.

30. MARSH, O. C.—Gigantic Ceratopsidæ or Horned Dinosaurs of North America. *Am. Jour. Sci.*, XLI., p. 167, 1891.

31. ZITTEL, KARL A.—Handbuch der Palaeontologie. Vol. III., 4 Lief., 1890.

32. DOLLO, L.—Quatrieme Note sur les Dinosauriens de Bernissart. Bull. Mus. Roy. d'Hist. Nat. de Belgique, Vol. II., 1883. pp. 224–243, pls. IX., X.

CUP-STONES NEAR OLD FORT RANSOM, N. D.

BY T. H. LEWIS.

APPARENTLY the earliest mention of cup-stones, in print, was in 1751, in a historical work on the Province of Brandenburg, by J. C. Bekmann. The author speaks of certain boulders there which have on them *näpfchensteine*, or little-bowl-stones, as he terms them. Next, in 1773, there was found at Lynsfort, in North Britain, a druidical altar full of "rock basons," which was pictured in Camden's Britannia, 1789. From that time on, at intervals, first incidentally, then by purposed search, interesting discoveries were made until, so far as the rings were concerned, almost every country on the earth was represented. As regards the cups, their distribution has not yet proved to be nearly so widespread. Still they have been found in the British Isles, France, Switzerland, Bohemia, Austria, Northern Germany, the Danish Islands, and Sweden; but these are all the European countries known to possess them, apparently, according to the authorities. Flitting now eastward over vast kingdoms we meet with them again in far-off India. Here, in 1867, Mr. Rivett-Carnac found cup-cuttings upon the stones of the cycloliths of Nagpoor, and, shortly after, upon rocks *in situ* of the mountains of Kumaon, where, in one place, he found them to the number of more than two hundred, arranged in groups of apparently parallel rows. In the Kumaon region he also found ring sculpturing, which very much resembled that which is seen in Europe. Outside of these named countries, and North America to be mentioned further on, the world is a blank as regards cup-cuttings on rocks, so far as our present knowledge goes, or at least to the extent that I have been able to find recorded information of the same.

Although met with and described nearly a century and a half ago, as hereinbefore related, it is only within the last forty-five years that incised cups on rocks and stones have been particularly written about, either in Europe or in the United States, and speculative theories advanced concerning their origin and uses.

It was in 1847 that Messrs Squier and Davis, partners in original research in the state of Ohio, brought their operations to a close by the production of the "Ancient Monuments of the Mississippi Valley," the comprehensive work which methodically displayed all that was then known of the antiquities of the great region implied by that geographical expression. In this book (on page 206) there is a description, with wood-cut illustration, of a block of sandstone which had been found in some unnamed Ohio mound. The stone weighed between thirty and forty pounds, and showed several circular depressions, evidently artificial, which our authors thought were used as moulds for the purpose of hammering thin plates of copper into small bosses of concavo-convex shape, such as had been often found. This is the prototype of the cup-stones of the western hemisphere.[1]

Professor Daniel Wilson, of Toronto, in his "Prehistoric Man," (third edition, 1876, Vol. I.), also devotes several pages to the subject, and gives drawings of two cup-stones found, too, in Ohio. Of the first he speaks thus: "A cupped sandstone block on the banks of the Ohio, a little below Cincinnati. Others much larger were described to me by Dr. Hill," etc. The second one he describes as a "cupped sandstone boulder," found near Tronton [Ironton] in 1874. The author, in this work, considers that the use of these cups—everywhere, all the world over—was to grind the ends of stone implements, and that where they were accompanied by concentric circles and other devices the latter were no more than additions of idle fancy.

The late Professor Charles Rau, of Washington, D. C., seems, however, to be the first writer in the United States to bring forward and collate comprehensively in a special treatise the data relating to cup-stones on this side of the Atlantic, and to treat of

[1] Were the facts concerning the *Teololinga* rock, situated sixteen leagues southeast of Orizaba, Mexico, exactly known, it might with propriety take precedence here in the text of the Squier and Davis stone; for it was discovered in 1805 by Captain Dupaix, who said that on its surface were some circular holes of little depth. By reason of the dissimilarity of the published representations of it, however, Professor Rau (1881) thought that a proper doubt remained, not to be removed until the stone had again been examined and reported upon.

their resemblance to those found in the eastern hemisphere. In his "Observations on Cup-Shaped and Other Lapidarian Sculptures in the Old World and America" (1881) he[2] describes a few specimens whose characteristics are undoubted. The best of these are the "incised rock" in Forsyth County, Georgia; the sandstone block with cup-cavities discovered by Dr. H. H. Hill in Lawrence county, Ohio;[3] and the sculptures on Bald Friar Rock in the usquehanna River, Cecil county, Maryland. Toward the end of the work Professor Rau gives the various speculations which have been published as to the purpose for which cup- and ring-cuttings were made, but states that after all that has been said concerning their significance in the Old World, he hardly ventures to offer an opinion of his own. Still he thinks that both kinds of sculpture belong to *one* primitive system, of which the former seems to be the earlier expression. Turning to America, he considers that here, as yet, the number of discovered cup-stones is by far too small to permit the merest attempt at generalization.

The author just referred to has shown in his book that true cup-stones have been found in the United States as far east as Connecticut and as far west as Illinois, but the fact that rocks having such incised work exist also far beyond the Mississippi valley has not yet, apparently, become known to the antiquarian world. It is therefore for the purpose of describing one so located that this paper is written.

The rock in question is situated in Ransom county, North Dakota, and, with others, it came under my observation in the middle of last August, at which time full notes were taken, and the pictographs to be described further on carefully copied.

Ransom county derives its name from a post of the United States army which was formerly maintained on the west side of the Shyenne River, in that part of its course known as the Great Bend. The top of the bluff on which the ruined fort stands is about two-hundred-and-fifty feet above the river. About one-quarter of a mile to the westward, on the north half of the south-

[2] In "Contributions to North American Ethnology," Vol. V., Washington, 1882.

[3] This is the same as the "cupped sandstone boulder" already illustrated in Professor Wilson's "Prehistoric Man" (1876).

west quarter of section 11, town 135, range 58, there is a large spring known as the "Fort Springs," situated in the bottom of a deep ravine, which is about ninety feet below the fort site. It is probably formed by a seepage from "Big Slough," which starts about one mile south and extends some fifteen or twenty miles in a southerly direction. The bluff immediately to the west of the ravine rises to the height of about one-hundred-and-sixty feet, and on the top, over a quarter of a mile away in a northwesterly direction, there is a small knoll which was called "Bear's-Den Hill" by the Indians. On the steep slope of the bluff, about one hundred yards north of west from the spring and fifty-three feet above it, there is a large light-colored granite boulder, on which there are a number of incised lines, cups, and other figures. The base of the boulder, which is firmly imbedded in the side-hill, is eight-and-a-half feet in length and four-and-a-half feet in width, and on the side next to the spring extends out of the ground about three feet. The top surface on which the carvings occur is irregular in outline, and is seven feet two inches in length, and from two feet six inches to three feet ten inches in width, sloping slightly towards the east. The particular figures seen upon it, and reproduced here in fac-simile as regards their forms, are explainable somewhat as follows, viz.:

FIG. 1.—Apparently the horns of some animal.

FIG. 2.—A nondescript. There is a similar figure on the quartzite ledge near Little Cottonwood Falls, in Cottonwood county, Minn.

FIG. 3.—A crescent. This figure is often found along the Mississippi River in Minnesota, Wisconsin, and Iowa.

FIG. 4.—A nondescript animal.

FIG. 5.—A peculiar-shaped cross. There is one similar in form on the face of a cliff a few miles above Stillwater, Minn.

FIGS. 6, 6.—"Pins," so-called. There are two of the same shape on the quartzite ledge, among other figures, near the "Three Maidens," at Pipestone, Minn.

FIGS. 7, 7, 7.—Three pairs of cups, one set being joined by a straight groove, and the other two by curved grooves.[4]

[4] Sir James Simpson describes and figures an isolated stone near Balvraid, in Inverness-shire, Scotland, which has five pairs of cups that are joined by straight or curved grooves.

FIGS. 8, 8, 8, 8.—Are four long grooves with odd-shaped ends. These grooves are only about one-eighth of an inch in depth, while the ends are from one to one-and-a-half inches in depth.

CUPS (not numbered).—The cups or circular depressions are from about one-half-inch to nearly two inches in diameter, and one inch to one-quarter of an inch in depth. Some are perfect circles, while others are oblong in outline. There are thirty-four single cups and twenty-five cups that are connected with or intersected by grooves, making a total of fifty-nine positive cups, without considering the terminals of the four long grooves and others that are more doubtful. Where grooves intersect the cups an arbitrary line has been drawn on the illustration, in order to separate them and to more fully demonstrate the character of the designs. In every instance where this has been done the cups are well defined, but yet they cannot otherwise be fully shown on a tracing giving only surface outlines.

Within a radius of four hundred feet from the spring there are thirteen incised boulders of various sizes and shapes, the one here described being the largest and finest of the group. The pictures, etc., on five of the best ones were copied; the others having only slight grooves and a few cups were not.

On the bluffs on both sides of the ravine there are a number of ancient mounds of the mound-building period, one of which is located on the west side immediately above the spring.

There are other boulders at various places in the northwest on which these cup-like depressions occur, and they are also occasionally found on the face of perpendicular ledges and on the walls of caves, but in nearly every instance there are other incised figures on the same surface. It may be further stated that the cup-cavities as shown at the terminals of Fig. 5 of the illustration now given are also seen in connection with incised figures on rocks at these other localities referred to.

The cup-stones (large boulders or rocks) are not to be con-

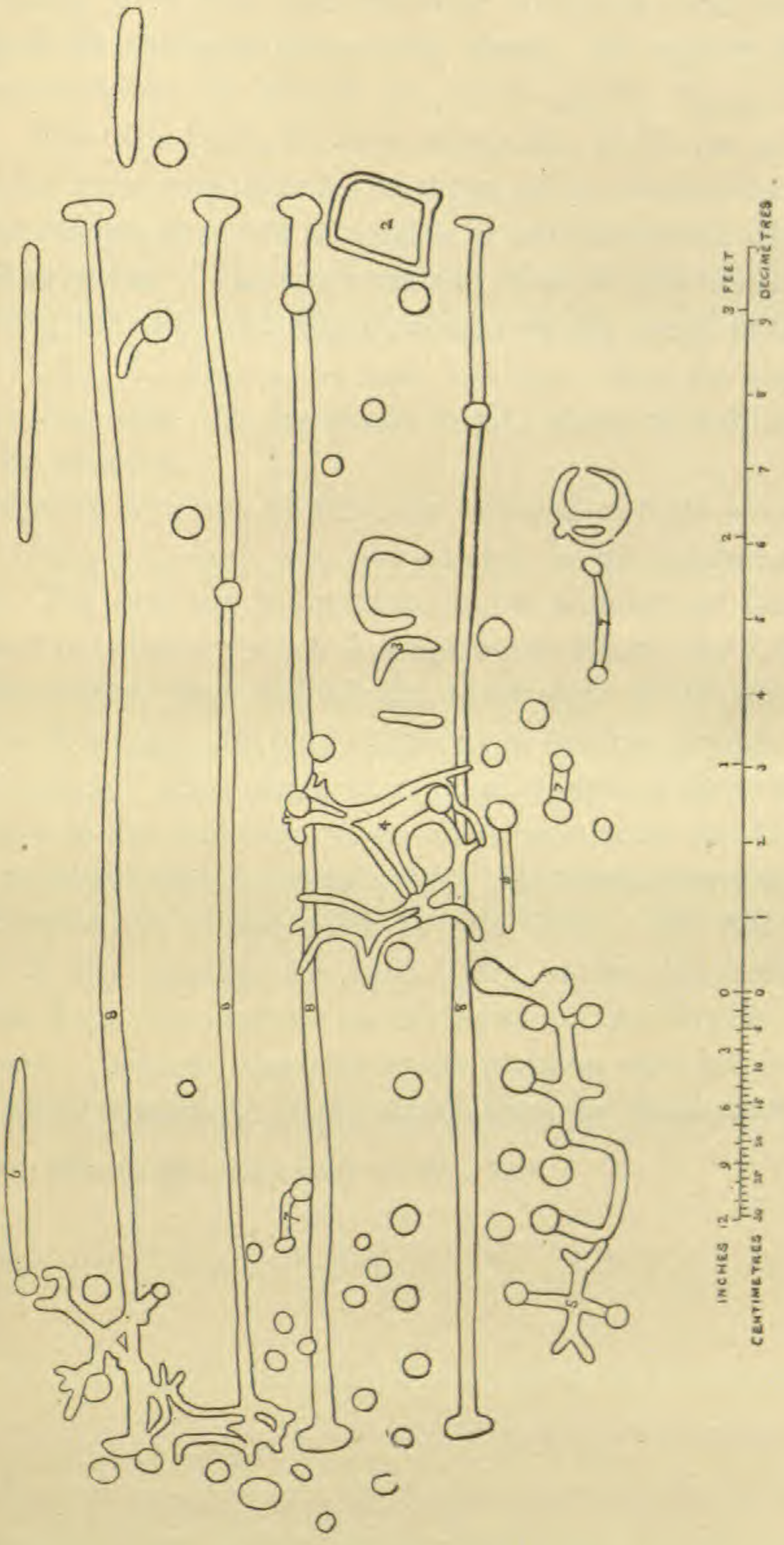
See Plate XIV., 2, of his "Archaic Sculpturings upon Stones in Scotland," etc., Edinburgh, 1867. The same type occurs on boulders and slabs found in France, Switzerland, and Sweden. Similar figures also appear on early British coins prior to Cunobeline's time (A.D. 40), and on the French-Keltic coins of moulded bronze. See Plates LIII. and LV. of Waring's "Stone Monuments," etc., London, 1870.

founded with the smaller stones called "nut-holders" or "anvils," which are from two to twenty inches in diameter, one to four inches in thickness, and which have one or more slight cavities or pits on each face. These cavities average about one inch in diameter, and very rarely exceed one-half inch in depth, the average being one-fourth of an inch. These relics are found throughout the west and south along the streams and lakes, and the prairies are no exception to the rule. Still less should cup-stones proper be confounded with the large circular excavations in rocks found in various regions which have been used as mortars. Mortars are found in fields. The rocks may be ten inches square and upwards, and the cavities range from six to fifteen inches in diameter and from one to five inches in depth. They are also found on the upper surface of ledgesand on the tops of very large boulders. In one place in this vicinity there are at least twenty-five mortars on two acres of land.

While the American cup-stones are similar in nearly every respect to those found in Europe and other portions of the globe, it would be the best policy to study them as an entirely separate class of antiquities, for in all probability there is not even a remote connection between the two hemispheres in this respect. After a thorough comparison has been made and the necessary links have been found, there will then be ample time in which to bring forward the facts to prove relationship. In the meanwhile, awaiting thorough exploration of the field, all such attempts, though interesting in a literary point of view, may be considered somewhat premature in a scientific one.

Since the above was written I have examined a book, just published, which treats of the same kind of ancient work. It appears nine or ten years after Rau's, and, so far as known to me, is the only general handling of the subject within that period. Its title is "Archaic Rock Inscriptions; an Account of the Cup and Ring Markings on the Sculptured Stones of the Old and New Worlds." It is of anonymous authorship, but bears the imprint of A. Reader, London, 1891, and is a 12mo of only 99 pages. The writer is evidently one of the mystical antiquarians who, to speak figuratively, have their eyes continually turned to those *ignes fatui* the

PLATE XI.



CUP-STONES.

elusive and ever unapproachable ancient faiths—the Tree, Serpent, Phallic, Fire, Sun, and Ancestor worships—and delight in the search for analogies concerning them. As regards the cup- and ring-markings, he himself adopts the phallic theory for their origin. His little book, however, admirably fulfills the promise of its title, for it not only includes most that prior writers collected, but gives interesting facts not accessible or not discovered when Professor Rau wrote. The most striking piece of new information is concerning the cup- and ring-markings on the rocks in the environs of Ilkley, Yorkshire,—a new locality. Here the cups have been counted into the hundreds in all; many of them are connected by grooves.

As regards America, all that this new author finds—and probably all there is to find—are two articles in the AMERICAN NATURALIST. The first one is contained in the number for December, 1884, and is entitled "Rock Inscriptions in Brazil," by J. C. Branner. The author does not use the word *cups* at all, nor do his diagrams show any; he only mentions in his text certain "points or indentations," often arranged in parallel vertical lines, and portrays them in the drawings, where also single circles are shown,—mostly provided with a central point. He found, however, "mortars" scooped out on the rocks by the river. The other article appears in the number for July, 1885, under the heading of "Ancient Rock Inscriptions on the Lake of the Woods," by A. C. Lawson. Neither does this writer mention *cups*, but his illustrations show concentric circles which have the usual central dot.

Tupelo, Mississippi, February 11th, 1891.

ON THE GROWTH–PERIODICITY OF THE POTATO-TUBER.[1]

BY CONWAY MACMILLAN.

WHILE considerable research has been bestowed upon the physiology of bulbs, corms, and tubers, it does not appear that any extended observations have been made upon the method of growth of such an organ as the potato-tuber. It is a well-known fact that the growth in length of upright stems and other aërial organs is not regular, but exhibits a marked daily periodicity, the time of greatest average growth being in most cases not far from six o'clock in the morning. Upon this subject, since the researches of Sachs,[2] Baranetski,[3] Pfeffer,[4] and others, a number of observations have been made by various investigators. It appears that in most above-ground organs there is a clearly marked diurnal period, unless this period is obliterated by etiolation, suffocation, anæsthesia, or some other abnormal condition. We know, too, that besides the daily periodicity there is a grand-period of growth for each organ of the plant; that some organs reach the grand-period more rapidly or continue in it longer proportionately than other organs or similar organs on the other plant, or in the same plants under different conditions. The growth in length, then, of any organ is not regular, but is to be graphically represented as a wavy curve, with an ascending portion, a climactic portion, and a descending portion. In all of the parts of this large curve, the climax of which represents the grand-period of growth, one must notice the rhythmic pulsations due to the daily growth-periods, and more or less synchronous with the alternating periods of light and darkness, of higher and lower temperature, of less and of greater oxidation.

[1] Read before the Minnesota Academy of Science, May 5th, 1891.

[2] Arbeit. d. Würtzb. Institute, 1873.

[3] Die tägliche Periodicität d. Langenwachsthums, 1879.

[4] Physiolog. Untersuchungen, 1873.

Seasonal rhythm in the growth in girth of organs is well known in the ordinary woody stems of Dicotyledons[5] and Gymnosperms,[6] where the increasing tensions of later months reduce the rate of growth below the rate of the earlier months. This periodicity is a more simple and readily explained form than those forms which have been alluded to above. It is found principally in organs provided with a cambium cylinder and a relatively inextensible bark, and is referred to merely by way of illustration. While the potato-tuber, which is to be considered, has a cambium area, it can scarcely be said to have a cortical area at all analogous to that of the erect tree-trunk. We shall not find the tuber, protected as it is and growing during a single season, affected by the conditions of alternate freezing and thawing, wind disturbance, stress, flexion, etc., which have so much to do with seasonal periodicity of growth in girth of woody stems.

A few months ago the writer was struck with what seemed to be a great dearth of investigations into the manner of growth of tubers, and forthwith gave some attention to devising a method by which the gap in our knowledge of tuber-physiology might be filled in part. After due deliberation a method was formulated and applied, with but imperfect success at first, but as experience became wider the imperfections were gradually remedied. In all of the experiments Mr. C. P. Lommen, student in biology at the University of Minnesota, gave much assistance in setting up apparatus, and by one or two helpful suggestions concerning certain technical difficulties which presented themselves in the course of our investigations. The method of research first adopted by us has been described elsewhere somewhat in detail,[7] but upon this method certain important improvements have been made. The apparatus used was the Baranetski self-registering auxanometer, with electric clock attachment, manufactured by Albrecht, of Tübingen. At first both wheels of the apparatus were not employed, but afterwards it was found that two wheels could be combined in such a way as to multiply the tracings tenfold, and

[5] Pfeffer. Pflanzen-physiologie, II., 89.

[6] Hartig. Anat. und Phys. der Holzpflanzen, p. 366.

[7] *L. c. Botan. Gazette*, May, 1891.

in our later experiments the wheel attached to the tuber-thread does not bear the tracing needle, but carries another thread on its large circumference, which runs to the small circumference of the tracing wheel. By this means hourly registrations are obtained instead of three-hour registrations as by the first method.

To recapitulate the method as finally developed: A potato-plant, grown in a box from which one end had been removed, was selected and carried to the experimenting room. With due care a tuber was exposed, and under it, resting upon the bottom of the box, a wooden block was placed in such a way that downward pressure would not disturb the position of the tuber. The root-stock umbilicus was protected from desiccation or injury during these processes of blocking up. Next a wooden jacket consisting of two squares of cigar-box material, held together by a number of slightly stretched rubber-bands, was fitted over the tuber in such a way that one square of the cigar-box wood clung to the block below and the other piece was parallel, but on the upper side of the tuber. To the center of this upper square a small screw was fixed, and to this screw a fine silver wire was tied,—since thread was rotted by the soil,—and this wire, after the whole apparatus of block, tuber, and jacket was covered with earth again, came to the surface of the soil under the first wheel of the auxanometer. An inch and a half above the ground a twisted linen thread, which gave better friction on the wheel, was attached to the silver wire, and this twisted thread was passed over the small circumference of the first wheel and drawn taut by a weight of about forty grams. Passing from the large circumference of the first wheel to the small circumference of the second was a linen thread equally weighted at each end, and over the large circumference of the second wheel was passed a thread, bearing at one end the tracing needle and at the other a small counterpoise. The tracing needle was placed in contact with the vertical smoked cylinder of the registering apparatus. This rested upon a clock-work in which a ratchet-wheel was caught by a lever attached to the clock-work by a spring and bearing at the opposite end an armature near the poles of a small electro-magnet. Connected with the magnet was a two-celled La Clanche battery, but interpolated in the circuit was the electric clock, so adjusted that every hour the circuit was closed for a few seconds. During the closure of the circuit the electro-magnet attracted the armature, overcoming the tension of the spring and releasing one cog of the ratchet-wheel. By this means the vertical cylinder turned about one-sixteenth of an inch with the hands of the watch, and the tracing needle made a horizontal mark upon the smoked paper covering the cylinder. The opening of the circuit as the hands passed by the hour released the armature, allowed the spring to pull back the lever, and stopped the clock-work until the next hour, when a similar horizontal mark was made. During the hours, then, any expansion of the tuber would loosen the string attached to the jacket. Pulling against this the weights would turn the first wheel. This would turn the second wheel, and the indication of growth, one hundred times magnified, but in proper ratio, would appear as vertical tracings upon the smoked cylinder. This brief description of the Baranetski apparatus is given that the exact method of research may be apparent.

The first experiments upon the growing tuber, made in accordance with the method described in the *Botanical Gazette*, were satisfactory in so far that they demonstrated the availability of the Baranetski apparatus for the purpose for which it was employed. In one of the early experiments a trace of periodic growth was distinguished, but it did not seem to be sufficient to justify any confident assertion of periodicity. The first experiment continued two weeks. During this time the needle kept falling; at the close of the experiment it was about half an inch below its original level. In the second experiment certain drops in the tracings, usually in the early morning, were noticed, but I have since come to believe that not all of these were true growth-tracings, but were due, at least in part, to changes of temperature of the soil, the strings, and the atmosphere, with consequent shortenings, relaxations, and alterations in the needle-position. Against such accidental and confusing records there was a constant necessity of guarding. In general, a conservative statement of conclusions from these experiments with the single wheel is as follows:

1. The apparatus as set up indicated growth by cylinder-tracings.

2. A possible indication of periodicity in the growth may have manifested itself.

Further than this one could not go under the conditions of the experiment.

Desiring to obtain more perfect results, and to solve the question as to the manner of growth of the tuber, the improved method of setting up the apparatus was developed as described above, and the first experiment gave some interesting results. The method of culture in water employed by De Vries[8] in the study of roots was contemplated, but rejected on account of certain practical difficulties.

The experiment began with a tuber about ¾-inch in diameter. At this time the full-sized top of the plant had begun to perish from the effects of mildew. After attachment the registering needle gave two or three sharp drops, owing to the stretching of strings and general getting into equilibrium of the apparatus. After this stage was passed the needle began dropping very gradually. This slow descent was continued from eight o'clock in the evening until about eight o'clock in the morning. At this time the drop ceased, and horizontal tracings continued until about 1.30 P. M., when a short, abrupt hour's drop was registered, followed by a longer one, then by one shorter than the second but longer than the first, next by one longer than any, closely succeeded by another long one. After this the registrations were short, and the regular, gradual fall until 8 A. M. began. Here again the horizontal mark began and continued until 2 P. M., when a second drop began, on a somewhat smaller scale than the one registered the first day. The total extent of the second day's maximum, between 2 P. M. and 8 P. M., was about one-half of the first day's maximum. The third day the same tracings continued at the same hours,—only the tracings of the maximum were very much reduced, so as to be not more than one-quarter the total length of the second day's tracings. The fourth day's tracings were like those of the second day in almost every par-

[8] *Landwirthschaftliches Jahrbuch*, 1880, Bd. IX., p. 37.

ticular, and those of the fifth day likewise, except that the latter showed a less maximum growth. The sixth day was peculiar. During this day no appreciable drop in the tracings was detected. The explanation of this cessation is not offered. It may be said, however, that the death of the top was now about complete, so far as the leaves and the secondary branches were concerned. Only in the lower part of the main stem was living green tissue to be found. During the whole twenty-four hours of the sixth day, then, no divergence of the tracings from the horizontal was observed; but during the succeeding twelve hours a slight drop began. At 7 o'clock A. M. of the seventh day a decided drop began, continuing until 11 A. M. There then succeeded a period of gradual dropping, which disappeared about 3 P. M. Another drop took place in the evening from 6 to 9 P. M. The eighth day began with a drop at 7 A. M., continuing until 11 A. M., when three hours of horizontal marks followed. At 2 P. M. a five-hour drop began, and continued as a gradual depression until 10 P. M. At 7 A. M. again another abrupt drop was registered, terminating at 11.30 A. M. At 3 P. M. a gradual, slight drop, lasting until 8 P. M., ensued. During four succeeding days the same rhythm continued, only the drops became slighter and slighter. Finally, on the fifteenth day the needle ceased to trace.

The explanation of these very curious maxima and minima in the growth of the tuber is a complicated matter. It can be given as yet only conjecturally. Before passing to any such conjectures it may be well to give in their order the conclusions arrived at from the line of research described above:

1. The increase in diameter of the potato-tuber is not regular, but is rhythmic.

2. Maxima of growth may occur either once or twice, and perhaps oftener, during twenty-four hours.

3. Maxima of growth are not of long duration, and are followed by periods of slower growth, or of entire cessation of growth.

4. The maxima of some days are greater absolute maxima than those of other days. This indicates a grand-period for the tuber.

5. Regular periodicity in the tuber continues after the periodicity of the aërial stem is suspended.

6. Connected with profound changes of condition in the aërial stem changes in the periodicity of the tuber may be noted.

7. There is some connection between the periodic growth of the tuber and the periodic growth of the aërial stem. What this connection is does not appear.

8. There is also, it is probable, an *independent* periodicity in the growth of the potato-tuber which is obscured and modified by the secondary *induced* periodicity, which is related to conditions of the aërial stem and its mode of growth.

Passing now to conjectural explanations of the observed periodic growth of the potato-tuber, it may be affirmed that very little can be expected at this stage of the investigations. Whether like embryonic shoots of Hedera, with their heliotropic irritability, the potato-tuber retains, somehow, in hereditary fashion, its above-ground periodicity, and thus gives hint of the time when its precursors were exposed to rhythmic alternation of light and darkness, is entirely an open question. On the other hand, it is equally uncertain whether the induced periodicity is due to one or many causes. Some lines of attack are indicated below, and it is hoped that they may be followed to their rational conclusion.

1. The rhythm of *assimilation* in the above-ground stem may affect the growth of the below-ground tuber. The synthesis of carbohydrates is a diurnal affair. From these carbohydrates the substance of the tuber is formed. Thus the rhythm above might induce a rhythm below.

2. The conversion of plastic into reserve materials is characteristic of an organ like the tuber. This conversion depends upon the activity of certain ferments which are results of destructive and constructive metabolic changes in the shoot area. These metabolic changes are consequent upon the *respiration* function, and this is a rhythmic function.

3. The *growth* of the above-ground stem is strongly periodic, and demands, in any plant, the same kind of material which would be supplied to a growing tuber. This drain upon the plastic material in one direction might induce a corresponding dearth of it in

another, so that the periodic growth of the above-ground stem might induce a periodic growth in the below-ground tuber.

4. The *asynchronous grand-periods* of growth of the different above-ground organs might be reflected in an irregular and erratic periodicity in the below-ground tuber.

5. *Combinations* of these various conditions, and a modification of them all by the independent rhythm of the tuber itself, would have to be considered, and only by the most elaborate and extended researches could the proximate causes for the observed tuber-periodicity be detected.

In closing this contribution to the physiology of tubers, one word may be added by way of note. It is possible, as may be shown, to apply auxanometer methods to root stocks by uncovering the root stock, attaching a silver thread, running it horizontally to the open side of the box, passing under a horizontal roller and upward, and finally adding the linen or silken thread which runs on the small circumference of the first wheel. Or, in this case, doubtless one wheel alone could be employed. Such study of underground stems, as in the grass root stock, the potato rhizome, or any other underground stem, would scarcely fail to throw some light upon the method of growth of the tuber. A comparison of underground organs should be made along this line.

University of Minnesota, Minneapolis, May 1st, 1891.

EDITORIAL.

EDITORS, E. D. COPE AND J. S. KINGSLEY.

IN these pages nearly four years ago (AMERICAN NATURALIST, XXI., p. 549) we made an appeal for some properly qualified person to write a "Complete Unnatural History." The necessary conditions of mind were stated at some length. There must be an instinctive ability to unerringly discriminate between the false and the true, and to invariably appropriate the former; a capacity to trace results from no adequate cause; and a firm conviction that all the so-called leaders of science were totally wrong, while the author is infallible.

Although we have not returned to the subject in the interval, the editors of the NATURALIST have been constantly on the lookout for the proper person. Numerous claims have been investigated, for many pretenders have arisen. It is useless to enumerate them all, for until this present year of grace, 1891, not a single candidate has been proposed who had the necessary grasp of subject, the proper disregard of cause and effect, and the all-important wealth of imagination. The Ohio minister who preached those celebrated sermons on the Creation in which petroleum was regarded as "strong-smelling grease," fried out from the decomposing bodies of antediluvian reptiles; the man who claimed that the Great Lakes are drained by an underground channel into the Mississippi River; the Buffalo doctor who maintained that bacteria are decomposing fibrin; the crowd of "pyramidologists,"—all were soon dismissed in short order. We debated longer in the case of a callow youth whom we found studying the relations existing between the abundance of birds and meteorological conditions,—not because of any capacity shown in choice of a subject, but from the methods of thought revealed by a glance at his notebook. A sample will suffice: "June 23d, 9 A. M. Saw two gulls. Sky clear. Wind S. W. June 23d, 9.23. Three loons on water, distant half mile. Sky clear. Wind S. S. W. June 23d, 9.37. Wilson's tern flying overhead towards west. Sky clear. Wind a little stronger." And so on page after page. Imagination is here clearly lacking, and the promising youth was therefore turned over to the tender mercies of Dr. Chadbourne's Society for the Suppression of Useless Knowledge.

Now we believe that we have obtained the long-sought author. The essay which forms the basis of this opinion was published in January, 1890, in Vol. III. of *The Literary Light*, published by C. D. Raymer, 243 Fourth Avenue, S., Minneapolis, Minn. The essay is entitled "The Origin of Life and Species, And Theory by Which all Phases of Life, and Phenomena in Connection with Such, can be Readily Explained." Would we had the space to reproduce the whole essay! Excerpts must for the present answer, for doubtless this brochure will be embodied in the long-looked-for Unnatural History.

"An organism is a creature of environment, and has, like all things, obtained its life and all that belongs to it, and sequently all the possibilities of its future, during its incipiency by heredity. Whatever evolved properties and principles an environment may contain, generation rarely leaves any out. The future growth determines where and what from they were produced. Sequently they are species."

"A reproduction, like all things, is composed of ponderables and imponderables. It is an organism with life attached, or composed of an aggregation of lives. . . . I have yet to learn that ponderables alone exhibit any activity whatever. They are invariably produced by, through, and are an organism."

"Generation is not a substance. It is a word to express the workings of the activities of a thing, a substance or a combination of substances by which phenomena are exhibited or produced. . . . . . It being the agent in all reproduction, performing the functions of the activities of a combination or an environment of material, containing definite substances, in first producing organized nuclei out of that material through the positive energies, usually in vast numbers. . . . They are called in the animal kingdom when fully developed, 'episoids' or 'zooids'; in the vegetable, 'pollen grains' or pollen."

"When we are first able to perceive nuclei with the most perfect lens yet constructed, we find them to be mere specks. By close observation we are able to perceive that the albuminoid substance is consumed, and that the nuclei grow, and in a short time are developed living organisms, just ready to emerge from the first stage of their existence."

"Bacilli by generation are a product of the properties of the products of the earth, where they first originate. Properties of the earth's products are a substance that we can usually taste."

"Intelligence is an imponderable substance, grown and produced by the animal kingdom, and as it and bacteria are products of products of the earth, they may be called kingdoms of growth. Human intelligence is a product produced by the animal man, the seat of which is located by phrenologists in his brain, in no less than thirty-five sections, and like all organisms in nature, may be classed into genera, species, and varieties."

"Should any error of fact or otherwise occur in my explanations, or should any phenomena in nature appear that no place can be found in my hypothesis, or a desire for further explanation on the subject, I would like to be informed of the fact, and what it is. If a fallacy, wherein does it lay.—GEORGE DAVIS; address, 2613 First Ave. S., Minneapolis, Minn."

We can assure a long-waiting world that if Mr. Davis attempts the Unnatural History the result will be a complete success.

—THE commission selected to examine and report on suitable locations for national reservations of land for the purpose of creating public parks has done a good work. They have selected about one hundred tracts from all parts of the country, which will be recommended to Congress for adoption. To the Yellowstone, the Yosemite, and the Sequoia Parks will be added one or more from nearly every state and territory of the Union. This is a measure which the scientific sentiment of the country will universally sustain. The preservation of tracts of forest, if only of limited extent, is highly important; and the preservation of game commends itself to everybody. Reasonable hunters are rare, and a good many men consider themselves sportsmen who do not deserve the name. Without game reservations like the national parks, the large game of this continent will soon become extinct.

What we need further is an efficient forestry organization which shall prevent or suppress the forest fires which annually desolate our country. As our state organizations have shown themselves incompetent to deal with the question, the national government should take hold of it. It is to be hoped that the Forestry Commission of the Agricultural Department will be empowered to do so. Not only should the forest fires be suppressed, but their authors should be punished, whether the former are, as in some instances, at least, of incendiary origin or not. Railroad companies should be compelled to place spark catchers or extinguishers on their engines, under heavy penalties for non-compliance. Some action must be taken in the matter immediately, especially as we are now receiving the scum of Europe, whose carelessness of all matters of public economy is well known. We cannot afford to have our mountain regions converted into bare rocks, as most of the regions inhabited by the earlier civilizations of Europe now are. First the forests disappear, and then the soil from the mountain sides. Fire is a great friend of man, but in the hands of an unwatched European peasantry it is an evil great enough to render the punishment inflicted on Prometheus a wholesome warning to all who misuse this one of the greatest of nature's benefits.

RECENT BOOKS AND PAMPHLETS.

ABBOTT, C. C.—Annual Report of the Museum of Am. Archæology of University of Penna., Vol. I., No. 1, 1890. From the author.

Anales de la Sociedael Española de Historia Natural.

Annual Report of the Cornell University Agri. Exp. Station, 1890.

Annual Report (Third) of the Marine Biological Laboratory, 1890.

Annual Report of the Curator of the Museum of Comparative Zoology at Harvard College for 1889-'90.

ALLEN, J. A.—Notes on Collections of Mammals made in Central and Southern Mexico, by Dr. Audley C. Buller, with Descriptions of New Species of the Genera Vespertilio, Sciurus, and Lepus.—List of Mammals collected by Mr. C. P. Streator in British Columbia, with Descriptions of two New Sub-species of Sciurus.—Notes on a Small Collection of West Indian Bats, with Descriptions of an Apparently New Species. —Description of a New Species and a New Sub-species of the Genus Lepus. Exts. Bull. Am. Mus. Nat. Hist., Vol. III. From the author.

AULD, R. C.—The Wild Cattle of Great Britain. From the author.

AYERS, HOWARD.—Concerning Vertebrate Cephalogenesis. Reprint from *Journ. Morph.*, Vol. IV., No. 2. From the author.

BODINGTON, ALICE.—Studies in Evolution and Biology. From the author.

BRONN, H. G.—Klassen und Ordnungen des Thier-Reichs. Vierter Band, Vermes, 15-16 Lieferung. Fünfter Band, Arthropoda, 28 Lieferung; Sechster Band, Reptilien, 69 Lieferung.

BROWNE, MONTAGUE.—Revision of a Genus of Fossil Fishes—Dapedius. Ext. Trans. Leicester Literary and Philos. Soc., Oct., 1890. From the author.

CHAPMAN, F. M.—On a Collection of Birds made by Mr. Clark P. Streator in British Columbia, with Field Notes by the Collector. Ext. Bull. Am. Mus. Nat. Hist., Vol. III., No. 1. From the author.

COPPI, FRANCESCO.—Observationi Malacologiche circa la Nassa semistriata e N. costulata del Brocchi.

DAWSON, WM.—Nature as an Educator.—The Quebec Group of Logan. Reprints *Canadian Record of Science*, July, 1890. From the author.

DUGÈS, A.—Aparato Venenoso del Bagre (*Ictalurus dugesi* Bean). From the author.

DEWALQUE, G.—Quelques observations au sujet de la Note de M. E. Dupont sur Le Pondingue de Wéris. From the author.

FELIX, JOHANNES.—Beiträge zur Kennniss der Gattung Protosphyraena Leidy. Besonderer Abdruck aus der Zeitschrift der Deutschen Geologischen Gesellschaft, Bd. XLII., 1890. From the author.

Geological Survey of Illinois, Vol. VIII. Geology by A. H. Worthen; Paleontology by A. H. Worthen, C. Wachmuth, F. Springer, E. O. Ulrich, and O. Everett. Edited by J. Lindahl.

GILL, THEODORE.—The Osteological Characteristics of the Families Ranicipitidæ, Dactylopteroidea, Anguillidæ, Murænidæ, Murænesocidæ, Simenchlyidæ, and Synaphobranchia. Exts. Proc. U. S. Nat. Mus., Vol. XIII. From the author.

HAECKEL, ERNST.—Plankton-Studien. Vergleichende Untersuchungen über die Bedentung und Zusammensetzung der Pelagischen Fauna und Flora. From the author.

HEGELER, E. C.—A Protest against the Legal and Moral Doctrine of the Supreme Court of Illinois.

HEILPRIN, ANGELO.—The Geology and Paleontology of the Cretaceous Deposits of Mexico. Ext. Proc. Phila. Acad. Nat. Sciences, Dec., 1890. From the author.

LERCH, O.—Remarks on the Geology of the Concho Country, Texas. Ext. *Am. Geol.*, Feb., 1891. From the author.

LINTNER, J. A.—First, Second, and Sixth Annual Reports on the Injurious and other Insects of the State of New York. From the author.

MERRIAM, C. H.—Descriptions of Twenty-six New Species of North American Mammals. Bull. U. S. Dept. Agri., Division of Ornithology and Mammalogy. North American Fauna, No. 4. From the author.

MEYER, OTTO.—Beitrag zur Kennniss der Fauna des Alttertiärs von Mississippi und Alabama. Sonder-Abdruck aus Bericht über die Senckenbergische naturforschende Gesellschaft in Frankfort a. M., 1887. From the author.

MORENO, F. P.—Extraits de la Revista del Museo de la Plata, Tome I., 1890. Rapide Coup d'oeil sur sa fondation et son développment.—Projet d'une Exposition Rétrospective Argentine à l'occasion du quatrième Centenaire de la découverate de l'Amérique. From the author.

MORRIS, CHARLES.—The Aryan Race: Its Origin and Its Achievements. From the author.

NIPHER, F. E.—Electrical Industries in St. Louis.—The State Weather Service. From the author.

PRESTWICK, J.—Discours de M. le Professeur J. Prestwich, President du Cong. Geol. Internat., 1888. From Henry Osborn.

PROSSER, CHARLES S.—The Thickness of the Devonian and Silurian Rocks of Western Central New York. Ext. *Am. Geol.*, Oct., 1890. From the author.

Records of the Australian Museum, Vol. I., No. 4, No. 5.

Report of the Work of the Brooklyn Ethical Association, 1890-'91.

RICE, WM. N.—The Degree of Probability of Scientific Beliefs. Extract *New Englander and Yale Review*, Jan., 1891. From the author.

SAMSON, F. A.—A Bibliography of the Geology of Missouri. Bull. No. II., Geol. Survey of Mo. From the author.

SQUIRE, J.—Report on the Cahaba Coal Field, with an Appendix: On the Geology of the Valley Regions Adjacent to the Cahaba Coal Field, by Eugene Smith. Part of the Geol. Surv. Alabama. From Eugene Smith.

STEARNS, R. E. C.—Descriptions of New West American Land, Fresh-Water, and Marine Shells, with Notes and Comments. Ext. Proc. U. S. Nat. Mus., Vol. XIII., pp. 205-225. From the Smithsonian Institution.

Transactions Wagner Free Institute of Science, Vol. II., 1890.

TRUE, F. W.—Description of Two New Species of Mammals from Mt. Kilima-Njaro, East Africa. Ext. Proc. U. S. Nat. Mus., Vol. XIII., pp. 227-229. From the Smithsonian Institution.

WACHSMUTH, C., and FRANK SPRINGER.—The Perisomic Plates of the Crinoids. Ext. Proc. Phila. Acad. Nat. Sciences, October, 1890.

WALCOTT, C. D.—Description of New Forms of Upper Cambrian Fossils. Proc. U. S. Nat. Mus., Vol. XIII., pp. 266-279, pls. XX., XXI. From the author.

WEBER, MAX.—Zoologische Ergebnisse einer reise Nederländisch Ost. Indien herausgegeben. From the author.

WIEDERSHEIM, R. VON.—Über die Entwicklung des Urogenitalapparates bei Krokodilen und Schildkröten. Sonder-Abdruck aus *Anatomischer Anzeiger*, 1890, No. 12. From the author.

RECENT LITERATURE.

Wheeler's Report Upon the United States Survey West of the One-Hundredth Meridian.[1]—An approximate notion of the extent of the work of the United States Survey west of the one-hundredth meridian, and of the labor involved in putting it upon record, may be had by a consideration of the extent of the territory involved.

The area within the United States west of the one-hundredth meridian of longitude (1,443,360 square miles) embraces, entire, the basins of the Colorado (270,000 square miles), Interior (208,600 square miles), Coast (100,900 square miles), and Sacramento (64,300 square miles); also that part of the Columbia (215,700 square miles) south of the forty-ninth parallel, and portions of the basins of the Missouri (338,200 square miles), Rio Grande (123,000 square miles), Arkansas (75,500 square miles), Brazos (34,800 square miles), and the Red River of the North (3,360 square miles).

Volume I., recently issued, closes the series. It is devoted to the geographical report, and is a most interesting as well as comprehensive description of the areas occupied, and their population, with their industries, their communications, irrigation systems, and artesian wells. The chapter on the Indians is the result of the author's personal observations, and contains advice worth heeding.

Appendix F contains a detailed account of the operations of the Wheeler survey. The first expedition took the field in May, 1871. The area embraced was 72,250 square miles, including portions of Central, Southern, and Southwestern Nevada, Eastern California, Southwestern Utah, Northwestern, Central, and Southern Arizona.

The survey of 1872 commenced on July 7th, and was completed on the 11th of December. The area embraced was 47,866 square miles, including portions of Central, Western, and Southwestern Utah, Eastern Nevada, and Northwestern Arizona.

In 1873 the expedition took the field in three divisions, organized respectively at Santa Fé, New Mexico; Salt Lake City, Utah; and Denver, Colorado. The area embraced was 72,500 square miles, including portions of Central and Southern Utah; Northern, Central,

[1] Report Upon the United States Geological Surveys West of the One-Hundredth Meridian, in Charge of Captain George M. Wheeler, Corps of Engineers, United States Army, under the Direction of the Chief of Engineers, United States Army. Volume I., Geographical Report.

Eastern, and Southeastern Arizona; Southwestern, Western, Northwestern, and Central New Mexico; and Central, Southern, and Southwestern Colorado. The area of the expedition of 1872 was entered along certain lines.

The several parties of the expedition in 1874 took the field from the camp of organization at Pueblo, Colorado, previous to and on the 6th of August. The territory embraced in the field of operations is bounded on the north by the latitude of the Spanish Peaks, and on the south by a latitude line passing through Santa Fé; on the east by longitude 104° 07′ 30″ west, and on the west by the western boundary of Colorado and New Mexico, approximately.

The expedition of 1875 was organized in two sections of three parties each, one to operate from Los Angeles, California, and the other from Pueblo, Colorado, at initial points. The California division disbanded at Caliente, California, in November, 1875, and the Colorado section at West Las Animas, Colorado, November 25th. The area occupied was 39,169 square miles, including portions of Southern Colorado, Northwestern New Mexico, Southern California, small sections in Southwestern Nevada, and Western Arizona.

In 1876 the survey was again organized in two sections; the Colorado section, of two parties, at Fort Lyon, Colorado, and the California section, of four parties, at Carson City, Nevada. These sections took the field during the month of August, and were disbanded late in November at the above-named points. The areas that had been visited in 1871, '72, '73, '74, and '75 were again entered along certain lines when necessary to perfect the continuous belts of triangulation required to cover entirely the country under examination.

The expedition in 1877 was organized in three divisions; one, of two parties, at Fort Lyon, Colorado; a section, of two parties, at Carson, Nevada; and a third, of two parties, at Ogden, Utah. The field of survey comprised 32,477 square miles, in West Central Colorado, Central New Mexico, Northwestern Utah, Southeastern Idaho, Northeastern and East Central California, and South Central Oregon.

The areas embraced by the expeditions of 1873, 1874, 1875, and 1876 were again entered along certain lines when required to complete triangular observation.

The expedition of 1878 took the field in three divisions of three parties each. Of the Colorado division one party was organized at Fort Stanton, New Mexico, and two at Fort Garland, Colorado. The two parties of the California division were organized respectively at

Carson, Nevada, and at Camp Bidwell, California. Ogden, Utah, was the initial point of the Utah section. An area aggregating 25,550 square miles was occupied, situated chiefly in Southwestern New Mexico, Northern Utah, Northern, Central, and Southwestern California, Western Nevada, and Central Oregon.

Areas embraced during the seasons of 1873, 1874, 1875, 1876, and 1877 were again visited along certain lines when rendered necessary in perfecting triangulation and topographic details.

In 1879 several small parties were sent out to complete details in certain areas entered during the years 1873, 1875, 1877, and 1878.

The survey was terminated at the same time as that under Dr. F. V. Hayden, by the act of Congress creating the United States Geological Survey. While it was probably well that the geological survey should have been undertaken by a bureau of the Interior Department, it is not so clear that the topographical work should have been so disposed of. That this should be done by the United States Engineers seems eminently proper, since the educated men and the plant in instruments, etc., have been in that department of the government service from its commencement. To duplicate this seems to be an unwise and unnecessary expense.

The Itinerary of the Colorado Grand Cañon and River trip of 1871 is of absorbing interest.

The text is abundantly illustrated with fine chromo-lithographs, and the value of the work enhanced by the reproduction of old maps, with notes and references to geographical coördinates for a permanent official topographic atlas of the United States.

The value of a reliable geographical report on the territory discussed in this book is inestimable, and the highest praise is due to the distinguished author for the faithful, accurate, and above all, systematic production of so great an amount of geographic, geologic, and other scientific material.

General Notes.

GEOLOGY AND PALEONTOLOGY.

On the Non-Actinopterygian Teleostomi.—Material is not at present accessible in the United States from which to learn the structure of the median fins in the Holoptychiidæ and Osteolepididæ. In drawing up my Synopsis of the Families of the Vertebrata, in 1889,[1] I assumed that these fins had the primitive structure, such as is found in the oldest members of the Teleostomi (Tarassiidæ), Dipnoi, and other subclasses, viz., that the axonosts are equal in number to, and continuous with, the neural spines of the Vertebrata. This definition threw the families in question into the Crossopterygia as distinguished from the Rhipidopterygia. In the latter the axonosts are much reduced in number, so that one or two fused into a single piece supports each dorsal and anal fin.

Prof. Traquair has, however, stated that the dorsal fins of the Osteolepididæ are of the Rhipidopterygian type, and Mr. A. Smith Woodward in the Volume II. of the Catalogue of Fossil Fishes in the British Museum[2] confirms this statement, and shows that the Holoptychiidæ agree with them in this respect. He does not adopt the superorder Rhipidopterygia, but combines it with the Crossopterygia; and he places the families mentioned, together with the Rhizodontidæ, which is my Tristichopteridæ, in the order to which I referred the latter, the Rhipidistia. As regards this ordinal reference, it is clearly necessary on the evidence brought forward by Traquair and by Woodward. I do not, however, see that the Rhipidopterygia can be properly combined with the Crossopterygia, since the structure of the median fins is radically different, and one which offers as good ground for superordinal distinction as do the paired fins offer ground for the separation of the Actinopterygia. The Tarassiidæ and the Polypteridæ possess the characters of the median fins which I viewed as characteristic of the Crossopterygia, while the paired fins, so far as can be discovered from the descriptions of the former,[3] indicate two distinct orders within it.

[1] AMERICAN NATURALIST, p. 856.

[2] *L. c.*, 1891, p. 321.

[3] Smith Woodward, *l. c.*, II., p. 317.

With this new information in our possession, it appears to me that the relations of these fishes is best expressed in the following way:

Subclass IV.—TELEOSTOMI.

There are four superorders of the Teleostomi or true fishes, which differ in the structure of the fins.

I. Median fins each with a single bone representing axonosts.
Paired fins unibasal; *Rhipidopterygia.*

II. Median fins with numerous axonosts.
Paired fins with baseosts; pectorals with separate axonosts; ? uni- or pluribasal; *Crossopterygia.*
Paired fins with baseosts; pectoral fins with axonosts and baseosts confounded; pluribasal; *Podopterygia.*
Pectoral fins only with baseosts, these confounded ? with an axonost, and pluribasal; *Actinopterygia.*

Rhipidopterygia.

The orders of Rhipidopterygia are the following. They all have actinotrichia in place of fin-rays:

I. Paired fins with the basilars arranged on each side of the median axis, or archipterygial.
Median fins with basilars; *Taxistia.*

II. Paired fins with the basilars arranged fan-shaped at the end of short axis.
Median fins with basilars; *Rhipidistia.*
Median fins without, caudal fins with, basilars; *Actinistia.*

The Taxistia includes but one family, the Holoptychiidæ, which is of Devonic age. The Rhipidistia includes the Tristichopteridæ, from the Devonic and Carbonic; the Osteolepidæ, from the same; and possibly the Onychodontidæ, which are Devonic.

The Actinistia includes the single family of the Cœlacanthidæ, which appears in the Lower Carbonic and ranges to the Upper Cretacic in both Europe and America.

The *Crossopterygia* includes two orders, as follows:
Dorsal baseosts and axonosts well developed; actinotrichia; no fin-rays; pectorals ? unibasal; *Haplistia.*
Dorsal baseosts rudimental; fin-rays; pectorals tribasal; *Cladistia.*

But one family is included in the Haplistia, the Tarassiidæ, from the Lower Carbonic of Scotland. The Cladistia are represented by a family which is not known in the fossil state, Polypteridæ, of the rivers of Africa. The vertebræ in this genus are ossified and biconcave.

The *Podopterygia* has also two orders. They are thus defined:

Branchiostegal rays present; *Lysopteri.*
No branchiostegal rays; *Chondrostei.*

In these orders the notochord is persistent, and there are either actinotrichia, or fin-rays which are more numerous than the baseosts. Tail heterocercal or diphycercal.

The location of the Lysopteri in the Podopterygia by Woodward is due to the discovery by Traquair of the characters of the pectoral and ventral fins. The order includes four families, which differ as follows:

I. Tail heterocercal.

Teeth acute, external; *Palæoniscidæ.*
Teeth obtuse, on palate and splenial; *Platysomidæ.*
No teeth; *Chondrosteidæ.*

II. Tail diphycercal.

Teeth present; scuta on body; *Belonorynchidæ.*

The Chondrostei include two families, the Accipenseridæ and the Polyodontidæ, both of which make their first appearance in the Eocene.—E. D. Cope.

Paleontology of Argentina.—A new journal devoted to natural history has just been established by M. Florentino Ameghino, at Buenos Ayres, under the title, *Revista Argentina de Historia Naturel.* In the *Bulletin Bibliographic* is given the titles of the memoirs in the first number. Among the notes will be found the following statements of especial interest to paleontologists:

Two scientific expeditions are now at work in Southern Patagonia. One, under the direction of M. Ramon Lista, governor of the territory of Santa Cruz, which has for its object the geography of the country, left the Island of Pavon November 5th, 1890, in order to explore the lakes of the Andes. The other exploration, which is exclusively geological, under the direction of M. Carlos Ameghino, had for its object the study of geology, and to collect fossil remains in that region. The notes received up to this time (February, 1891) warrant us in stating that the results of this expedition surpass all preceding ones.

Farther north, the oligocene formations in the vicinity of Parana were explored, during the year 1890, by MM. Scalabrini and Lêon Lelong, who collected an immense quantity of bones of fossil vertebrates belonging to a type entirely unknown up to this time. A second formation of the same epoch, equally rich in fossil remains, has been discovered at Arroyo del Espinillo, about fifteen miles from the city of Parana. Many of the species are new to science.

Finally, the Miocene sands which form the valleys between the spurs of the Acouquija (Tucuman and Catamarca) have furnished M. Manuel B. Zavaleta with remains of fossil mammals indicating a fauna almost entirely new, and which is badly represented in the formations of the same epoch hitherto explored.

These fossils will be described in the next number of the *Revista Argentina*, as well as the new type of Ungulates named by M. Ameghino *Notohippus toxodontoides.—Revue Scientifique.*

Water-Marks on Paleozoic Rocks.—In the *Quar. Jour. Geol. Soc.*, Nov., 1890, Sir Wm. Dawson has figured and described some peculiar markings of Paleozoic rocks. Bilobites, which have been regarded by Saporta, Delgado, and others as true algæ, are, so far as American examples are concerned, undoubtedly the tracks of a marine animal, probably crustacean. Scolithus, originally placed with fucoids, represents burrows of worms with castings at their entrances. Sabellarites is a name the author proposes for certain elongated tubes composed of grains of sand and calcareous organic fragments associated with carbonaceous flocculent matter, indicating a horny sheath. They are formed of the phosphatic dejections of animals subsisting on Lingulæ, Trilobites, Hyolithes, and other creatures having coverings of calcium-phosphate. Certain trunk-like forms in the Potsdam Sandstone are now shown to be concretions, the nucleus of which must have been a Chorda-like alga.

In many cases species of fossil plants have founded on rill-marks, notably the genera Dendrophycus, Delesserites, and Vexillum.

The Mutual Relations of Land-Elevation and Ice-Accumulation during the Quaternary Period are described by Professor Joseph LeConte as follows:

"It is generally agreed that the Quaternary was characterized by remarkable oscillations of land level, and corresponding oscillations of climate and of ice-accumulation. But the most opposite views are held regarding the time-relations of these two sets of phenomena. Some hold that the land-elevation was coincident with the cold and the ice-accumulation, and was at least one of its causes; and that the moderation of temperature and removal of the ice was coincident with the depression, and was its effect. Others take exactly the opposite view. I believe that the two extreme views may be reconciled, and all facts satisfactorily explained, by supposing (1) that the continental elevation which commenced in the Pliocene culminated in the early

Plistocene, and was at least one of the causes of the cold, and therefore of the ice-accumulation; (2) that the increasing load of ice was the main cause of subsidence below the present level; (3) that the removal of the ice-load by melting was the cause of the re-elevation to the present condition; but (4) that all these effects lagged far behind heir causes." (Bull. Geol. Soc. Am., Vol. II., pp. 223–330.)

Submarine Channels of the Pacific Coast. — In a recent paper in the Bull. Geol. Soc. Am., Prof. Joseph LeConte discusses the submarine channels off the Pacific coast. The researches of Professor Davidson have brought to light twenty or more submarine channels on the coast from Cape Mendocino to San Diego. The distinctive feature of these, as contrasted with those on the eastern shore, is that they have no obvious relation to existing rivers. They are not a submarine continuation of any system of river valleys on the adjacent land. On the contrary, they run in close to shore, and abut against a bold coast, with mountains rising in some cases 3,000 feet within three to five miles of the shore-line, and wholly unbroken by any large river valleys. Mr. LeConte thinks it is impossible to account for this except by orogenic changes which diverted the lower courses, and places of emptying of the rivers, since the channels were made. He dates these changes about the end of the Pliocene or beginning of the Plistocene; they were probably coincident with the lava-flows and consequent displacement of the rivers, which took place at that time in the Sierra region.

Geological News.—Walter Harvey Weed has been working up the geology of the Cinnabar and Bozeman coal fields of Montana. He believes that facts warrant him in stating that these Coal Measures are of Laramie age. They are conformably overlain by volcanic material containing an abundant fossil flora of recognized Laramie types, in turn overlain by beds of fresh-water clays and sandstones of undetermined age, but which belong to what has heretofore been considered as undoubtedly Laramie strata. (Bull. Geol. Soc. Am., Vol. II., pp. 349–364.)——According to E. T. Newton, the rodents now known to occur in the brick-earth of the Thames valley are: *Castor fiber* Linn., *Spermophilus erythrogenoides* Falc., *Microtus* (*Arvicola*) *amphibius*, Linn., *Microtus* (*Arvicola*) *ratticeps* Key. and Bl., *Myodes torquatus* Desm., and *M. lemmus* Linn. (*Geol. Mag.*, Vol. VII., Dec., 1890.) ——According to Mr. Robert Bell, ore bodies of the nickel and copper deposits in the Sudbury (Canada) district do not appear to have been accumulated like ordinary metalliferous veins from mineral matter in aqueous solution, but to have resulted from igneous fusion. The fact that they are always associated with diorite, which has been left in its present positions in a molten state, points in this direction. (Bull. Geol. Soc. Am., Vol. II., pp. 125–140.)——According to R. Etheridge, Jr., there have been no geologic traces of man discovered in Australia up to the present time. The meagre details in the finds recorded render their evidence untrustworthy. (Proc. Linnean Soc. New South Wales, Vol. V., pp. 259–268.)——Professor von Ettingshausen, the eminent Austrian paleobotanist, has published a memoir on the fossil plants of New Zealand. This work is now being reproduced in English, and will be published with a large amount of additional information upon the same subject. (Rept. Col. Mus. and Geol. Surv. New Zealand, No. 20.)——The annual appropriation for the Geological Survey of Texas, made by the Legislature just adjourned, is $35,000, exclusive of printing. Appropriations were also made for testing the lignites, for the publication of an accurate map of the state, and for the erection of a laboratory building at the University of Texas, which will contain a suite of rooms for the chemical department of the survey.

BOTANY.

North American Diatoms.[1]—Seven years ago the botanists of this country were presented by Mr. Wolle with a handy book on Desmids, and three years later they found themselves again indebted to the industrious author for an equally useful work on the fresh-water Algæ of the United States, exclusive of the Desmids (treated in the previous work) and the Diatomaceæ. We have now the pleasure of noticing a volume on the Diatoms of North America, in which the author completes his series of works on the Algæ.

The plan of the work resembles that of Schmidt's "Atlas der Diatomaceen Kunde," in which figures serve in place of specific descriptions. Any one who has worked with these tiny plants knows full well that a good figure is of much more use in the determination of species than a great deal of descriptive text. The text is useful,

[1] Diatomaceæ of North America. Illustrated with twenty-three hundred figures from the author's drawings on one hundred and twelve plates. By the Rev. Francis Wolle, author of "Desmids of the United States," "Fresh-Water Algæ of the United States." Bethlehem, Pa., The Comenius Press, 1890.

but the figures are much more so. Accordingly, our author has given us an abundance of figures, to represent our fourteen hundred species. He has also greatly simplified the work of comparison by having all the figures drawn to the same scale. By a little patience and practice the student of Diatoms may easily identify any species he may happen to find.

The book contains in addition to the plates a short preface, in which a brief historical account is given of the study of Diatomaceæ in this country; following this is a bibliography, including forty-seven citations; next follows a short "Introduction" of five pages, devoted to a summary account of habits, structure, etc.; after which comes Prof. H. L. Smith's "Conspectus of the Families and Genera," as published in *The Lens*, in 1872. Last of all in the text is an alphabetical arrangement of genera and the American species under them (also arranged alphabetically), with references to the plates in which they are illlustrated.

The work will at once become a necessity to every botanist who gives any attention to these interesting plants. The low price of the book ($6.00) is another feature which will commend it to all.—CHARLES E. BESSEY.

The "Field Edition" of Gray's Manual.—This new book weighs fourteen ounces, and measures seven and three-eighths by four and five-eighths inches, and is but seven-eighths of an inch in thickness. The old book weighs more than two pounds, is an inch longer and wider, is is twice as thick, and more than two-and-a-half times the bulk of the new one. With exactly the same type, and actually four more printed pages, the little book is admirably suited to the botanist's needs. Its leather cover and strong binding give it much greater durability than the old one, while its small size enables the collector to slip it easily into his pocket. Now that such an edition has appeared, we wonder that publishers did not venture to bring it out sooner.—A. F. WOODS.

The Flora of the High Nebraska Plains.—The 20th of August, 1890, I set out for Western Nebraska, where I spent a month in collecting on the plains above 4,000 feet altitude above sea-level. Waiting for the train at Julesburg, Col., I could not withstand the temptation to take a walk on the bottomland of Lodge Pole Creek. The flora was far from rich. The grass here, as well as nearly everywhere in Deuel, Banner, and Cheyenne counties, Neb., was very short, and, on account of the long drought, dried up. The whole valley reminded me of a pasture in the month of November. A list of a few of the plants I saw I give from memory: *Cnicus ochrocentrus, Liatris punctata, Cleome integrifolia, Cleomella angustifolia, Gaura parviflora, G. coccinea, Lygodesmia juncea, Eriogonum annuum, Psoralea tenuiflora.*

I spent about two weeks on the high table-lands of Deuel county, seven to ten miles northeast of Chappel. Here the principal grasses are the buffalo grass (*Buchloë dactyloides*) and the grama (*Bouteloua oligostachya*). Both, even when dry, make an excellent pasturage for cattle. The animals graze on them throughout the winter, if the snow is not too deep.

At first I strolled over the prairies and hills, but found very little of interest in the way of plants. Everything was dried up. Three kinds of cactus, viz., *Mammilaria vivipara, Opuntia missouriensis,* and *O. fragilis;* two thistles, *Cnicus undulatus* and *C. ochrocentrus, Yucca angustifolia, Erysimum asperum,* and *Astragalus sericoleucus,* were the most remarkable.

My trip had been a failure had I not found another field for botanizing, viz., the "sand-draws." Sand-draw is a word that I have not seen in any book, and still it is a word in common use among the settlers of Western Nebraska. The sand-draw is about the same as the "wady" of Arabia. It is a stream in which the water, as a rule, is never seen. The sand-draw looks like a dried-up stream with sandy or gravelly bottom. The sand is five to ten, or even up to fifteen or twenty feet deep. In this sand the water is running, perhaps the year round. In one of the smaller I saw a well dug, about fifteen feet deep, that contained water in the month of August.

In the sand-draws I found many plants which for their beauty are well worthy of cultivation. Among others I may mention the pink-purple *Ipomœa leptophylla* (also remarkable for its immense root, weighing sometimes as much as 100 pounds); the white prickly poppy, *Argemone platyceras;* the yellow *Menezelia nuda;* the white or pink *Œnothera albicaulis; Lupinus argenteus* var. *procumbens; Polanisia trachysperma; Cleome integrifolia; Chrysopsis villosa; Asclepias speciosa; Croton texensis; Eriogonum annuum* and *E. corymbosum,* etc. Also of interest is the little sand cherry (*Prunus pumila*), a low shrub with creeping branches and big, juicy, edible berries. Among the rarer plants I found were *Pectis angustifolia, Acerates auriculata, Petalostemon tenuifolium,* and another near to *P. gracile.*

I also took a day's ride out to a cañon near North Platte River. The additions to my collection made during the trip contained, among others: *Psoralea linearifolia, Eriogonum alatum, E. flavum, Ribes aureum, R. cereum, Dalea aurea, D. laxiflora,* and *Prunus demissa.*—P. A. Rydberg, *Lincoln, Neb.*

ZOOLOGY.

Plathelminthes.—Dr. Braun in Bronn's "Klassen und Ordnungen des Thier-Reichs," Bd. IV., catalogues the known species of ectoparasitic Trematodes. The following species are enumerated from North America: These are *Tristomum maculatum* from Diodon sp.; ? *Plectanocotyle elliptica* from *Labrax mucronatus; Polystomum coronatum* from *Cistudo carolina; Pol. oblongum* from *Dromochelys odoratus;* and *Sphyranura osleri* from *Necturus lateralis.* As soon as our species are systematically studied this list will be greatly increased.

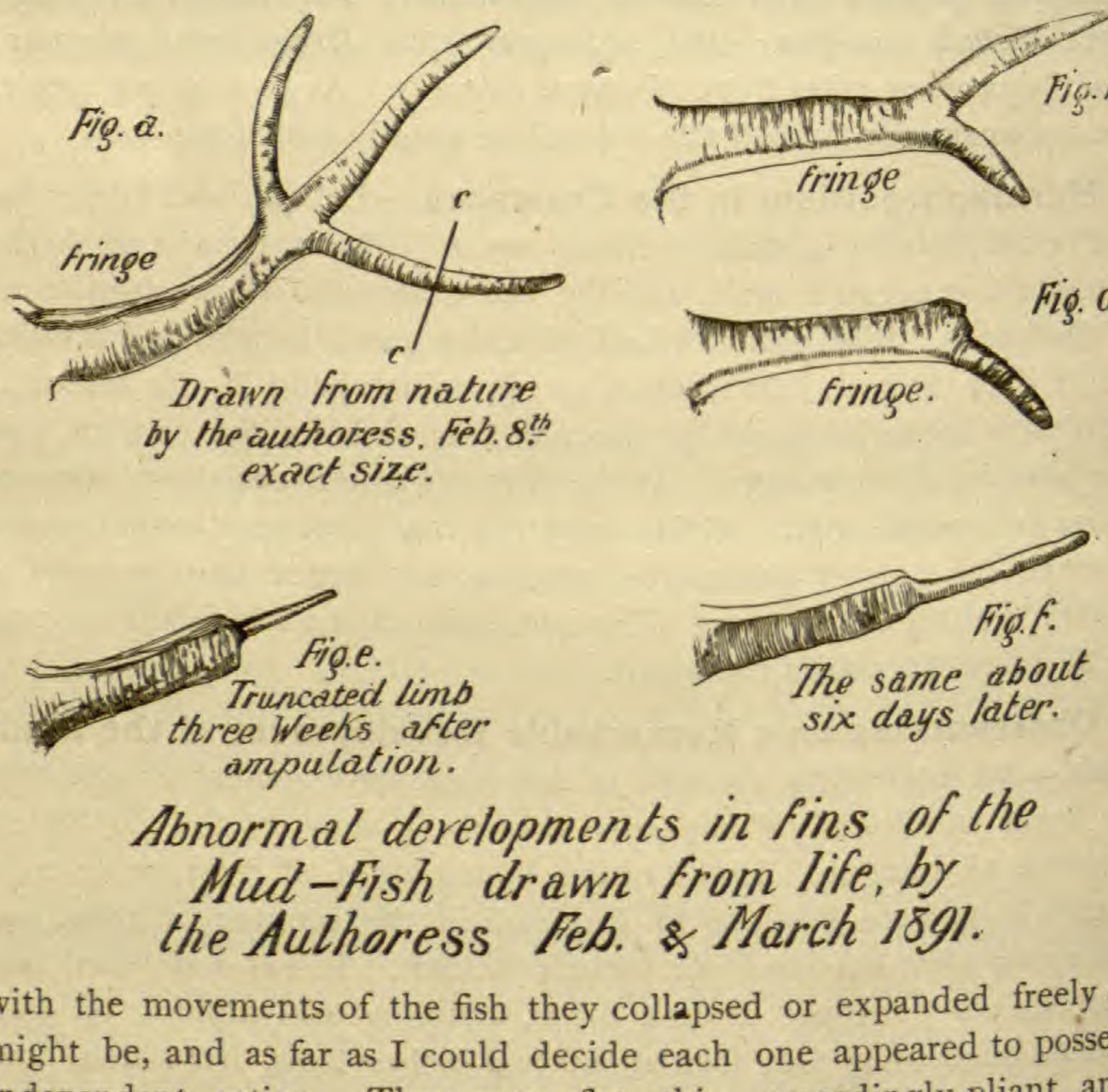
Hermaphroditism in the Crustacea.—Dr. Ishikawa[1] describes the hermaphrodite glands in *Gebia major.* The anterior part of the reproductive organ is male, and the vasa deferentia are much as usual in Decapods. The posterior half of the organ is female, and is much larger than the rest. In sections the germinal band in the testicular portion is seen giving rise to spermatozoa, while in the ovarian part the same band forms eggs. At the point of junction eggs and spermatozoa are commingled. Grobben thinks that these eggs cannot escape through the narrow generative opening, and hence must atrophy at certain seasons of the year. This hermaphroditism was found to occur in all of twenty males examined.

Observations on a Remarkable Development in the Mudfish.—An interesting example of abnormal development may be seen in some mudfishes (*Protopterus annectens*), now in the Zoological Gardens of London. Eight rather young ones, of from six to eight inches long, were brought to England in the summer of 1889, and have ever since occupied one capacious tank. It was soon seen that they viciously snapped at each other, maiming and nipping off each other's filamentary fins, then about two inches long, but which, however, soon grew again. By degrees, and particularly within the last six months, I observed that, in consequence of frequent mutilation, the fins did not attain their normal length, but were stouter and flatter, less and less filiform, and with a more distinct fringe, as if nature were compensating in breadth what was lacking in length. The fish, being now much grown, snap at each other with greater force. The biggest is nearly two feet long.

During our unusually severe winter my observations were suspended, and I was therefore greatly surprised in February to find that one of

[1] *Zool. Anz.*, XIV., 70, 1891.

the mudfishes had meanwhile developed a trifid member (the left pectoral fin) like the accompanying sketch (Fig. *a*). The keeper informed me that some weeks previously that fin had been bitten, but not quite severed, about midway, leaving a jagged wound with terminal portion pendant. It had now not only healed, leaving no trace of the wound, but the nearly severed portion had become firm and solid, forming one direct, tapering line from the body. The two lateral segments were, when quiescent, at right angles with the middle fin (or branch?); but



Abnormal developments in fins of the Mud-Fish drawn from life, by the Authoress Feb. & March 1891.

with the movements of the fish they collapsed or expanded freely as might be, and as far as I could decide each one appeared to possess independent action. They were flat, thin, exceedingly pliant and membranous, especially towards the edges; and when the fish was detained in a net out of the water, and I attempted to examine the limb more closely, it was flapped about vigorously, or it clung to the net, and to handle it would have invited a vicious and forcible bite. The segments somewhat resembled the tail of a tadpole.

Another of the mudfishes had grown a bifid fin (Fig. *b*), though one cannot affirm positively that a portion had not been nipped off before it was observed, for three days afterwards it was already partially gone (Fig. *d*), and the trifid fin had also been bitten, as at the lines *c c*. Concluding that these singular developments were worthy the attention of our scientific authorities, I lost no time in sending a description of them to Dr. Günther and Mr. Boulenger, even venturing to suggest that before they were eaten off by degrees a snip of the professional scissors might preserve the specimen for the museum. Mr. Boulenger, in consequence, secured the trifid limb, and in due time the result of his investigations will appear in the Zoological Society's "Proceedings." I observe, too, that the long, vertical fin and also the tail, when bitten, now no longer regain their normal form as they did at first, but remain indented with broad, rounded lobes, and with an indurated edge, like a cord. The whole development strikes one as an example of rapid evolution ; as if Protopterus, after many fruitless attempts to restore its slender limbs, had "improved" upon them, growing them stouter and stronger to assist it in swimming, compensating in bulk what it could not acquire in length. But this is mere imagination on my part. I must leave to science to account for the anomaly.

The amputated limb healed entirely, with the angles rounded off, in in three days. Within three weeks a point (Fig. *e*) grew out from the truncated limb, but not in the center. In a few days more the point was nearly three-fourths of an inch long and more in the center (Fig. *f*). It will be closely watched.—CATHERINE C. HOPLEY.

The Lower Jaw of Sphenodon.—It seems to me that there has never been given a correct description of the lower jaw of Sphenodon. Günther[2] writes in 1867, in his "Anatomy of Hatteria": "A part of the sutures between the bones of which the lower jaw of lizards is generally composed have entirely disappeared (if they ever existed), so that the following bones only can be distinguished. The dentary (*u*) forms nearly entirely the outer surface of the mandible, a comparatively small articular portion, and the top of the coronoid process excepted. There is a very distinct foramen between the dentary and articular, penetrating to the inner surface of the mandible. The splenial (*v*) is narrow elongate, behind twisted downwards to the lower side of the mandible and terminating about three millims. from its extremity. The coronoid (*x*) is triangular, covering with one angle the cartilage of Meckel, and forming with another the coronoid process. The articular bone (*w*) is very peculiar ; if an angular bone was present at an early age it has now entirely coalesced with the splenial, there being scarcely any osseous projection behind the articulary surface. The articular surface itself does not correspond in form with

[2] Philos. Trans., 1867, pp. 600, 601, Pl. XXVI., Figs. 6, 7.

the condyle of the quadrate bone, being much elongate in the direction of the longitudinal axis of the body, and, in fact, nearly four times as long as the opposite articular surface."

Exactly the same description is given by Brühl :[3] "Der Hatteria Unterkiefer setzen wirklich in jeder Hälfte nur vier elemente züsammen: 1. dentale, d.; 2. articulare, ar.; 3. coronoideum, cor.; mit einen mässigen processus coron.; und 4. marginale, marg. (mihi = angulare autor. = spleniale Owen, Günther); die sonst bei Echsen meist vorkommenden Mehrstücke; 5. ecto-complementare, ec. cp. (mihi = supra angulare autor.) und 6. endocomplementare, en. cp., auch operculare, op., *fehlen* bei Hatteria *spurlos.*"

In a lower jaw of Sphenodon (length of each ramus 56 mm.) I find all the six elements of the Reptilian lower jaw represented. The whole arrangement, however, is only comparable with that seen in the Testudinata and not with that of the Squamata.

The dentary, coronoid, and angular (splenial Günther, marginal Brühl) are described correctly by both Günther and Brühl. The remaining portion of each ramus is considered as articular. In the specimen before me this portion plainly consists of three elements,—an articular, splenial, and supraangular.

The articular is a small element, only visible from above and very little from behind. It is surrounded by the splenial on the inner and the supraangular on the outer side; it is very much like the corresponding element in the Testudinata. The supraangular is that portion of Günther's and Brühl's articular which is seen on the outside and inside. It is connected with the articular, the splenial, the angular, the dentary, and the coronoid. Between this element and the coronoid the foramen is placed. The splenial is the inner portion of Günther's and Brühl's articular. It is connected with the articular, supraangular, angular, and coronoid. We have therefore a condition which is typically that of the Testudinata. In all the Testudinata, however, the angular separates the splenial and supraangular behind; in Sphenodon the splenial and supraangular meet at the posterior lower end of the jaw.

The structure of the lower jaw in Sphenodon gives another support to the opinion of the affinity between Rhynchocephalia and Testudinata.—G. BAUR, *Clark University, Worcester, Mass., April 8th, 1891.*

On the Development of the Male Copulatory Organs in Snakes.—Although the adult anatomy of the male copulatory organs in snakes has been carefully worked out by Neumann[4] and others, very

[3] Brühl. Reptilienkopf. Wien, 1886, Tafel p. CXLVIII., Figs. 12, 13, 17, 18, 19, 20.

[4] Begattungsapparat der Schlangen. Leipzig, 1884.

little seems to be known of their development. Rathke[5] is, so far as I know, the only one who has studied it; his account deals merely with superficial appearances, and is therefore very incomplete.

I have been able to make out a few points in the early history of these organs from specimens collected in July, 1890, at the Marine Biological Laboratory, at Cold Spring Harbor, Long Island. My specimens were mostly embryos of the black snake (*Bascanium constrictor*), of from the second to the ninth week of embryonic life, together with a few garter snake (*Eutænia sirtalis*) embryos, taken at a considerably later stage in their development.

First, a word on the general anatomy of these organs. The male copulatory organ in snakes, as in lizards, is made up of two distinct parts. Each part is in the form of a long, hollow sack, more or less irregular in outline, and in some species bifurcated at the end. A thick layer of connective tissue, containing numerous cavities in its outer portion, forms the greater part of the walls of this sack. These cavities are connected by a branch with the dorsal artery, and it is by a flow of blood into them that erection of the penis is accomplished.

Outside of this connective tissue is the epithelium, a continuation of that covering the rest of the body. This epithelium consists of two layers. The inner, called by Neumann the "stratum mucosum," is made up of large, columnar cells arranged side by side, and containing prominent nuclei; the outer is a layer of very much flattened cells with deeply staining nuclei, joined by their edges to form a thin covering to the whole.

On the inner side of each penis, running obliquely from base to tip, is the *semen canal*. This is a deep depression, approximately anchor-shaped in cross section. During copulation the two parts of the penis are brought together in such a way as to make of these two canals one long tube, which then serves to conduct the semen into the oviduct of the female.

Closely set all over the surface of the penis are numerous cartilaginous teeth-like bodies, which arise in the connective tissue, and project out through the epithelium. Their exact function is not known, though they have been regarded as "wollustorgane," or contrivances for stimulating the sexual organs. It is possible that they may serve to hold the sexes more firmly together during the act of copulation.

These penes arise as external appendages. At the close of embryonic life, however, they are drawn back into two pouches, one on either side of the body just behind the cloaca. This action is effected

[5] Entwicklung. der Natter. Königsberg, 1839.

by a long muscle, the ***retractor penis***, which runs from the point of the penis through its interior back for a considerable distance in the tail; there it is attached to one of the caudal vertebræ. The action of this muscle is such as to turn the penis inside out,—as the finger of a glove could be turned,—back into its place under the skin. At times of copulation the organs are everted, chiefly by an influx of blood into their erectile tissue.

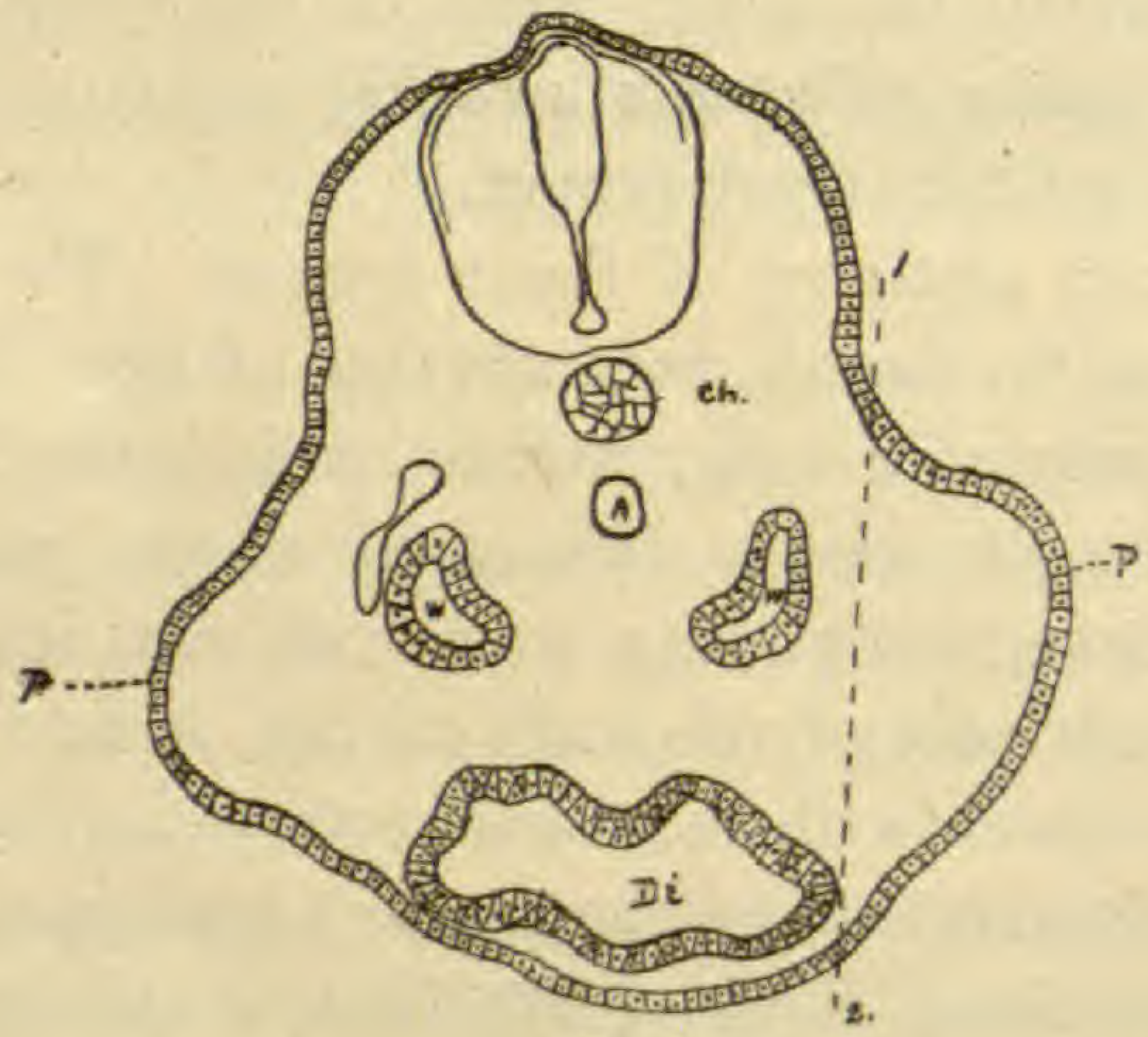


Fig. I.

Fig. II

The copulatory organs first appear in embryos of about the sixth week. At this stage most of the important organs of the body are formed; the body has completely closed in, except at the umbilicus, the food-yolk not being entirely consumed until a much later period. The wolffian ducts open into the cloaca, but the ureters have not yet grown so far back.

The first appearance of the penes takes the form of two ridges, one on either side of the body, and extending from a point a little ahead of the cloaca to about opposite its posterior end. In sections across the body at this stage (Fig. 1, *p*) these ridges can be seen as bulgings of the body-wall. These bulgings are filled (Fig. 2) with an undifferentiated mass of mesoderm cells, similar to and continuous with those composing the body proper. The whole is covered with the characteristic double-layered epithelium.

The further growth of the penes from these ridges reminds one strongly of the manner of formation of the posterior appendages in the chick, from the end of the wolffian ridge. The extreme posterior end of each ridge swells out, forming a rounded prominence, the "nipple-shaped swellings" of Rathke. The remaining portions of each ridge grow no further, and finally disappear. In embryos of a week later no trace of them is to be found.

These swellings, however, continue to enlarge, and form the penis proper. They grow very rapidly in length, and attain their full size in about three weeks. They are then equal in length to three-quarters the vertical diameter of the body.

Simultaneously with the growth of these swellings a differentiation of the mesoderm cells in their interior begins. The cells near the exterior gradually lose their round form, become more and more angular, their ends prolonged more and more into slender processes,

Fig. III.

Fig. IV

until, in my latest sections of the black snake, they can be seen to be well on their way toward the formation of connective tissue. Among these cells clear spaces with a regular outline appear (Fig. 4, *n*). These are lined with a layer of flat cells, similar to those Neumann describes as lining the blood cavities in the adult penis. They are the beginnings of the blood spaces, which, with their connective tissue walls, compose the erectile tissue in the adult.

While this change into connective and erectile tissue is going on among the outer mesoderm cells, those on the interior undergo a differentation which leads to the formation of the *retractor penis*. In embryos of about the seventh week the first rudiments of this muscle may be seen as a thickening or crowding together of the mesoderm cells in the middle of each organ (Fig. 3, *r*). These cells elongate, become nearly elliptical in form, and arrange themselves in rows, thus giving rise to the muscle fibres.

In the adult penis there are two sets of these fibres, a large, inner, longitudinal band, with an incomplete circular band surrounding it.

The separation into two sets of fibres can be readily seen in the manner of grouping of the mesoderm cells. The exact manner in which muscle fibres arose from mesoderm cells, I was, however, unable to determine from my specimens.

Neither semen canal nor cartilaginous "teeth" had been found in the latest of my black-snake embryos, but both were present in the garter snakes. From this I infer that they arise at about the same time, and at about the same stage in the development of the organs. The semen canal is lined with large cells, continuous with those of the stratum mucosum, and is undoubtedly formed by an invagination of the epidermis. The "teeth" are modifications of the connective tissue walls, as Neumann has shown, but the exact manner of this change I could not determine.

Lying behind the cloaca in the adult snake are two cone-shaped glands, with ducts opening to the exterior just behind the cloacal opening. These are the "*anal sacs,*" and secrete a stickly fluid, with a highly unpleasant odor. Rathke thinks this odorous fluid enables the sexes to find one another during the breeding season.

These glands occupy, in the female, a corresponding position to that of the drawn-in penis in the male. Hoffmann[6] quotes Retzius to the effect that they occur only in the female, and are homologous with the male penis. Neumann finds them, though much aborted, in the adult male. In embryos I find them present, and of equal size in both sexes. They cannot, therefore, be considered homologues of the penis. Their ducts open to the exterior in the male,—not, as Rathke states, on the *inner* side of each penis, but on the *outer* side. In the female they open in corresponding positions.

These glands first appear in the embryos of the seventh week. Rathke's statement that they arise as invaginations of the posterior wall of the cloaca does not agree with my observations. In my specimens they were formed by an invagination of the *outer* wall of the body just above the penis (Figs. 3, 4, *s*). The gland is formed, as Rathke states, by a continued growth inward of this invagination. Both layers of the epidermis are carried in with it, and enter into the composition of the sac. In the "grosszelligen Plattenepithel," which forms its outer coating, Neumann recognizes a transformed stratum mucosum, now exercising a glandular function; in a thin layer covering its inner surface he finds the remnants of the original stratum corneum.—AARON L. TREADWELL, *Biological Laboratory of Wesleyan University, Feb. 6th, 1891.*

[6] Bronn's Thier Reichs, p. 1557.

EXPLANATION OF FIGURES.

FIGS. 1 and 2 are drawn to the same scale. Figs. 2 and 3 are drawn to a scale a little larger than 1 and 4.

FIG. 1.—Section through body of embryo of black snake, in front of the cloaca.

FIG. 2.—Portion of Fig. 1, to right of line 1–2, drawn to larger scale.

FIG. 3.—Right penis of black-snake embryo, two weeks older than Fig. 1. Section passes through body just behind the cloaca.

FIG. 4.—Section of left penis of black-snake embryo, one week older than Fig. 3. Section taken just behind cloaca.

P, ridge which marks first appearance of penis; *ch*, notochord; *a*, dorsal artery; *w*, wolffian duct; *d*, alimentary canal; *m*, mesoderm; *d*, stratum mucosum; *c*, stratum corneum (not figured in 1 and 2); *r*, retractor muscle; *s*, beginning of anal sac; *n*, blood spaces forming in the mesoderm; *l*, edge of posterior wall of cloaca.

The Quadrate Bone.—R. Broom thinks[7] that all previous morphologists have been in error in trying to recognize the quadrate among the bones of the middle ear of mammals. He thinks it forms the articular cartilage.

"Some of the Causes and Results of Polygamy Among the Pinnipedia."—In the February number of the AMERICAN NATURALIST (Vol. XXV., pp. 103–112), Mr. C. C. Nutting has published some interesting notes on sexual disparity among polygamous seals, and deductions from the observations recorded. Mr. Nutting, however, was not the first to draw attention to such facts and the principles involved. Over twenty years ago (January, 1871) the subject was noticed, and the resulting conditions tersely formulated in the AMERICAN NATURALIST (Vol. IV.). In a review of Mr. Allen's then recent memoir on the eared seals I published the following paragraph immediately after one on the genetic relationships of the families of Pinnipeds:

"In this connection it may be recalled that while in the monogamous Pinnipeds, or those living in small communities, there is little difference in size between the males, in the social species, or rather those of which the males have harems, the males are vastly larger than the females. Macrorhinus, of the Phocids, and all the Otariids belong to the latter category. The difference between the sexes would be readily explained by Mr. Darwin on the principle of natural selection. It is evident that the larger and more vigorous males would be the eventual possessors of the females, and the disproportion of the sexes

[7] *Ann. and Mag. Nat. Hist.*, VI., 409, 1890.

would in lapse of time culminate, till it had reached a proportion when obvious mechanical difficulties would more than balance the advantages resulting from superior size and vigor, and when, therefore, farther disproportion would be arrested. It may be added that the like disproportion of the sexes in the forms above enumerated furnishes not the slightest evidence of more intimate primordial affinity, for like causes would in each special case, such as this, produce like effects."—THEODORE GILL.

Errata of article on Chromatophores in fish embryos in February NATURALIST: Page 113, 9 lines from bottom, read oviparous for viviparous; page 114, 15 lines from top, read periblast for epiblast; page 116, 16 and 29 lines from top, read periblast for epiblast; page 117, 25 lines from top, read periblast for parablast; page 118, 2 lines from bottom, read *Hemirhamphus* for *Hemisbamphus*.—C. H. EIGENMANN.

EMBRYOLOGY.[1]

The Later Larval Development of Amphioxus.[2]—Mr. Arthur Willey has published a most interesting account of the later stages of the larval Amphioxus. It is a continuation of a preceding paper by Professor Lankester and himself on the younger larva. In the first paper the larva, with its large mouth on the left side and the single row of gill-slits on the right, was described; also the structure and position of the club-shaped gland and the endostyle were given, and the origin of the atrial folds. In the present account the author begins with a larva having fourteen primary gill-slits arrayed in a single row, and all on the right wall of the pharynx. Above these and on the same side is to be seen a thickened rod of endodermal tissue with six swellings. These later break through to form six secondary gill-slits, second to seventh inclusive. The atrium is still open in front. The posterior primary gill-slits now begin seriatim to close and atrophy, beginning with the fourteenth and continuing until but eight remain. At the same time this primary row of gill-slits begins to move around the ventral surface to the opposite side of the larva (the left), where they assume their adult position. Meanwhile the secondary gill-slits increase in number and size, and occupy the right side of the

[1] Edited by Dr. T. H. Morgan, Johns Hopkins University, Baltimore, Md.

[2] *Quart. Jour. Micro. Sci.*, March, 1891.

embryo. A single anterior (to the six) slit appears, and others are also added behind the first-formed slits, ultimately the number of eight secondary gill-slits being formed. There is then a pause for a time in the formation of slits, and much later the tertiary slits appear behind on each side, and the number goes on increaeing during life.

While these changes have been taking place in the gill region other important organs have been modified. The mouth has moved from its left lateral position to the mid-ventral line, and the oral hood with its buccal cirri has appeared. The V-shaped endostyle, at first high up on the right wall of the pharynx, moves as the primary gills move, from right to left, as far as the middle line, and at the same time the arms of the V become parallel, and the apex grows backwards between the gill-slits. The club-shaped gland, which communicates both with the cavity of the pharynx and the outer world, atrophies, and at the same time also the first primary slit. For this or other reasons the author believes the club-shaped gland to be a modified gill-slit,—the first of the secondary ones.

In the theoretical part of the paper the asymmetry of the larva, the change of position of the endostyle, and the homologies of the club-shaped gland, are discussed. Interesting as this excursion is, it cannot be given here at all fully. It is assumed that the ancestral Amphioxus had a mouth opening in the mid-dorsal line, and that the growth forward of the notochord caused this to shift to the left side. At the same time the whole pharynx became twisted to the right, corresponding to the movement of the mouth, so that the proper gill-slits of the left side were carried around to the right side. Consequently when these (the primary) appeared the gill-slits belonging to that side (right and secondary) were for a time retarded in development; hence the asymmetry of the larva.

Several sections deal with the homologies between the Ascidian tadpole larva and Amphioxus, and the startling conclusion is reached that the intestine of the Ascidian is not homologous with the intestine of Amphioxus, but is to be compared to the club-shaped gland, and therefore represents the modified first right (secondary) gill-slit of Amphioxus.

Development of the Pancreas in Batrachia.—The origin of the pancreas in both Urodeles and Anurans has been studied anew by Göppert.[3] In the embryos of both groups the pancreas arises by three evaginations from the intestine. One of these is from the dorsal surface; the other two from the sides, right and left. The

[3] *Morph. Jahrbuch*, XVII. Band, 1st Heft, 1891.

cells of these evaginations fold in and form the tissues of the pancreas. The three portions separated at first subsequently fuse into a single organ. The three openings into the gut, however, undergo several changes. In the adult Urodeles there is a forward opening for the pancreatic gland into the intestine near to the pylorus. This comes from the dorsal evagination of the embryo. There are in the adult Urodeles two or more other openings behind this, some of which fuse with the duct from the liver (ductus choledochus). The posterior openings result from various combinations of the two ventral (right and left) evaginations. In the Anuran the adult has no anterior opening of the pancreas near the pylorus. In the embryo, however, there is one (the dorsal), as in the Urodeles, but it is subsequently lost. The two ventral (or side) evaginations unite with one another and form a single opening, which subsequently fuses with that of the ductus choleodochus, as in the adult.

Embryology of Glires.—M. Duval has published another of his series of papers on the development of rodents, entitled, "Le Placenta des Rougeurs." [4] The young stages of the mouse are described. Sections through the whole gravid uterus were made in most cases. The earliest stage described had a single layer of ectoderm cells surrounding a central cavity. Underneath one portion of this layer were a very few large granular amœboid-like cells, which subsequently spread out beneath the ectoderm to form the endodermal lining of the vesicle. Above this portion in later stages the ectoderm thickens greatly, resulting in a solid plug in which a cavity subsequently appears to form the cavity of the amnion and the ectoplacenta. The relation subsisting between this ectoplacenta and the allantois on the one side and the uterine walls on the other form the substance of the latter part of the paper. The problem of the inversion of the layers in the mouse and rat were discussed in a preceding paper (see abstract in AMERICAN NATURALIST for April, 1891).

[4] *Journal de l'Anatomie et Physiologie*, Jan.-Feb., 1891.

ARCHEOLOGY AND ETHNOLOGY.[1]

The International Congress of Anthropology and Prehistoric Archeology of Paris, 1889.—(*Continued from page 395.*)

II.—*Second Question:* "The Periodicity of Glacial Phenomena."

Mr. Geikie's paper had been real earlier in the session.

Marquis de Saporta opposed the theories of Mr. Geikie. He saw no evidence in the fossil flora of a periodic return of the cold climate. The periodicity of this phenomona, according to his idea, only showed the oscillations. "There is," he said, "in all this a mass of concordant facts which we are at this time far from being able to understand or analyze." He doubted whether the learning of the geologists had served to elucidate the question in any degree.

Le Docteur Garrigou presented a memoir by which he sought to establish the multiplicity of glacial movements in the Pyrenees.

Monsieur Marcellin Boule said it was necessary that the savants of all countries should make study of this question, and bring closer together and face to face the accurate evidence of detailed facts which were necessary to solve the problem. In his opinion the Glacial epoch had commenced at least as early as the Pliocene; that it was not localized, nor did it belong to the end of the Plistocene. The glaciers had successively covered and abandoned, and again recovered, vast regions, and instead of being continuous were periodic. The question could be solved only in a general fashion, but he desired to put on record his opinion that the question of the glaciers, the cutting and filling of the valleys, and the formation of the caverns all belong together, were but one, must stand or fall together, and any studies made of the one which neglects the other will only be partial, and therefore may be erroneous. His (Boule's) conclusions regarding the caverns were as follows: 1. That the most ancient deposits are the alluvials of the water which had eroded and made the valleys, and that the antiquity of these deposits was in direct relation to the altitude of the cavern above the valley. 2. That the deposits of the rivers, poor in fossils, are nearly always cut up, carried down, and replaced by new deposits coming from later erosions. 3. That the fossils found in this newer deposit belong to the late Plistocene; those from the earlier Plistocene are rarely found in it; and such as are found are, by reason of the erosion and redepositing, difficult to determine.

[1] Edited by Dr. Thomas Wilson, Smithsonian Institution, Washington, D. C.

Monsieur Gabriel de Mortillet spoke of the glacial phenomena as being divided into two groups: the one at the far north, and the other in the Alps, Pyrenees, etc., in the south. The Alps and glacial phenomena could have been produced by only one cause, that of the increased cold, and this cause would at the same time produce an extension of the glaciers of the north. He might admit the fluctuations, oscillation, retreat and advance, appearance and disappearance of the glaciers, but this was far from admitting a plurality of glacial periods, and was contrary to this idea.

M. Marcellin Boule took up the question and gave a detailed description of European glaciers. After late investigations the epochs of the glaciers of the north and of the Alps could not be separated, and geologists were not in accord in opposing the ancient hypothesis of the Plistocene sea of floating ice. The grand glacier coming down and through Scandinavia had attained to Erzgebirge, where it had deposited erratic blocks *geschicbelehm.* This was followed by a retreat corresponding to the melting and opening of the North and Baltic Seas, during which time was deposited the interglacial alluvium, with a fauna of a warm country. Alluvium deposits of this epoch were so extensive that they measured in Brandenburg alone a surface of 200,000 square miles, German. In the Alps the deposits of interglacial plant at Innsbruck are found at 1,000 metres of altitude, at the very top of the chain of mountains. As for paleontology, M. Boule declared that the stratigraphic facts must dominate, though he doubted the pretended facts of stratigraphy as given by some of the investigators, though he was far from saying that the fauna and flora of the Upper Pliocene, the Plistocene, affected detrimentally or were in opposition to the facts found by stratigraphy. MM. Bleicher and Fliche have just described to the Geologic Society of France a deposit in the northeast of France, in the plants and mollusks demonstrating the alternating epochs of cold and heat.

Third Question: "Art and Industry during the Paleolithic Period —in the Caverns."

Judge Piette, of Angers, who probably headed the list of cavern investigators in France, had displayed at the great exposition his magnificent and extensive collection, principal among which were his late finds in the cavern of Mas d'Azil, on the river Avise, in the Department of Ariège, and so he was entitled par excellence to lead in the discussion. He gave a description of these latest discoveries, the results of three years' continuous labor in Mas d'Azil, and presented his opinions and conclusions deduced from a study and comparison of the art works of the period. He said that the most ancient pieces of flint were worked in an elegant form ; a perception of the beautiful was evident. There was an extension of art during the Madelenien epoch ; the sculpture first, and engraving afterwards. Each prehistoric station in that country had its particular style or manifestation of art. Along the river Vezere the horses engraved in relief are represented with such enormous heads as to be veritable caricatures. In the Pyrenees, at the Grotte Gourdan and Lortet, numerous beautiful engravings were found. The artists of Lourdes and the Grotte Arudy had invented the volute, the spiral, and different designs which were not encountered at any other place. The sculptors of Mas d'Azil sought out imaginary, apparently mythological beings. Man at that time had the leisure to pursue his own imagination, the opportunity to indulge his love for the beautiful according to the best means that art presented. M. Piette presented different engravings of the reindeer in certain positions and conditions sustaining his theory. He also exhibited the advance sheets of his great work on art during this age, and showed by chromo-lithography the reproduction of a great number of objects engraved and sculptured.

M. Montelius asked if the spiral exhibited by M. Piette as from d'Arudy did not belong to the age of iron ; that it would be so if found in his country.

M. Cartailhac responded on behalf of M. Piette that he had assisted in its find ; that there was no doubt of its authenticity ; that it was made out of the bone of a reindeer, and its contemporaneity with that age was indisputable.

One of the objects presented by M. Piette he declared to be a sphinx or winged quadruped. Le Baron de Baye was surprised that it was found in a deposit of the stone age. But M. Cartailhac responded that it required much imagination to determine or say that it was a sphinx. It was incomplete, and the wings were more than doubtful, and he denied largely the propositions advanced by M. Piette, though praising him for his exceedingly valuable excavations.

M. Gabriel de Mortillet also opposed the hypothesis of M. Piette upon the subject of the demonstration of the reindeer and the horse.

Monsieur Fraipont ranged himself on the side of Mortillet, and he criticized mercilessly the fantastic idea that the artist studied art in the same way that the schools were now conducted at the Academy of Beaux Arts, or in the studios of the great painters of Paris. He declared it to be a common error which substituted for the prehistoric man the cultivated, educated artists of the nineteenth century, making the primitive man to look at art through his eyes, and to study it with his critical or æsthetic eye, as though the primitive works were to be submitted to the committee for entrance into the great Salon of Paris. He declared this to be not scientific nor even sensible, but to be in the highest degree fantastic; that the sooner it was laid away, and the students and archeologists of to-day come down to common ground, and devote themselves to presentation of the actual facts, the better it would be for the science. He ridiculed the idea put forth by M. Piette that these artists of the paleolithic age made studies and executed sketches of skeletons, whether of man or beast, for the same reason as do our modern artists,—that is, to study the anatomy and be better able to render correctly the form in the flesh. "No," said he, "the artist of Mas d'Azil copied the heads which may have been skinned or flayed, and the bare bones of the skull or skeleton which he may have had many times before his eyes."

M. Piette responded. He demanded the proofs that the domestication of the reindeer was impossible without the dog. He declared his belief that the engravings of the woman and the reindeer constituted a true picture, of which we now unhappily have but part. The lines of the two subjects do not penetrate or interfere with each other; the legs of the reindeer, as they cross the picture of the woman, are brusquely interrupted, while the lines depicting the woman continue across. It is the case of the one object being represented behind the other.

Mr. John Evans said the interpretation of a few designs slightly obscure is not sufficient proof that the reindeer and other animals were domesticated. The dog would appear to have been the first animal domesticated, and this was in accordance with logic and reason.

Monsieur Delgado made an elaborate, detailed, and interesting communication upon a series of prehistoric caverns found in Portugal. They had served as habitations and also as burial places. The objects of human industry were of worked flint, arrow, and spear-heads, flasks, pottery, polished stone hatchets, worked bones, ornaments, etc., interspersed with weapons or tools and ornaments of bronze. They were the same race apparently, so far as could be judged from the human remains, as had been found in the south of Portugal and Spain. The skull was dolichocephalic, and the tibia platycnemic.

Question III. had a second part: "The Value of Paleontologic and Archeologic Classifications as Applied to the Plistocene Period."

Doctor Gosse, of Geneva, presented charts of Lake Geneva showing the various deposits along its banks made during the Plistocene period, and attempted to show the relations between them and the various ages of man as manifested by the fauna of the mammoth, then of the reindeer, and finally of historic times. He showed a Chellèen instrument coming from a deposit of the time of the mammoth, from one of the highest (altitude) localities.

M. Amerano, Superior of the College of Finalmarini, Liguria, described his discovery at the station occupied by prehistoric man in the cavern of the de la Fèe in that neighborhood, and 300 metres above the sea-level and one-and-a-half hours distant. He found in a single day, within the space of four cubic metres, six entire heads of the cave bear, twenty large fragments of others, eighty under jaws, one hundred and ten teeth, etc., representing no fewer than fifteen hundred individuals. There were two human occupations in this cavern; the earliest and lowest contained objects of human industry which Monsieur Reviere thought were similar to those of the most profound depths of the Grottes de Menton. The upper and later was entirely neolithic, with polished stone hatchets, grinding stones, and a piece of copper or bronze.

The Mexican Tonalamatl of the Aubin collection, and the other calendars related to it, have been investigated by Dr. Edward Seler, and described in the "Compte Rendu du Congrès International des Américanistes," seventh session, Berlin, 1888, his illustrated report filling not less than 219 octavo pages. The tonalamatl is a representation of the Mexican astrologic year of 260 days, and exists in several copies, differing considerably from the copy once in the possession of the French collector, Aubin. They represent heads of gods and genii, which are ornamented in various ways with symbols, and arranged in squares. Before we can understand these astrologic calendars we have to discover which god or genius is meant in every instance, and to this task Seler's pages are devoted, for the Spanish texts accompanying the pictures are not always clear enough. The erudition which Seler brings into play is astonishing, and only a close comparison of his interpretation with the published pictures can convey to us an understanding of the astrologic art of the Mexican people. This article is composed in German, as is also another publication of his, "Altmexicanishe Studien," published in the "Veröffentlichungen aus dem Königlichen Museum für Völkerkunde," Vol. I., No. 4, fol., Berlin, 1890. The first of Seler's articles treats learnedly of "A Chapter from the Unpublished Aztec Materials Supplementary to the 'History' of Father Sahagun"; the second deals with "The So-called Sacral Vases of the Zapotec Indians." These meritorious antiquarian inquiries of the Berlin savant are profusely illustrated with wood-cuts in such manner that the original colors are made apparent from the drawings.—A. S. G.

Huastec Language. — Reliable information upon this language of Eastern Mexico is not easily obtainable. We notice with agreeable surprise that a treatise of considerable extent has just been published by a native of that country, by the Statistical Bureau of Mexico. The title runs as follows: "Cartilla huasteca con su gramatica, diccionario, y varias reglas para aprender el idioma, etc. por Marcelo Alejandre, Mexico, Calle de San Andrès, numero 15, 1890. Quarto, pp. 179." The Huastec language is the northernmost of the Maya dialects, and differs very considerably from all others in the lexicon and in the grammatic portion. This difference is ascribed by linguists to the archaic character of the language, but other causes may also have been at work. The nouns do not inflect for case, but for number only; for the verb the author establishes two conjugations, according to the suffixes which are employed in forming the preterit tense. The personal pronoun is placed separate from the verb. The dictionary, by Lamberto Asiain, contains about 2900 items, and is supplemented by a Spanish-Huastec part. There are two principal dialects of Huastec, the Potosino and the Veracruzano; they are spoken at Tantoyuca, Chontla, Tantima, Amatlan, San Antonio, Tancoco, and are heard sporadically also at Ozuluama, in the state of Vera Cruz, where Alejandrė composed his Cartilla or elementary manual. The volume concludes with some specimens of conversation and poetry in that language, and makes mention of historic traditions once current among the ancestors of the present Indian population. —A. S. G.

Zapotec Language.—The Licentiate Francisco Belmar, of Oajaca, has composed a juvenile manual for the study of the mountain dialect of the Zapotec, which is spoken in the central parts of the state of Oajaca, Mexico. The thirty pages of the little book are filled with Zapotec words, arranged after the number of syllables which they contain, and with their Spanish definitions; the book concludes with some religious short texts, and although the translation is not added to these, the lexical portion of the Cartilla, which was published in Oajaca, 1890 (16mo), will be of service to the students of linguistics at large.—A. S. G.

Mixtec and Mije are two aboriginal nations of Oajaca, Southern Mexico, which have retained their Indian languages in a comparatively pure condition up to the present epoch. Mixtec is spoken in the western and northern parts of Oajaca, and also in the adjoining portions of the state of Guerrero, and is closely related to the Chuchon, Amusgo, Cuitlatec, and other idiomatic forms of speech heard in these parts. The Mixtec proper is divided into upper and lower Mixtec, the majority of the Pueblos speaking the upper Mixtec, or Mixteco alto. In former times the Pueblos of Tanguitlan and of Tepuzculula were considered to speak the typical and purest form of the upper Mixtec. The Spanish grammar (Arte) of the Dominican father Antonio de los Reyes, printed in 1593, represents the dialect heard at Tepuzculula at that time, and has just been reëdited by Leon Reinisch, at the expense of Count Hyacinthe de Charencey, in the eighteenth volume of the "Actes de la Société Philologique de Paris," 1890, making 93 octavo pages. The prologue which precedes the work (eight pages) contains much that is valuable upon the ethnography and dialects of the Mixtec people.

The same eighteenth volume contains a Confessonario en lengua Mixe, by the Dominican father Augustin de Quintana, also republished at M. de Charencey's expense, and filling 331 pages. It is a reprint from the edition of LaPuebla, Mexico, 1733, and besides the devotional texts embodies a vocabulary of the parts of the human body, the names of relationships, the numerals, and some grammatic information. Mije or Mixe is spoken in the eastern parts of Oajaca State. —A. S. G.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

The National Academy of Sciences met at Washington April 21st. The following papers were read: Further Studies on the Brain of *Limulus polyphemus*; A. S. Packard. On Aërodromics; S. P. Langley. The Solar Corona, an Instance of the Newtonian Potential in the Case of Repulsion; F. H. Bigelow (introduced by S. Newcomb). Report on the Human Bones of the Heminway Collection in the U. S. Army Medical Museum, prepared by Dr. Washington Matthews, U. S. A.; J. S. Billings. Application of Interference Methods to Spectroscopic Measurements; A. A. Michelson. The Corona from Photographs of the Eclipse of January 1st, 1889; H. S. Pritchett (introduced by A. Hall). Stellar Motion Problems; Lewis Boss. Effect of Pressure and Temperature on the Decomposition of

Diazo-Compounds; Ira Remsen. Researches on the Double Halides; Ira Remsen. Allotropic Silver; M. Carey Lea (introduced by Ira Remsen). Note on a Paper by M. G. Lippmann; M. Carey Lea (introduced by Ira Remsen). On the Yttrium Earths, and a Method of Making Pure Yttrium; H. A. Rowland. Report of the Watson Trustees, and Presentation of the Watson Medal to Professor Arthur Auwers, of Berlin. On the Distribution of Colors in Certain North American Reptiles; E. D. Cope. The Taxonomy of the Apodal Fishes; Theodore Gill.

Francis A. Walker, of Boston, was elected vice president to fill the vacancy caused by the resignation of Professor S. P. Langley. The Watson gold medal and $100 in gold were presented to the German Minister, to be forwarded to Dr. Arthur Auwers, of Berlin, in recognition of his work in determining the positions of the fixed stars. The following gentlemen were elected foreign associates: Dr. Karl Gegenbaur, of Heidelburg, and Dr. Jean Servais Stas, of Belgium.

Biological Society of Washington.—April 4th, 1891.—The following communications were read: Kennerley's Salmon; Dr. T. H. Bean. Remarks on Recent Bacteriological Progress in the Prevention and Cure of Disease; Dr. Theobald Smith. Production of Immunity in Guinea Pigs with Sterilized Cultures of Hog Cholera Bacillus; Dr. V. A. Moore. On the Classification of the Apodal Fishes; Dr. Theo. Gill. A Monograph of the Carolina Parrakeet; Mr. E. M. Hasbrouck.

April 18th, 1891.—The Recent Introduction of Date Palms; Mr. H. E. Van Deman. Recent Observations on a Bacterial Disease of Oaks; Mr. B. T. Galloway. Some Florida Plants; Prof. L. F. Ward. Practical Value of Investigating Parasites of Live Stock; Dr. Cooper Curtice. Abnormal Flowers in Glyceria; Mr. Theo. Holm.—FREDERIC A. LUCAS, *Secretary*.

SCIENTIFIC NEWS.

The Boston Marine Biological Laboratory makes the following announcement for its fourth season:—Corps of instructors: Director, Dr. C. O. Whitman, Professor of Zoology, Clark University, editor of the *Journal of Morphology;* E. G. Gardiner, Instructor in Zoology, Massachusetts Institute of Technology; J. Playfair McMurrich, Docent in Zoology, Clark University; T. H. Morgan, Bruce Fellow, Johns Hopkins University; W. M. Wheeler, Fellow in Biology, Clark University; H. C. Bumpus, Assistant Professor of Zoology, Brown University; W. M. Rankin, Instructor in Zoology, Princeton College. Ryoiche Takano, Artist; G. M. Gray, Laboratory Assistant; J. J. Veeder, Collector.

In addition to the regular courses of instruction in zoology, botany, and microscopical technique, consisting of lectures and laboratory work under the direct and constant supervision of the instructors, there will be two or more courses of lectures on special subjects by members of the staff. One such course of six lectures will be given by Dr. McMurrich on the Ctenophora and the Turbellaria. Similar courses on the Mollusca, Crustacea, and Echinodermata will be given by Professor Bumpus and Dr. Rankin.

The laboratory is located on the coast at Wood's Holl, Massachusetts, near the laboratories of the United States Fish Commission. The building consists of two stories,—the lower for the use of teachers and students receiving instruction, the upper exclusively for investigators. The laboratory has aquaria supplied with running sea-water, boats, a steam launch, collecting apparatus, and dredges; it is also supplied with reagents, glassware, and a limited number of microtomes and microscopes. By the munificence of friends the library will be provided henceforth not only with the ordinary text-books and works of reference, but also with the more important journals of zoology and botany, some of them in complete series.

The laboratory for investigators will be open from June 1st to August 29th. It is fully equipped with aquaria, glassware, reagents, etc., but microscopes and microtomes will not be provided. In this department there are fourteen private laboratories supplied with aquaria, running water, etc., for the exclusive use of investigators, who are invited to carry on their researches here, free of charge. Those who are prepared to begin original work, but require supervision, special suggestions, criticism, or extended instruction in technique, may occupy tables in the general laboratory for investigators, paying for the privilege a fee of fifty dollars. The number of such tables is limited to ten. Applicants for them should state precisely what they have done in preparation for original work. For the completion of any considerable piece of investigation, beginners usually require from one to three full years. It is not expected, therefore, that the holders of these tables will finish their work in a single season. The aim is rather to make a secure beginning, which will lead to good results if followed up between sessions and renewed, if need be, for several successive years.

The laboratory for teachers and students will be opened on Wednes day, July 8th, for regular courses of seven weeks in zoology, botany, and microscopical technique. The number admitted to this department will be limited to thirty, and preference will be given to teachers and others already qualified. By permission of the director, students may begin their individual work as early as June 15, without extra charge, but the regular courses of instruction will not begin before July 8th.

Rooms accommodating two persons may be obtained near the laboratory, at prices varying from $2.00 to $4.00 a week, and board from $4.50 to $6.00. By special arrangement, board will be supplied to members at The Homestead at $5.00 a week.

Applications for places in either department should be addressed to Miss A. D. Phillips, secretary, 23 Marlborough Street, Boston.

Laboratory of Marine Biology of the University of Pennsylvania.—The University of Pennsylvania, though the liberality of Mr. Chas. K. Landis, will be enabled to occupy a modest laboratory building the coming season at Sea Isle City, New Jersey. A building 80 x 24 feet will be provided with places for advanced workers and students, and with an equipment of aquaria for the purposes of biological study. Larger aquaria will be operated for the purpose of displaying to the public the character of the living marine forms found in the immediate vicinity. It is provided that a biological director and staff shall control the workings of the laboratory. While popular or elementary instruction will be given, it is intended that the place shall be mainly a laboratory of research. With this object in view, it is intended, as soon as possible, to throw open its facilities to all biologists of repute, American as well as foreign. It is hoped that the establishment may be got under way by the first of July, 1891, at the latest.

While the location on the New Jersey coast is not as rich faunally as that of New England, it is believed that certain counterbalancing advantages will be gained. One is the accessibility of the location, being only two hours by rail from Philadelphia.

Friedländer's *Naturæ Novitates* for May, 1890, advertises under Vermes: "Thomas, C. The Circular, Square, and Octagonal Earthworms of Ohio."

Judging from the plates in the Proceedings for 1890, the new addition to the Academy of Natural Sciences of Philadelphia does not make an architectural unity with the older portion.

Dr. E. Koken, of Berlin, has been elected ordinary professor of mineralogy and geology in the University of Königsberg.

Dr. M. Braun, of Rostock, has been made ordinary professor of zoology in the University of Königsberg.

Col. N. S. Goss died at Neosho, Kansas, March 11th, 1891. He is best known through his papers on the birds of his adopted state.

Professor E. Ray Lankester has been appointed professor of zoology in the University of Oxford. His former position in the University College of London is filled by Mr. W. F. R. Weldon.

Professor O. Frass has been appointed conservator, and Dr. Lampert second conservator, of the Royal Museum of Natural History, at Stuttgart.

The following choice bit of science is from Atkinson's translation of Ganot's "Elêments de Physique," page 5. It *illustrates* the divisibility of matter: "Blood is composed of red flattened globules floating in a colorless liquid called serum. In man the diameter of one of these globules is less than the 3,500th part of an inch, and the drop of blood which might be suspended from the point of a needle would contain about a million of globules. . . Again, the microscope has disclosed to us the existence of insects smaller even than these particles of blood; the struggle for existence reaches even to these little creatures, for they devour still smaller ones. If blood runs in the veins of these devoured ones, how infinitesimal must be the magnitude of its component particles!" . . . "It is hardly necessary to remind the reader that an insect is an insect, whether it is an unhatched egg, a growing larva, an apparently lifeless pupa, or a flying or creeping imago."—*Entomological News*, Vol. I., p. 86, 1890."

Recent Deaths.—Dr. J. J. Friano, botanist, at Paris, Oct. 31st, 1890; E. T. Atkinson, entomologist, at Calcutta, Sept. 15th, 1890; Mathias Auinger, paleontologist, at Vienna, Oct. 11th, 1890, aged 80 years; W. J. Stephens, Pres. Linnean Society, N. S. Wales, Nov. 22d, 1890, at Sydney; James Croll, author of "Climate and Time," at Perth, Dec. 15th, 1890; A. Stoppani, geologist, at Mailand, Italy, Jan., 1st, 1891, aged 60 years; John Marshall, anatomist, at London, Jan. 3d, 1891, aged 70 years; Adam Handlersch, dipterologist, in Vienna, Mar. 24th, 1890, aged 27 years; Otto von Meske, lepidopterist, in Albany, N. Y., Aug. 13th, 1890, in his 53d year.

Prof. C. L. Herrick, of University of Cincinnati, announces the establishment of a quarterly periodical in the interests of the comparative study of the nervous system, entitled *The Journal of Comparative Neurology*. It is the object of *The Journal of Comparative Neurology* not only to afford to those laboring in this direction an avenue for the publication of more descriptive papers than could find a place in other journals, but to supply a brief summary of the foreign literature of this department.

The nominal dates of publication will be March, June, September, and December, but fasciculi will be issued at more frequent intervals whenever material is ready. Thus it is hoped that the publication may combine some of the advantages of a bi-monthly with the greater detail of a quarterly.

Each volume will contain about 500 pages. The annual subscription price has been fixed at $3.00, or $2.50 if paid in advance. Separate fasciculi will be sold at an approximately uniform rate of one cent per page and five cents per plate contained.

While the majority of the articles will be original, due attention will be given to technique and the discussion of the more suggestive current papers.

The first volume will contain, among other things, a full account of the histology of the brain of the opossum, a paper on the histology of the Avian brain and the taxonomic value of the brain in birds, a résumê of the recent results obtained by the application of Golgi's method, comparative histology of reptilian brain, suggestions as to the architectonic of the cerebellum, etc., etc. The coöperation of all interested in this department is earnestly solicited. The first fasciculi will follow in the course of a few weeks.

NOTICES.

Notices for scientific societies and private individuals inserted under this head free of charge. For business houses, two cents per word.

MINERALOGY. — Course conducted by correspondence. First collection and book $1. Postage 25 cents. Address
GUSTAVE GUTTENBERG,
Central High School, Pittsburgh, Pa.

WANTED—To correspond with conchologists in America, especially in California, with a view to exchange. Many British land, fresh-water, and marine duplicates; some foreign. Address Mrs. Falloon, Long Ashton Vicarage, Bristol, England.

WANTED—Position in Academy, Normal or High School, as teacher of the Natural Sciences and Modern Languages. Latin taught in addition, if necessary. Address G., box 441, Hanover, N. H.

A COLLEGE PROFESSOR of Natural Sciences and German, of four years experience and special Biological training received at the Universities of Leipzig and Bonn, Germany, is open for a position in a college. Good references.
Address, C., Box 136, New Berlin, Pa.

FOR EXCHANGE.—14 Volumes (1883–1889) AMERICAN JOURNAL OF SCIENCE; 10 volumes (1880–1889) AMERICAN NATURALIST; 21 volumes (1879–1890) ENGLISH MECHANIC; all in good condition for binding; also, Morris Typewriter. If you have a good Microscope, Camera, or anything else to offer, please send full description.
E. R. CHADBOURN, LEWISTON, ME.

FOR SALE.—Beautiful sets of Fossil Plants from the Dakota Group Cretaceous. On receipt of $3.00 I will forward, prepaid, to any address in Europe or America, 20 different species and varieties of Dakota Plants. Send 5 cents for plate illustrating the set. The specimens will equal the figures. CHAS. H. STERNBERG,
P. O. Box 60, Lawrence, Kans.

WANTED—Hall's works on Palæontology, and other works giving plates which show fossils of the Niagara Epoch. Address M. D. Sullivan, St. Ignatius College, Chicago, Ill.

VOLUMES I., II., III., and IV., of THE AMERICAN NATURALIST, in first-class condition, bound in half Morocco, for sale. Price $16.00. Address GEO. W. MACKAY,
25 Congress St., Boston, Mass.

WANTED—For dissection and microscopic work, Polyps, Jelly-fish, or other Hydrozoa, Actinozoa, and Ctenophora; also Echinodermata and Mollusca. Cash or exchange given. J. A. Leighton, Trinity College, Toronto, Can.

FOR EXCHANGE—Thirty species of *Unionidæ* from Spoon river, Ill.; the finest in the world. Fine *Helices* and other land shells. Fifty species of birds' eggs in full sets; Indian stone and flint implements. WANTED, shells, minerals, fossils, curios and scientific literature.
DR. W. S. STRODE, BERNADOTTE, ILL.

MINERALS TO EXCHANGE for others.
JOHN HOLL. ROLLO,
Wilmington, Delaware.

NOTICE TO CONTRIBUTORS TO THE AMERICAN NATURALIST.

Send Contributions to the EDITORS ONLY.

Send to the PUBLISHERS ONLY:

All Orders for Extra (or Reprint) Copies.
All Proofs of Texts and Engravings.

NOTE.—All orders for reprint or extra copies must be given before the number containing the article goes to press; otherwise none will be furnished.

$4.00 per Year. 40 cts. per Copy.

THE AMERICAN NATURALIST.

A MONTHLY JOURNAL
DEVOTED TO THE NATURAL SCIENCES
IN THEIR WIDEST SENSE.

Vol. XXV. JUNE, 1891. No. 294

CONTENTS.

PHILADELPHIA:
FERRIS BROS., PUBLISHERS
SIXTH AND ARCH STREETS

To Scientific Investigators.

One of the greatest needs of American science at the present time is a convenient medium in which brief preliminary notices of the results of investigation can be published. A considerable length of time of necessity elapses between the conclusion of any series of observations and their appearance in print, and it is of great advantage to the observer, and still more to his fellow-workers, to have the results made known as soon as possible, thus insuring priority of discovery to the one, and allowing the others to keep more perfectly posted with what is going on in the scientific world around them.

A preliminary notice should be published *at once* to be of value, and hitherto there has been no scientific periodical in this country, published at sufficiently brief intervals, and open to all investigators, which has specially opened its columns to the publication of such notices, and has undertaken to make them public with as little delay as possible. This the Naturalist proposes to do, and invites the coöperation of all investigators in an attempt to inaugurate a department for the prompt and satisfactory publication of preliminary notices of the results of scientific investigations.

THE

AMERICAN NATURALIST

VOL. XXV. JUNE, 1891. 294.

WANDERING CELLS IN ANIMAL BODIES.

BY J. L. KELLOGG.

IF some of the surface sediment of a quiet fresh-water pond be examined under the microscope, one would very likely find a curious, colorless organism, containing a number of granules, and perhaps now and then a microscopic plant. A little observation will show this animal—for such it is—to be merely a mass of protoplasm which possesses the power of changing its shape by the protrusion of any part of its body in irregular branches, or thin, fine filaments. By means of these, it is able to move very slowly from place to place, forcing its way between particles of dirt which surround it, and also to take in solid food. This latter process is accomplished by a covering over or flowing about a piece of food by the thin, jelly-like body. When the food is thus covered over, the fluid protoplasm of the animal, which is called an amœba, is seen to possess the power of truly digesting the food which it holds. This process, taking place in a single unspecialized or undifferentiated cell, is called intracellular digestion.

The amœba is, in its structure, a single cell, comparable to any one of the myriads of cells that go to make up the body of one of the higher animals. These cells may lose, in a higher organism, the simple amœboid form, and assume complex shapes and functions in different parts of the body; generally losing, also, the power of movement. Many, however, retain the power of moving under proper stimuli,—as, for example, the cells that go to make up muscular tissue, where their united contraction causes movements of organs of which they may form a part. This movement is, of course, not voluntary with the cell; but there are certain cells, even in the bodies of the most highly differentiated animals, which still possess this power of acting voluntarily without external stimuli.

If a drop of blood be taken from the body of any of the vertebrated animals, with one or two exceptions, and the microscope again called into use, its fluid part will be seen to be filled with motionless, pale-yellow discs. Among these red blood corpuscles will be seen, here and there, transparent bodies, larger or smaller than these, as the case may be, which we recognize by their slow movement as amœboid cells. These are the white corpuscles of the blood. In lymphoid tissue, such as that of the spleen, and small lymph nodules occurring in different parts of the body, larger amœboid cells of the same nature are collected in great masses, which are richly supplied from the general vascular system. Though these amœboid cells in the blood are called white corpuscles, and in the lymph glands lymph corpuscles, and so on, they are all included in the general term "leucocytes." Their functions in these different tissues will be more readily understood if we first examine cells of the same nature in some of the lower forms of animal life; for in these their habits and relations to the bodies of which they are a part are more easily observed and classified.

The student of biology will recognize a distinct morphological bearing in the observations about to be recorded concerning these wandering cells. Our knowledge of them has come mainly through a study of the embryonic development of lower animals, and foremost among investigators of this subject must be placed the name of the great Russian morphologist, Metschnikoff. It was he who first noticed their similarity of function in the whole animal series, and he formulated his great mass of observations in what is called his phagocyte theory. Almost all the examples to be given here are the results of his researches. On account of their very great interest to all classes, these observations are very widely known, and we may briefly consider a few of them. In so doing, also, we will be better able to comprehend the important functions supposed to be possessed by amœboid cells in higher animals.

In the embryo of Echinoderms, such as the starfish, there is a stage in which the organism consists of a single layer of cells in the form of a sphere, called a blastosphere or blastula, and its interior is filled with a jelly-like mass. Certain of these cells in the layer work out from between their neighbors by amœboid movement, and come to lie free in this jelly (Fig. 1), where they move about. This is a fact of morphological interest, as these cells eventually form one of the primary layers—the germ-layers—of the embryo, which, by a definite development, form certain organs of the adult. As the starfish blastula becomes older, it reaches a stage in which certain of its tissues break down, and these are not to pass into the body of the adult animal. Metschnikoff has observed that broken-down particles were taken up by the moving cells, as the Amœba takes its food, and also found that they were digested by the cells. Now these particles, if allowed to remain, would have been injurious to the animal, so their assimilation by the amœboid cells was of great use to the individual. It was because of this peculiar function that the wandering cells were called phagocytes, or eating cells, and they are very generally known by this term.

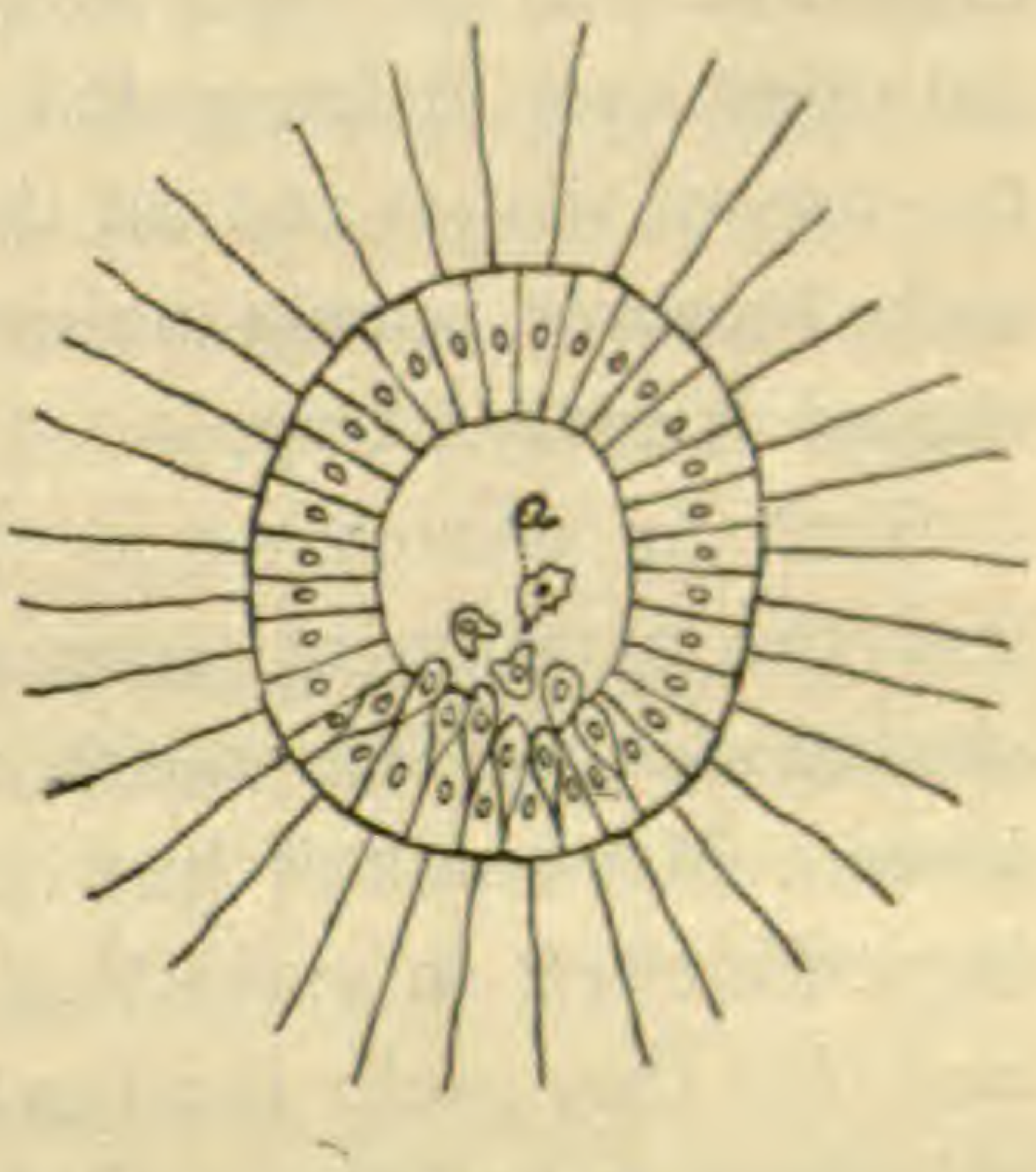


Fig. I

Larva of Echinoderm which has begun to swim by means of cilia, showing amœboid cells.

In order to establish a theory, now generally accepted, of the descent of the Metazoa, or many-celled animals, from the Protozoa, or single-celled forms, Metschnikoff sought for and proved the existence of this intracellular digestion in certain amœboid cells of sponges. Following out these facts, obtained in purely morphological research, he was enabled to lay the foundation for certain views which are of the utmost practical interest, as we shall see, even in such an apparently remote field as that concerning many diseases of the human race.

In a tadpole, whose legs have commenced to grow, preparatory to assuming the adult condition, the tail begins to wither and disappear; and in this organ, Metschnikoff made another interesting and well-known discovery. The tissues were now of no further use to the organism, and he found that the leucocytes had attacked them, and were gradually eating them away. He often found unmistakable pieces of nerve and muscle-tissue inside their bodies, which were evidently undergoing a process of obliteration by digestion. In the pupa stage of insect metamorphosis the internal organs are disintegrated, and here again the phagocytes attack the useless tissues and eat them. Certain strong, well-nourished cells, however, remain unharmed, and from these the organs of the adult are built up.

Such an occurrence as this appears to be rather remarkable, and the question at once arises as to why these phagocytes should destroy one tissue, and apparently leave another uninjured. Metschnikoff has conclusively shown that these wandering cells exert an undoubted choice in the selection of their food, and that they prefer dead to living tissue. His method of proving this fact was as follows. Taking some sea-urchin's eggs, and killing them by boiling, he carefully injected them under the skin of a nudibranch,—one of the Gastropods,—and found that they were immediately surrounded by amœboid cells, and eaten by them in the usual manner. The same experiment was again tried, but this time the injected eggs were not killed. The result was that they not only remained unharmed, but, on the introduction of spermatozoa among them, they were fertilized, and commenced to develop.

In such an experiment as this, it is noticeable that when a foreign body is introduced into an animal through an injured region of the skin, the leucocytes already in the vicinity are not the only ones which are ready to attack the invading particles. Very soon their fellows appear, having come from distant tissues, and take part in the fray: and not only do they attack organic substances, which by digestion would be assimilated, but also inorganic particles, which they cover by their protoplasm, and retain, so that they cannot do harm to the animal. I have been told that in men whose arms have been extensively tattooed with India ink, the small lymph nodules in the axillæ are sometimes very deeply pigmented. As has been said, these nodules are made up principally of amœboid lymph leucocytes, and when the lymph, carrying particles of ink, passes through them, the phagocytes pick up the pigment granules and retain them.

Again, it has recently been stated that if a bit of sponge be inserted under the skin of any of the mammals it will in a few days entirely disappear; and if, before this occurs, it be taken out and examined, it will be found to be full of phagocytes which are destroying it.

Osler, in a recent address on the subject, says that in the sputum of smokers there appear cells from the alveolar epithelium of the lungs, which are evidently amœboid, carrying particles of carbon. The same is said to be the case with miners who inhale coal-dust, and that these carbon-laden cells may continue to appear for months after a man has ceased to expose himself to the dust. It need not be said that such unusual work put upon the lungs might lead to serious results.

In the process of digestion in mammals, fats are emulsified, or broken into small particles in the intestine, and are transferred bodily through its wall into lymph vessels. In this it differs from the transfer of a dissolved salt through a membrane by dialysis, and the numerous leucocytes in the intestinal wall are known to carry the fat particles through the lining epithelium into the lymph capillaries beneath, where they disintegrate and liberate their load. It is not definitely understood how the fat particles are taken in, but it is supposed that the phagocytes push out processes or pseudopodia to the surface of the stationary epithelium cells, and then surround them, and draw them inward.

There seems to be a tendency to divide the functions of leucocytes into those which are normal, and abnormal. For example, in the last instance mentioned, the work done by amœboid cells is said to a natural or normal one, and it undoubtedly is so. On the other hand, the attack made upon the bit of sponge introduced beneath the skin would by some be called an abnormal function performed by the wandering cells. It would seem, however, that a tissue so constructed as to be able to adapt itself to conditions caused by some unforeseen accident would employ an entirely normal function in adapting itself to new circumstances. An irritating particle may be placed between the shell and mantle of an oyster, and very soon the cells of the latter secrete a hard covering of pearl over the foreign object. The secretion would not have taken place had it not been for this accident, and yet we regard the process as an entirely normal one. In the case of the collecting of dust particles in the alveoli of the lungs, some may call it a natural function, while others may have a different opinion. The leucocytes in animal bodies, though they may differ from one another in some respects, are essentially alike in function as far as is known, and anything that they are called upon to do, and are able to perform, may be regarded as normal.

One more fact concerning the action caused by the introduction of foreign, inorganic bodies is that, if the substance be too large, the leucocytes often unite with one another and cover the object. They make a fixed covering of what is called fibrous tissue, and the process is known as encystment. Sometimes, however, great numbers of leucocytes may die in the attempt to dispose of foreign particles, and their disintegrated bodies form a substance called pus. The sore resulting from this is an abscess.

We shall now see that these leucocytes have a far more interesting and important function than those already mentioned, and its discovery[1] was made by Metschnikoff. It is known to every one that a number of diseases to which man and other mammals are subject are caused by bacteria,—microscopic plants,—which enter the body in various ways, and by their multiplication occasion changes in the tissues that may be exceedingly dangerous to the attacked individual. It is claimed by many, that the most important function of the phagocytes is to take up these micro-organisms and destroy them.

Perhaps the most interesting observation given us on this subject by Metschnikoff is that made upon Daphnia, a small fresh-water crustacean. He found that many of these animals, which he kept in an aquarium, were very liable to be attacked by the long, needle-like spores of a certain fungus. These, once established in the tissues, multiplied and often caused the death of the animal. The spores first obtain a position in the intestine. By degrees they work their way through its walls, and appear in the body-cavity. As soon as this happens, phagocytes appear on the scene in great numbers, and attack the invaders. If these can only be killed, they will be rendered harmless, for then their breaking down can be accomplished, and they can be removed. But if they are too numerous, some will escape uninjured, and, finding themselves under suitable conditions, will sprout and grow, and this means the death of the individual. It will be seen by Figure 2 that one of these spores is several times larger than a leucocyte, and though the latter is capable of great distension, it may not be able alone to dispose of a spore. In such a case, two or more may invest different parts of the same enemy. But a more effectual coöperation may be secured in this remarkable way. Several cells may become fused into one great mass, forming a single individual of sufficient size to surround a spore and kill it. When this has been accomplished, the spore soon loses its original shape, and finally falls to pieces. These different stages are shown in Figure 2. This united effort of the phagocytes may thus prevent disease; though very often, when the invasion is too great, they are not able to stem the tide, and the animal dies.

Fig. 2

Spores and blood corpuscles from the body-cavity of Daphnia. After Metschnikoff.

Still following, for the present, the experiments of Metschnikoff, we may notice a few observations made upon vertebrates. The microörganism of splenic or relapsing fever is a large bacillus, and favorable for study on this account, for bacteria appear as extremely small objects, even when magnified as greatly as possible. Taking a bit of infected tissue from an animal suffering from this disease, Metschnikoff placed it under the skin of a mammal, such as a mouse or rabbit, and on taking it out and examining it, in the course of a few hours, he found that it had been surrounded by the wandering cells of the animal, and that many of the bacilli had been taken up, and appeared to be undergoing a process of digestion in their interior (Fig. 3). Of course, it often happens that in animals suffering from this disease, the bacilli may become so numerous as to kill the amœboid cells, and finally cause the death of the animal itself.

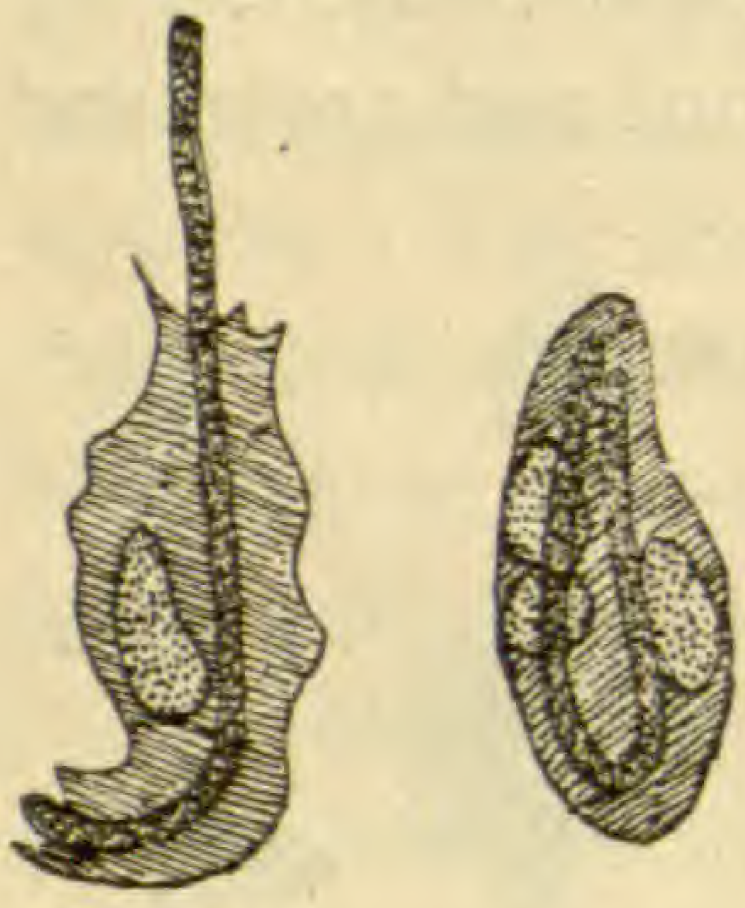


Fig. 3

Leucocytes from a frog, taking up the bacilli of splenitis. After Metschnikoff.

It is well known that in typhus fever there are certain stages of the disease in which great numbers of spirilla—another form of bacteria—are found in the blood of the suffering individual. Now one would naturally expect, from what has been stated, that the white blood corpuscles would be found to contain them; but, curiously enough, this is seldom, if ever, found to be the case. In making experimental investigations with the prevention of this disease in view, Metschnikoff recognized in this fact a serious objection to the theory which he had advanced concerning these leucocytes. He inoculated an ape with the spirilla, and they soon appeared in the blood. Some time afterward, however, they became less numerous, and finally disappeared altogether. This circumstance led Metschnikoff to suspect that perhaps they had collected in some other part of the body, so he killed the ape, and finally found that the amœboid cells of the spleen were filled with the missing spirilla. To be sure, some were yet free, but a great many were not only invested, but in all stages of digestion. This fact throws some light on the unknown function of the spleen, and at least indicates the conclusion that it attains to the importance of a therapeutic organ.

In erysipelas there is not only an acute inflammation, but also a degeneration of tissues; and it has been for some time an unexplained fact that a resorption of these broken-down parts took place. The disease is caused by the penetration of a streptococcus; and Metschnikoff found that there were here two kinds of amœboid cells at work, one of which, the smaller, attacked the cocci in the usual manner, while the other concerned itself only with the taking up of tissues which had been broken down in necrosis.

We have here an interesting array of facts, which have been graphically summed up by Osler. He says that Metschnikoff has likened specific inflammation to a warfare in which the invading forces are represented by microörganisms, and those who offer resistance by leucocytes. The news of the arrival of an enemy is telegraphed to headquarters by the vaso-motor nerves, and the blood vessels are used as an avenue of communication with the threatened region. When the invaders are established, they live on the host, and scatter injurious substances which they have formed. The active leucocytes make an attack, and try to eat the microörganisms, and some may die in the fight. Their dead bodies form an accumulation of pus, and when many are slain, the battle-ground is known as an abscess. Either force may be victorious, resulting in the one case in the recovery of the animal, and in the other in its sickness or death. In our bodies, then, there is a standing army of movable cells, which may be quickly concentrated, and attack any foreign foe which may appear.

With a view of determining how active the phagocytes actually were in attacking foreign bodies, C. Hess took a small glass receptacle, on the side of which was a very fine slit opening into its interior. He now filled this glass with a pure culture of whatever microörganism he chose to use, and, leaving the slit open, he placed it beneath the skin of a dog or pigeon. This foreign body very soon caused an inflammation. After some time, Hess found that a multitude of wandering cells had collected about the glass, and upon removing it, he found that a great number of them had worked their way through the opening into its interior, and were then actively engaged in a battle with the bacteria. He did not stop here in his observations, however, but continued to watch the movements of the phagocytes, and finally came to the conclusion that the invested plants were destroyed by a true process of intracellular digestion.

Sutton has recently given some valuable information in regard to tuberculosis in birds, which he says is more prevalent than in man. He tells us that the bacilli, from whatever place they may have come, get into the alimentary canal, and there penetrate into its walls. In some cases they may be taken up in the blood vessels, and getting into the general circulation, may finally be deposited in distant tissues of the body, such as the liver, lungs, or brain, and, in multiplying, cause the death of the animal. In the bowels, they are undoubtedly attacked by the leucocytes, and are surrounded, killed, and destroyed. Sometimes the battle may go against the defending force, when the bacilli are gaining an entrance, and then great numbers gather to reinforce their comrades. Many are killed, forming pus-cells, and others fuse together, as Metschnikoff saw them doing about the spores in Daphnia, and forming the giant cells. "These giant cells," says Sutton, "are powerful antagonists, for I have seen one contain as many as fifty bacilli."

The relation of leucocytes to inflammation and fever is pretty generally admitted. It is easily demonstrated that, under certain stimulation, such as the exposure of a bit of the mesentery of an animal, or the introduction of some foreign body, the leucocytes appear on the spot, coming in blood vessels from distant parts; and that they, in some way, penetrate the vessel walls, and appear in the tissue outside, ready to engage an enemy which may be present. As the last author referred to says: "Zoologically considered, inflammation is, in essence, a local struggle between irritants and the white cells of the blood. When the whole of the blood is engaged in the struggle, as in ague, anthrax, and the like, we have general inflammation or fever. The different varieties of fever, when due to microörganisms, depend on the habits of specific bacteria; some are more virulent, others are slower in attaining maturity, or are more irritating to the tissues."

There is something wonderfully attractive in this theory of Metschnikoff's, and of course when it became known, a great number of investigators at once began to make all kinds of experiments bearing on the question. Many have confirmed the theory, but there are also those who bitterly oppose it, and among such there are a few very prominent scientists.

Before saying anything about this other side of the question, it may be of interest to depart from the subject for a moment, and notice a few important facts in regard to the supposed micro-organisms of disease.

Different species of bacteria—using the term to include all micro-organisms—appear everywhere in great numbers; but they are not all to be dreaded as enemies of mankind. When an animal dies its body is disintegrated and returns to dust by their action. Not only is this the case, but some species are actually of great benefit to our living bodies, by helping to carry out the functions of some of its organs. Some time ago, however, the presence of certain specific microörganisms was noticed to be of constant occurrence in certain diseases, while they were absent in a normal condition. The discovery was an interesting one. Investigations multiplied, and finally a great number of diseases were believed, by some, to be caused by these so-called "germs." It made little difference whether or not there was any other reason for it than the presence of some form in the course of the disease, which was supposed to be its cause. Finally conservative men saw the danger of allowing this unsound reason of *post hoc, ergo propter hoc*, to carry things any farther. Better reasons for the prevailing belief were asked for, and generally failed to be given. Almost everything was then received with doubt, and to-day the pendulum of popular belief in the subject seems to have swung very far in the opposite direction. This is evidenced in a statement by Dr. Koch, the great German bacteriologist, who has recently created such an interest through the world by his supposed cure for consumption. In a recent address before the International Medical Congress, he says that but three microörganisms are positively proven to be the causes of disease: namely, those of anthrax, erysipelas, and tuberculosis. Other great authorities, however, would add a few more, such as those causing glanders, cholera, pneumonia, and so on. At any rate, the number is now surprisingly small. Variations of the theory are now being suggested. Some believe that certain diseases may be caused by a combination of many kinds of microörganisms. The opinion seems to be growing that ordinarily harmless, or septic, forms may, under favorable conditions, change into those which are harmful, or pathogenic.

It is probable that most people, or at least those living in great cities, take into their bodies daily, micro-organisms which, under very favorable conditions, would cause disease. One person may take in safely, perhaps, many times the number required to cause disease in another. Sutton has expressed this fact as follows: "The more these questions are studied, the more we perceive that the outbreak of infectious diseases depends not so much on the presence of microörganisms—for, like torula (the yeast plant), they seem to exist everywhere—as upon the existence of suitable conditions, and as yeast cannot grow and multiply without sugar, neither can the poison of erysipelas, typhus fever, and the like propagate without the presence of some substance produced in living bodies, of the nature of which we are ignorant." For example, "relapsing fever is unknown except in times of famine, when the body-chemistry is deranged by want of food, privation, and hardships of every kind."

But to return to the phagocytes, we must notice a few objections that have been urged against the experiments of Metschnikoff. A few investigators who do not believe in the phagocyte theory, claim that there are other elements in the body which exert an active influence against microörganisms; but, of course, this, in itself, is no argument against the supposed function of the wandering cells. Ribbert, and one or two others, while agreeing with Metschnikoff on some points, believe from their experiments that such fungi as microörganisms, or spores of fungi, are prevented from growing in a tissue, not so much on account of an active attack of leucocytes, as the fact that the latter probably deprive them of oxygen necessary to their growth, and perhaps also keep away other nourishing materials. It seems to be impossible for any one to contradict, in any case, the fact that the phagocytes take up bacteria, unless in the instance referred to of splenic fever, when in the blood, this does not occur, as Metschnikoff himself found. But Flügge, and others, claim that the parasites taken up are really only those which have already been killed, or at least injured, by chemical substances of the body, and that the white blood corpuscles are simply scavengers that pick up dead material, as the lymph corpuscles are known to destroy feeble and broken-down red blood corpuscles in the spleen.

In experimenting with the anthrax bacillus, Baumgarten found that after having been injected into pigeons, the bacilli were very seldom taken up by leucocytes, but that they seemed to degenerate precisely as they did when left in distilled water. A great many objections have been of the nature of a direct contradiction of the observations which Metschnikoff claims to have made. For instance, it is stated by Koch that anthrax bacilli, though taken up in leucocytes, may actually continue to grow there. There are a great many bitter opponents of this eating-cell theory, and, no doubt, many observations have been made which would be very difficult to explain by it.

It is apparent from what has been said, that in spite of these objections, many facts remain, which are of great importance to the study of pathology and therapeutics. It will be of value, also, to the medical practitioner to keep himself informed on the progress of this work at the present day.

It is often asked by those who are not able to understand the true aim of a science, what practical results are obtained by the great search for unknown facts that is being made in the so-called natural sciences. Without mentioning the discoveries made in this way, which have successfully answered many economic questions, it is a noticeable fact that all the knowledge developed by this phagocyte theory, and the work it has stimulated, sprang, in the first place, from Metschnikoff's purely morphological researches.

If the knowledge obtained from the experiments here enumerated, cannot be directly applied to the relief of human suffering, it is probable that a foundation has been laid, upon which it may be possible to build up methods for operation against the common enemy.

A RECENT LAVA FLOW IN NEW MEXICO.

BY RALPH S. TARR.

IN the southern central part of New Mexico, on the mail road from Carthage to Fort Stanton, and about fifty miles east of the Rio Grande, there is a flow of basalt having every evidence of being very recent. It has a north and south extension of more than thirty miles, and a width varying from one-fourth of a mile to four miles. The point of extrusion is a small cone standing at the northern end. The period of eruption was brief, and the material extravasated has barely succeeded in filling a narrow valley. Some time ago I crossed this region, and made a few observations, which, though by no means complete, are deemed worthy of presentation, with the hope that the notice may serve to call the attention of some one to the interesting phenomena, and thus lead to a more detailed study.

The lava flow is situated in a basin of interior drainage, almost completely enclosed by mountains. This basin, which varies in width from ten to thirty miles, and has a north and south extension of fully one hundred miles, is bounded by the Oscura and Jicarilla Mountains on the north, the White and Sacramento Mountains on the east, the Huego and El Paso Mountains on the south, and the Organs and San Andreas on the west. The exact area of interior drainage cannot be told at present, but it must exceed one thousand square miles. On the foothills of the mountains are quite distinct beaches, which with other evidence tend to prove that this basin is the site of one of the Quaternary lakes, of which there were others in this vicinity. The loose gravels of the basin quickly absorb all the moisture which falls upon the surface, and the mountain torrents rarely escape far into the plain before being entirely absorbed. A few never-failing mountain brooks enter from the White Mountains on the northeast side, and they also sink into the soil within a few miles of their outlets from the mountain gorges. At the lowest part of the basin are some shallow salt lakes and marshes of the "playa" type, surrounded by extensive deposits of gypsum. These desiccated lake remnants, together with the beaches and extensive lake-bed deposits, conclusively prove the former existence of a lake in this interior basin, and the freshness of the deposits points strongly to the conclusion that the lake is of recent date.

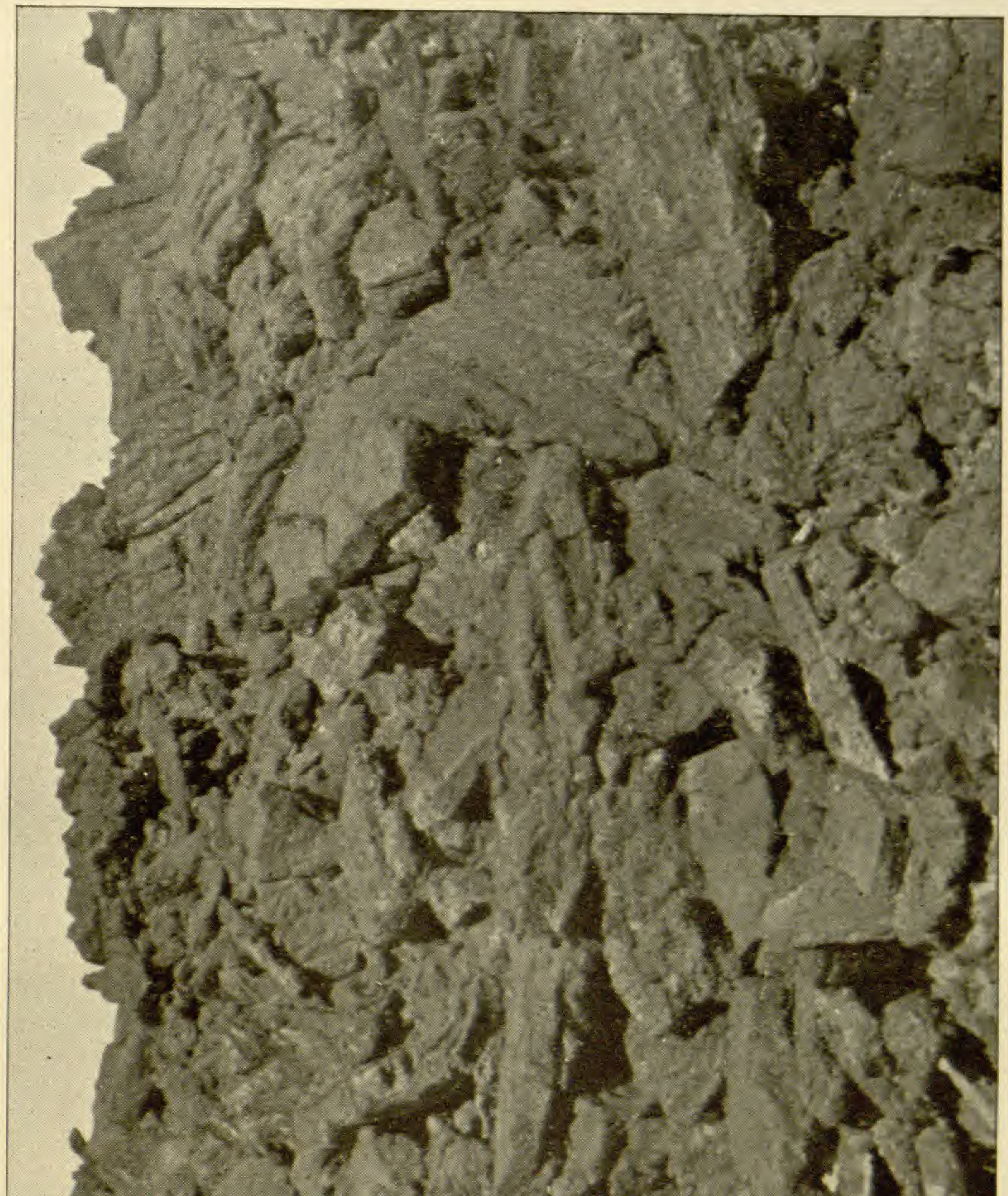
Both the mountains and foothills show signs of much more powerful erosion than seems possible under the present conditions of rainfall. This would not be so strongly stated if it were not for the fact that well-defined valleys, now somewhat clogged, extend well out into the lake deposits, much farther than the present streams succeed in going. It is in one of these valleys that the lava flow under consideration is found.

The cone which is at the northern end was not visited, but I was informed that it was fresh and had every appearance of extreme youth, and this must be so from the evidence furnished by the lava itself. Near the cone the lava spreads out over considerable territory, but farther south becomes constricted, and at the southern end again broadens out, conforming in a measure to the shape of the stream valley which it fills. The elevation at the northern end is 5,360 feet, while at the southern end it is 4,100 feet. Viewed from either side of the basin the flow is a striking object, forming as it does a jet-black stripe in the monotonous brown of the surrounding plain,—the brown so characteristic of the parched soil of an arid country. No bushes or grass have found life possible upon these black basaltic rocks, no soil has formed, and so the lava stands out with all its native blackness. Some moss, cacti, and a few stunted shrubs are the only forms of vegetable life that have as yet found a footing on this inhospitable rock, and these only in a few nooks and crevices.

The present surface is undoubtedly the surface of original cooling, and one might almost be justified in the belief that the cooling took place but yesterday were it not for the evidence to the contrary furnished by the scanty vegetation. The flow is made up of rolling masses of a vesicular, ropey lava, very much broken and fissured. Everywhere on the floor the basalt has been broken into splinters and boulders, which are piled up in little hillocks over almost every part of the surface. So ragged is this surface that in only one or two places is it possible for even a mule to find his way across the lava. The stage road is deflected by it for a distance of several miles, then crosses it at the narrowest part, running for the entire distance over bed-rock, which rings with a metallic ring under the hoofs of the horses and the wheels of the wagon. On either side of the road is an impassable desert of boulders, slaggy and black, and ranging in size from mere splinters to large blocks many tons in weight. Frequently it is possible to see where the consolidated crust of the flow burst asunder and a small side stream issued forth, cooling and cracking into slaggy, vesicular splinters and blocks. At other places the lava surface has broken into innumerable pieces, as if under the influence of some irregularity in the underlying topography. Not uncommonly the surface has been thrown into rounded waves, and cooled with the ropey surface so characteristic of some lava flows. The action of the weather has made no impression on the broken blocks. The sharp-pointed splinters and the ragged edges of the vesicles are as untouched by weather as if they had just ceased forming. The two photographs accompanying this paper, one a view of the side of the flow, the other a nearer view in the same locality, will vouch for what I have said, and will give a much better idea of the appearance than any description that I can write.

The region for many miles on either side of the lava flow is a desolate one, almost destitute of water and inhabited only by the ranchmen, who here and there have found a small spring at which they can water their cattle. Those who live in the vicinity are all of the opinion that the flow is a very recent one, and their conclusion is, as I think I have shown, well founded. They base their conclusion upon still another bit of evidence, which I cannot verify, since I have been unable to visit the locality. Without any personal evidence for or against it, I present the matter as it was told to me. The belief is that the lava has been erupted, if not since historic times, at least not long before the time of the Spanish Invasion. It is believed that the lava flow has been the means of destroying a large and thriving Pueblo Indian town. Many reliable persons have told me of certain ruins, fifteen or twenty

PLATE XII.



RECENT LAVA IN NEW MEXICO.

miles north of the volcanic cone, which indicate the former existence there of not only a pueblo, but extensive irrigation works. These ruins are quite famous in New Mexico under name of the Gran Quivira. At present there is not even drinking water within many miles of the ruins, much less water for an irrigation supply. Furthermore, the canals are said to be at present tilted at various angles, as if disturbed by some subterranean disturbance. If this be true, we have not only a recent eruption, but also one which by either surface or subterranean disturbances has destroyed canals, and even caused a spring or stream to disappear. As I have said, whether this eruption has taken place since the time of the Pueblo Indian occupation of New Mexico or not I am not prepared to state ; but certainly this isolated flow is in no way connected in point of time with the great basalt flows of the Tertiary in New Mexico, but is vastly more recent. The time of eruption must be reckoned, if not in hundreds, in thousands rather than tens of thousands of years. The matter deserves, I think, a much more careful study than I was able to give it, and I hope that some one may find it convenient to give it such a study.

THE ORIGIN OF THE AVIFAUNA OF THE BAHAMAS.

BY FRANK M. CHAPMAN.

SO far as the relationships of the islands themselves are concerned the Bahaman group offers from the zoological standpoint an apparently simple case. As a coral formation arising from the Bahaman banks we may regard them as oceanic and of independent origin. In an analysis of their fauna, therefore, we are not confronted by the perplexing problems which beset us in studying the larger West Indian Islands, where a probable connection with the mainland greatly enlarges the scope of our inquiry, and renders more involved the questions to be determined. Here, however, we have an area which has not been populated by a past connection with contiguous regions, but owes its life to the more or less fortuitous occurrence of the ancestors of the species which now inhabit it. Primarily through the resulting isolation the original forms have in many instances become evolved into what we term new species, whose range is restricted to one or more of the islands in question. The Bahamas possess no indigenous terrestrial Mammalia, and thus conform to the law which generally obtains among oceanic islands. The two or three species of Mus which are found there have evidently been introduced through artificial means.

Birds, however, possessing in their power of flight a most effective means for extended wanderings, have found the intervening waters no bar to their occupation of the Bahamas. The islands furnish them with resting places in their migrations, with homes during the rigors of a northern winter, with breeding grounds during the summer, or with a permanent habitat, beyond which they are unknown.

We may imagine these islands as at first barren coral reefs and sand-bars, tenanted alone by gulls, terns, and other pelagic species, as indeed some of the islands are now. But, devoid of a vegetation which, through its fruit or support of insect life, would furnish food, no land bird could exist there. Increasing vegetation finally rendering them habitable, they were ready to receive the first-comers of a future avifauna. This, as we shall see, has been supplied from various sources, and there have now been recorded from the Bahamas about one-hundred-and-fifty-six species and subspecies of birds. The influences which have been most active in producing this fauna we may discuss after we have reviewed the fauna itself.

Of the one-hundred-and-fifty-six species, seventy-two are water-birds of generally wide distribution, and, with two exceptions, we may dismiss them at once as in no way distinctively Bahaman. The remaining eighty-four land birds we may divide into non-breeding and breeding birds. The first class, or non-breeders, is composed of thirty North American species which find in the Bahamas either a winter home or a pathway for their migrations to and from the tropics. Although, as we have said, the islands afford many of these species congenial homes during the winter, the migratory habit is evidently too strongly developed to permit of their becoming permanent residents. Unless, therefore, they are residents in the same latitude on the mainland, apparently in no instance have they assisted in populating the Bahamas.

It is the second class, however, of breeding birds which claims our especial attention. Here it is we shall find the truly Bahaman species which give character to the avifauna. We owe our knowledge of this avifauna largely to the original investigations of Dr. Bryant, Mr. Cory, the naturalists of the "Albatross," and to Dr. Northrop. It is, however, far from complete. Several islands have as yet been unexplored, and we need more exact information concerning the distribution of many species. Dr. Northrop's recent paper on the birds of Andros is an important step in this direction, and his success in this field may well stimulate and encourage other workers. So far as we at present know, fifty-four species of land birds may be considered as breeding in the Bahamas. In our study of their relationships we may include two species of water birds whose comparatively sedentary habits have promoted their differentiation into Bahaman forms. These birds we may divide into two classes:

the first consisting of species of more or less general distribution, and not confined to the Bahamas; the second consisting of species and subspecies peculiar to the islands, beyond which they are, as a rule, unknown. The first class numbers thirty-two species, which may be summarized according to their distribution, as follows :

Cosmopolitan.—1, *Circus hudsonius ;* 2, *Falco peregrinus anatum ;* 3, *Pandion haliaëtus carolinensis ;* 4, *Strix pratincola.*

Continental.—1, *Cathartes aura ;* 2, *Falco sparverius ;* 3, *Ceryle alcyon.*

North American.[1]—1, *Accipiter velox ;* 2, *Antrostomus carolinensis ;* 3, *Agelaius phœniceus bryanti ;* 4, *Ammodromus savarnarum passerinus ;* 5, *Dendrœca vigorsii ;* 6, *Mimus polyglottus.*

Tropical.—1, *Columba leucocephala ;* 2, *Columbigallina passerina ;* 3, *Zenaida zenaida ;* 4, *Geotrygon montana ;* 5, *Crotophaga ani ;* 6, *Tyrannus domenicensis.*

West Indian.—1, *Chordeiles minor ;* 2, *Euethia bicolor.*

Cuban.—1, *Chrysotis leucocephala ;* 2, *Sporadinus ricordii ;* 3, *Tyrannus magnirostris ;*[2] 4, *Vireo altiloquus barbatulus ;* 5, *Dendrœca petechia gundlachii ;* 6, *Mimus gundlachii.*

Haytian.—1, *Speotyto cunicularia dominicensis.* 2, *Loxigilla violacea ;*[3] 3, *Dendrœca petechia ;*[2 3] 4, *Mimus elegans.*[2]

Porto Rica and Northern Windward Islands.—1, *Margarops fuscatus.*[2]

The second class numbers twenty-four endemic species and subspecies. In attempting to explain their specific affinities we shall be obliged to consider each one in connection with its allies.

1. *Rallus coryi.*—Known from two specimens taken on Andros. It is closely related to the *Rallus longirostris* group of rails of continental distribution.

2. *Ardea bahamensis.*—Found throughout the Bahamas. It is nearly allied to the North American *Ardea virescens*, which, ranging from Northern South America to Canada, is subject to more or less variation under favorable conditions.

[1] The species here given are all residents in Florida.

[2] Recorded only from Inaugua.

[3] Occurs also in Jamaica.

3. *Coccyzus minor maynardii.*—A resident representative of *Coccyzus minor*, a species of general distribution throughout the West Indies and coasts of the surrounding mainland. In Southern Florida it occurs only as a summer resident, and is not there distinguishable from the Bahaman bird.

4. *Saurothera bahamensis.*—Known only from Andros and New Providence. Allied species of this very distinct West Indian genus occur in Cuba, Jamaica, Hayti, and Porto Rica. The Bahaman species most closely resembles *Saurothera vieilloti* of Porto Rica. When we consider the limited power of flight now possessed by this species (Dr. Northrop states that he was told they could be captured after a short chase),[4] its appearance in the Bahamas is certainly remarkable. Nor can we here argue loss of flight-power through the influences of an insular existence, for the bird's congeners are no better adapted fcr extended journeys.

5. *Dryobates villosus maynardii.*—A common resident of Andros, New Providence, and Abaco. It differs very slightly from the Florida form, *Dryobates villosus audubonii.*

6. *Centurus nylanus.*

7. *Centurus blakei.*—This is one of five instances in which a Bahaman form has become further separated into two or more forms inhabiting different islands. *Centurus nylanus* is found on Wattling's Island, while *C. blakei* is known only from Abaco. They are closely related to each other, and also to their obvious ancestor the Cuban *Centurus superciliaris.*

8. *Doricha lyrura.*

9. *Doricha evelynæ.*—The first of these nearly related species is apparently restricted to Inaugua and Long Islands; the second has a wider range, and has been found on most of the remaining islands. The genus Doricha is Central American, and not elsewhere represented in the West Indies. The presence of these two species in the Bahamas is, therefore, not easily accounted for. *Doricha elizæ*, the most northern species on the mainland, is found in the vicinity of Jalapa. The Bahaman birds, however, more closely resemble *D. bryanti* of Costa Rica.

[4] *The Auk*, VIII., 1891, p. 74.

10. *Myiarchus lucaysiensis.*—This fly-catcher is evidently derived from the Cuban *Myiarchus sagræ*; indeed, some authors consider the birds inseparable.

11. *Blacicus bahamensis.*—A near relative of a West Indian group of fly-catchers, and probably closest to the Cuban *Blacicus carribeus.*

12. *Pitangus bahamensis.*—Related species occur on the four larger West Indian Islands. The Bahaman bird is probably nearest the Cuban *Pitangus caudifasciatus.*

13. *Icterus northropi.*—A well-marked species, known as yet only from Andros, where its discover, Dr. Northrop, found it not uncommon. It is an evident representative of the Haytian *Icterus dominicensis.*

14. *Spindalis zena.*

15. *Spindalis zena townsendii.*—The distribution and relationships of these birds are particularly interesting. The first is found in Andros, the second is apparently restricted to Abaco, while on the intervening island, New Providence, an intermediate and connecting form occurs. Spindalis is a characteristic West Indian genus; Cuba, Grand Cayman, Jamaica, Hayti, and Porto Rica each have distinct species, and quite recently a well-marked species has been described from Cozumel. Strange to say, the more northern of the Bahaman birds, *Spindalis zena townsendii* of Abaco, finds its nearest ally in this Cozumel species.

16. *Vireo crassirostris.*

17. *Vireo crassirostris flavescens.*—The center from which the species of this group of Vireos have originated is now difficult to determine. Their exact relationships to the North American *Vireo noveboracensis* and the Cuban *Vireo gundlachii* can be only questions of uncertain speculation. However, without determining their origin, we have in them a marked instance of the appearance of similar types in widely separated regions. *Vireo crassirostris* occurs in the western Bahaman Islands, subspecies *V. flavescens* in the eastern members of the group. Cuba has no near representative, but southward, on the island of Grand Cayman, we find *Vireo allenii*, a race so nearly resembling *V. c. flavescens* that Mr. Cory considers them to be inseparable. On

the mainlands at Yucatan the species reappears in *Vireo ochraceus*, which, although decidedly smaller than the island birds, exactly resembles them in coloration. On the islands of Old Providence, 250 miles north of Aspinwall, the species again is found, but here is nearer the West Bahama bird, *V. crassirostris*.

18. *Callichelidon cyaneoviridis.*—Callichelidon is the only genus of birds peculiar to the Bahamas. That this single instance should be among the swallows, birds possessing great power of flight, and generally having extended habitats, is indeed most remarkable. Mr. Scott's recent capture of this species in the Tortugas [5] is, so far as we know, the only occasion on which it has been found beyond the Bahamas. It has not been recorded from Cuba, and this is one of a number of cases where species which should occur there have not been recorded from that island. Indeed, our knowledge of Cuban birds may well be supplemented by much additional information before it can be considered complete. As has been said, *C. cyaneoviridis* in its generic distinctness stands alone among Bahaman birds, and unless it is a survivor of a once more widely distributed species it is difficult to give even a probable theory of its origin. It has no near West Indian relatives, unless the very different *Tachycineta euchrysea* of Hayti be considered as such, and it is perhaps as near to *Tachycineta thalassina* of Northern North America as to any other species.

19. *Certhiola bahamensis.*—One of a very distinct group of three species of peculiar distribution. *Certhiola caboti*, very closely related to *bahamensis*, is found in Cozumel, while the remaining species, *C. tricolor*, which inhabits the island of Old Providence, is nearer to *bahamensis* than to *caboti*.

20. *Geothlypis rostrata.*

21. *Geothlypis coryi.*

22. *Geothlypis tannerii.*—Three closely related forms inhabiting respectively the islands of New Providence, Eleuthera, and Abaco. Additional material will doubtless show, as Mr. Allen states, that the bird from Andros will constitue a fourth form. This is the fifth and by far the most interesting instance in which an

[5] *The Auk*, VII., 1890, p. 265.

established Bahaman species has become further divided into several insular races.

The genus Geothlypis is not found in the West Indies, and we are forced to consider the very distinct *Geothlypis trichas ignota* of Florida as the probable ancestor of the *rostrata* group. The supposition becomes more probable when we consider that *ignota*, in having a larger bill and more yellow below than the North American *Geothlypis trichas*, thus presents a distinct step towards the Bahaman species. In other words, although more nearly related to *trichas*, *ignota* is in a degree intermediate between it and *rostrata*. We dwell on this because the origin of the Bahaman bird is of special importance, although being evidently derived from the Florida form, it more nearly resembles, indeed is very similar to, *Geothlypis beldingii* of Lower California. Thus we find that quite independently of each other two birds whose habitats are separated by a continent have been evolved to almost specific identity. This instance is of great value in studying the relations of island faunæ, where the same type may appear on widely separated islands, and be replaced on intervening islands by a nearly related but still different species. We have noted somewhat similar cases in our remarks on Spindalis and *Vireo crassirostris* and Certhiola. May we not assume here that the intervening species is a common ancestor, and that by similar lines of divergence two forms have been produced which are more nearly related to each other than they are to the parent stock ?

23. *Polioptila cærulea cæsiogaster*.—A form differing very slightly from *P. cærulea*, which occurs both in Florida and Cuba.

24. *Mimocichla plumbea*.—A species closely related to *Mimocichla schistacea* of Cuba.

LIST OF BIRDS PECULIAR TO THE BAHAMAS, WITH THE SPECIES WHICH THEY APPARENTLY REPRESENT.

BAHAMAN SPECIES.	REPRESENTED SPECIES.
Rallus coryi.	*Rallus longirostris* group (Continental).
Ardea bahamensis.	*Ardea virescens* (Continental).
Coccyzus minor maynardi.	*Coccyzus minor* (Tropical).
Saurothera bahamensis.	*Saurothera vieillotii* (Porto Rica).

Dryobates villosus maynardii.	*Dryobates villosus audubonii* (Florida).
Centurus nylanus (Wattling's Island). *Centurus blakei* (Abaco).	*Centurus superciliaris* (Cuba).
Doricha lyrura (Inaugua, Long Island). *Doricha evelynæ* (Andros, New Providence, Abaco).	*Doricha bryantii* (Costa Rica).
Myiarchus lucaysiensis.	*Myiarchus sagræ* (Cuba).
Blacicus bahamensis.	*Blacicus barbirostris* group (Cuba, Hayti, etc).
Pitangus bahamensis.	*Pitangus caudifasciatus* group (Cuba, Jamaica, and Hayti).
Icterus northropii.	*Icterus domenicensis* (Hayti).
Spindalis zena. *Spindalis zena townsendii.*	*Spindalis pretrei* (Cuba).
Vireo crassirostris. *Vireo crassirostris allenii.*	(?)
Callichelidon cyaneoviridis.	(?)
Certhiola bahamensis.	*Certhiolo caboti* (Cozumel).
Geothlypis rostrata (New Providence). *Geothlypis coryi* (Eleuthera). *Geothlypis tannerii* (Abaco).	*Geothlypis trichas ignota* (Florida).
Polioptila cærulea cæsiogaster.	*Polioptila cærulea* (Cuba, Florida).
Mimocichla plumbea.	*Mimocichla schistacea* (Cuba.)

This completes our review of the endemic species and subspecies. We may now classify them according to the distribution of their apparent ancestors, and placing them with the land birds previously given as not peculiar to the Bahamas, summarize the avifauna exclusive of water birds, as follows. Bahaman forms obviously derived from the same ancestor, or from each other, are here included as one :

Habitat and Number of Represented Species.		Endemic.	Non-Endemic.
Cosmopolitan,	4	0	4
Continental,	5	2	3
North American,	5	0	5
Floridan,	3	2	1
Tropical,	8	2	6

West Indian,	2	0	2
Cuban,	12	6	6
Haytian,	5	1	4
Porto Rican,	2	1	1
Central American,	2	2	0
Uncertain,	2	2	0

We have said that the formation of the fauna we have just reviewed has, in the case of the land-bird element, been caused by more or less fortuitous circumstances. This in a measure is true. Inagua on the south is distant from Cuba and Hayti about fifty miles, Great Bahama on the north is distant from Florida sixty miles, while these islands are situated respectively thirty and ten miles from their nearest neighbors in the group. These in turn are separated from others by varying distances, never greater, however, than the distances first mentioned. Of Great Bahama we know nothing; no ornithologist has ever visited it. Of Inagua, we have some knowledge, and it has apparently served as a gateway for many species of West Indian origin which are now distributed throughout the Bahamas. Others, four in number, have not advanced beyond this portal. Once established on Inagua, the most difficult step would have been taken, and future ones become comparatively easy. It is not assumed that all the Bahaman species of West Indian origin have been derived through Inagua, though it is evident that some of them have, and we may in this way, through a northward movement among the more eastern islands, account for the distribution of the Cuban parrot, which is found on Abaco, but is unknown on Andros. We mention this island merely as a possible first step for future Bahaman birds. Our examination of the fauna renders in a degree apparent the chief cause which promoted this step.

As a rule, the land birds of oceanic islands have descended from or are non-sedentary species, whose habits render them subject to the influences of storms or trade-winds, the most potent factors in the formation of insular avifauna. For this reason we should not expect to find species of especially sedentary disposition forming a prominent part of an island fauna. Sedentary is not used here as meaning non-migratory alone, but also refers to those species which, being non-migratory, are at the same time species of retiring habits,—that is, are terrestrial or thicket-loving, and do not, as a rule, make extended flights. It is obvious that birds of this character would not be exposed to the action of storms and gales, and we rarely find them inhabiting islands. Wrens are excellent examples, and with the exception of a small group found on the southern Windward Islands, are unknown from the West Indies, although they are abundant on all the surrounding mainlands. The Carolina wren, one of the most common birds of Florida, has never been found in the Bahamas, nor indeed in Cuba. On examining the Bahama fauna, therefore, we find that the birds, although resident now, are descendants of, or are co-specific with, either migratory species or species whose non-sedentary habits have rendered them susceptible to the influences of that island populator, the wind, to which many Bahaman birds doubtless owe their original appearance on the islands. But we have also found that the descendants of the migratory species which have become endemic are residents in the same latitude on the mainlands. Birds of strictly migratory habits, therefore, are not apt to form a part of island life, unless the islands occur near the limits of their breeding habitats. The Bermudas are annually visited by large numbers of South American migrants, but the number of resident land birds is restricted to six.

Thus the Bahamas do not owe their avifauna to purely migratory species, but to the occurrence there of resident species from generally contiguous areas; and their original appearance may have been due to a gradual extension of range, or, as we have said, to their accidental occurrence through the influence of violent winds. With the exception of two bi-continental species, which throughout their ranges are subject to local specialization under favorable conditions, the endemic Bahaman birds are derived from species which in their generally limited ranges and close relationships with other species prove their susceptibility to the influences of their surroundings.

As to the causes which have produced differentiation in the forms we have just discussed, we can say very little. We may assume that changed conditions of environment acting on isolated species have resulted in their evolution into new species, presumably better adapted to their surroundings. But just what conditions have effected a given result we do not know. In the further division of a Bahaman species into two or more races the case becomes even more perplexing. We have not, then, different physiographic or climatic conditions to the influences of which we may ascribe observed changes. On the contrary, we find different forms of the same species inhabiting islands almost within sight of each other, where they are apparently subjected to similar conditions of existence. In several instances these differences, though here constant and characteristic, are not greater than those presented by individual variation in a larger series of a given species from one locality. Perhaps we can assume, then, that through the continued isolation of a comparatively small number of individuals certain characters, due originally to purely individual variation, have become perpetuated and specific. Among a smaller number of birds the extent of variation would, of course, be less; but this would be more than counterbalanced by the fact that any new character would be far more likely to be preserved through a forced interbreeding of closely related individuals.

Of the age of the Bahaman avifauna we can, of course, judge only by comparison. But the conditions which govern any given areas vary so greatly that even in this way we can form only an approximate idea of the relative age of their faunæ.

The isolation afforded by insular existence in tending to preserve new characters would at the same time hasten the consummation of permanent forms. The rate of divergence, therefore, is, without doubt, more rapid among island-inhabiting species than among those confined to the mainland.

From the comparative ease with which we have been able to trace the specific relationships of most of the endemic birds, and, with one exception, from the absence of peculiar genera, it is probable that the Bahaman avifauna is of recent origin. Being so largely derived from, it is, of course, more recent than, that of the larger West Indian Islands, where sixteen endemic genera occur; indeed, is not so old as the avifauna of the Windward group, where seven endemic genera are found. Perhaps in distinctness from related species the avifauna may be compared with that of Grand Cayman, an island situated 175 miles south of Cuba, and 200 miles northwest of Jamaica. The character of the formation of this island I do not know; Commander Bartlett has said of it, with Little Cayman and Misteriosa Bank, that they are the summits, fast appearing above tide-mark, of a submarine range having an average height of nearly 20,000 feet.

Through Mr. Cory's collectors and the naturalists of the "Albatross" Grand Cayman has been thoroughly explored, and fifteen endemic species and subspecies have been found there. These are largely derived from Cuban birds, and eleven of them are generically represented in the Bahamas.

From this review of Bahaman bird life we may presume to offer the following conclusions:

First.—The Bahamas are largely West Indian in their affinities, and the group of islands may claim the rank of a fauna of the Antillean region, characterized by the presence of forms differentiated from their West Indian ancestry and by the infusion of a slight Floridan element.

Second.—A greater number of endemic species have been derived from Cuba than from any other region.

Third.—North American migrant species which breed in higher latitudes, while occurring in great numbers in the Bahamas, at certain seasons of the year, have not assisted in forming the resident avifauna.

Fourth.—The avifauna is of comparatively recent origin.

Fifth.—Forms of a common ancestor may be differentiated from this ancestor in much the same manner, and thus, though having widely separated habitats, more closely resemble each other than they do the parent species.

Sixth.—In several instances certain Bahaman forms inhabiting contiguous islands have become differentiated from each other without, so far as we can observe, being subjected to changed climatic or physiographic conditions.

Seventh.—We may, perhaps, assume from this that these birds originally owe their characters to individual variations which, among a number of individuals, have become permanent.

ON THE GENUS CHLAMYDOPHORUS.

BY DANIEL D. SLADE.

THE Chlamydophoridæ of the group Loricata in the order of the Edentata comprises two species: *C. truncatus* and *C. retusus.* Chlamydophoridæ—Dorsal disk divided into a dorsal and a pelvic shield; pelvic shield agglutinated to the pelvis; feet strong; toes united; claws large. *C. truncatus*—Dorsal shield only attached by the middle of the back, which is covered with hair on the sides. *C. retusus*—Dorsal shield attached to the skin of the back to the edges. Both are extremely rare, and present very singular osteological modifications. The recent arrival of a mounted skeleton of the Pichiciego, *C. truncatus*, at the Museum of Comparative Zoology, in Cambridge, has induced me to bring together the few facts which constitute our present knowledge of these interesting Edentates. It is now about sixty-five years since the first description of *C. truncatus* was given by Dr. Harlan, of Philadelphia, and published in the New York *Lyceum of Natural History.* In 1828 the result of the investigations of Mr. Yarrell upon a second specimen received in England was published in the London *Zoological Journal.* But strange to say, neither he nor Dr. Harlan had recognized the bony shield and its relation to the pelvis, which constitutes its unique character among living mammals,—an oversight which may be explained by the anxiety to preserve intact the skin with its coat of mail, to accomplish which it was thought necessary to sever the bony processes by which the shield is connected with the pelvis. In 1855 a full descriptive monograph upon the *C. truncatus* was published by Prof. Hyrtl, of Vienna, in which full justice was done to its anatomy. In 1857 a short publication on the structure of the pelvis of the *C. truncatus* was made by Dr. J. E. Gray, of England; and in 1870 an interesting paper was read by Mr. Edward Atkinson, "On Some Points of Osteology of the Pichiciego," before the British Association, at Liverpool. In 1880 some interesting notes by E. W. White were published in the Proceedings of the Zoological Society. Since this, I find scarcely an observation or allusion to the subject.

Apart from its remarkable conformation, a certain interest attaches to the animal under consideration, due to its singular scarcity. There are but few specimens in the museums of the world. In Europe twelve to twenty only are known, and in our own country there are not more than six or eight, for some of which fabulous prices have been paid. The Pichiciego's sole habitat is in the neighborhood of Mendoza, in the interior of Chili, South America, at the base of the Andes, a country well noted for its terrible earthquakes. Our knowledge of its habits is very limited It is nocturnal; it passes most of the time in the sand-burrows which it makes; is extremely timid; is rarely seen, and very rarely captured, except when accidentally discovered nestled within the blankets of Indians who are sleeping upon the ground. Its food is said to be chiefly that of worms, and in this respect, as much as in its general subterranean habits, it resembles the European mole.

The entire external surface of the body is covered with a fine, white, silken hair, more delicate even than that of the mole. Over this is a shield, cloak, or covering, composed of a series of plates of a texture which resembles thin sole leather, covering the superior portions of the cranium, and extending half round the body for its entire length. This "coat of mail" is made up of twenty-four cross-series of quadrangular plates, counting from the vertex, the posterior edges of each row covering the anterior of the one immediately succeeding. The posterior truncation, formed by a sudden curving of the shield at a right angle to the body, is also composed of plates similar to those upon the back, but disposed in half circular rows, of which there are five. The lower margin of this surface at about its center presents a notch, beneath which passes the caudal extremity, also protected by plates. The semicircular margin of the truncated portion, as well as the lateral margins of the shield, are fringed with the same silken hair, that of the exterior ring of the truncated portion forming a double, somewhat bristly ridge, standing out at right angles.

Upon the cranium the dermal plates descend from the vertex to the snout in gradually narrowing series, being attached to the frontal protuberances, of which I shall presently speak. The extent of its attachment to the dorsal shield in the middle of the back varies; it would seem to be connected to the spinal metapophyses by a loose cuticular tissue, and posteriorily more intimately to the osseous pelvic shield beneath.

There is no distinct pinna,—only a slight elevation of cartilage at the external meatus. The small, entirely black eye is scarcely visible, deeply covered as it is by the intermingling of the hairy fringe and mantle. The mammæ are pectoral, two in number. The testes are abdominal. The entire length of the skeleton from the tip of the snout to the pelvic shield varies very slightly from five inches.

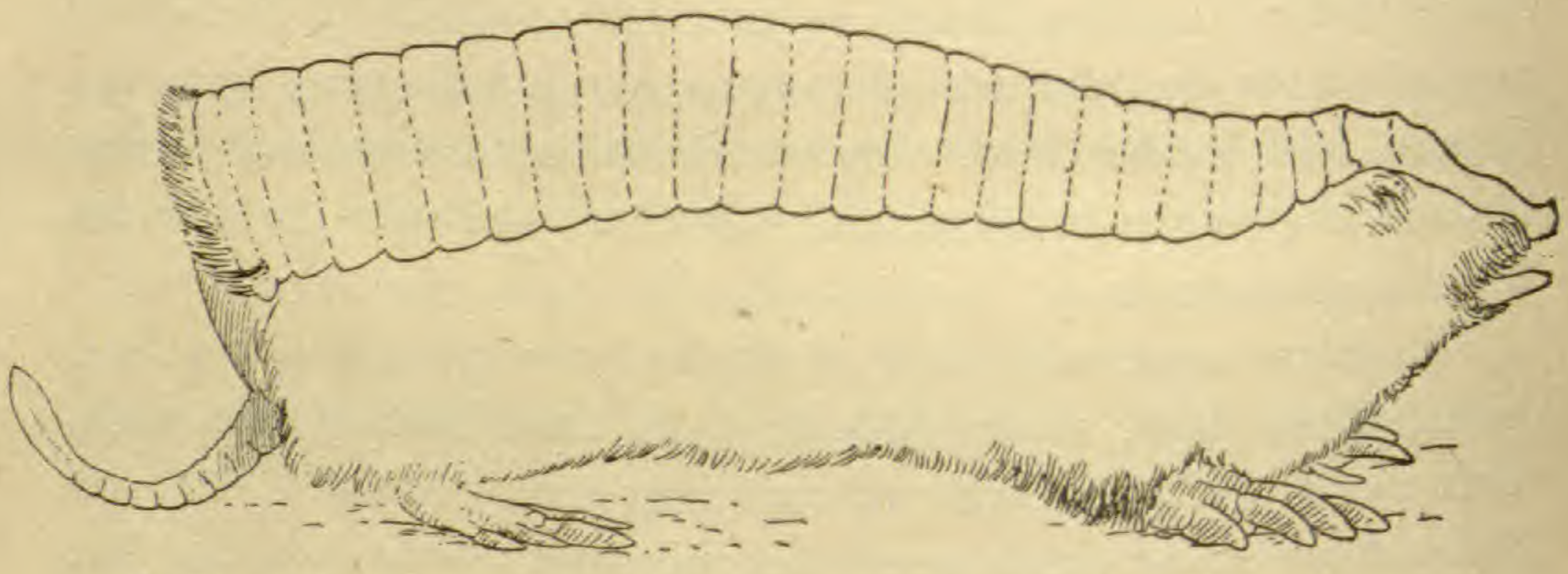


FIG. 1.—*Chlamydophorus truncatus* Harl.; two-thirds natural size.

The cervical region of the vertebral column presents the usual anchylosed condition of the centra of the second, third, and fourth vertebræ, with the rudimentary development of the arches and neural spines, commonly found in the Dasypodidæ. The metapophyses of the two last dorsal and three first lumbar vertebræ are elongated for the attachment of the dermal coat. The sacral vertebræ are uniform in number and arrangement with the corresponding bones of *Dasypus unicinctus*, but in the conformation of the pelvis, as shown in the wide separation of the pubes and the growing together of the tuberosites of the ischium, whence is produced the "sphœroma ischii," that "verum prodigium osteologicum" of Professor Hyrtl, there is a wide difference. For the proper understanding of the conformation of this singular pelvic shield the specimen should be before one. Without this aid, and even with the assistance of drawings, the admirable description of Professor Hyrtl can with difficulty be comprehended. But I have no better resource than to translate his words: "Three longitudinal crests spring up from the dorsum of the sacrum, of which the middle one absorbs, as it were, the two lateral, at a point just behind the ischiatic foramen; thus only one remains. This, in the shape of a long, perpendicular, thin, pellucid plate, perforated in many places, is produced throughout the entire length of the sacrum, and posteriorly is lost in the sphœroma. The middle crest at the spot where the meeting of the lateral ones produces a bony mass is transformed into a bony transverse plate, which is connected on either margin with a long and unusual process of the ischium, which I call the ascending.

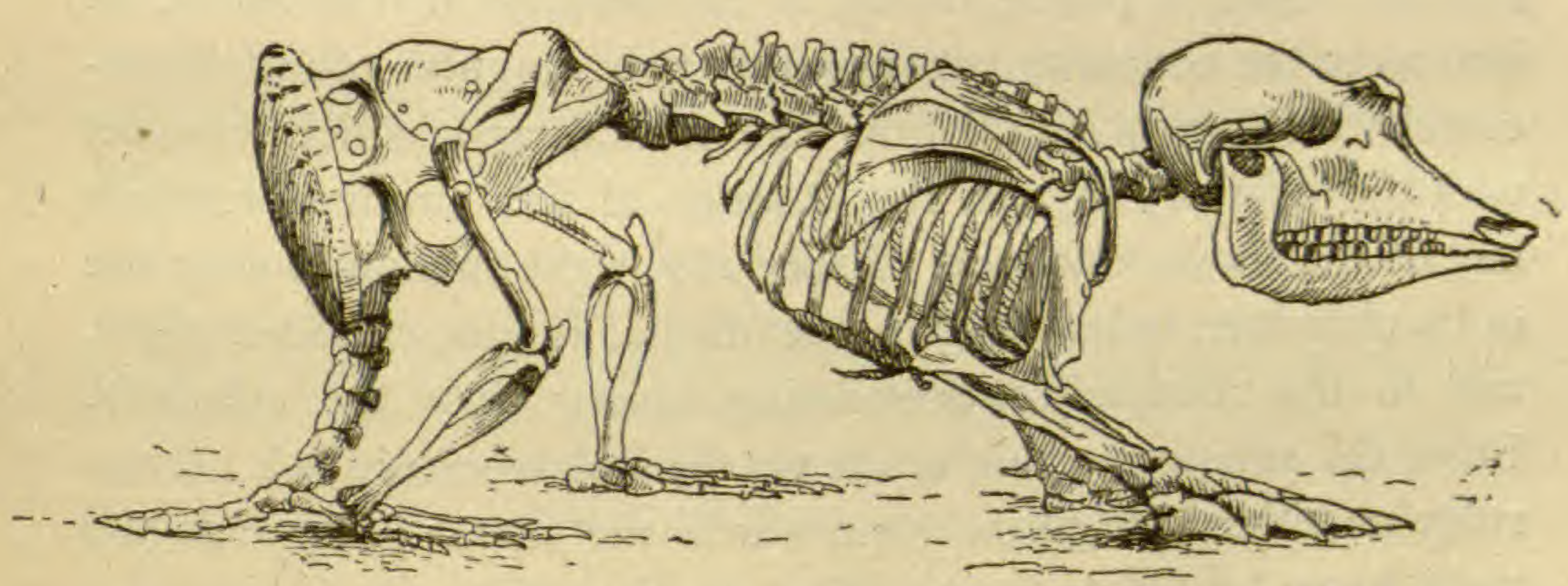


FIG. 2.—*Chlamydophorus truncatus* Harl.; two-thirds natural size; skeleton.

From the dorsal face of the transverse lamina two round, bony columns rise and become supports to the sphœroma. Thus this wonderful sphœroma is connected to the pelvis by five fulcra. The two first and principal ones arise from the ischia, the two middle are the two columns erected on the transverse lamina of the sacral crest, and the highest is the termination of the median crest."

Since the strongest fulcra of the shield are found in the place where in other Dasypodidæ the tubera ischii reside, it would seem evident that this unusual structure springs from the confluence of the tuberosites. Its shape is that of a semi-circular disc, with its convex margin upwards, which is thicker than the lower margin. It is vertical in position, and the smooth posterior surface is ornamented with semi-circular rows of foramina and fissures "which give insertion to the short, tough fibres by which the dermal coat is bound to the shield throughout." According to the dissection of Mr. Atkinson, the sphœroma is completely invested on *both* its surfaces by the common integument of the body, so that the anterior concavity and the bony fulcra inplanted into it are clothed with hairy skin, reflected from the back, while the posterior surface is covered by the closely adherent continuation of the dermal horny coat. The caudal vertebræ are fourteen in number; the transverse processes of the eighth, ninth, tenth, and eleventh are elongated so as to produce a spatulate condition of the organ.

The cranium is conical, capacious, compressed, and without sutures. Seen in profile, owing to the elevation of the vertex, as well as to the concavity between the two singular rounded processes which are given off from the frontal and which connect with the olfactory organs, the contour of the cranium reminds one of the Indian elephant. Especially is the mandible ungulate in its character, in its depth, perpendicular ramus, rounded angle, and in the condyloid process being longer than the coronoid. From the anterior portion of the two frontal tuberosities a narrow ridge on either side converges towards the nose. The elongate nasal bones terminate at an orifice, opening downward.

The dental system is composed of eight molars on either side of both jaws. The teeth are long, cylindrical, have no true roots or crowns, are encircled by enamel, are so deeply set that those of the mandible dimple its inferior margin. They are slightly curved. The orbital and temporal fossæ are not separated. The zygomatic arch is slender posteriorly, but anteriorly it is more developed with a descending process from the malar.

The external meatus auditorius is prolonged in the form of a long, winding, cylindrical osseous tube, ascending behind the articulation of the jaws, and, arching over the roof of the zygoma terminates in an aperture just behind the eye. This osseous tube is composed of two separate pieces, which are joined by an interposed ring of cartilage. This very remarkable auditory apparatus suggests a similitude to the common ear-trumpet used by the deaf, particularly as it is capable of limited movements.

The præsternum is broad for the articulation of the first rib. It has also a sharp crest or keel upon its anterior surface, being decidedly bird-like in its character.

The scapula presents several modifications. The prescapular border is deeply notched; the posterior border of the postscapula is greatly elongated, being sickle-shaped. The dorsum has a second spine, smaller, but parallel to and beneath the true spine. The acromion is very long, passing forwards, downwards, and inwards over the head of the humerus to be articulated with the complete clavicle. The humerus, large and broad, has a prominent deltoid ridge. The epicondyles are both much produced transversely, the inner one being perforated. The radius is small; the ulna much flattened, with an olecranon process nearly as long as the shaft. The first and second digits of the manus are slender and elongated, and both have the normal number of phalanges. The other three have the metacarpal short and broad, the proximal phalanx suppressed, the middle very short, and the ungual phalanges enormously developed, that of the third being the longest.

The femur is large and strong, with a well-developed third trochanter. The tibia and fibula are firmly anchylosed at each extremity, and arched in opposite directions. The os calcis is elongated backwards and flattened. The pes is normal in type, and presents no modifications. Both manus and pes are plantigrade.

The following abstracts are from the notes on *C. truncatus* by E. W. White, F.Z.S., London, published in the Transactions:

"I was induced in August, 1879, to undertake a ride of forty leagues from Mendoza, and a diligent search for six days, in company with a large number of men, in order to obtain a better knowledge of its habits. I was fortunate enough to secure one living specimen of *C. truncatus*, which, in spite of the utmost attention, survived capture only three days; in fact, no instance has occurred of a longer survival in captivity than eight days.

"The usual drawings of this animal in zoological works are erroneous in more than one particular.

"1st. The tail is represented as flexible, and terminating in a somewhat flattened, though, on the whole, solid, pointed paddle, whereas it is almost perfectly inflexible, the paddle at the extremity being completely flattened and rounded at the vertex.

"2d. The fringe issuing from the ultimate and large ring of the dorsal carapace, instead of being drooping, as often depicted, where it unites with that of the exterior ring of the truncated extremity, forms a double, somewhat bristly fringe, standing out well at right angles to that truncated extremity.

"3d. The lateral edges of the dorsal chitinous shield are sharply serrated, instead of forming a continuous wave-line.

"4th. The eye, instead of being distinctly visible, is rudimentary and hidden by the fringe and mantle.

"5th. The projection of the slightly convex truncated extremity is very exactly a section of a circle, the center of which is a point whence issues the tail, the whole of this truncated armor plate forming a very hard, solid, bone-like structure, which at once suggests the use to which it is devoted,—viz., to act as a rammer to consolidate the sand and to fill up the entrance to its burrow, from the inside, and thus prevent the ingress of its enemies.

"6th. When walking, the *C. truncatus* plants both fore and hind feet on the soles, and not on the contracted claws, as is the case with the ant-eater, carrying its inflexible tail, which it has no power to raise, trailing along the ground and inclined downwards from the body. As it commences to excavate, the fore feet are first employed, and immediately afterwards, supporting its body on the tripod formed of these and of the extremity of the tail, both hind feet are set to work simultaneously, discharging the sand with incredible swiftness. Although analogy and form would seem to indicate it, I never could detect the tail aiding in the operation of excavation; in fact, its inflexibility precludes this idea. The only use of the flattened extremity appears to me to be to furnish it with a more secure point of support in the shifting sands.

"Sluggish in all its movements, except as a fodient, in which capacity it perhaps excels all burrowing animals, the *C. truncatus* performs the operation of excavation with such celerity that a man has scarcely time to dismount from his horse before the creature has buried himself to the depth of his own body. The tunnel scooped out, of the exact size of the truncated extremity, presents three ways of exit.

"The light, fine sand in which it burrows proclaims unmistakably its presence by the tracks left. Besides the impressions of the four feet, the inclined, stiff tail leaves its deep, central, indented line. If the tracks were numerous the animal would no longer be rare, but it is a fact that a year or more sometimes elapses without any trace of its existence. Occasionally specimens have been unhoused by the plow. I could not succeed in discovering the nature of the food from the solitary live specimen which I obtained, but I fed it on milk, which it lapped like a cat.

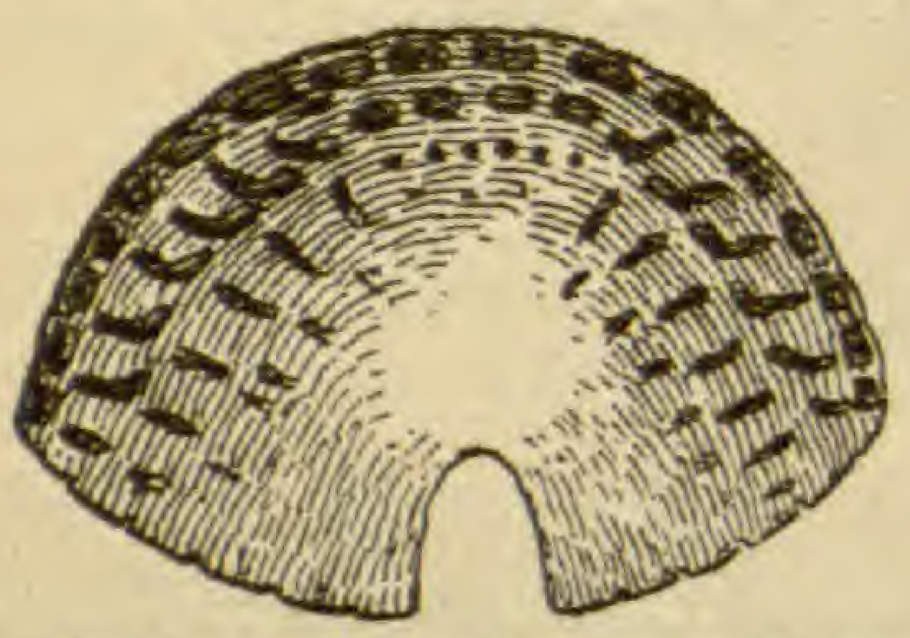


FIG. 3.—*Chlamydophorus truncatus* Harl. Pelvic shield from behind; two-thirds natural size.

"This delicate little animal is extremely susceptible to cold. My living example, after passing a night in a box of earth covered with flannels, was found the following morning in a very exhausted condition. Wrapped in warm clothing, and placed near the fire, it soon revived. Its normal paradise seems to be when the temperature of its residence is such as is produced by sand so hot as almost to scorch the hand. During the summer it leaves its burrow at dusk to search for food, and, being truly nocturnal, moonlight nights are very favorable for discovering it."

Mr. White thinks that the use of the fringe surrounding the shield is solely to prevent the introduction of sand beneath it during excavation.

The only description of *Chamydophorus retusus* is in the short monograph by Dr. Hermann Burmeister, Director of the Museum of Buenos Ayres.[1] This museum contained in 1863 the only specimen then known. The animal is a native of Bolivia, and its habitat the neighborhood of Santa Cruz. No one of the natives, says Dr. Burmeister, had ever seen the animal, until they were shown the one captured by St. Martin at Pari, Santa Cruz. They were aware that there was an animal which lived underground,

[1] Abhandlungen der Naturforschenden Gesellschaft zu Halle, 1863.

and to which they gave the name of Lloron, meaning a new-born infant, from the peculiar cries it made. Dr. Burmeister gives an amusing account of its capture, and the celerity with which it threw out the sand, supported by the hinder parts in its effort to escape by burrowing.

C. retusus is larger than *C. truncatus*, and has one or two bristles on the hinder edge of the dorsal shield, with many bristles on the lower edge of the lateral portions. The upper part of the pelvic shield has pencils of bristles. There is a well-developed pinna.

RECORD OF AMERICAN ZOOLOGY.

BY J. S. KINGSLEY.

(Continued from Vol. XXV., page 355.)

LEPIDOPTERA.

SMITH, J. B.—Contribution toward a monograph of the insects of the Lepidopterous family Noctuidæ of temperate North America.—Revision of the species of the genus Agrotis. Bull. U. S. Nat. Mus., No. 38, 1890.—An exhaustive paper of 231 pages. *Vide* AM. NAT., XXIV., p. 1090, 1890.

FERNALD, H. T.—External markings of Pupæ. *Zool. Anz.*, XIII., p. 47, 1890.—Reference to literature.

KELLICOTT, D. S.—Our injurious Ægerians. AM. NAT., XXIII., p. 1106, 1889 (1890).

SMITH, W. W.—*Carpocapsa pomonella* in New Zealand. *Ent. Mo. Mag.*, XXVI., p. 218, 1890.

BEHR, H. H.—Double broods of *Argynnis calippe*. *Zoe.*, p, 211, 1890.

PACKARD, A. S.—The life-history of *Drepana arcuata*, with remarks on certain structural features of the larva, and on the supposed dimorphism of *Drepana arcuata* and *Dryopteris rosea*. Proc. Bost. Soc. N. H., XXIV., p. 483, 1890.

——Hints on the evolution of the bristles, spines, and tubercles of certain caterpillars, apparently resulting from a change from low-feeding to arboreal habits; illustrated by the life-histories of some Notodontians; *l. c.*, p. 94, pls. 2, 1890.

BEHRENS, Jas.—Notes on Lepidoptera. *Zoe.*, I., p. 60, 1890.—Captures of *Lycæna regia* and 5 Papilios in California.

LORD WALSINGHAM.—Notes on the genus Argyresthia Hb. with descriptions of new species. *Insect Life*, III., p. 117, 1890.—New species are *A. cupresella* (Cal.), *freyella* (Tex.), *plicipunctella* (?)

PATTON, W. H.—Notes upon *Ephestia interpunctella*; *l. c.*, p. 158, 1890.

WALKER, PH.—Silk culture: Report of the year's operations. Rep. Dep. Agr. for 1888, p. 3, 1889.

MARLATT, C. L.—Swarming of *Lycæna comyntas*. Trans. Ent. Soc. Washington, I., p. 206, 1890.

SWARTZ, E. A.—Interesting food-plant of *Pieris rapæ*; *l. c.*, p. 250, 1890.—*Cakile americana.*

LUGGER, OTTO.—On the migrations of the milkweed butterfly; *l. c.*, p. 256, 1890.

MARLATT, C. L.—Abundance of oak-feeding Lepidopterous larvæ in the fall of 1889; *l. c.*, p. 259.

SLOSSON, A. T.—Larvæ of *Seirarctia echo*. *Entom. Amer.*, VI., p. 8, 1890.

DYAR, H. G.—Preparatory stages of *Plusia californica*; *l. c.*, p. 14, 1890.

——Preparatory stages of *Heterocampa subrotata*. *Entom. Amer.*, VI., p. 209, 1890.

SMITH, J. B.—A new Morrisonia; *l. c.*, p. 211.—*M. rileyana* (Fla.)

BEUTENMÜLLER, W.—Preparatory stages of *Samia cynthia*; *l. c.*, p. 216, 1890.

——Description of the preparatory stages of *Datana angusii*; *l. c.*, p. 219.

SMITH, J. B.—A new Copipanolis; *l. c.*, p. 220.—*C. stigma* (Fla.)

DYAR, H. G.—Preparatory stages of *Schizura leptinoides*; *l. c.*, p. 230, 1890.

EDWARDS, W. H.—On certain statements in Scudder's Butterflies of New England. *Canad. Ent.*, XXII., p. 61, 1890.

BRUCE, D.—A rainy day on the mountains. *Can. Ent.*, XXII., p. 67, 1890.—List of Colorado moths.

GROTE, A. R.—The Noctuidæ of Europe and North America compared. *Can. Ent.*, XXII., pp. 69, 105, 145, 1890.

BEUTENMÜLLER, W.—Food Plants of Lepedoptera. No. 13. *Ent. Amer.*, VI., 16, 1890.

SCHAUS, WM., JR.—New species of Mexican Lepidoptera; *l. c.*, p. 18, 1890.—*Caria melicerta*, *Lasaia sessilis*, *Theope eupolis*, *Th. bacenis*, *Enyo tædium*, *E. riscus*, *Calliomma germen*, *Pergesa mexicana.*

SMITH, J. B.—A new species of Feralia; *l. c.*, p. 26, 1890.—*F. major* (N. H., N. Y., D. C.)

——A new species of Oncocnemis; *l. c.*, p. 30, 1890.—*O. extremis* (Brit. Columb.)

MACHESNEY, C. P.—Notes on *Zeuzeura pyrina; l. c.*, p. 31, 1890.

NEUMŒGEN, B.—New beauties from near and far; *l. c.*, p. 61, 1890.—*Parnassius smintheus* var. *nanus* (Brit. Columb.), *Arctia dieckii* (B.C.), *Sphingicampa bisecta* var. *nebulosa* (no loc.), *Horama jalapensis* (Mex.) *Ira* (n.g.) *gundlachiana* (Cuba).

SCHMIDT, P. J.—A melanic *Argynnis bellona; l. c.*, p. 70, 1890.

DYAR, H. G.—Preparatory stages of *Arachnis picta* Packard. *Entom. Amer.*, VI., 73, 1890.

BEUTENMÜLLER, W.—Descriptions of the preparatory stages of *Edema albifrons; l. c.*, p. 75, 1890.

SMITH, J. B.—A new species of Agrotis; *l. c.*, p. 76, 1890. *A. atristrigata* (Brit. Columb.)

——A new species of Botis; *l. c.*, p. 88, 1890.—*B. nelumbalis* (N. J.)

FERNALD, C. H.—A bit of history; *l. c.*, p. 112, 1890.—Date of Zeller's "Crambidæ."

EDWARDS, HY.—Some apparently new Noctuidæ in the collection of the British Museum; *l. c.*, p. 114, 1890.—*Herrichia cervina* (Cal.), *Annaphila casta* (Oreg.), *Euclidia annexa* (Oreg.)

DYAR, H. G.—Preparatory stages of *Arctia dota; l. c.*, p. 117, 1890.

SMITH, J. B.—New species of Tæniocampini. *Ent. Amer.*, VI., p. 121, 1890.—*Tæniocampa carminta* (Col.), *T. curtica* (Cal.), *T. addenda* (Cal.), *T. venata* (N. Y.), *Perigonica* (n.g.) *angulata* (Cal.), *P. fulminans* (Col.)

DYAR, H. G.—The genus Datana; *l. c.*, p. 127, 1890.—Synopsis of N. A. species.

SLOSSON, A. T.—*Varina ornata. Entom. Amer.* VI., p. 136, 1890.

SKINNER, H.—A new Pamphila; *l.c.*, p. 138, 1890.—*P. slossonæ* (Fla.)

SMITH, J. B.—A new species of Plagiomimicus; *l. c.*, p. 139, 1890.—*P. triplagiatus* (N. Mex.)

DYAR, H. G.—Preparatory stages of *Dilophonota edwardsii* and *D. ella; l. c.*, p. 141.

SMITH, J. B.—Contribution towards a monograph of the Noctuidæ of temperate North America. Revision of Scopelosoma, *Ent. Amer.*, VI., p. 147, 1890.

GROTE, A. R.—The North American Eustrotiini; *l. c.*, p. 161, 1890.

NEUMŒGEN, B.—New species of Arctians. *Ent. Amer.*, VI., p. 173, 1890.—*Arctia favorita* (Col.), *Euchætes conspicua* (Col.), *Arachnis zuni* (New Mex.)

SMITH, J. B.—A new Bombycia; *l. c.*, p. 179, 1890.—*B. candida* (Fla.)

DYAR, H. G.—Preparatory stages of *Datana palmii; l.c.*, p. 181, 1890.

DYAR, H. G.—Arctiidæ of North America. *Can. Ent.*, XXIII., p. 43, 1891.—Synonymy of *Halesidota trigona.*

FLETCHER, J.—Popular and economic entomology. *Can. Ent.*, XXII., p. 41, 1890.—*Ephestia kühniella.*

FRENCH, G. H.—Some new Colorado moths. *Can. Ent.*, XXII., p. 44, 1890.—*Cossus brucei, Tolype distincta, Halesidota occidentalis, H. subalpina.*

EDWARDS, W. H.—Notes on *Erebia epipsodea. Can. Ent.*, XXII., p. 49, 1891.—Reprint from "Butterflies N. A."

FYLES, T. W.—*Gelechia gallædiplopapi* n. s. *Can. Ent.*, XXII., p. 248, 1890.

DYAR, H. G.—A new form of Cerura from California. *Can. Ent.*, XXII., p. 253, 1890.—*C. cineroides.*

FRENCH, G. H.—Preparatory stages of *Tolype velleda. Can. Ent.*, XXII., p. 255, 1890.

* EDWARDS, W. H.—Butterflies of North America. III. series, Part X., 1890.—*Argynnis alcestis, A. adiante, A. atossa, Satyrodes canthus.*

WRIGHT, W. G.—*Vanessa californica. Can. Ent.*, XXIII., p. 27, 1891.

FERNALD, C. H.—New. N. A. Microlepidoptera. *Can. Ent.*, XXIII., p. 29, 1891.—*Psecadia delliella* (Tex.), *Propexus magnificus* (Col.), *Schœnobius maximellus* (Tex.)

EDWARDS, W. H.—Description of a new species of Erebia, and notes on the so-called Chionobus bore of Colorado. *Can. Ent.*, XXIII., p. 31, 1891.—*E. ethela* (Wyoming).

THAXTER, R.—Food plants of some Bombycidæ and Noctuidæ not included in H. Edwards's catalogue. *Can. Ent.*, XXIII., p. 34, 1891.

DYAR, H. G—*Phragmatobia rubricosa. Can. Ent.*, XXIII., p. 40, 1891.

MOFFAT, J. A.—*Ællopos titan. Canad. Ent.*, XXII., p. 40, 1891.

BRUCE, D.—*Lepisesia flavofasciata. Can. Ent.*, XXIII., p. 42, 1891.

PATTON, W. H.—Scent glands in the larva of Limacodes. *Can. Ent.*, XXIII., p, 42, 1891.

SMITH, J. B.—A correction [to Arctiidæ, supra]. *Can. Ent.*, XXIII., p. 43, 1891.

DRUCE, H.—Description of new species of Lepidoptera (Heterocera) from Central and South America. Proc. Zool. Soc. London, 1890, p. 493.—New forms from limits of this record are: *Homœocera rodriguezi* (Guatemala), *Phœgoptera leda* (Dominica), *Ph. landia* (Trinidad), *Ph. alsa* (Dominica), *Arctia rodriguezi* (Guatemala), *Flavinia alcidamea* (Panama), *Edema lanassa, E. lata* (Panama), *Œdemasia alcimede* (Panama), *Hemiceras losa* (Trinidad), *Chasmina alcidamea* (Guatemala), *Celæna lilacina* (Panama), *Perigea agnonia* (Guatemala, south), *Caradrina alana*

(Panama), *Agrotis lamptera*, *A. limenia* (Guatemala), *Cosmia lavipra* (Panama), *Xanthia alala*, *X. alcandra* (Mex.), *Polia lavina* (Mex.), *P. ameria* (Guat.), *Anarta agonax* (Mex.), *Ardisura grandis* (Mex.), *Acontia splendens* (Panama), *Thalpochares lavonia*, *Th. lagore* (Mex.), *Xanthoptera laphyra* (Mex., Panama), *Callopistria agyra*, *C. langia* (Panama), *Plusia andra* (Guat.), *Plusiodes lavonia* (Panama), *Pl. agenoria* (Mex.), *Pl. alesa* (Panama), *Pl. laodamia* (Mex.). Packard's genus Coloradia reappears in Paraguay.

MARLATT, C. L.—Notes on the early stages of brier moths. Trans. Kansas Acad. Sci., XI., 1888 ['89].—*Nerica bidentata*, *Anisota stigma*, *Callimorpha suffusa*.

KELLICOTT, D. S.—Our injurious Ægerians. *Journ. Columbus Hort. Soc.*, V., p. 11, 1890.—Figures seven species.

ASHMEAD, W. H.—Report on an outbreak of the army worm, and on some other insects affecting grain, in Maryland. *Insect Life*, III., p. 53. 1890.

DYAR, H. G.—Description of certain Lepidopterous larvæ; *l. c.*, p. 61, 1890.—*Nola sexmaculata*, *Nerice bidentata*, *Schizura ipomϾ*, *Mamestra confusa*.

* DRUCE, H.—Descriptions of new species of Lepidoptera (Heterocera) from Central America. *Ann. and Mag. Nat. Hist.*, V., 1890.

* MÖSCHLER, H. B.—Abh. Senckenb. Naturf. Gesell. Frankfurt. —Lepidoptera of Porto Rico.

* GROTE, A. R.—Revised check-list of the North American Noctuidæ. Part I., Thyatirinæ–Noctuinæ. Bremen, 1890, pp. 52.

DYAR, H. G.—Two species of Lepidoptera new to our lists. *Ent. News*, I., p. 105, 1890.—*Callidryas statira* and *Composia fidelissima*, from Florida.

BUNKER, R.—Some experiences in larvæ-rearing; *l. c.*, pp. 108, 117, 1890.

BALLARD, JULIA P.—What can it be? *l. c.*, p. 124, 1890.—Wants information as to a large caterpillar.

BEUTENMÜLLER, W.—Description of the preparatory stages of *Datana contracta* Walker; *l. c.*, p. 144, 1890.

FRENCH, G. H.—Another tropical species of Lepidoptera in Florida. *Ent. News*, I., p. 153, 1890.—*Composia olympia*.

*——Ann. Soc. Ent. France, VI., ix., 1889–'90.—Describes new forms of Leptarctia from U. S.

WEBSTER, F. M.—Army-worm notes. *Insect Life*, III., p. 112, 1890.

COQUILLET, D. W.—The cypress-twig borer; *l. c.*, p. 116, 1890.

SMITH, J. B.—Contributions toward a monograph of the Noctuidæ of temperate North America. Trans. Am. Ent. Soc., XVI., 1889, p. 321.—Synopsis of Oconemis; 28 species, none new.

*DRUCE, H.—Descriptions of new species of Lepidoptera, chiefly from Central America. *Ann. and Mag. Nat. Hist.*, VI., iv., p. 77, 1889.

RIVERS, J. J.—A new species of Californian Lepidoptera. Proc. Cal. Acad., II., i., p. 103.—*Melitæa macglashanii.*

* SOULE, C. G., and ELIOT, I. M.—Notes on the early stages ot some Heterocera. *Psyche*, V., p. 259, 1889.

* HINCKLEY, H.—Second brood of *Callosamia promethea. Psyche*, V., p. 280, 1889.

* SOULE, C. G., and ELIOT, I. M.—Variation of color in the larvæ of *Sphinx gordius. Psyche*, V., 228, 1889.

* COCKERELL, T. D. A.—*Vanessa milberti. Entomologist*, XXII., p. 185, 1889.

* SMYTH, E. A.—Notes on the southern distribution of some common butterflies. *Psyche*, V., p. 347, 1890.

* ELWES, H. J.—The Argynnides of North America. Trans. Ent. Soc. London. Repr. *Psyche*, V., 308, 1890.

* ——A revision of the genus Argynnis. Trans. Ent. Soc. London., IV., p. 535, 1889.

* RIVERS, J. J.—The Argynnids of North America. *Psyche*, V., p. 328, 1890.

* SMYTH, E. A.—Notes on *Colias eurytheme* and *C. philodice. Psyche*, V., p. 334, 1890.

* FORBES, S. A.—The American plum-borer, *Euzophera semifuneralis. Psyche*, V., p. 295, 1890.

* GROTE, A. R.—North American Lepidoptera. Revised check-list of the North American Noctuidæ. Pt. I., Thyatirinæ–Noctuidæ. Bremen, 1890, pp. 52.

* PACKARD, A. S.—The partial life-history of *Pseudohazis eglanteria.* *Psyche,* V., p. 325, 1890.

* HOLMES, H.—Observations on *Saturnia io.* *Psyche,* V., p. 318, 1890.

SCUDDER, S. H.—Diary of a hibernating butterfly. *Psyche,* V., p. 330, 1890.

SMITH, J. B.—Preliminary catalogue of the Arctidæ of Temperate North America, with notes. *Can. Ent.,* XXII., pp. 52, 73, 100, 116, 141, 161, 175, 204, 230.

EDWARDS, W. H.—Correction of an error; *l.c.,* 75.—Eurynome vs. Erinna.

——Notes on a revision of the genus Argynnis by Henry J. Elwes; *l. c.,* p. 81, 1890.

BEAN, T. E—The butterflies of Laggan, N. W. T.; account of certain species inhabiting the Rocky Mountains in latitude 51° 25′. *Can. Ent.,* XXII., pp. 94, 126, 1890.

EDWARDS, W. H.—Description of a new species of Argynnis from Canada. *Can. Ent.,* XXII., p. 113, 1890.—*A. alberta.*

DANBY, W. H.—Food plants of *Melitæa taylori.* *Can. Ent.,* XXII., p. 121, 1890.

ROWLEY, R. R.—Causes of long pupal periods among Lepidoptera. *Can. Ent.,* XXII., p. 123, 1890.

GROTE, A. R.—*Hepialus quadriguttatus.* *Can. Ent.,* XXII., p. 124, 1890.

FRENCH, G. H.—Some new moths. *Can. Ent.,* XXII., p. 133, 1890.—*Crocota rosa* (Ohio, Tex.), *Platycerura gigantea* (Col.)

ELWES, H. J.—A reply to Mr. W. H. Edwards [supra]. *Can. Ent.,* XXII., p. 150, 1890.

LYMAN, H. H.—Notes on *Argynnis freya, chariclea,* and *montinus.* *Can. Ent.,* XXII., p. 181, 1890.

DYAR, H. G.—Partial preparatory stages of *Erycides batabano.* *Can. Ent.,* XXII., p. 211, 1890.

LYMAN, H. H.—Note on the occurrence of *Lepisesia flavofasciata.* *Can. Ent.,* XXIII., p. 8, 1891.—At Ormston, Canada.

WINN, A. F.—List of Lepidoptera taken at Little Metis (Rimouski Co.), P. Que. *Can. Ent.,* XXIII., p. 10, 1891.—107 species.

BEUTENMÜLLER, W.—Description of the preparatory stages of *Smerinthus excæcutus. Can. Ent.*, XXIII., p. 14, 1891.

TAYLOR, G. W.—*Hybernaria defoliaria* Linn. in Vancouver Island. *Can. Ent.*, XXIII., p. 15, 1891.

EDWARDS, W. H.—*Chionobas bore. Can. Ent.*, XXIII., p. 16, 1890.—In Colorado.

BEHR, H. H.—Classification of *Dryocampa riversii. Zoe*, I., p. 106, 1890—Belongs to Edema.

——Yosemite Lepidoptera. *Zoe*, I., p. 177, 1890.—List of 21 Rhopalocera, with notes on distribution.

LORD WALSINGHAM.—Steps towards a revision of Chambers' Index, with notes and descriptions of new species of [Tineina] continuation. *Insect Life*, II., p. 284, 1890.—*Cf.* NAT., XXIV., p. 450. New species are *Adela punctiferella* (Cal.), *A. æruginosella* (La.).—*Id., l. c.*, p. 322, 1890. *Coptotriche* (n. g.), *Fischeria ceanothi* (Cal.)

MURTFELDT, M. E.—An interesting Tineid. *Insect Life*, II., p. 303, 1890.—*Minesta melanella* n.sp. Larva mines in leaves of *Quercus obtusiloba.*

HOPKINS, C. L.—Mountain swarming of *Vanessa californica. Insect Life*, II., p. 355, 1890.

DYAR, H. G.—Preparatory stages of *Syntomeida epilais* Walker and *Scepsis edwardsii* Grote. *Insect Life*, II., p. 360, 1890.—Larva of first on oleander, of second on rubber tree.

APHANIPTERA.

JOHNSON, L. C.—The jigger-flea of Florida. Trans. Ent. Soc. Washington, I., p. 203, 1890.

DIPTERA.

RILEY, C. V., and HOWARD, L. O.—Anthrax parasitic on cutworms. *Insect Life*, II., p. 353, 1890.

WEBSTER, F. M.—Notes on a species of necrophagous Diptera. *Insect Life*, II., p. 356, 1890.—Larva of Conicira sp. in a disinterred corpse.

RILEY, C. V., and HOWARD, L. O.—The tulip tree gall-fly. *Insect Life*, II., p. 362, 1890.—Notes on *Diplosis liriodendri.*

——A peach pest in Bermuda. *Insect Life*, III., ix., 1890.—*Ceratitis capitata.*

* Bigot, J. F. M.—Ann. Soc. Ent. France, VI., ix., 1889–'90.—Describes from North America *Rhamphomyia morrisoni, R. pachymera, R. nigrita, R. geniculata.*

Curtice, C.—The animal parasites of sheep. Washington, 1890. —*Melophagus ovinus, Œstrus ovis.*

Osten-Sacken, C. R.—Correction to: Monographs of the Diptera of North America, Vol. I. Washington, 1862. Trans. Ent. Socy. Washington, I., p. 208, 1890.

Townsend, Tyler.—Notes on some interesting flies from the vicinity of Washington. Trans. Ent. Socy. Washington, I., p. 254, 1890.

——On the fall occurrence of Bibio and Dilophus; *l. c.*, p. 260, 1890.

Hamilton, J.—On the probable pollenization of greenhouse Chrysanthemums by *Eristalis tenax. Entom. Amer.*, VI., p. 81, 1890.

Wheeler, W. M.—On two new species of Cecidomyid flies producing galls on *Antennaria plantaginifolia.* Proc. Wisc. N. H. Socy., 1889, p. 209.—*C. antennariæ, Asynapta antennariæ* (Wisc.)

Wheeler, W. M.—Descriptions of some new North American Dolichopodidæ. *Psyche*, pp. 337, 355, 373, 1890.—*Dolichopus albiciliatus* (Wisc.), *D. incongruus* (Wisc.), *D. flagellitenens* (Wisc.), *D. henshawi* (Mass.), *D. germanus* (Wisc.), *Gymnopternus pœnitens* (Wisc.), *Chrysotus wisconsinensis, Ch. pratincola* (Neb.), *Ch. choricus* (Wisc.) *Diaphorus satrapa* (Nebr.), *D. palpiger* (Wisc.), *D. rauterbergi* (Nebr.), *Peloropeodes* (n. g.) *salax* (Wisc.), *Aphantotimus* (n. g.) *willistoni* (Wisc.), *A. fraterculus* (Wisc.), *Hydrophorus philombrius* (Wisc.) are new. Notes are given on other forms.

* Brauer, F., and Bergenstamm, J. Ed. v.—Die Zweiflügler des kaiserlichen Museums zu Wien. IV. Vorarbeiten zu einer Monographie der Muscaria Schizometopa (excl. Anthomyidæ) Denk. k. Akad. Wiss. Wien., Math. Nat. Classe, Bd., LVI., 1 Abth., p. 69, 1890.

Cockerell, T. D. A.—The Bigelovia Cecid. *Ent. Mo. Mag.*, II., 1, p. 109, 1890.—*Cecidomyia bigeloviæ.*

* Smith, J. B.—Notes on the structure and history of *Hæmatobia serrata. Psyche*, V., p. 343, 1890.

Riley, C. V., and Howard, L. O.—A grub supposed to have traveled in the human body. *Insect Life*, II, p. 238, 1890.

EDITORIAL.

EDITORS, E. D. COPE AND J. S. KINGSLEY.

PROFESSOR KARL VOGT, of Geneva, has been lecturing the naturalists, in the *Revue Scientifique*. Like a good blade he cuts both ways, for having hewed the theological Agag in pieces, he now reminds his fellow-workers that they, too, are no better than they ought to be. He quotes, with approval, the assertion of a modern author, that "in the early days of science the Creator dictated the laws; later, this function was attributed to nature; but now M. M. the naturalists have assumed the duty with much enthusiasm." Prof. Vogt's polemic is directed against the dogma promulgated by Agassiz, and which was then used by Haeckel as one of the foundations of the evolution hypothesis, that the embryologic and paleontologic records agree. He easily finds numerous examples where the earlier and primitive forms of life as revealed by paleontologic research do not agree with the embryonic stages of living types. He finds this to be true of both Vertebrata and Invertebrata, and then triumphantly asks, "Where is your fundamental biological law?"

As Prof. Vogt is no doubt aware, this is no new difficulty so far as regards the want of coincidence between the embryologic scale and that of living types. It was pointed out by Von Baer, the father of embryology. But the coincidences are so many that it was plain that an explanation had to be sought, which, if found, would harmonize the discrepancies. As long ago as 1868, in an article entitled the "Origin of Genera," the senior editor of this journal stated that explanation, and the progress of discovery has verified it, so that it is so far matter of common knowledge, that it is surprising that Prof. Vogt finds such a mare's-nest to-day. This essay showed the necessary distinction between "exact" and "inexact parallelism," and the reason for it. Haeckel has referred the same order of facts to two causes, which he termed "palingeny" and "cænogeny." In "palingeny" the complete phylogenetic record is preserved in the embryology (ontogeny); in "cænogeny" that record is not strictly adhered to. Now there are two kinds of "inexact parallelism." One of these is due to "cænogeny," where the record is not maintained, for various reasons.

The other kind of "inexact parallelism" exists only in the brain of the student, and this is what chiefly troubles Prof. Vogt. It is always apparent when one attempts to compare things which should not be compared.

If we compare, for instance, the embryologic record of a placental mammal with the adult non-placentals *as they now exist*, we will not get a parallel series, for the simple reason that both lines have long since abandoned their points of departure, and have added characters which were not present in their ancestors. The non-placentals are supposed with good reason to have been the ancestors of the placentals, yet the embryos of the latter, as is well known, do not possess marsupial bones nor inflected angles of the lower jaw. But it is also well known that a few existing Marsupialia do not possess either of these characters, and it is generally admitted that some of the Jurassic Mammalia resemble such Marsupialia most closely, and are probably the very ancestors for which we are looking. And so everywhere.

It was expressly pointed out in the paper mentioned, that in order to find "exact parallelism" it is necessary to compare the species which form the same single line of descent; and that in proportion as our comparisons depart from this line, by so much will the inexactitude appear. As regards the Vertebrata, it will not be long before we will be able to present several such lines, and ultimately many of them. In the lower animals the case will be more difficult as to their major characters at least, since these originated in such ancient geologic ages, and the structures themselves are generally so fragile, that some of the evidence must have been lost. "Cænogeny" is, however, most especially seen in animals with long periods of metamorphosis. Here the larva has a life of its own, subject to the same classes of stimuli as those which affect the adult. But the history of these changes, when unraveled, will present the same parallelism between the primitive and later forms of larvæ as does the adult evolution itself.—C.

SOME important extra-American explorations have been recently undertaken by our citizens. The U. S. Fish Commission steamer "Albatross," while on her way to the Pacific coast, recently conducted a series of sounding and dredging operations between the Central American coast and the Galapagos Islands, aided by

Prof. Alexander Agassiz, who accompanied the expedition. More recently Prof. G. Baur, of Clark University, has undertaken an exploration of the Galapagos, with the express object of making the fullest geological and biological researches. An expedition has been fitted out by Lieut. Peary, U.S.N., for the purpose of approaching as near to the North Pole as possible via Northern Greenland. He goes under the auspices of the Academy of Natural Sciences of Philadelphia, and is accompanied part of the way by Profs. Angelo Heilprin and Sharp, of that institution, and by Prof. Hoyt, of the Philadelphia High School. Mr. W. L. Abbott, of Philadelphia, recently returned from an extensive exploration of Central Africa, bringing with him several new vertebrates (including two antelopes) from Mount Kilimanjaro. He has recently returned, and will continue his researches.

At its last meeting the National Academy of Sciences elected two foreign associates: Prof. Karl Gegenbaur, of Heidelberg, and Dr. J. S. Stas, of Belgium. These gentlemen occupy the first rank in their respective pursuits, viz., comparative anatomy and chemistry. Their election confers honor both upon them and upon the Academy. Two vacancies existed in the membership at the time of the last meeting, but the Academy did not see its way clear to fill them, although eligible candidates were not wanting. The deaths of Hilgard, Leidy, and Le Conte have caused vacancies which will render more probable several elections next year.

Most of the Philadelphia members of the committee on reception of the International Congress of Geologists of 1892, have resigned from that body as an expression of their dissatisfaction with the change of place of holding the congress from Philadelphia to Washington, after the former had been adopted by the Bureau of the Congress. Prof. Leidy, who signed a protest against the change, has since died, and Prof. Heilprin, who did not protest, has since resigned. Prof. Lesley alone remains on the committee.

The new Scribner's Century Dictionary has an especial value to scientific men from the care its publishers have taken to represent fully the language of modern science. The editorship of Profs. Gill and Coues guarantees its excellence from the side of biology.

RECENT BOOKS AND PAMPHLETS.

AMEGHINO, F.—Los Plagiaulacideos Argentinos y sus Relaciones Zoologicas Geologicas y. Geográficas. Boll. del Inst. Geograf. Argentino, Tome XI., 1890. Lista de las Especies de Mamiferos Fosiles del Mioceno superior de Monte-Hermoso, Hasta Ahora Conocidas, 1888.—Rapidas Diagnosis de Algunos Mamiferos Fosiles Nuevos de la Republica Argentina, 1888.—Apuntes Preliminares sobre Algunos Mamiferos Estinguidos del Yacimiento de "Monte-Hermoso" Existentes en el "Museo la Plata." Ext. de la Entraga 1*a* del Tomo 1 del Bol. del Mus. La Plata, 1887.—Emuneracion Sistematica de las Especies de Mamiferos Fosiles Collecionadas por C. Ameghino en los Terrenos Eocenos de la Patagonia Austral y Depositados en el Museo La Plata. Ext. Tome I de Bol. del Mus. La Plata, Dec., 1887. From the author.

BECKER, G. F.—Antiquities from Under Tuolumne Table Mountain in California.—Notes on the Early Cretaceous of California and Oregon. Exts. Bull. Geol. Soc. Am., Vol. II., pp. 189–200, Pl. 7; pp. 201–208. From the author.

BRAINERD, E.—The Chazy Formation in the Champlain Valley. Ext. Bull. Geol. Surv. Am., Vol. II., pp. 293–300, Pl. 11. From the society.

BROWNE, M.—Revision of Dapedius. Reprint Trans. Leicester Lit. and Philos. Soc., October, 1890. From the author.

CAMPBELL, H. D., and W. G. BROWN—Composition of Certain Mesozoic Igneous Rocks of Virginia. Ext. Bull. Geol. Surv. Am., Vol. II., pp. 339–348. From the society.

CHANCE, H. M.—The Resources of the Black Hills and Big Horn Country, Wyoming. Read before the Am. Inst. Mining Engineers, September, 1890. From the author.

CHARENCEY, M. LE COMPTE DE.—Etude sur la langue Mam. Ext. der Compte Rendu du Congrès International des Americanistes me session Berlin, 1888. From the author.

CLUTE, O.—Education at the Michigan Agricultural College. From the author.

CREDNER, H.—Die Urvierfüssler (Eotetrapoda) des Sächsischen Rothliegenden. Sonder-Abdruck aus der Naturwissenschaftlichen Wochenschrift. From the author.

DALL, W. H.—On Dynamic Influences in Evolution. From the author.

DIXON, S. G.—Koch's Method of Treating Tuberculosis. Ext. *Medical News*, January, 1891. From the author.

DUPONT, E.—Notice sur Laurent-Guillamme de Konick. From the author.

EARLE, C.—On a New Species of Paleosyops. AM. NAT., January, 1891.

——Preliminary Observations upon Paleosyops and Allied Genera. Reprint Proc. Acad. Nat. Sci., Phila., January 27th, 1891. From the author.

EYERMAN, J.—Bibliography of North American Vertebrate Paleontology for the year 1890. From the author.

HAGERUP, A. T.—The Birds of Greenland, Translated from the Danish by F. B. Aungrimson.

HAY, O. P.—The Skeletal Anatomy of Amphiuma during its Earlier Stages. Reprint *Journ. Morph.*, Vol. IV., No. 1. From the author.

HILL, R. T.—A Brief Description of the Cretaceous Rocks of Texas and Their Economic Value. First Annual Report Geol. Surv. Texas. From the author.

HINDE, G. J.—Notes on Radiolaria from the Lower Paleozoic Rocks of the South of Scotland. Ext. *Ann. and Mag. Nat. Hist.*, July, 1890.

——A Geological Section Across the Piedmont Plateau in Maryland. Ext. Bull. Geol. Soc. Am., Vol. II., pp. 319–322.

——Stratigraphy of the Carboniferous in Central Iowa. Ext. Bull. Geol. Soc. Am., Vol. II., pp. 277–292, Pls. 9, 10. From the society.

LE CONTE, J.—Tertiary and Post-Tertiary Changes of the Atlantic and Pacific Coasts, with a Note on the Mutual Relations of Land-Elevation and Ice-Accumulation during the Quaternary Period. Ext. Bull. Geol. Surv. Am., Vol. II., pp. 323–380. From the society.

LUNDGREN, VON BERNHARD.—Ein Gavial aus dem Senon von Annetorp bei Malmö. Separat-Abdruck aus dem Neuen Jahrbuck für Mineralogie, etc., 1890, Bd. II. From the author.

LYDEKKER, R.—On a New Species of Trionyx. Ext. *Quart. Journ. Geol. Soc.*, February, 1891, Vol. XLVII. From the author.

MANIGAULT, C. E.—Notes on the Osteology of *Chinchilla lanigera*. Ext. Proc. Elliott Soc., May, 1890. From the author.

MASON, O. T., W. H. HOLMES, T. WILSON, W. HOUGH, W. FLINT, W. J. HOFFMAN, J. G. BOURKE.—Arrows and Arrow-Makers. Reprint *Am. Anthropologist*, January, 1891. From O. T. Mason.

Massachusetts State Agricultural Experiment Station. Bulls. 29 to 38, inclusive.

MOSES, A. J.—Notes on Blowpipe Analysis.—Mineralogy.—Tables for the Rapid Determinations of the Common Minerals by "External Signs," and by the Behavior of the Minerals before the Blowpipe. Reprints *School of Mines Quarterly*, Vol. XI., No. 4. From the author.

NEWBERRY, J. S.—The Genus Sphenophyllum. Ext. *Journ. Cin. Soc. Nat. Hist.*, January, 1891. From the author.

NEWTON, E. T.—On Some New Mammals from the Red and Norwich Crags. Ext. *Quart. Journ. Geol. Soc.*, August, 1890. From the author.

OBER, A. K.—Relics of the Norsemen. Ext. *Salem Gazette*.

OSBORN, H. F.—Are Acquired Variations Inherited? Read before Am. Soc. Nat., Boston, Mass., December 31st, 1890.

——Preliminary Account of the Fossil Mammals from White River and Loup Fork Formations Contained in the Mus. of Comp. Zool. Part II., Perissodactyla. Bull. Harvard Mus. Comp. Zool., Vol. XX., No. 3, p. 87. From Alexander Agassiz.

RÜTIMEYER, VON S.—Uebersicht der eocänen Fauna von Egerkigen nebst einer Erwiederung an Prof. E. D. Cope. Separat-Abdruck aus den.

SCHLOSSER, MAX.—Literaturbericht für Zoologie in Beziehung zur Anthropologie mit Einschluss der fossilen and recenten Säugethiere für das Jahr 1887. Verzeichniss der Anthropologischen Literatur, Part IV. From the author.

SCOTT, W. B.—Preliminary Account of the Fossil Mammals from White River and Loup Fork Formations Contained in the Museum of Comp. Zool. Part II., Carnivora and Artiodactyla. Bull. Harvard Mus. Comp. Zool., Vol. XX., No. 3. From Alexander Agassiz.

SHARP, B.—An Account of the Vincelonian Volcano. Ext. Proc. Acad. Nat. Sci., Phila., 1890. From the author.

SHUFELDT, R. W.—Contributions to the Comparative Osteology of Arctic and Sub-Arctic Water Birds, Part VII. Ext. *Journ. Anat. and Physiol.*, Vol. XXIV. From the author.

SMITH, T. B.—Studies in Nature and Language Lessons, designed for use in Intermediate Grades of Educational Work. From D. C. Heath & Co., Boston.

SQUIRE, J.—Report on the Cahaba Coal Field, with an Appendix on the Geology of the Valley Regions Adjacent to the Cahaba Field, by Eugene Smith. From E. A. Smith.

TYRRELL, J. B.—Foraminifera and Radiolaria from the Cretaceous of Manitoba. Trans. Roy. Soc. Can., Vol. VIII., Sec. 4, 1890. From the author.

Verhandlungen der Naturforschenden Gesellschaft in Basel, Bd. IX., Heft. 2. From the society.

WEED, W. H.—The Cinnabar and Bozeman Coal Fields of Montana. Ext. Bull. Geol. Soc. Am., Vol. II., pp. 349–364, Pl. 13. From the society.

WHITEAVES, J. F.—Descriptions of Some New Species of Fossils from the Devonian Rocks of Manitoba. Trans. Roy. Soc. Can., Vol. VIII., Sec. 4, 1890. From the author.

WHITMAN, E. O.—Specialization and Organization, Companion Principles of all Progress. Reprint from Biological Lectures, 1890. From the author.

WIEDERSHEIM, R.—Beiträge zur Entwicklungsgeschicte von *Proteus anguineus.* Separat-Abdruck aus dem Archiv für Mikroskop. Anatomie, Band XXXV. From the author.

WILLIAMS, G. H.—The Petrography and Structure of the Piedmont Plateau in Maryland. Ext. Bull. Geol. Soc. Am., Vol. II., pp. 301–319. From the society.

WILLIS, B.—Graphic Field Notes for Areal Geology. Bull. Geol. Soc. Am., Vol. II., pp. 177–188, Pl. 6. From the author.

WINSLOW, A.—The Geotectonic and Physiographic Geology of Western Arkansas. Bull. Geol. Soc. Am., Vol. II., pp. 225–242, Pl. 8. From the author.

WOLFF, J. E.—On the Lower Cambrian Age of the Stockbridge Limestone. Ext. Bull. Geol. Surv. Am., Vol. II., pp. 331–338. From the society.

WOODWARD, A. SMITH.—On a Tooth of a Carboniferous Dipnoan Fish: *Ctenodus interruptus.*—On Two Groups of Teeth of the Cretaceous Selachian Fish Ptychodus. Reprints from the Annual Report Yorkshire Philos. Soc., 1889. From the author.

WOLTERSTORFF, W.—*Alytes obstetricanus* und *Triton palmatus* im Thüringer Wald. Separat-Abdruck aus dem *Zoologischer Anzeiger*, No. 357, 1891.

——Ueber die Geographische Verbreitung der Amphibien Deutschlands insbesondere Württembergs. Separat-Abdruck aus "Jahrshefte des Vereins für vaterl. Naturkunde in Württ," 1890. From the author.

RECENT LITERATURE.

The Oyster: A Popular Summary of a Scientific Study,[1] by Prof. William K. Brooks, of Johns Hopkins University, is a most fascinating little volume,—fascinating not only for the way in which the story of an oyster's life is told, but also because it is the first time that the real dangers to the great oyster industry of the Chesapeake have been clearly told so that the "practical man" may no longer have any excuse for ignorance and disregard of them. The remedy for the threatening danger of extinction of the oyster in a large proportion of the waters of Maryland is pointed out, and it is to be hoped that the necessary steps may be taken looking towards rational methods of oyster culture and adequate legislation in the state of Maryland.

The author, after giving an account of the most successful experiments in rearing spat at home and abroad, gives histories of how our

[1] The Oyster: A Popular Summary of a Scientific Study. By W. K. Brooks. Johns Hopkins Press, 1891.

people have been abusing the promise of the lavish fecundity of nature until to-day oysters are extinct in certain places, or rapidly becoming so over areas as large as the Chesapeake Bay. He speaks in no uncertain tones, and from abundance of verified observation and experience, in regard to what are the most important steps to be taken in practical culture and legislation which shall protect the cultivator and give him the reward of his labor.

The illustrations are selected for the most part from more technical memoirs already published by the author and others, and illustrate the little volume and its subject admirably. The second plate illustrating the relations of the viscera is, however, open to the criticism that the "liver" is represented in a manner which does not obtain in the oyster at any time in the course of its life. No ducts open upon what may be regarded as the dorsal aspect of the stomach, as seems to be represented on this plate. The histological details representing the structure of the gills might also have been more carefully and accurately represented than is done in Plate III. But these are matters of minor importance, and do not essentially detract from the value of this little volume as an epoch-making contribution to the whole subject of the oyster industry and oyster culture. It is to be hoped that the advice it contains will be heeded by the legislators and the interested public, else it may be safely predicted that the center of maximum production, ten or twenty years hence, will not be the Chesapeake and its tributaries, but Long Island Sound, New Jersey, and Delaware Bay will become the dominant sources of supply. If the productiveness of those regions should fail, we should soon be reduced to paying as dearly for our oysters as the English, German, and French do for theirs, and to whom the oyster has long since become a luxury that is not within the reach of the slender means of the poor. They have already suffered the penalty for the improvident exploitation and exhaustion of the natural supply, and now depend almost wholly upon the artificially cultivated product. Let us not imitate their example.—J. A. R.

General Notes.

GEOLOGY AND PALEONTOLOGY.

On the Crystalline Schists and Their Relation to the Mesozoic Rocks in the Lepontine Alps.[1]—At the close of the year 1888 Prof. T. G. Bonney read before the London Geological Society a paper in which he maintained that these rocks could be arranged in certain fairly definite groups, which exhibited a stratigraphical succession. On this communication only two criticisms of importance were offered. Of these one expressed a doubt as to the value of the method which Mr. Bonney had adopted in his work; the other affirmed that certain schists, regarded by Mr. Bonney as members of a very ancient series, probably Archean, had been demonstrated by the presence of Mesozoic fossils to be of the latter age; or, in other words, that in the Alps ordinary sediments deposited in the Jurassic epoch had been subsequently converted into true crystalline schists, a result of metamorphic action, which he had implicitly affirmed to be incredible. Early in 1890 Prof. Bonney replied to these criticisms in the following language:

"The former criticism, which amounted to an assertion that the general succession of the Alpine rocks could only be ascertained by very detailed mapping, in my opinion indicated an imperfect knowledge of the subject, while it was scientifically unsound and historically incorrect. It indicated an imperfect knowledge because, as a matter of fact, a considerable part of the Alps has already been mapped, not by irresponsible amateurs but by official surveyors, and it was with the interpretation of these maps that I was largely concerned; and because it assumed that an impossibility could be performed. As I have had the honor to fill the same position in the Alpine Club that I have done in this society, I may affirm, without fear of contradiction, that a very elaborate petrographical mapping of the Alps is impossible, for the most painstaking and conscientious of surveyors must assume much that is incapable of demonstration. A very large part of the whole area is concealed by snow, glaziers, *débris*, pasture, forest; and some

[1] On the Crystalline Schists and Their Relation to the Mesozoic Rocks in the Lepontine Alps. By T. G. Bonney, D.Sc., LL.D., F.R.S., F.G.S., Professor of Geology in University College, London, and Fellow of St. John's College, Cambridge.

one of these obstacles very frequently interferes, in a most provoking way, just at the most critical point. Further, no small amount of the rock which is visible can only be regarded from a distance. Many a cliff, many a ridge, is inaccessible, and the examination, even of every point which it would be possible to reach, would require the expenditure of such an amount of time that I am certain it never has been, and believe that it never will be done.

"But further, the criticism, in my opinion, was scientifically unsound and historically unjustifiable,—scientifically unsound because very commonly the most important problems which are presented by the crystalline rocks receive a decisive answer from one or two sections only. I have not the slightest desire to undervalue elaborate mapping, but we must be careful not to treat it as a fetish, as though it were the only means appointed for the discovery of geological truth. Its results more commonly are the removal of minor difficulties in a conclusion already attained, and the disclosure of the precise mode in which certain effects have been produced. The criticism was historically unjustifiable because, so far as my knowledge goes, it is a fact that in regard to difficult petrological questions infallibility has not been found to reside with the makers of geological maps.

"My work, both in the Alps and in other regions, which has been carried on with a definite object and a fairly clear idea as to the needful evidence, has led me to the following conclusions, which, though they have been already expressed, I will venture to repeat for the information of the reader:

"1. That a group of truly crystalline schists is always more ancient than any rock to which, on the evidence of fossils, a date can be assigned.

"2. That many such groups can be proved to be older than any Paleozoic rock.

"3. That though crystalline schists have often been claimed as metamorphosed sedimentary strata of Paleozoic or Mesozoic, if not of Tertiary age, the evidence in support of this claim has hitherto always broken down on careful examination, and in not a few instances has proved hardly worthy of the name.

"4. That in certain cases structures exist in the crystalline schists which must be indicative of sedimentation, and that in not a few instances a sequence can be detected which must be due to successive deposition. Great as modifications resulting from subsequent pressure very frequently are, these may often be separated, and the earlier record as in the case of a palimpset be deciphered.

"In the Alps there exists, as has frequently been pointed out by those who have preceded me, a great group of crystalline schists, the bulk of which must be metamorphosed sedimentary deposits. This group can be traced, practically without a break, from one end of the chain to the other. These schists certainly overlie, sometimes it would seem unconformably, another series of gneisses and schists, generally coarser in texture. These seem to be divisible into two groups, differing in lithological characters, of which the upper, though sometimes well developed, is not seldom wanting; so that instead of the gradual transition from it to the first-named group, which can sometimes be observed, we find the latter resting with marked discordance upon some part of the lower series.

"The oldest unaltered rocks in the Alps generally belong to the lowest part of the Mesozoic system, Jurassic or Triassic (possibly sometimes Permian), but in certain districts not inconsiderable deposits of Carboniferous age (quite disconnected from the last named) occur, and in the northeastern Alps Paleozoic rocks of yet earlier date have been identified. All these are practically unaltered. An exceptionally wide experience enables me to affirm, without fear of contradiction, that, in case of any large mass which would be referred without hesitation to the Jurassic, Triassic, or Carboniferous group, there will not be found, however great may have been the mechanical disturbances which it has undergone, any transition exhibited by it into one of the normal gneisses or schists; at most a microfoliation has been developed or a superficial resemblance set up. The crystalline schists also do not exhibit, as a rule, any tendency to pass into ordinary sedimentary rocks. Appearances suggestive of this transition are found on closer examination to be due either to pulverization of the rocks by pressure, or to the inclusion of a later series by folding or faulting.

"But while there can be no doubt of the general truth of this statement, it has recently been asserted that in certain districts of the Alps there is a passage from Jurassic rocks into truly crystalline limestones, while in others fossils of that age occur together with garnet, mica, and minerals resembling staurolite, in schists which cannot be distinguished from certain members of the above-named group. If this assertion be correct, it must follow (1) that the Alps exhibit true schists which are metamorphosed sediments of Mesozoic age, and (2) that, inasmuch as these are undistinguishable from schists which by stratigraphical evidence can be proved to be very much older than any Mesozoic rocks, a schist, like a granite or a dolerite, might belong to almost any geological epoch.

"This last opinion can claim the sanction of antiquity and the authority of weighty names, but the progress of investigation had largely diminished the number of its supporters, when it seemed to receive a new life from a recognition of the amazing effects of mechanical forces in modifying rock-structures, and from the above-named discoveries in the Alps. Specimens illustrative of the latter were exhibited at the International Congress in September, 1888. Those supposed to indicate the passage of an ordinary Jurassic limestone into a crystalline marble (from a district which I had already visited) did not appear to me convincing. But those exhibiting fossils in a rock resembling a true schist were certainly very remarkable, and seemed to afford considerable support to the opinion mentioned above. I was, not, however, convinced by them, because, though I had not examined the two localities in which the supposed 'fossiliferous schists' occurred, I was fairly acquainted with the geology of the district, and had been very near, in one case within less than a mile, to each locality. I had also examined rocks identical, as I believed, with those in which the fossils occurred. The knowledge thus obtained, notwithstanding the apparent evidence of the specimens exhibited, suggested to my mind the possibility of a mistake, and a doubt whether the identity of the fossiliferous rock with the true schists of the district was not more apparent than real. Still, so remarkable were the specimens, so great was the weight of authority, that when these cases were quoted against me in the discussion on my paper, I departed from that which has become almost a rule with me, viz., to pay no regard to criticisms founded on second-hand information —and stated that I accepted the challenge."

During the summer of 1889 Prof. Bonney resumed his study of the district under discussion in company with Mr. J. Eccles, F.G.S. The results of their investigations fully confirm the conclusions Prof. Bonney had stated the year before.

The Australian Cenozoic Fauna.—Mr. J. W. Gregory says that this fauna seems to be composed of two constituents; about a third are species of the ordinary Palæarctic Upper Cretaceous genera; these seem to have migrated southwards and become mingled on their journey with a fauna that agrees most closely with that of the Eocenes of India and Malaysia. No abyssal types were picked up on the march, nor do any of the species retain any trace of the influence of a deep-sea habitat. Hence the route may have followed the coasts of Asia and Malaysia, or the line may have lain across what is now occupied by the deep abysses of the Indian Ocean ; but if so it must have occurred before its bed had subsided to anything like its present depth. (*Geol. Mag.*, Nov., 1890.)

Fossil Fishes of the Cretaceous Formations of Scandinavia.[2]—This is a quarto publication of the Royal Dublin Society, and forms part of Vol. IV. (Series II.) of their Transactions. As the author had placed at his disposal the collections at Stockholm and Copenhagen, and furthermore had the opportunity of comparing the Scandinavian specimens with those in the British Museum, his memoir is a valuable contribution to science.

The classification is based on that of Mr. A. Smith Woodward, and with few exceptions, the most important family represented is the Lamnidæ.

A general view of the ichthyic fauna of the Swedish chalk is given as follows:

"It has shown, generally, a closer relationship to the Cretaceous fauna of the north of Europe, as represented in the English and French chalk, than to the more highly specialized fauna of Asia Minor; but it does not afford representatives of several of the Physostomous Teleostomi, such as Ichthyodectes, Protosphyræna, and Pachyrhizodus, which occur in the English chalk, and have been found in the Upper Cretaceous rocks of North America. A few teeth occur in the Swedish chalk which are referred to Enchodus. Examples of a large species of Dercetis occur, and some fragmentary remains which are probably Clupean. The highly specialized forms, such as Chirothrix, Rhinellus, etc., found in the Lebanon chalk, do not occur in the chalk of Sweden. Among the Acanthopterygian Teleosteans the most important are the remains of Beryx and Hoplopteryx.

"The great majority of the fish remains are Selachian, and comprise no fewer than twenty-four species. Three species, viz., *Carcharodon rondeletii* (M. & H.), *Otodus obliquus* (Ag.), and *Odontaspis acutissimus* (Ag.) are usually regarded and known as indicating a Tertiary fauna; but in the Scandinavian chalk they have been found in association with many undoubted Cretaceous forms in the Faxe limestone, and so appear to prove that these species were in existence before the advent of the deposition of the Tertiary strata. The Tectospondylic sharks are represented by two species of Ptychodus and indefinable teeth of Myliobatis. The Asterospondylic sharks occur in very large numbers,

[2] On the Fossil Fishes of the Cretaceous Formations of Scandinavia. By James W. Davis, F.G.S., F.L.S., F.S.A., etc. Plates XXXVIII. to XLVI. Trans. Royal Dublin Soc., Vol. IV., Series II.

and represent several genera. Beautifully preserved specimens of Notidanus, Scapanorhyncus (Rhinognathus), Odontaspis, Oxyrhina, Otodus, Lamna, and Corax are abundant, and have a wide vertical range. The character and extent of the Selachian fauna indicate conditions very similar to those accompanying the deposition of the English and French chalk, and that of Central Europe generally, whilst it affords comparatively few data for comparison with that of Lebanon."

The Surface Geology of Alaska.—I. C. Russell's paper on the surface geology of Alaska contains some interesting facts on the glaciation of that region. He agrees with Dauron and McConnell that there is a great area to the north of the Cordilleran glacier which was not occupied by ice during the Plistocene. Of living glaciers those on the north side of the Coast Range are very much smaller than, and do not descend nearly so far as, the glaciers on the south side of the same range. Closely related to the distribution of the glaciers are certain climatic phenomena.

In the Yukon region the winters are long and extremely cold, but the snowfall is not great. The summers, though short, are pleasant, and hot enough to melt the winter's snows. On the southern coast the winters are not severe, but the snowfall is heavy on the mountains, and the summers are cloudy and hot, with much fog.

These observations show that abundant precipitation, accompanied by a low mean annual temperature (due especially to a cool and cloudy summer) has resulted in the formation of the vast ice-fields on the southern coast of Alaska from which magnificent glaciers descend to the sea. (Bull. Geol. Soc. Am., Vol. I., pp. 99–162.)

Geological News.—General.—Sir. Wm. Dawson has retained the name "Quebec Series" in his recently published hand-book, as the name for the Atlantic type of the lower member of the Ordovician, and as equivalent to Upper Calciferous and Chazy of the interior region of America. (*Canadian Record Science*, July, 1890.)——Alexander Somervail offers the theory of "segregation" as an explanation of the banded structure of certain rocks in the Lizard District, England. By the the term segregation he means the separation of the unlike, and the union of like, minerals during the cooling of the common magna out of which the rocks are formed. (*Geol. Mag.*, Nov., 1890.)——Henry Hicks is of the opinion that the pre-Cambrian rocks of Britain contain evidences of successive periods of elevation and depression, and probably of volcanic activity. He thinks also that the tendency of the evidence is to show that some granitoid rocks, such as those classed in Wales under the name Dimetian, are among the very oldest of the pre-Cambrian rocks which are now found exposed, and that some quartzites, porcellanites, and schists occupy an intermediate position in point of age between these granitoid rocks and the Pebidian series. (*Geol. Mag.*, Nov., 1890.)

MINERALOGY AND PETROGRAPHY.[1]

Petrographical News.—Mount Aviólo, in the southern Alps, consists in part of tonalite and in part of a quartz-mica-diorite, both of which intersect a series of crystalline schists, in which contact alteration has been effected. The tonalite is the rock so well known as comprising a large part of the Adamello group of the Alps. It is essentially a hornblendic quartz-mica-diorite. A garnetiferous variety is described by Salomon[2] as an endomorphous contact product. It is characterized by the possession of plagioclase zonally developed, with the most acid zones on the exterior. The extinction of crystals varies as much as 30°, being by this much greater in the nucleus than in the peripheral portions. The quartz-mica-diorite forms a boss only two kilometers distant from that of the tonalite, but it is regarded by the author as having no genetical relation with the latter. These two masses of eruptives are surrounded by two series of schists: a younger series including phyllites and epidote-amphibolites, and an older one embracing gneiss and mica-schists. The former are in contact with the diorite, by which they have been changed into rocks composed essentially of quartz, muscovite, biotite, chlorite, and andalusite, of which the biotite and andalusite are new products. Corundum, tourmaline, sillimanite, and zircon are also new products, but are present only in small quantity. A cordierite-biotite rock, consisting of these minerals together with quartz, was found as an inclusion in the diorite. According to the degree of alteration effected in them the rocks are separated into two zones: an outer one, the zone of the ilmenite-frucht-schiefer, in which the phyllites have suffered merely the change of their chlorite into biotite, and an inner zone, in which andalusite is an important constituent. The schists around the tonalite belong to the older series of gneiss and mica-schists. These have been

[1] Edited by Dr. W. S. Bayley, Colby University, Waterville, Me.

[2] *Zeits. d. deutsch. geol. Ges.*, XLII., 1890, p. 450.

more completely metamorphosed than the members of the phyllite series, for in addition to andalusite there is an abundant development of cordierite in them, where they approach the eruptive. As in the case of the diorite contact belt, there have also been recognized in the belt surrounding the tonalite two distinct contact zones. In the outer one the normal gneiss and mica-schists have been changed into cordierite and andalusite varieties, containing a fibrous orthoclase. In the inner zone all resemblance to gneiss and mica-schists has disappeared, and the rocks have become aggregates of cordierite, andalusite, plagioclase, sillimanite, tourmaline, garnet, spinel, corundum, and zircon. The replacement of the orthoclase of the outer zone by plagioclase in the inner one indicates a difference in the composition of the two belts, but this is thought not to be a result of more intense metamorphism, but as due rather to a difference in the composition of the original materials. The cordierite in these rocks is colorless and non-pleochroic, but it becomes brown and pleochroic on heating. It often twins parallel to ∞P, and alters readily to a pinnite-like substance. The other constituents possess no unusual peculiarities. They are all well described, but none are analyzed. Dykes of porphyrite cut the schists, and a single one occurs in the tonalite, but none of them merit special mention in this place.——The most valuable contribution to the study of the crystalline schists that has appeared for some time is entitled "The Greenstone-Schist Areas of the Menominee and Marquette Regions of Michigan." In it the author, Dr. G. H. Williams,[3] discusses the origin of the crystalline schists found so widely spread over the country bordering on Lake Superior. The paper opens with an excellent historical review of the recent work on crystalline schists in Europe, in which all the important articles on dynamically formed schists are abstracted. This chapter, together with the foot-notes accompanying it, form a splendid résumé of the present state of our knowledge on this subject, and is well worthy the study of all geologists, particularly of those who still hold to the belief that all schistose rocks were originally laid down as sediments. In the special part of the volume the author describes the present features of the green schists of Michigan, and shows conclusively that these were once igneous rocks, often volcanic flows, sometimes tufas, in which foliation and mineral changes have been produced by dynamic agencies. The rocks from which the schists were formed were diabases, diabase-porphyries, diorites, and gabbros among the basic types, and granites and quartz-porphyries among the acid types. The resulting

[3] Bull. No. 62, U. S. Geol. Survey.

types are chlorite and hornblende-schists, granulites, gneisses and porphyroids, sericite-schists, and other foliated rocks. An important part of the study is that embracing the discussion of the effects of pressure upon the mineral constituents of the original rocks, and of the new structures produced in the secondary rocks. The new minerals formed during the production of the schists are albite, microcline, zoisite, garnet, quartz, hornblende, epidote, biotite, muscovite, sericite, rutile, anatase, and sphene. Each of these is carefully described, and the conditions under which it was formed are carefully examined. The genesis of the schistose structure is finely worked out, both macroscopically and microscopically, and the mineral change that accompanies the development of the foliation is well shown. A large body of green schists is thus proven to have been developed by pressure from massive rocks, just as the gabbro-diorites were formed from gabbros in the Baltimore region. There are many interesting features of the Michigan schists that might be dwelt upon at some length did space permit, and many important mineralogical metamorphoses might be referred to. But no review, however full, can do more than suggest the outline of the bulletin. It must be read to be understood. The many good maps and illustrations and the nine lithographic plates of rock structures render great aid to the reader. It is evident that the schists of Michigan cannot grade into the overlying fragmentals, and since they are much more squeezed than these, that they cannot be of the same age.——An important communication, bearing upon the relation existing between dyke rocks and their corresponding plutonic facies, has lately appeared under the names of Hunter and Rosenbusch,[4] who have discovered that one of the rocks occurring in dyke form in the elæolite-syenite region of the Serra de Tinguá, Brazil, is a new type, which may be regarded as the equivalent of the plutonic elæolite-syenite. The rock has been called trachyte, phonolite, and basalt by various writers, but the present authors have decided to give it a distinctive name, "monchiquite," from the locality in Portugal from whence the type was first described. The rock belongs among the camptonites. It is of a dark color, and is composed of a dense ground-mass holding small phenocrysts of amphibole, pyroxene, mica, and olivine. Carefully examined, the ground-mass is found to be a colorless glass containing microlites of the same minerals as occur in the phenocrysts, and occasionally a few laths of plagioclase. The glassy base has a composition that indicates a close relationship with elæolite-syenite:

[4] *Miner. u. Petrog. Mitth.*, XI., 1890, p. 445.

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	H_2O	CO_2
Rock	46.48	.99	16.16	6.17	6.09	4.92	7.35	5.85	3.08	4.27	.45
Base	53.43		20.86	2.61		.29	1.14	11.63	2.51	7.06	

But little interest attaches to the components of the rock. The hornblende and augite are often zonally developed. In the former the kernel shows evidence of having been corroded, while the external envelope never exhibits sign of such resorption. Analyses of one variety of the augite and of the hornblende appear in the paper. The latter mineral contains 3.37 per cent. of K_2O.——As the result of a microscopic study of the "Weissenberg gneiss," in Saxony, in which cordierite and other characteristic contact minerals were discovered, Weber[5] pronounces the rock a member of the graywacke series that has been metamorphosed by the Lausitz granite.—The basalt of Royat (Puy-de-Dome) contains geode-like cavities lined with calcite and other minerals. Calcite also fills crevices and holds fragments of the rock torn from the sides of the clefts. In some of these fragments are crystals of feldspar with the morphological and optical properties of orthoclase, but with a large proportion of sodium in its composition ($SiO_2 = 66.83$; $Al_2O_3 = 19.20$; $CaO = .06$; $K_2O = 6.29$; $Na_2O = 6.8$).[6]——Zirkel[7] has determined the small hexagonal crystals in the altered sandstone of Steinberg, in the Habichtswald, Germany, to be cordierite, produced probably by the solution of the interstitial substance of the sandstone by basalt.——Termier[8] notes the occurrence of veins of orthoclase and quartz in the silicified Carboniferous schists of Saint-Étienne, whose structure is neither micropegmatitic nor microgranulitic, though both minerals were deposited simultaneously from the same mother-liquor. He also describes briefly a silicified schist consisting of bands of opal and chalcedony, from the Butte of Montraynand.——Quartz-twins occur porphyritically developed in the pumice of Cobo de Gata.[9]

Miscellaneous.—Offret[10] has recently published a very exhaustive account of some investigations upon the effect of various temperatures upon the indices of refraction of several minerals, for every color in the visible spectrum. His paper opens with an historical review of the work already published. Then follows a very full description of the

[5] *Neues Jahrb. f. Min.*, etc., 1891, I., p. 211.
[6] Jannetaz. Bull. Soc. Franc. d. Min., XIII., 1890, p. 372.
[7] *Neues Jahrb. f. Min.*, etc., 1891, I., p. 109.
[8] Bull. Soc. Franc. d. Min., XIII., 1890, p. 330.
[9] Osann. *Neues Jahrb. f. Min*, etc., 1891, I., p. 108.
[10] Bull. Soc. Franc. d. Min., XIII., 1890, p. 450.

methods used in his investigations, and of the apparatus employed. A thorough discussion of the limitations of his methods covers about a hundred pages. After showing that the results obtained by the method used, which is that of the prism, are quite accurate, he records his measurements upon calcite, beryl, phenacite, aragonite, barite, cordierite, two topaz crystals from different localities, orthoclase, and oligoclase, at temperatures up to 330°. In two tables, appended to the statements of general results reached in each case, are given the indices of refraction for six differently colored rays moving along the several axes of elasticity in each mineral, and under different conditions of temperature: (1) as measured in warm air, (2) as calculated for a vacuum. A third table contains the values of the double refraction calculated for a vacuum, and a fourth represents the variations in the angle of the prism used produced by different temperatures. Without entering into the details of the investigation, it may be said that the figures reached by the author are worthy of the greatest confidence, and that when differing from those obtained by other observers they must be accepted in place of these latter. Among the most interesting of the general results obtained are the following: Of the minerals examined only barite and aragonite show a refractive index decreasing with an increase in temperature. There is a general increase in the value of the optical angle and in the dispersion of the axes, with increase in temperature. The double refraction increases with the temperature only in the case of beryl. Brazilian topaz is the only mineral showing a decrease in the amount of double refraction, in passing from red to violet light. Other points of interest brought out in the work are too numerous for mention here. The paper covers two hundred and eighty-seven pages.——In a recent communication Behrens[11] gives a very valuable synopsis of microchemical methods, applicable not only to the determination of the constituents of minerals in thin sections of rocks, but useful also as aids to the blowpipe in determinative mineralogy. His article opens with a few introductory remarks on manipulation. Then follows a résumé of the tests that have given most satisfaction in the detection of fifty-nine of the elements. These are arranged alphabetically, and under each are given the directions for making the tests selected.——Wyrouboff[12] proposes a new theory for the explanation of polymorphism, and shows how this may include also the explanation of pseudo-symmetry. His paper, which is a very clear exposition of his views, opens with the account of his under-

[11] *Neues Jahrb. f. Min.*, etc., B. B. VII., p. 434.
[12] Bull. Soc. Franc. d. Min., XIII., 1890, p. 277.

standing of the differences between polymerism, polymorphism, and pseudo-symmetry. The first he regards as purely chemical, and as not affecting in any way the arrangement of particles in crystals. It has to do merely with the molecules, while polymorphism has to do with the crystal particles.[13] The molecules unite according to certain definite laws, yielding the crystal particles, which may exist even in solution, when they may reveal themselves by their effect upon polarized light. The crystal particles are in their turn disposed regularly to form the crystal. When this disposition is identical with that of the molecules in the crystal particles a symmetrical body results. When the arrangement of the particles is different from that of their constituent molecules the body is pseudo-symmetrical. The various forms of a polymorphic body belong to the first class, which is divided into two groups. In the first belong those substances in which a change in crystallization occurs without a corresponding change in homogeneity. In the second class belong those bodies which, when heated, break up into a large number of individuals of a different grade of symmetry from the original individual, without definite contours and without definite arrangement. To explain the first class the author supposes the molecules in the crystal particles to undergo a rearrangement coincident with that of the particles themselves. This is called direct polymorphism. Indirect polymorphism is the term applied to the change the second class of substances undergo. In these the symmetry of the particles changes, while that of the aggregate of particles remains unchanged. To the first class only is the term polymorphism strictly applicable. The second class belong rather to the paramorphic bodies. The second part of the paper contains results of observations on polymorphic substances, among which are the bichromates of rubidium, potassium, and ammonium, and the sulphates of sodium and of lithium.——O. Lehmann,[14] in a very brief communication, states his view of crystal structure, which is quite different from that of Wyrouboff. He declares that the essential condition of a crystal is not the regular arrangement of the molecules in the particles, but it is the construction of these molecules. He also reiterates the statement made in his "Molecular Physik" to the effect that no chemical substance can crystallize in more than one way. Allotriomorphic and polymorphic substances are different chemically. In a second paper[15] he gives brief descriptions of eight additional

[13] Cf. AMERICAN NATURALIST, Feb., 1890, p. 174.

[14] *Zeits. f. Kryst.*, XVIII., 1890, p. 456.

[15] Ib., p. 464.

organic compounds that show allotropic forms.——The parts of Dr. Hintze's[16] Mineralogy continue to appear with commendable rapidity. The fourth part concludes the discussion of prehnite, takes up in order axinite, harstigite, and the pyrosmalite group, and begins the treatment of the micas, which occupies one-hundred-and-twenty-five pages, and is not yet finished. Although there are perhaps some omissions to be noted with respect to American occurrences, the thoroughness of the author's work cannot be gainsaid. The analyses of biotite given in the article on that mineral number 177, and those of muscovite 120, in addition to some twenty or thirty of varieties of these minerals.——Dufet[17] describes a new method for the determination of the optical orientation and of the dispersion of the axes in triclinic minerals, and applies his method to the study of potassium bichromate.——Mr. Lane[18] illustrates a method for determining the planes in crystals in thin section. It is based in the relations existing between the zone-circles and face-points in a stereographic projection.

ZOOLOGY.

The Coloration of the Flounders.—Whoever has seen the flounders alive, or even dead but not deprived of their skin, has noticed the remarkable difference existing between the dorsal aspect exposed to the water and the ventral surface which in the living animal moves along the bottom. While the dorsal face is more or less pigmented, the ventral is white. Why is this? The school of Weismann, more Darwinian than Darwin himself, is accustomed to attribute the fact to natural selection; and the school, which is rapidly increasing, according to which the environment affects the animal, ought to attribute it to a physical influence, in view of the fact that the ventral side receives naturally much less light than the dorsal. In truth, one cannot see how natural selection could produce it. From this point of view the coloration of the ventral side seems of no importance, and if it is not one would think that it is more advantageous to the flounder to have this side gray, like the dorsal, rather than white,—that is to say, showy. Professor Cunningham, of the Marine Biological Association, has recently studied this phenomenon, and believes that it is caused by the

[16] Handbuch der Mineralogie. 4te Lief., pp. 481–640. Leipzig, 1891.

[17] Bull. Soc. Franc. d. Min., 1890, p. 341.

[18] Bull. Geol. Soc. Amer., Vol. II., 1891, p. 365.

action of the environment. He resumed his studies a short time since, and gives us the following results.

He has experimented on young flounders (*Pleuronectes flesus*), in which the eye had not yet entirely left the ventral face. Already the pigment of this face had largely disappeared; the animal swam with the left side down, and on the dorsal side the color was pronounced. Blackening the cover and sides of a glass jar, he put it with the young fish within on a support, and arranged beneath the vase a mirror in such a way as to reflect the sunlight into the vase. Now the dorsal side of the fish would be in darkness, and the ventral side exposed to the light, thus reversing the normal conditions. The water was renewed frequently, and the fish given all the food they required. Other flounders were put into a similar vase, which was normally lighted. The results were as follows:

Of thirteen fish lighted from below three only kept the usual coloration; the others showed a greater or less quantity of pigment cells and chromatophores. Under these conditions it seems probable that the absence of color from animals in normal conditions is due to the difference of circumstances, and that light is the agent which determines the development of pigment cells. It can, nevertheless, not be the only one; there exists coloration among animals living in the obscurity of profound depths.—*Revue Scientifique.*

Parmella etheridgei.—Mr. C. Hedley records a new mollusc, *Parmella etheridgei* Brazier. It was found on the stems and leaves of the palms growing on the lower ground of Lord Howe Island. It is the second species of a long-lost genus. (Records Australian Museum, Vol. I., No. 4.)

The Spawning Seasons of San Diego Fishes.—The following is a summary of observations on the spawning seasons of the San Diego fishes. Those marked with an asterisk (*) are viviparous, and the length of gestation has not in all cases been made out. The time indicated for the viviparous species is that during which young, sometimes well developed, were taken:

Heterodontus francisci, from January to April; **Squalus acanthias*, from July 20th to September; **Scylliorhinus ventriosus*, egg found ready to hatch Dec. 27th; **Galeus californicus*, September 7th to February 14th; **Triacis semifasciatus*, September 6th to October 7th; **Rhinotriacis henlei*, September 7th; **Galeorhinus zyopterus*, August 30th; *Clupea mirabilis*, December 11th to February; *Stolephorus ringens*, April, May, and June; *S. delicatissimus*, April, May, and June;

S. compressus, April 24th to July; *Tylosurus exilis*, April; *Siphostoma auliscus*, throughout the summer; *S. leptorhynchum*, throughout the summer; *Atherinopsis californiensis*, from November to March; *Atherinops affinis*, May and June; *Sphyræna argentea*, July; *Serranus maculofasciatus*, June to September; *S. nebulifer*, June to September; *Sciæna saturna*, April and May; *Genyonemus lineatus*, January; **Micrometrus aggregatus*, with young from December to May; **Holconotus argenteus*, December, January, and February; **Amphistichus argenteus*, November to March; **Ditrema laterale*, December, January, and February; **D. jacksoni*, November 7th to March; *Caulolatilus princeps*, July and August; *Typhlogobius californiensis*, May and June; *Ophiodon elongatus*, January 30th (San Francisco); **Sebastodes paucispinis*, December, January, and February; **S. flavidus*, January; **S. ovalis*, October; **S. miniatus*, November to March; **S. ruber*, July; **S. levis*, January and February; **S. rubrovinctus*, September, October, and November; **S. auriculatus*, September; **S. vexillaris*, January and February; *Oligocottus analis*, January to April; *Isesthes gentilis*, May; *I. gilbertii*, March; *Heterostichus rostratus*, March; ? *Fierasfer dubius*, floating eggs procured in August from ocean's surface; *Pleuronichthys cœnosus*, pelagic eggs in April; *Hypsopsetta guttulata*, pelagic eggs in April. Descriptions and figures of most of the eggs of these have been prepared, and will be published later.—C. H. EIGENMANN, *San Francisco.*

The Pineal Eye.—Several papers have appeared in the past two years treating of this organ. Possibly those of Leydig[1] have attracted most attention. Leydig was the first to suggest that this might be a sense organ, but in these later papers he takes the ground that the pineal gland is a lymph gland, and that the "nerve cord," which has been described as connecting it with the brain, is in reality a strand of connective tissue. On account of the author's position as a histologist, these views are certainly entitled to weight, but connective tissue of ectodermal origin is certainly an anomaly. Professor A. P. W. Thomas, in an article on the development of Sphenodon,[2] states that in the recently hatched tuatara the pineal eye still shows as a dark spot through the translucent skin over the parietal foramen. This I have been able to observe even in a tuatara eight inches in length. But as the tuatara grows older the skin over the pineal eye becomes more opaque, and though in some individuals the scantier development of the pigment over the parietal foramen affords a feeble indica-

[1] *Biolog. Centralbl.*, Bd. VIII., p. 707, 1889. Ibid, Bd. X., p. 278, 1890.

[2] Proc. Royal Society, XLVIII., p. 152, 1890.

tion of the position of the eye, yet in others the pigment is deposited there as elsewhere, so that all external trace of the eye is finally lost."

Mr. W. E. Ritter has investigated the pineal eye in several lizards from the western states.[3] The species studied are ***Phrynosoma douglassii***, ***Ph. cornuta***, and ***Uta stansburiana***, which are described at some length. The author upon morphological grounds is willing to accept the view that the organ in question was a visual structure, and that, contrary to Leydig, its function was not primarily that of a portion of the lymph system, although it may have secondarily acquired the latter character. The conclusion which one comes to after reading the literature is that the ontogeny of the whole region must be carefully followed before the question can be settled.

A Migration of Butterflies.—While sailing up the Gulf of Mexico from St. Andrew's Bay to Pensacola, Florida, on the 14th day of February last, I noticed a great many butterflies passing north. We were from five to ten miles from shore, and the butterflies all came from the south. I was at a loss to know just where they could come from, there being no land to the south nearer than Cuba and Central America. Would it be possible for them to fly such a distance? I could not procure a specimen, so cannot say what species they were; but for size and general appearance they compared quite favorably with the frittillarys. They certainly were migrating north, for hundreds passed us during the day.—A. H. BOIES.

BOTANY.

Saccardo's Suggestions to Phytographists.[1]—The extensive experience which I have gained in the elaboration of my "Sylloge Fungorum" convinces me of the utility, I may say the necessity, of following in the description of plants certain oft-neglected rules. The following are recommended:

1. It is necessary that the botanist who describes with minute and involved details new species from morphological and biological standpoints should append thereto careful and comparative diagnoses

[3] Bull. Mus. Comp. Zool., XX., No. 8, 1891.

[1] Rathschläge für die Phytographen, inbesondere die Kryptogamisten. Hedwigia, Bd. XXX., Heft 1, 1891.

(preferably in Latin) according to phytographic rules. Indeed, it is very difficult and often very uncertain to seek out in the multitude of details the essential and distinctive characters.

2. The diagnosis is with certain authors (especially among the cryptogamists) extraordinarily detailed and prolix; in others too laconic. A good diagnosis should give in a clear and careful statement only the essential and distinctive characters; all observations concerning details should be given after the diagnosis; for new species it is necessary to give the relationships with the nearest related known species. Whoever determines new species knows how much time it takes if he has to do with very prolix diagnoses without reference to relationships.

3. Experience has already shown, at least for the Cryptogams, that relative to authority it is very useful to give in brackets the author who first described the concerned species under other genera. It is always necessary to subjoin the name of the author who has transferred the species from the original genus to another, for otherwise one must assume that the writer of the treatise in which the combination of names is cited is also the author of this combination. We find, for example, in Winter's works, names as follows: "*Sphærella convexula* (Schwein.), Syn. *Sphæria convexula* Schwein." If the name of Thümen is not added after the parentheses we must assume that Winter is the author of the combination, and then we should have, according to the rules of other botanists, the two expressions: *Sphærella convexula* (Schwein.) Wint., or *Sphærella convexula* Wint., both of which are incorrect. But if we say *Sphærella convexula* (Schwein.) Thüm., we have the entirely new information that Schweinitz established the species and Thümen transferred it to the proper genus.

4. In the description of parasitic Cryptogams the host plants (or animals) are to be given with their technical Latinized nomenclature. The common names (English, Italian, German, etc.) are often difficult to identify.

5. In measuring organs, microscopic or macroscopic, one system, the metric, should be employed; for microscopical measurements the micromillimetre, or mikron (μ) is suggested in place of fractions. The different measures and fractions are often the source of error or doubt.

6. For concise statements of the dimensions of microscopic organs it is suggested (as it is moreover done in manifold ways) to write first the figure of the length, then that of the greater breadth, the two connected by the sign $\asymp$, and the character μ omitted; for flat organs

a third figure can be added for the thickness; for instance, spore $15 \asymp 4$ signifies spores 15 μ long and 4 μ broad and thick; spore $15 \asymp 4 \asymp 2$ signifies spores 15 μ long, 4 μ broad, and 2 μ thick. Some authors use in place of the character $\asymp$ (which I proposed and have used since 1872) the characters =, :, ×, which have in mathematics other and fixed meanings. For macroscopic organs one must give the units of measurement, m., cm., mm., and the parts measured.

7. In designating plant groups feminine forms are used (Dicotyledones, Ranunculaceæ, Anemoneæ, etc.). The same should be done in the Cryptogams; if we say Sphæriaceæ, Mucedineæ, Hydneæ, we should also necessarily say Pyrenomyceteæ, Hyphomyceteæ, Hymenomyceteæ, and not Pyrenomycetes, Hyphomycetes, Hymenomycetes, as many do.

8. The colors of plants, especially those of the corolla, of fungi, of spores, are often inexactly described. It were well to use an exact nomenclature which is founded on normal specimens. I shall publish for this purpose a Chromotaxy which I hope will be of great use.

9. In respect to the nomenclature of the fruits and spores of fungi it would be expedient to use only the following terms, which are already adopted by most mycologists: Hymenomyceteæ: pileus (which form it also possesses), basidia, sterigmata, sporæ, cystidia. Gasteromyceteæ et Myxomyceteæ: peridium, gleba, capillitium, flocci, sporæ. Uredineæ: sorus, uredosporæ, teleutosporæ, mesosporæ, pseudoperidium, æcidiosporæ, paraphyses. Ustilagineæ: sorus, sporæ. Phycomyceteæ: oögonia, oösporæ, antheridia, spermatia, zygosporæ, azygosporangia, zoösporæ. Pyrenomyceteæ et Phymatosphæriaceæ: stroma, perithecium, loculus, ascus, sporidia, paraphyses. Discomyceteæ et Tuberoideæ: ascoma, gleba, ascus, sporidia, paraphyses. Schizomyceteæ: filamenta, baculi, cocci, endosporæ, arthrosporæ. Sphæropsidea: perithecium, basidia, sporulæ. Melanconieæ: acervulus, basidia, conidia (but not gonidia, a name which must be reserved for the lichens). Hyphomyceteæ: cæspitulus, sporodochium, hyphæ, sporæ.

From the germinating spore arises the promycelium, which commonly produces the sporidiola.—Translated by H. W. Norris.

EMBRYOLOGY.[1]

Development of the Scyphostoma of the Scyphomedusæ.—Professor C. Claus has published a paper dealing with the early stages of the embryo and the structure of the scyphostoma of Cotylorhiza, Aurelia, and Chrysaora.[2] The paper is largely a detailed criticism of Goette's work on the same subject, and a vindication of Claus's preceding paper, especially on those points in which Goette differed from him. The discovery of the ectodermal origin of the four muscle-bands of the scyphostoma would seem to be the only new point of value added by Goette. The others were either pointed out by Claus in his former paper, or else are now shown to be erroneous. Goette described the endoderm in Aurelia as arising from cells wandering from the blastula into the segmentation-cavity, where they united into a solid plug, attached at one joint to the wall of the blastula. Later a cavity arises in the middle of the mass, and this communicates with the exterior by means of a blastopore. Claus denies this method of formation of the endoderm. Exceptionally, he says, wandering, isolated cells are found in the segmentation cavity of Aurelia, but the large mass of cells pushes in from the endoderm pole. The two or three cells which may arise elsewhere from the blastoderm take no part in the formation of the permanent endoderm, and seem to degenerate. In Cotylorhiza the gastrula arises by invagination.

Goette's statement that the lining of the proboscis is formed by an ectodermal invagination is verified, but there is not formed an œsophagus like that of the Actinians in the Scyphomedusæ, as Goette affirmed. In contradistinction to the Hydropolyp, the Scyphopolyp has not only the ectodermal lining of the proboscis, but is also characterized by four evaginations from the part of the stomach-cavity, which go to form the interior of the tentacles, and there alternating with the tænioles. The four septal muscles arise from ectodermal ingrowths from the peristome, differing in this from the Anthozoa. The sense-organs arise from the bases of the eight radial tentacles.

Goette has denied that the polyp and jelly-fish in the Scyphomedusæ are to be regarded as forming an alternation of generations. Claus shows, however, that to deny the traditional alternation of generations in Scyphomedusæ consists merely in giving a narrow meaning to

[1] Edited by Dr. T. H. Morgan, Johns Hopkins University, Baltimore, Md.

[2] Arb. Zool. Inst. Wien., T. IX., H. 1.

the terms themselves, and that, properly speaking, the process found in the group is clearly to be regarded as a true alternation of asexual generations.

Body-Cavities of Paludina vivipara.—A short preliminary notice is published in the *Zool. Anzeiger* for February 23d, by R. v. Erlanger, on the "Development of *Paludina vivipara.*" The description of the origin of the body-cavities is interesting. The gastrula arises by invagination. "Soon the archenteron pushes out (aus stülpt sich) at the sides and ventrally, so that one sees in side-view of the embryo two sacs (Schläuche), one long dorsal, one the archenteron, and a shorter ventral one the cœlom sac. Soon the cœlom sac pinches off from the archenteron, and surrounds it ventrally and at the sides. In course of development the mesoderm cells (which before formed a mass with the cells in close contact) separate more from each other, forming a parietal and visceral layer, at the same time growing around the archenteron dorsally. Lastly, the mesoderm breaks up into the characteristic spindle-cells which run irregularly through the the body-cavity. In the meantime the œsophagus arises by invagination of the ectoderm, and connects with the archenteron, while the gastrula mouth (blastopore, Urmund), as is known, is converted into the anus. At this stage the mesoderm collects ventrally in the archenteron, not far from the hinder end of the body, in two cell-masses, and in these soon a lumen appears. The sacs so formed press together in the ventral mid-line until they fuse with one another and fuse into a single mass, whose paired origin is for a long time indicated by a middle septum. In this way is formed the sac of the pericardium."

ENTOMOLOGY.[1]

Recent Publications.—Mr. Lawrence Bruner has lately published[2] an interesting and extended account of the insects affecting the sugar-beet. A number of new original illustrations appear in connection with it.——Full reports of the recent meetings of economic entomologists at Champaign, Illinois, have appeared in late issues of *Insect Life* (VIII., Nos. 5 and 6).——Mr. S. H. Scudder has begun, in *Psyche*, the publication of a series of interesting letters between Harris, Say, and Pickering.——Prof. A. J. Cook and Mr. G. C. Davis have lately published, in Bulletin 73 of the Michigan Agricultural College, descriptions of seven new species of hymenopterous parasites. ——Professor Cook also has a number of interesting entomological articles in the Report of the Michigan State Board of Agriculture for 1890.——Mr. C. H. Tyler Townsend has published several important papers concerning Diptera in the Proceedings of the Entomological Society of Washington. In the same Proceedings Mr. E. A. Schwarz has also printed a number of interesting papers on Coleoptera and general entomology.——An excellent account of the facilities for investigating injurious insects possessed by American experiment stations, together with a summary of the results so far obtained by the station entomologists, appeared recently in the *Journal für Landwirthschaft.* It was prepared by Prof. M. Wilckens, of Wien, who some months ago passed through America, studying the systems of our agricultural colleges and experiment stations.——Article XI., Vol. III., of the Bulletin of the Illinois State Laboratory of Natural History is by Prof. C. P. Gillette, and consists of descriptions of a large number of new species of Cynipidæ in the laboratory collection. It is illustrated by a good plate.

Osborn on Pediculi and Mallophaga.—Prof. Herbert Osborn, of the Iowa Agricultural College, has lately published as Bulletin No. 7 of the United States Division of Entomology an excellent discussion of "The Pediculi and Mallophaga Affecting Man and the Lower Animals." One new genus—Hæmatopinoides—and five new species of Pediculi are described; while a single species is also added to the known Mallophaga. The bulletin is well illustrated, many of the figures being new, and forms a very acceptable contribution to our knowledge of these little-known groups.

[1] Edited by Prof. C. M. Weed, Hanover, N. H.

[2] Bulletin Nebraska Experiment Station, IV., pp. 55–72.

Scudder's Tertiary Insects.—One of the most notable of recent entomological publications is Mr. S. H. Scudder's "Tertiary Insects of North America," which forms the last monograph published by the United States Geological Survey,—a quarto volume containing 734 pages and 28 plates. According to the author's summary, the monograph contains descriptions of 1 species of Myriapoda, 34 of Arachnida, 66 of Neuroptera, 30 of Orthoptera, 266 of Hemiptera, 112 of Coleoptera, 79 of Diptera, 1 of Lepidoptera, and 23 of Hymenoptera, making 612 species in all. Mr. Scudder states that for the lower orders "these numbers are slightly in excess of those obtained from the European Tertiaries, if the rich amber fauna of the Baltic is excluded; for the corresponding number for the European species from the rocks would be approximately as follows: Myriapoda, 1; Arachnida, 24 (recently, however, nearly doubled); Neuroptera, 59; Orthoptera, 36; and Hemiptera, 218; a total of 338 species, against 397 for the American rocks. There is no doubt that this excess would be found even greater in the higher orders by the material already many years in hand; and the extent of insect-bearing rocks of the west, which as yet have been touched only here and there, is so immeasurably greater than that of similar European strata that only the lack of students in this field of American paleontology can prevent our deposits from assuming a commanding position in the world."

Packard's Forest Insects.—The long-expected Fifth Report of the U. S. Entomological Commission has lately been issued. It consists of an enlarged and revised edition of Bulletin No. 7 of the Commission, treating of "Insects Injurious to Forest and Shade Trees." The author, Prof. A. S. Packard, is to be congratulated upon the completion of the report upon which he has been at work so long. It will prove extremely useful to entomologists as well as lovers of trees and forests. The volume contains forty plates, twelve of which are colored, and nearly a thousand pages of letter-press. "It is hoped," says Dr. Packard, in his preface, "that the work in its present form may serve as a convenient synopsis, a starting point for future more detailed work, as well as a hand-book of reference for the use of future observers. . . . A volume could be written on the insects living on any single kind of tree, and hereafter it may be expected that the insect population of the oak, elm, poplar, pine, and other trees will be treated of monographically. Certainly there could be no more interesting and profitable work for the young entomologist."

ARCHEOLOGY AND ETHNOLOGY.[1]

The International Congress of Anthropology and Prehistoric Archeology of Paris.—(*Continued from page 503.*)

Fourth Question.—"The Chronologic Relations between the Civilizations of the Ages of Stone, of Bronze, and of Iron."

Monsieur Judge Piette continued the discussion from the last question by continuing the description of his discoveries in the grotto of Mas d'Azil. The principal idea which he sought to elucidate in his dissertation was of an epoch of transition which should be intermediate between the cavern period, the Madalenien epoch, and the polished stone age. He declared that the human industry of the Madalenien epoch had not been uniform in its duration. In the Pyrenees there were four phases of this civilization, which might be grouped into two series, the first or earliest represented by the bones of the horse, and the later that represented by the bones of the deer. Thus, going from the bottom to the top there were four strata, the first that of the ox (Bos), the second that of the horse (Equus), the third that of the reindeer, and the fourth that of the common deer. In the last epoch the climate, which had been until then dry and cold, became warmer and humid. The reindeer became rare, and the art of the epoch fell into decadence. This was the prelude to the age of polished stone. The evidence which he cited to prove these conclusions was derived from his excavations in the Grotte Mas d'Azil. He described the fauna, the industrial implements in bone, the shells, and pieces of pottery, and insisted particularly upon the discovery which he had made of the pebbles which had been colored with the oxide of iron, ground and made into a paint, and applied with a brush. He also described the designs, some of which were in straight lines, parallel, cutting each other at right angles, chevron, fern, and curious and rare concentric circles with dots in the center.

While many of the strata belong to the age of the caverns, and were paleolithic, yet some of those on the surface were neolithic; and between the two, Judge Piette though he could identify a transition in the civilization, and he undertook to make two series of this transition, and to give to it, the first and lowest, the name of *acesmolithic* and to the top that of *cèmolithic,* the one being the commencement and the other the completion of the art of polishing stone. This

[1] This department is edited by Dr. Thomas Wilson, Smithsonian Institution, Washington, D. C.

paper was followed by Mr. Boule, who said that it attacked the theory of hiatus between the paleolithic and neolithic ages which had been heretofore recognized by nearly all prehistoric anthropologists. But he declared that there was more to this theory of Judge Piette than had been supposed, for it corresponded largely with the discoveries made by himself and M. Cartailhac in the Grotte de Reilhac, where they found objects of human industry which suggested an intermediate stage between the two periods and not a hiatus.

M. Adrien de Mortillet recalled that M. Salmon had already made similar discoveries, and that he had given to the first period mentioned by Judge Piette the name of Campinienne. But Judge Piette defended the nomenclature which he had made. A large discussion took place over this subject; many instances and localities were brought to the attention of the congress, and while nothing was permanently decided or determined concerning the question at issue, yet the members were requested to investigate with particularity and in detail this question of the possible hiatus, or whether there was an age of transition intermediate between the two great ages of stone. M. Cartailhac cited M. de Mortillet as having said, in 1874, that the hiatus, instead of being a veritable one, was simply our want of knowledge, and he continued the discussion by a description of the objects found by himself and M. Boule in their excavations in the Grotte de Reilhac, near Gramat, at which I had assisted.

Dr. Sophus Müller, of Copenhagen, had commenced the methodical publication of the types of objects of the age of polished stone in Scandinavia. The first part of his work, comprising 270 figures, was presented before the congress. The first epoch of prehistoric man in Denmark was that of the shell heaps. The cutting implements common to these shell heaps are unknown in the sepultures; the hatchets were chipped and not polished. The second epoch was represented by forms more developed, among which were hatchets and chisels with the edge polished. A few of these were found in the Danish sepultures, which is contrary to that in France. They, or the knowledge to make them, were probably brought from the west, where they appeared to the author to belong to the civilization of the megalithic monuments. After this epoch came that of megalithic monuments, more recent than those of France; simple dolmens, those with small and single chambers, are probably the most ancient. The large chambers and the duplication of them are probably the types more recent. The earlier and simpler dolmens of the most archaic forms have a certain relation to the same monuments in Asia. According to Dr. Müller, the theory of the Scandinavian archeologists as to the relative age and epoch of these monuments is confirmed.

Monsieur Ad. de Mortillet coincided with Dr. Muller as to the anteriority of the small dolmens of Scandinavia. He said it derived support from an investigation of those of France, and also of those in Algeria, which he had been charged by the Commission of Prehistoric Monuments to examine and describe.

Dr. Verneau gave descriptions of his studies of the antique monuments of the Canary Islands.

Dr. Hamy took exception to some of the conclusions of M. de Mortillet, and objected to premature generalization which should include different countries. He declared in favor of special conclusions for each region. He proposed to publish a work giving the results of his investigations in Algeria.

Monsieur Felix Gaillard, of Plouharnel, argued in favor of the contemporaneity of the stone cists as places of sepulture with the dolmen. He cited many cases from his locality in Plouharnel, Carnac, etc., Morbihan.

Monsieur B. Reber described the tombs in the neighborhood of Geneva, made after the fashion of the stone cist,—that is, with flat, unwrought, rude stones.

Monsieur Montelius, of the Prehistoric Museum of Stockholm, gave a most interesting paper upon "The Chronology of the Age of Bronze in Europe." He said there were no coins, and consequently no dates, which belonged to the age of bronze, but in Northern and Central Europe there had been found among the pieces of bronze a vase, a fibula, and some other objects, which were undoubtedly of Italian or southern manufacture. The age of bronze in Scandinavia, according to M. Montelius, divides itself into six periods. In Italy, in France, and elsewhere in Europe, one can distinguish but four periods. The difference of the date of the origin of bronze between Italy and Northern Europe is not so great as we have heretofore believed. According to the most detailed and particular investigation of M. Montelius, he thought himself able to divide the age of bronze in Scandinavia into six periods, which were thus distributed: The first was from 1500 to 1300 B. C.; second, from 1300 to 1100; third, from 1100 to 900; fourth, from 900 to 750; fifth, from 750 to 550; sixth, from 550 to 400, and including the transition towards the age of iron. One who has not seen M. Montelius, and compared with him these divisions, can scarcely understand how he is able to distinguish them, what the evidences are, or their character, on which he bases his theory; and yet to me, who had seen and heard Monsieur Montelius in all the minutia, extent, and number of his investigations, the proofs were highly satisfactory and convincing.

M. Montelius continued with antoher paper,—"The Preclassic Civilization of Italy." He recommended to the prehistoric archeologist the study of this civilization, and declared that it had never been satisfactorily done either by the prehistoric archeologist, nor yet by the classic archeologist. He said the Italian objects found in Central Europe, even up to the north, established the fact of commerce, or, at least, relations between the peninsula of Italy and the center and north of Europe in times of high antiquity. He had chosen specimens and types of objects which are exhibited in the museums, and also those shown only in publications, by means of which he has formed an album containing no less than two thousand figures, which are classed chronologically and divided into four parts geographically. The first was Sardinia; the second, Sicily and Southern Italy; the third, Central Italy; and fourth, Northern Italy. Each one of these divisions was again subdivided into chronologic periods, thus: For Northern and Central Italy he had four periods: 1. Objects which were of simple form in bronze and sometimes in copper. The hatchets were rude, flat, with only an indicated edge. 2. Celts, hatchet-shaped. 3. Celts, with wings and the most ancient type of fibula. 4. Celts, with a stop and a socket; the fibula made of spiral form and with a simple arch. During the age of iron the civilization divided itself, and changed according as it was on the one or the other side of the Apennine mountains. To the north was the fifth period of Benacci, sixth of Arnoldi; both of which periods were of Villanova and Pre-Etruscan. 7. The period of La Certosa or Etruscan. 8. The period Celtic or Gaulois. On the south of the Apennines was the fifth,—the first period of the age of iron. 6. Periods of Proto-Etruscan, with a notable invasion, bringing new and strange elements; and 7th was the Etruscan period. Supposing the Etruscans to have arrived in Etruria by sea, they had not traversed the Apennines till a much later epoch.

This communication of M. Montelius was exceedingly interesting to me, not alone because of his investigations into the age of bronze in the Scandinavian countries, of which I have already favorably spoken, but because I had been over this preclassic country of Italy, and had been struck many times with what I conceived to be the errors of classic scholars, with their apparent failure to comprehend the modern science of prehistoric archeology, with the difference which it had wrought in our opinions concerning the antiquity, and particularly of its occupation, of Europe, and consequently of Italy. I have neither the competence nor the opportunity to make any such investigations as had been done by M. Montelius. I was all the more satisfied and gratified to find that he, a prehistoric archeologist, had done so, and that his conclusions were so much in harmony with my own.

Monsieur E. Vouge described the extreme west of Lake Neuchatel and changes which have taken place therein. He showed various stratigraphic charts by which the strata of the different ages were known and to be recognized, and from this examination he arrived at a series of conclusions. The lowest, and consequently the earliest, stratum containing evidence of human industry was that which belonged to the neolithic age. But these people did not long remain at this point. Their houses and establishments, once burned, were never reconstructed. But their occupation of this country was evident, and that it was extended cannot at all be doubted. It was separate, distinct, and anterior to that of the age of bronze or of the Helvetes, which followed. It is difficult to say at what epoch of time the men of the bronze age made their appearance on Lake Neuchatel. The stations of bronze did not remain intact because of the movements of the lake, which, for 1,500 years or more, have changed the borders. There was, said M. Vouga, at this point a commercial station. There may have been also there, or in the neighborhood, a foundry or manufactory, but he thought it more than likely to have been only a commercial station, for they found, in what might have been called or served as a warehouse or salesroom, swords in their scabbards, shears for shearing, and knives, also in their scabbards. All these were bound up in packages, whether separately or together is not stated, but tied together, as though they were intented for sale, or possibly for transportation, so, in any event, it was considered as a commercial station, either of sale or transshipment. This was all covered with turf, and with the dèbris and clay, and is distinctly and definitely separated from the antiquities of the Gallo-Roman epoch, which are to be found on the turf and scattered through it.

Monsieur Baron Joseph de Baye gave a rèsumè of his excavations in the Gauloise sepultures in Saint-Jean-sur-Tourbe, in the Department of Mame. There were two levels to these tombs, and the funeral furniture, torques, bracelets, fibulas, lances, beads of glass, of amber, of bone, etc., were exceedingly important, as they were in part different from anything that this district had yielded to this time. In one of the tombs was found the skeleton of a young man, from sixteen to twenty years, with skull abnormal, with numerous os wormiens, and possibly artificially deformed, following a custom that prevailed in the east of Gaul. The skeleton still carried about the neck and on the arms beads of amber of large size and great number. On a bronze wire were strung the small beads of glass, amber, coral, a boar's tooth, pebbles, fossil shells, and a small statuette. The latter was anterior to the Roman epoch, but was similar to those which have been found in the Departments of Meurthe-et-Moselle, Argovie, Hungary, and in Caucase, and was a new evidence of the relations between Gaul and the Orient.

Monsieur Cartailhac presented the results of an archeologic voyage made by him to the Balearie Isles. He showed a most beautiful series of photographs, which represented the ancient city and edifices, and the objects most notable belonging thereto.

(*To be continued.*)

Remains of the Worship of Ashtaroth in Palestine.—To this day the *fellaheen* (peasants) of Palestine have the custom of ascending some high place, at the full of the moon, and pouring out olive oil, as an oblation, on some particular rock, long used for the purpose, and having a hollowed space on top,—being, in fact, a rude sort of altar. When questioned on the subject, they can give no reason for the act, except that it is an old custom,—that their fore-athers did so from time immemorial. As they are Mohammedans, and therefore abhor all idolatrous practices, this is all the more remarkable. It seems to be unquestionably a remnant of the ancient worship of Ashtaroth, the two-horned or crescent-bearing goddess, and which once prevailed so extensively in this country.

Ashtaroth was especially the goddess of the Zidonians, and the Israelites fell at once into the idolatry when they slew the Zidonians at Dan, preserving the idol and the priests of this people, in order to continue the abomination. The worship of Ashtaroth was set up in Jerusalem, and on the hills in its vicinity, King Solomon himself building high places for the purpose, and participating therein. Interesting indications of this are revealed at the present date. From time to time images of the goddess are found in excavating in Jerusalem and its neighborhood, as well as in the Moabite country, where this form of idolatry greatly prevailed. These idols are of terra-cotta or baked red clay, and are about from seven to eight inches high. They are usually hollow within, and represent the goddess draped, but with bare, protuberant breasts, and wearing a tire or moon-shaped ornament on the head.

. These smaller images must have been the personal or household gods which we find so often referred to; while for the public worship doubtless a larger idol was set up.

A thorough exploration of the "high places" of Palestine, which abound, would no doubt prove of great importance, and add largely to our knowledge of the religion and ancient customs of the early inhabitants of the land. — HENRY GILLMAN, *Jerusalem, Palestine, April 16th, 1891.*

The Mika Operation.—The rite known as the Mika Operation, performed by the natives of Australia, is supposed by most observers to be for the purpose of limiting the population. Mr. R. Ethridge, however, agrees with Mr. J. Frazer that the custom is a remnant of a forgotten religious ceremony. (Proc. Linnean Society of New South Wales, Vol. V., pp. 255–258.)

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Boston Society of Natural History.—April 15th.—Dr. R. R. Andrews read a paper on "The Development of the Enamel of the Teeth," illustrated by the stereopticon. The annual meeting of the society was held on Wednesday evening, May 6th, at 7¾ o'clock. Business: The curator, secretary, and treasurer read their annual reports. The directors of the Natural History Gardens and Aquaria presented their first report. Officers for 1891–'92 were elected. Dr. C.-S. Minot spoke on the "Evolution of the Head."

May 20th.—Business: Election of a councillor for one year. Prof. W. O. Crosby read a paper on the "Geology of Hingham." Mr. G. H. Barton described a "Glacial Pot-Hole at Pearl Hill, Fitchburg, Massachusetts."—J. WALTER FEWKES, *Secretary.*

Biological Society of Washington.—May 2.—The following communications were read: Dr. Theodore Gill—"On the Classification of the Apodal Fishes." Mr. B. T. Galloway—"Recent Progress in the Study of Plant Diseases." Dr. Frank Baker—"Notes on Dwarfs." Mr. Charles Hallock—"Distribution of Fishes by Underground Water-Courses." Mr. F. C. Test—"Notes on the Dentition of Desmognathus." Mr. J. M. Holzinger—"Incentives to Natural History Work."

May 16th.—The following communications were read: Prof. C. V. Riley—"The Mexican 'Arrow Weed' and 'Jumping-Jack.'" Mr. J. M. Holzinger—"Incentives to Natural History Work." Mr. William Palmer—"The Distribution of Certain Mammals, Birds, and Plants on the Pribyloff Islands." Dr. George Vasey—"Notes on Recent Field Work of the Botanical Division of the Department of Agriculture." Mr. F. A. Lucas—"On a Tortoise from Duncan Island."—FREDERIC A. LUCAS, *Secretary*.

SCIENTIFIC NEWS.

Francis W. Cragin, S.B., Professor of Geology and Zoology in Washburn College, Topeka, Kansas, has issued a prospectus of a geological and physical geography of Kansas, an illustrated handbook, educational in its relation to pure science, and practical in its relation to the development of the natural resources of the state, for the use of students, teachers, travelers, farmers, investors, and general readers.

We have received the prospectus of the Geologists' Association (University College, Gower Street, London). The president is T. V. Holmes, F.G.S., M.A.I. The object of the association is to facilitate the study of geology and its allied sciences. The methods adopted by the association are: (1) Monthly meetings for the reading of papers, etc., (2) visits to museums, etc., (3) excursions, (4) publication of papers, etc., (5) the formation of a library. They are well adapted to meet the requirements of those who may be interested in, but know little of, geology; whilst the experienced geologist is enabled both to add to his own knowledge and to impart it to others.

Dr. H. Hensoldt, curator of the Geological Museum and lecturer in Petrographical Philosophy at the School of Mines, Columbia College, New York, will shortly issue a work, "Studies in Microscopical Petrography." It will consist of a series of one hundred mineral and rock sections for the microscope, with descriptions and accurate, artistic lithographed plates.

NOTICES.

Notices for scientific societies and private individuals inserted under this head free of charge. For business houses, two cents per word.

MINERALOGY. — Course conducted by correspondence. First collection and book $1. Postage 25 cents. Address
GUSTAVE GUTTENBERG,
Central High School, Pittsburgh, Pa.

WANTED—To correspond with conchologists in America, especially in California, with a view to exchange. Many British land, fresh-water, and marine duplicates; some foreign. Address Mrs. Falloon, Long Ashton Vicarage, Bristol, England.

WANTED—Position in Academy, Normal or High School, as teacher of the Natural Sciences and Modern Languages. Latin taught in addition, if necessary. Address G., box 441, Hanover, N. H.

A COLLEGE PROFESSOR of Natural Sciences and German, of four years experience and special Biological training received at the Universities of Leipzig and Bonn, Germany, is open for a position in a college. Good references.
Address, C., Box 136, New Berlin, Pa.

FOR EXCHANGE.—14 Volumes (1883–1889) AMERICAN JOURNAL OF SCIENCE; 10 volumes (1880–1889) AMERICAN NATURALIST; 21 volumes (1879–1890) ENGLISH MECHANIC; all in good condition for binding; also, Morris Typewriter. If you have a good Microscope, Camera, or anything else to offer, please send full description.
E. R. CHADBOURN, LEWISTON, ME.

FOR SALE.—Beautiful sets of Fossil Plants from the Dakota Group Cretaceous. On receipt of $3.00 I will forward, prepaid, to any address in Europe or America, 20 different species and varieties of Dakota Plants. Send 5 cents for plate illustrating the set. The specimens will equal the figures. CHAS. H. STERNBERG,
P. O. Box 60, Lawrence, Kans.

WANTED—Hall's works on Palæontology, and other works giving plates which show fossils of the Niagara Epoch. Address M. D. Sullivan, St. Ignatius College, Chicago, Ill.

VOLUMES I., II., III., and IV., of THE AMERICAN NATURALIST, in first-class condition, bound in half Morocco, for sale. Price $16.00. Address GEO. W. MACKAY,
25 Congress St., Boston, Mass.

WANTED—For dissection and microscopic work, Polyps, Jelly-fish, or other Hydrozoa, Actinozoa, and Ctenophora; also Echinodermata and Mollusca. Cash or exchange given. J. A. Leighton, Trinity College, Toronto, Can.

FOR EXCHANGE—Thirty species of *Unionidæ* from Spoon river, Ill.; the finest in the world. Fine *Helices* and other land shells. Fifty species of birds' eggs in full sets; Indian stone and flint implements. WANTED, shells, minerals, fossils, curios and scientific literature.
DR. W. S. STRODE, BERNADOTTE, ILL.

MINERALS TO EXCHANGE for others.
JOHN HOLL. ROLLO,
Wilmington, Delaware.

First-Class Histological Mounts at European Prices.
25 cts. each.

WM. N. BEGGS, M.D.,
Instructor of Histology in the St. Louis Med. College.
2207 Sidney St., St. Louis, Mo.

New York, Kingston-on-Hudson.

GOLDEN HILL SCHOOL,

A Preparatory School for Boys.
$450 Per Annum.

JOHN M. CROSS, A.M., Principal.

NOTICE TO CONTRIBUTORS

TO THE

AMERICAN NATURALIST.

Send Contributions to the EDITORS ONLY.

Send to the PUBLISHERS ONLY:

All Orders for Extra (or Reprint) Copies.
All Proofs of Texts and Engravings.

NOTE.—All orders for reprint or extra copies must be given before the number containing the article goes to press; otherwise none will be furnished.