JOHNS HOPKINS UNIVERSITY CIRCULARS

Published with the approbation of the Board of Trustees

VOL. XIV.—No. 119.] BALTIMORE, JUNE, 1895. [PRICE, 10 CENTS.

PROCEEDINGS OF THE SCIENTIFIC ASSOCIATION OF THE JOHNS HOPKINS UNIVERSITY, 1894-95.

CONTENTS.

SCIENTIFIC ASSOCIATION.

One Hundred and Sixteenth Regular Meeting, November 15, 1894.

Professor IRA REMSEN, President of the Association, in the Chair.

Inaugural Address of the President: "The Past and the Future of the Scientific Association."

The speaker referred to the organization of the Scientific Association in 1877. The first meeting was called as a result of a conversation between Professor Rowland and himself. Professor Sylvester was elected President, and took up the work with interest. At first there was a tendency towards the highest plane, but experience showed clearly that, if the Association was to serve any useful purpose, it would be necessary to put it in touch with a larger number than could be found upon the highest plane. It has passed through a number of phases illustrative, in a comparatively small way, of the phases that other scientific societies pass through. Each one in turn, like a human being, has to learn by experience what it can do, and many experiments and failures seem to be essential to the learning of the lesson.

Those who are charged with the management of the Association feel that it has been of benefit, and that it is likely to prove of benefit in the future. The effort will be, as it has been, to present from time to time the results of investigations in the different departments of science, in hope of counter-acting to some extent the tendency to narrow specialization. If there were no opposing forces at work, scientific workers would, of course, tend to become narrower and narrower; and, as the opposing forces furnished by nature are, apparently, not of sufficient strength for the purpose, artificial forces must be brought into play.

The management has decided to get rid of as many rules as possible. An examination of the records has shown that the Association has been over-burdened with rules, and that many of them have never been observed. Very few seem to be called for, and after a careful study of the subject such suggestions as may seem wise will be made.

One Hundred and Seventeenth Regular Meeting, December 20, 1894.

The President of the Association in the Chair.

1. Origin and Development of Learned Societies and Academies since the Renaissance. By D. C. GILMAN.

Four such institutions were selected as typical, all of them originating in the seventeenth century. Each of them was due to the vigorous initiation of an individual; all are still active. Frequent modifications of the original laws and conditions are obvious, showing a disposition frequently arising to improve the mechanism of such agencies. The tendency is also shown to become so special that no general interest is taken in the meetings, and again so general that no special interest is taken. Thus there is a perpetual vibration between associations and meetings of a comprehensive character and those of a very distinct and limited activity. Throughout them all these aims are obvious: 1. The intellectual gratification and improvement of the individual members; 2. The initiation and encouragement of investigations; 3. The publication of memoirs and proceedings; 4. The making known (by correspondence or otherwise) of the progress of science, without special regard for the researches of any particular organization.

The four academies which were selected as examples were those of Rome, London, Paris and Berlin.

2. Pseudo-Satellites of Jupiter in the Seventeenth Century. By C. W. L. Johnson.

Abstract printed in University Circular, No. 117, 1895.

3. Recent Observations of the Planet Mars. By C. L. Poor.

There was given a brief outline of the generally accepted theories in regard to the surface conditions existing upon this planet. Then followed a discussion of the observations made in 1892 and 1894, at Arequipa, at the Lick, and at the Lowell Observatories. These observations seem to overthrow all existing theories in regard to the planet: the hitherto accepted division of the surface into seas and continents, so called, was shown to be erroneous. The light and dark markings seem to be due to actual color differences of the surface, and are analogous to the familiar markings on the moon. Irregularities in level are seen to exist in the midst of the dark markings; the so-called seas exhibit the characteristics of a rugged continent. The evidence is strongly against the existence of any large bodies of water on this planet, although the phenomena of the ice-caps point conclusively to its presence in certain quantities. The general conclusion drawn from the observations reported upon, was that we know almost nothing concerning the surface of this interesting planet.

Lantern slides were shown illustrating the various points brought out in the discussion.

One Hundred and Eighteenth Regular Meeting, January 17, 1895.

The President of the Association in the Chair.

The following papers were presented and read:

1. Notes on Lunar Photography. By William H. Pickering, Harvard College Observatory.

Professor Pickering spoke of the difficulties in obtaining a really good photograph of the moon; difficulties arising from three sources: 1st. Imperfect figuring of the lens; 2d. Imperfections in "following" during exposures of one or two minutes; 3d. Unsteadiness of the atmosphere during the exposure. His remarks were mostly confined to the last two points, and in regard to the last he gave the results of his experience in Peru and in Southern California. In his opinion, a high desert climate is the best for all astronomical research. As to "following," Professor Pickering thought that the best results would be obtained in the future by means of a horizontal telescope of two or three hundred feet focus. In a telescope of ordinary focal length the adjustments are so extremely delicate that our hands fail to make them with sufficient accuracy. In such a telescope as he described a second of arc subtends an appreciable length at the focus, and the adjustments are, therefore, facilitated.

2. Recent Ideas as to the Structure and Physiology of the Nerve Cells of the Brain and Cord. By William H. Howell.

The paper gave an account of the recent work of Cajal, Lenhossek, Retzius and others upon the structure and relations of the nerve cells in the brain and spinal cord. The importance of this work in giving a fundamental conception of the paths of conduction and association in the central nervous system was explained.

Extra Meeting, February 14, 1895.

The President of the Association in the Chair.

Professor Remsen gave an account of the work of Lord Rayleigh and Professor Ramsay on Argon, the recently discovered constituent of the atmosphere.

An abstract of this address appeared in Science (New Series, Vol. I, 1895).

One Hundred and Nineteenth Regular Meeting, February 21, 1895.

On account of the absence of the principal speaker the President adjourned the meeting.

One Hundred and Twentieth Regular Meeting, March 21, 1895.

The President of the Association in the Chair.

The following papers were presented and read:

1. Preliminary Results on the Water Temperatures of the Great Lakes. By Mark W. Harrington, Chief of the U. S. Weather Bureau.

The paper gave the results of an investigation of the temperatures of the Great Lakes, which was carried on during the open period of the years 1893 and 1894. The observations were mainly made by masters of vessels, the necessary apparatus and instructions being furnished them by the Bureau. For this reason the measures at hand are confined to definite parts of the lake system; in large portions of the lakes there are no available records. The records for Lake Superior are far more complete than for any of the other lakes, the observations of the masters in this case being supplemented by those of a special expedition sent out by the Bureau. Diagrams were exhibited showing the isotherms for different months during which the lakes are open to navigation.

2. Experiments with a new Chronograph applied to the measurement of the Velocity of Projectiles. By G. O. Squier, Lieutenant, U. S. Army.

One Hundred and Twenty-first Regular Meeting, April 25, 1895.

The President of the Association in the Chair.

The following papers were presented and read:

1. Recent Researches on Immunity. By William H. Welch.

The distinctions between natural and artificial immunity were pointed out. The manner of production and general principles underlying antitoxic immunity were described, with especial reference to diphtheria and tetanus. The recent studies concerning the sources of alexins and their bearing upon the phagocytic and humoral theories of immunity were considered. An account was given of the investigations of R. Pfeiffer upon experimental immunity from Asiatic Cholera, and attention was called to the new points of view regarding immunity disclosed by these investigations.

2. The Infra-Red Spectra of the Elements. By E. P. Lewis.

After referring to previous work in this field, a brief account was given of an investigation now going on under Professor Rowland's direction. The infra-red arc spectra of the elements formed by a concave grating are examined with a modified form of the Boys radiomicrometer. This instrument has been made sufficiently sensitive to respond to the heating effect of a single line. The wave-lengths of several lines in the spectra of sodium, lithium, calcium, and silver, have already been determined, with a probable error of less than one Angström unit—an accuracy which has never been attained hitherto.

The following papers were presented and read by title:

1. Experiments upon the Reflex Fall of Blood Pressure and upon Reflex Changes in the Rate of the Heart-beat. By REID HUNT.

The object of these experiments was two-fold. In the first place to investigate, somewhat more fully, the conditions under which a reflex fall of blood pressure occurs on stimulation of afferent nerves and to determine as far as possible the vascular areas in which the dilatation takes place. Attention was given to the question as to whether the afferent nerves concerned are the same as those producing a reflex rise of pressure. In the second place some observations were made upon the effect on the heart rate of stimulating afferent nerves.

The principal conclusions are as follows:

1. Anaesthetics and curare have a marked effect upon the ease with which a reflex fall of blood pressure is obtained; some decrease, others increase it.
2. There are a number of methods by which this fall of pressure can be obtained without any change being produced in the vaso-motor centre.
3. Stimulation of the central end of a recently regenerated nerve causes a fall of pressure.
4. It was argued from "2" and "3" that this reflex fall can be best explained on the hypothesis that there are two sets of fibres in different nerves—depressor and pressor.
5. The dilatation in these cases occurs largely in the muscular system.
6. The hypothesis that this fall of pressure is due to a stimulation of dilator nerves agrees better with the commonly accepted theories of vaso-motor actions than does any other.
7. The "weakening fibres" of the vagus are probably in tonic activity.
8. The effect of some anaesthetics is to diminish, that of others to increase, the tonic activity of the vagus; they thus exercise an important influence on the reflex phenomena.
9. The effect upon the heart rate of stimulating a sensory nerve differs in different animals. The usual effect is an acceleration in the dog, an inhibition in the cat.
10. Stimulation of the central end of a recently regenerated nerve causes an acceleration of the heart in the cat.
11. A reflex acceleration of the heart rarely, if ever, occurs after section of the vagi. This agrees with the observations of Roy and Adami.
12. When a nerve trunk is cooled the fibres to the cardio-inhibitory and augmentor centres lose their property of conductivity at a higher temperature than do the depressors to the vaso-motor centre.
13. As in the case of the afferent fibres to the vaso-motor centre, so here the simplest explanation is that there are two sets of fibres, reflex accelerator and reflex inhibitory, and that these are distinct not only from each other but also from those going to the vaso-motor centre.
14. The expression "different sets of fibres" is used only in the sense that different sensory fibres may make different connections with the vaso-motor and other centres.

2. The Effect of Olfactory Sensations upon the Blood-Supply to the Brain, Studied by means of Plethysmographic Observations upon the Arm. By T. E. SHIELDS.

The object of this investigation was to determine whether olfactory sensations are accompanied by definite changes in the blood-supply of the brain, and what differences, if any, exist in the effect of disagreeable as compared with agreeable sensations.

The most important outcome of the work has been the completion of various improvements in the construction and use of the plethysmograph, by means of which the numerous errors attending the use of this instrument have been almost entirely eliminated. The results of the work show that all olfactory sensations, in so far as they produce any effect upon the circulation, tend to bring about a diminution in the volume of the arm, and therefore probably cause a congestion of the brain. This effect was most apparent in individuals sensitive to odors. Irritating vapors such as those from formic acid have a marked effect in the same direction. The experiments give no support to the view that pleasant sensations are accompanied by a diminution in the blood-supply to the brain and unpleasant sensations by the opposite effect.

The following is a list of other investigations carried on in the different laboratories and departments of scientific instruction of the Johns Hopkins University, which have been reported to the Scientific Association within the last academic year. References to the place of publication are given.

ASTRONOMY.

A. S. CHESSIN: On the Expressions of Bessel's Functions in the Form of Definite Integrals. (*University Circulars*, 116.)
—— On Poisson's Coefficients (a_i, a_j) for the Planetary Motion. (*University Circulars*, 116.)
—— Note on Professor Newcomb's Development of the Perturbative Function. (*Astronomical Journal*, 326, 1894.)
—— On Professor Newcomb's Development of the Perturbative Function. *Astronomical Journal*, 332, 1894.)
F. H. CLUTZ: Demonstration of a Formula. (*University Circulars*, 116.)
—— Measurements of Double Stars, 1893–1894. (*University Circulars*, 116.)
C. L. POOR: Special Perturbations due to the Elliptic Figure of a Planet. (*University Circulars*, 116, 1895.)
—— Formulas for Computing the Perturbations of Hyperbolic Elements. (*University Circulars*, 116, 1895.)
—— Observations of the Transit of Mercury, 1894, Nov. 10. (*Astronomical Journal, No.* 330, 1894; *University Circulars*, 116.)
—— Finding Ephemeris for Comet, 1889, V. (*Astronomical Journal, No.* 340, 1895.)
B. M. ROSZEL: Note on the Mass of the Asteroids. (*University Circulars*, 116.)
—— The Action of the Asteroids on Mars. (*In preparation for the press.*)

CHEMISTRY.

Following are the titles of the completed investigations carried on under the direction of Professor REMSEN during the past year. *The articles will be published in the American Chemical Journal:*

D. BASE: On the Double Halides of Zinc and Aniline and the Toluidines.
W. BROMWELL: On the Action of Methyl Alcohol on the Diazo-Compound of Orthotoluidine.
H. FAY: The Action of Light on some Organic Substances in the Presence of the Salts of Uranium.
G. W. GRAY: The Isomeric Chlorides of Nitroorthosulphobenzoic Acid.
J. J. GRIFFIN: Metatoluenesulphonic Acid.
H. H. HIGBEE: On the Double Halides of Antimony and Aniline and the Toluidines.
J. F. HUNTER: The Anilides of Orthosulphobenzoic Acid.
W. J. KARSLAKE: Orthocyanbenzenesulphonic Acid and its Derivatives.
S. R. McKEE: The Isomeric Chlorides of Orthosulphobenzoic Acid.
A. M. MUCKENFUSS: The Action of Phosphorus Pentachloride on Parasulphaminebenzoic Acid.
L. C. NEWELL: On Parabenzoyldiphenylsulphone.
J. F. NORRIS: On Double Halides of Selenium and the Substituted Ammonias.

Further investigations have been carried out in the Chemical Laboratory, under the direction of Professor MORSE, during the past year as below indicated:

A. D. CHAMBERS and E. W. MAGRUDER: On the ratio of Oxygen to Manganese in certain oxides of Manganese. (*A series of Articles will appear in American Chemical Journal.*)
H. N. MORSE and T. L. BLALOCK: A System of Calibration for Volumetric Apparatus. (*American Chemical Journal, Vol. XVI, No.* 7, 1894.)

H. C. JONES: A redetermination of the Atomic Weight of Yttrium. (*American Chemical Journal, Vol.* 17, 1895.)
—— On the Lowering of the Freezing-Point of Water produced by Non-electrolytes. (*To appear in Zeitschrift für Physikalische Chemie.*)

GEOLOGY.

The following papers were presented by title to the Association and will be printed, in abstract, in the *University Circulars*. They represent chiefly the various investigations conducted in the Geological Laboratory during the past year.

R. M. BAGG, JR.: Preliminary notes upon the Cretaceous Foraminifera of New Jersey.

A. E. BIBBINS: Contributions to the Flora of the Potomac Formation of Maryland.

S. W. BEYER: Contributions to the Geology of Minnehaha County, South Dakota.

W. B. CLARK: Contribution to the Eocene Fauna of Maryland and Virginia.

—— Description of two new Brachiopods from the Cretaceous.

—— Additions to the Mesozoic Echinoderma of the United States.

H. S. GANE: Preliminary notice of the Neocene corals of the United States.

E. B. MATTHEWS: Structural variations in the Pike's Peak Massiv.

—— Notes on some Flattened Garnets from North Carolina.

J. A. MITCHELL: Discovery of Fossil Foot-prints in the Jura-Trias Sandstones of Frederick County, Maryland.

S. M. PRINDLE: Notes upon an Andalusite Contact Zone near Washington, D. C.

D. E. ROBERTS: Contributions to the Cretaceous Formations of the Eastern Shore of Maryland.

G. B. SHATTUCK: The Cretaceous-Tertiary Formations of the Bordentown Atlas Sheet, New Jersey.

G. O. SMITH: The Volcanic Series of Fox Islands, Maine.

A. C. SPENCER: Crystallography of Meta-toluene-sulphon-amide.

The following papers have already appeared.

W. B. CLARK: Cretaceous deposits of the northern half of the Atlantic Coastal plain. (*Bull., Geol. Soc. Amer., Vol. VI.*, 1895, *pp.* 479-482.)

E. B. MATHEWS: Preliminary paper on the Granites of Pike's Peak. (*Bull., Geol. Soc. Amer., Vol. VI.*, 1895.)

PATHOLOGY.

List of investigations during the year ending April, 1895, of which reports have been published:

L. F. BARKER: The Presence of Iron in the Granules of the Eosinophilic Leucocytes. (*Johns Hopkins Hospital Bulletin.*)

—— The Pathological Study of Four Cases of Fatal Malaria. (*Johns Hopkins Hospital Reports.*)

H. J. BERKLEY: Dementia Paralytica in the Negro Race. (*Johns Hopkins Hospital Reports.*)

—— Studies in the Histology of the Liver. (*Ibid.*)

—— The Intrinsic Pulmonary Nerves in Mammalia. (*Ibid.*)

—— The Intrinsic Nerve Supply of the Cardiac Ventricles in certain Vertebrates. (*Ibid.*)

—— The Intrinsic Nerves of the Submaxillary Gland of Mus Musculus. (*Ibid.*)

—— The Intrinsic Nerves of the Thyroid Glands of the Dog. (*Ibid.*)

—— The Nerve Elements of the Pituitary Gland. (*Ibid.*)

—— A Case of Paranoia with a Study of the Central Convolutions. (*Johns Hopkins Hospital Bulletin.*)

MEADE BOLTON: The Effect of Certain Metals upon the Growth of Bacteria. (*Trans. of the Assoc. of American Physicians.*)

W. D. BOOKER: The Bacteriology and Pathology of Summer Diarrhœa in Children. (*Johns Hopkins Hospital Reports.*)

T. S. CULLEN: The Pathology of Hydro-Salpinx. (*Johns Hopkins Hospital Reports.*)

—— Abscess in the Urethro-Vaginal Septum. (*Johns Hopkins Hospital Bulletin.*)

—— Angio-Sarcoma of the Ovary. (*Ibid.*)

—— Papilloma of the Ovary. (*Ibid.*)

—— Tumor of the Kidney developing from Aberrant Adrenal Gland. (*Ibid.*)

SIMON FLEXNER: Fatty Degeneration of the Heart Muscle. (*Johns Hopkins Hospital Bulletin.*)

—— The Histological Changes caused by certain so-called Tox-Albumins. (*The Medical News.*)

SIMON FLEXNER: Typhoid Septicaemia associated with Focal Abscesses in the Kidneys due to the Typhoid Bacillus. (*Journal of Pathology.*)

—— The Bacteriology and Pathology of Diphtheria. (*American Jour. of Med. Sciences.*)

—— Effects of the Intratracheal Inoculation in Rabbits of the Bacillus Diphtheriae. (*Reported to the Johns Hopkins Hospital Medical Society.*)

—— and H. D. PEASE: Primary Diphtheria of the Lips and Gums. (*Johns Hopkins Hospital Bulletin.*)

W. H. WELCH: General considerations concerning the Biology of Bacteria, Infection and Immunity. (*American Text Book of Medicine.*)

—— General Bacteriology of Surgical Infections. (*A System of Surgery by American Authors.*)

—— Bacteriological Investigations of Diphtheria in the United States. (*American Journal of the Medical Sciences.*)

—— and A. W. CLEMENT: Hog Cholera and Swine Plague. (*Trans. of International Congress of Veterinary Medicine.*)

J. WHITRIDGE WILLIAMS: Deciduoma Malignum. (*Johns Hopkins Hospital Bulletin.*)

In addition to the preceding, investigations have been carried on by W. H. Welch, On a Bacillus causing Pseudo-Tuberculosis, The Group of Capsulated Bacilli resembling the Friedländer Bacillus; by W. H. Welch and Simon Flexner, Additional Investigations upon the Bacillus Aerogenes Capsulatus; by Simon Flexner, Bacillus Endometritidis (nov. spec.) and its Pathogenic Effects, The Effects of repeated Injections of the Blood-Serum of Dogs into Rabbits; by J. Whitridge Williams, Extra-Uterine Pregnancy, Pathology and Etiology of Puerperal Fever; by T. S. Cullen, on Tuberculosis of the Endometrium and other subjects; by T. C. Gilchrist, on Protozoic Infections; by Parsons, Post-Typhoid Periostitis due to the Typhoid Bacillus; by S. Cone, On Dermoid Cyst with Carcinoma of its Walls. Papers upon these subjects will be published.

PHYSICS.

J. S. AMES: The Use of Plane and Concave Gratings.

W. J. A. BLISS: The Apparent Forces between Fine Solid Particles totally Immersed in Liquids. (*The Physical Review, Jan.-Feb.*, 1895. *Thesis.*)

W. L. DAY: Variation of the Specific Heat of Water. (*In preparation.*)

J. W. HUMPHREYS: Description of an Experiment to Demonstrate the Laws of Fluid Pressure.

—— and MOHLER: Measurement of the Surface Tension of Water at Temperatures below 0° Centigrade. (*The Physical Review*, 1895.)

L. E. JEWELL: The Spectrum of Mars. (*Astrophysical Journal, I*, 1895.)

—— An Investigation on the Presence of Water Vapour in the Atmosphere. (*To be published by the U. S. Weather Bureau.*)

E. P. LEWIS: The Measurement of some Standard Wave-Lengths in the Infra-Red Spectra of the Elements. (*Astrophysical Journal, I*, 1895.)

L. T. MORE: A study of the Changes in Length in Iron Wires Produced by Magnetization. (*In preparation for the press.*)

F. A. WOLFF, JR.: The Effect of Magnetization upon Chemical Action. (*American Chemical Journal*, 1895.)

H. A. ROWLAND: Preliminary Table of Solar Spectrum Wave Lengths. (*Astrophysical Journal, I*, 1895.)

—— and R. R. TATNALL: The Arc-Spectra of the Elements: I. Boron and Beryllium; II. Germanium; III. Palladium, Platinum, Osmium, etc. (*Astrophysical Journal, I*, 1895.)

ZOÖLOGY AND BOTANY.

Abstracts of the following papers will appear in the University Circulars. (See beyond.)

E. A. ANDREWS: The Breeding Habits of the Crayfish.

—— The Breeding Habits of Earthworms.

W. K. BROOKS: The Olindiadae.

F. S. CONANT: Chaetognaths.

SEITARO GOTO: Notes on the Histology of Trematodes.

—— The Origin of Bell-nucleus of the Medusa-buds of Physalia.

J. E. HUMPHREY: On Seed-development in the Scitamineae. (*Annals Botany, September*, 1895.)

H. McE. KNOWER: The Organ of Johnston.

—— The Biology of Termites.

GEORGE LEFEVRE: The Development of Tunicates.
J. P. LOTSY: The Sprouting of Chara coranata.
C. P. SIGERFOOS: The Pholadidae.

Other investigations are,

W. K. BROOKS: The Sensory Clubs or Cordyli of Laodici. (*Journal of Morphology, X,* 1, 1895.)
—— The Medusae of North Carolina.
SEITARO GOTO: The Embryology of Synapta.
J. E. HUMPHREY: On the Nucleoli and Centrosomes in Plant-cells. (*Annals of Botany,* 1895.)
—— The Reduction of the Chromosomes in Plants.
D. S. JOHNSON: The Crystallization of Cellulose. (*Botanical Gazette, January,* 1895.)
J. P. LOTSY: Some new species of Euphorbiaceae collected by Captain John Donnell Smith in Guatemala. (*Botanical Gazette,* 1895.)
—— The Food of the Oyster. (*In press, Bulletin, U. S. Fish Commission.*)
—— The Morphology of Reproduction in the Vegetable Kingdom. (*A text-book of about* 400 *pp., based on lectures delivered at the Johns Hopkins University.*)
H. McE. KNOWER: The Germ-bands of Insects.
C. P. SIGERFOOS: The Nutrition of Molluscs.

NOTES FROM THE BIOLOGICAL LABORATORY.

ABSTRACTS OF PAPERS PRESENTED TO THE UNIVERSITY SCIENTIFIC ASSOCIATION.

The Organ of Johnston. A Review. By H. McE. KNOWER.

The collection of microscopic preparations and apparatus which was presented to the University by the late Christopher Johnston shortly before his death has been placed in a memorial cabinet in the Hall of the Biological Laboratory.

As the collection covers a very wide field, its value to us is very great, and its interest is increased by the fact that most of the preparations were made by Dr. Johnston himself.

Among them are some made nearly fifty years ago to illustrate his paper on the sense-organ, which is fitly named the "Organ of Johnston" by the author of the paper here reviewed.

Ein bisher wenig beachtetes antennales Sinnesorgan der Insecten, mit besonderer Berücksichtigung der Culiciden und Chironomiden.

Such is the title of a paper embodying the results of an investigation carried on by Dr. C. A. Child in Leipsic, during the winter of 1894. It is of special interest to a Baltimorean, from Dr. Christopher Johnston's connection with the subject.

In 1855 Dr. Johnston described two pyriform capsules, projecting from the forehead of the mosquito, between the eyes. He found each capsule filled with a fluid, and receiving nerve fibres from the brain. Springing from the capsule and extending forward is a long, delicate, feathery shaft, also supplied with nerves. The two feathery organs are, of course, the antennae of the insect. The capsules Dr. Johnston took to be auditory organs, and explained their action as follows: Sound waves in the air set the long hairs in motion, and cause the shaft to vibrate. These vibrations are transmitted to the fluid in the capsule, and movements set up there act on the sensitive nerve endings of that organ. Impulses, started in this way, reach the brain through the antennary nerve and give rise to the sensations of sound. According to this view, the idea of intensity of sound (or distance of the sounding object) is given by the number of hairs vibrating together; the quality, by the relative lengths of the hairs called into play; and the direction, by the angle in which the sound waves strike the hairs. Dr. Johnston observed that the organs are greatly developed in males; and thought this is to enable the male to find the female, by following her peculiar call, when flying in the twilight or night. He believed, also, that the antennae of the female are of use to her as organs of touch, as well as of hearing.

Later, in 1874, A. M. Mayer, another Baltimorean, working with living mosquitos, made some interesting experiments which were suggested by Johnston's work. He placed the animal under the microscope, and, while watching one of the antennae, had a tuning-fork singing near by. On making the tuning-fork vibrate at different rates, he finally determined that 512 vibrations a minute cause a number of hairs to respond most actively. He then measured the hairs and constructed a large wooden model of the same relative proportions, which acted in a similar manner in the presence of a tuning-fork. Mayer showed by this model, that the greatest vibration is caused by sound waves striking at right angles to the long axis of the hair, while no vibrations are set up by waves parallel to this axis. Hence the direction of the sounding body is given by the angle of incidence. Since the notes of different females vary in pitch, the antennae of the male should bear hairs adjusted to each tone.

Dr. Child, with the aid of modern methods, which enable him to push the matter further than was possible in 1855, has studied the structure of this antennary organ and traced its development. He gives an extremely careful and detailed account, and finds that the organ, which he calls after its discoverer *Johnston's organ*, occurs widely among insects. The observations on the development, and his very thorough histological studies, enable Dr. Child to make these important comparative facts sure. A careful study of other flies, beside the mosquito, and of representatives of all the great groups of insects, reveals the fact that *Johnston's organ* is found in all, though most highly developed among the Diptera. In the female of this highest form, the organ is most like the general type in other insects; while in the male it has become especially modified, as Johnston thought, in relation to the sexual function.

Child's figures show the structure to be essentially as follows: A complicated arrangement of nerve-endings hangs from little spines, into the fluid of the capsule formed by the second joint of the antenna. The spines project radially from a thin, taut membrane (like a drumhead), in the centre of which stands the long feathery shaft. The antennary nerve, on reaching the second joint, spreads out radially on all sides and joins the end-organ, at the same time, supplying two nerves to run out into the axis of the shaft of the antenna.

As to the function of the organ, Child confirms Dr. Johnston's view that it is essentially auditory, in the mosquito. He, however, seeks to explain the action of an auditory organ in an insect, without ascribing to it sensations of sound like ours. He believes the structure, and what is known of the physiology of *Johnston's organ*, indicates that the complex end-organ must be stimulated by vibrations of the "tympanic plate," responding to movements of the feathery shaft fixed on it. The male organ is adapted to receive all sorts of sound waves, not those of the female alone; but, as Mayer showed, the hairs vibrate best in response to a note like that of the female. Hence the male may distinguish the presence of a mate by the *force* of the vibration, and not at all by a discriminating sense of *tone*, as we understand this term. One antenna may be affected more than the other, in which case the sounding body is on that side, and the animal gets the idea of direction immediately.

Though the vibrations entering this organ are chiefly from sounding objects, in the case of the mosquito, it is clear, as Child thinks, that the resulting sensations are rather those of touch than of hearing. If the finger be held against a vibrating tuning-fork, the nerve impulses give rise to sensations of touch in us. It would seem to be much the same for the antenna of the mosquito. In this case however, instead of the vibrations of the tuning-fork, it is the impact of sound waves which starts up impulses along the nerves. The sensations thus set up are simple, when compared to our sensations of hearing; but still may be spoken of as auditory, since due to vibrations of sounding bodies.

Now if the antennae touch a solid body, the resulting vibrations should affect *Johnston's organ.* The rougher, coarser resistance of the solid would make an important difference; but essentially similar sensations would probably be given, for either sound vibrations or those due to touch.

In many insects the antennae are clearly adapted for touch by their great freedom of movement, &c. The same is true of the females of the flies, though here the movement is not so free. In all these forms *Johnston's organ* is less developed.

From these considerations Child thinks it safe to attribute the great size and complexity of the organ, in certain forms, to a special development.

In these forms, as in the mosquito, the organ has become very nicely adjusted for the action of sound waves. In most insects the structure has remained simple, and its function is probably chiefly tactile.

The particular form of auditory sensation given by *Johnston's organ* is, then, a highly developed tactile one.

The Breeding Habits of the Crayfish. By E. A. Andrews.

The breeding habits of the European crayfish, Astacus, have been studied and recorded but nothing is known of the processes of conjugation in the American species.

A study of *Cambarus affinis* kept in confinement shows that conjugation takes place in the autumn and in the spring and that it differs in important respects from what is known in Astacus.

That peculiar organ of the female, the annulus, proves to be an essential, secondary sexual character. The male passes the sperm into the cavity of the annulus of the female and does not distribute it elsewhere. The annulus, then, serves as a sperm-receptacle and thus corresponds to the similarly situated organ described by Bumpus, as a sperm-receptacle, in the lobster, *Homarus Americanus*. The well known hooks on the ischiopodites of the third walking legs of the male serve to hold the two animals firmly together and are necessary secondary sexual organs. They are hooked over the firm ridges on the basipodites of the fourth legs of the female.

The special instincts and actions of the male and female are complex, and are very accurately inter-adjusted to secure the deposition of sperm in the annulus. The male, at a definite stage in the process of conjugation, passes either the right or the left fifth walking leg across below his thorax in such a way as to support and guide the first and second pleopods, or intromittent apparatus, and thus secure effective function.

In the only case in which eggs were laid the sperm was removed from the annulus, by the female, soon after laying: the eggs, however, did not develop: various conditions were abnormal.

The Breeding Habits of the Earthworms. By E. A. Andrews.

The only detailed and accurate account of the complex phenomena of mutual conjugation in earthworms is that given by Hering for the European *Lumbricus Terrestris.*

In studying the much smaller *Allolobophora fœtida* I find that it conjugates beneath the surface and cannot, therefore, be directly observed.

Momentary immersion in boiling corrosive sublimate, or boiling water followed by Perenyi's liquid, preserves the conjugating individuals in the natural position so that they may be studied by dissection and by the serial section method.

This study shows that the process is essentially as in Lumbricus. The union is, however, a much firmer and more intimate one, each individual being almost completely enveloped by the clitellum of the other and firmly fastened to it by a stout enveloping case of mucus.

An important anatomical difference, the fact that the sperm-receptacles of Allolobophora open on to the *dorsal* surface and not on to the ventral surface, as they do in Lumbricus, necessitates a change in our conception of the method of sperm-transfer. The peculiar muscular contractions of the clitellum described by Hering are obviously insufficient to explain the filling of these dorsal sperm-receptacles and we must, apparently, suppose there is some aspirating action of the receptacles involved in the process.

Light is also thrown upon the question of the origin of the so-called spermatophores or "penes" of the older writers.

The sections show that they are formed opposite the openings of the vasa deferentia. Each is a secretion of skin glands poured out from the lips of the vas deferens and adhering firmly to the body of the opposite animal, about the region of the 21st somite. Each is filled with a mass of sperm that issues from the vas deferens.

The idea advanced by Vejdovsky, that the spermatophores in Lumbricus are formed from the sperm-receptacles, does not hold in Allolobophora. A renewed study of *Lumbricus terrestris* by the above method of hardening in situ with boiling water and Perenyi's liquid shows that here also the spermatophores are opposite the vasa deferentia.

Until reasons for other views are given we may tentatively hold that the spermatophores in terrestrial Oligochætæ are not of the importance they assume elsewhere, but that they are to a large extent accidental results of secretions taking place during conjugation and that they play no part in the subsequent processes leading to fertilization of the eggs.

An Analytical Key for our Local Ferns, Based on the Stipes. By C. E. Waters.

This key is designed as an aid to the identification of our local ferns when they cannot be obtained in fruit. Every species that could be had in a fresh condition is here described. The manuals have little or nothing to say about the fibro vascular bundles. There is a single note in Underwood's "Our Native Ferns and their Allies," under Camptosorus. My attention was directed to the subject by occasional remarks in Eaton's "Ferns of North America."

In all the ferns examined the extreme base of the stipe was always more or less flattened or distorted, or differing in quite a degree from the upper part. But a section taken just above this lower portion is practically the same in all specimens of any one species. The bundles appear as light dots or lines towards the centre of the cross section. In many cases they are surrounded by black sclerenchyma, but this is not a constant character.

I. One fibrovascular bundle in the stipe.

* Bundle circular, or nearly so, in cross-section.

Stipe castaneous, shining, but thickly clothed with 1-6 celled hairs (which appear jointed under a lens.)

Cheilanthes vestita, Swz.

Stipe light brown, slender and wiry, slightly flattened in front.

Lygodium palmatum, Swz.

Stipe very dark brown, slender and wiry, shining, very narrowly two-ridged.

Asplenium Trichomanes, L.

** Bundle more or less curved in cross-section.

§ *Bundle more or less scroll-shaped at the ends.*

Stipe very dark brown, polished, slightly grooved in front towards the base.

Adiantum pedatum, L.

Stipe brown or stramineous, smoothish, rather hard (not herbaceous). Rachis winged above. Bundle strongly rolled up.

Osmunda regalis, L.

Stipe smooth, soft and herbaceous, yellowish green, with two slight lateral ridges that run into the two narrow wings of the rachis.

Osmunda Claytoniana, L.

Stipe soft and herbaceous, smooth, but clothed with loose woolly pubescence, yellowish green, not ridged. Rachis narrowly winged and with a tuft of woolly hairs at the base of each pinna.

Osmunda cinnamomea, L.

§ § *Bundle not scroll-shaped at the ends.*

Stipe very dark brown, wiry and brittle, with light brown pubescence.

Pellœa atropurpurea, Link.

Stipe yellowish green, soft and herbaceous, grooved in front.

Dicksonia pilosiuscula, Willd.

Stipe soft and herbaceous, reddish or grayish above; bundle almost or quite curved into a ring below; above it divides into four.

Botrychium ternatum, Swz, *var. obliquum*, Milde, and *var. dissectum*, Milde.

II. Two small bundles very soon uniting into a cross-shaped one.

Stipe and rachis very dark brown; stipe not ridged or flattened; rachis grooved in front.

Asplenium ebeneum, Aiton.

Stipe and lower part of rachis brown; rachis and upper part of stipe grooved, with a slight ridge down the centre of the groove.

Asplenium Bradleyi, D. C. Eaton.

Stipe brown at the base; rachis and upper part of the stipe flattened, with two parallel grooves in front.

Asplenium montanum, Willd.

III. Two fibrovascular bundles in the stipe.

*BUNDLES ROUND OR OVAL IN CROSS-SECTION.

Stipe brown below, more or less pinkish, and finally green, above; with two slight ridges passing into the broad wings of the rachis.

Woodwardia angustifolia, Smith.

Stipe dark green, flattened on three sides, slightly grooved laterally, and two-grooved in front, above.

Camptosorus rhizophyllus, Link.

Stipe slightly flattened in front below, slightly grooved above, very slender, weak and transparent.

Phegopteris Dryopteris, Fée.

Stipe light brown or yellowish, grooved in front. Rachis grooved, and more or less pubescent in front.

Aspidium Thelypteris, Swz.

Stipe stramineous, grooved in front, and with traces of lateral grooves. Rachis similarly grooved and more or less pubescent.

Aspidium Noveboracense, Swz.

Stipe and rachis stramineous, with scattering pale brown scales. Upper part of stipe and entire rachis grooved in front. Rachis flattened on the sides, and often marked with two dark green lines.

Woodsia obtusa, Torrey.

Stipe stramineous or green, slender. Stipe and rachis three-grooved, flattened on the sides, smooth.

Cystopteris bulbifera, Bernh.

Stipe very weak and slender, transparent. Stipe and rachis pale green, grooved in front and (slightly) on the sides.

Cystopteris fragilis, Bernh.

**BUNDLES FLAT OR CURVED IN CROSS-SECTION.

Stipe stramineous, becoming dark above. Rachis dark. Stipe and rachis hairy pubescent. Lower part of stipe grooved in front, slightly flattened, and with traces of grooves, on the sides.

Phegopteris polypodioides, Fée.

Stipe green or stramineous, often slightly reddish towards the base; slightly flattened in front and with a light green line on each side.

Phegopteris hexagonoptera, Fée.

Stipe yellowish green. Stipe and rachis three-grooved (very slightly on the sides), pubescent. Lateral grooves dark green. Stems soft and herbaceous, toothed along the two light brown lateral ridges at the base.

Asplenium thelypteroides, Michx.

Stipe and rachis green or red, very weak and full of sap. Stipe, and especially the rachis, three-grooved, the lateral grooves being dark green on green stems and light green on red stems. Stipe with tooth-like projections on each side of the two-ridged base.

Asplenium Filix-fœmina, Bernh.

Stipe pinkish at the base, yellowish above, grooved in front, smooth; two-ridged on the sides below, above simply marked with two light lines.

Onoclea sensibilis, L.

Stipe and rachis dark green and full of very watery sap, deeply grooved in front, much flattened and with traces of grooves on the sides (especially the rachis). Rachis brown-puberulent, very narrowly winged on each side of the groove in front.

Onoclea Struthiopteris, Hoffm.

IV. Three fibrovascular bundles in the stipe.

Stipe green, narrowly two-winged above, two-ridged below. (At a very short distance above the base there are but two bundles, and a little higher up only one).

Polypodium vulgare, L.

V. Four fibrovascular bundles in the stipe.

Stipe very fleshy, pinkish, bundles in a small circle near the centre of the cross-section; usually two larger curved ones at the front, and two small ones at the back of the stipe.

Botrychium Virginianum, Swz.

VI. Five fibrovascular bundles in the stipe.

*STIPE AND RACHIS RATHER DEEPLY GROOVED IN FRONT, SLIGHTLY ON EACH SIDE. THE MIDDLE ONE OF THE THREE SMALL BUNDLES SLIGHTLY LARGER.

Stipe densely clothed at the base with large pale brown scales; upper part of stipe and lower part of rachis more sparsely clothed with narrower scales. Towards the base of the stipe the lateral grooves pass into light brown lines or ridges.

Aspidium marginale, Swz.

Stipe slightly clothed with dark brown scales which become narrower and fewer above, and on the lower part of the rachis. Lateral grooves running to the very base of the stipe. Bundles soon becoming three nearly equal ones.

Aspidium cristatum, Swz.

Stipe with scattered light brown scales at base. (In the varieties the scales have dark centres). Secondary rachises three-grooved like the main rachis. The lateral groove as well as the one in front extending to the very base of the stipe.

Aspidium spinulosum and var.

**STIPE AND RACHIS NOT THREE-GROOVED. THE THREE SMALL BUNDLES EQUAL IN SIZE.

Stipe with a very slight groove in front above, merely flattened below; rachis grooved in front. Stipe with two slight lateral ridges or light green lines (discontinued at the middle portion of the stipe), running into two ridges along the sides of the rachis.

Aspidium acrostichoides, Swz.

VII. Fibrovascular bundles more than five.

Stipe brown. Bundles numerous and very irregularly arranged.

Pteris aquilina, L.

Stipe and rachis green or brown. Stipe grooved in front, with a large bundle on each side of the groove and a semi-circle of five smaller ones around the back.

Woodwardia Virginica, Smith.

Just before this key went to press Dr. Lotsy told me of a similar key by G. Colomb (Comptes Rendus, Vol. 107, 1888, p. 1012). This author re-establishes the antiquated genus Lastrea on the basis of the fibrovascular bundles alone, making use of the peculiarities of foliage and fruit solely to distinguish the five species given, which are Asplenium Filix-fœmina, Aspidium Oreopteris, A. Thelypteris, Phegopteris polypodioides and P. Dryopteris.

On Budding in Perophora. By GEORGE LEFEVRE. (*With Figs. I–V.*)

While the Johns Hopkins Marine Laboratory was stationed at Beaufort, N. C., during the summer of 1894, I collected material for the purpose of studying the development of the buds of this Ascidian. *Perophora viridis*, Verrill, was found growing luxuriantly on the wharf-piles, and ample material was easily obtained.

My main object in undertaking this work was to compare the bud-development of this form with that of Botryllus, as described by Hjort,[1] and especially to determine, if possible, the origin of the nervous system.

The material at my disposal, which had been prepared in various ways, proved to be most excellent for my purpose, as it contained unlimited numbers of buds in every stage of development.

I might mention here that I have made use of Patten's method of orientation to much advantage, and have found it of invaluable assistance in manipulating the very small young buds; in this way I was enabled to cut sections with great accuracy in any plane desired.

[1] Mitth. Zoöl. Stat. Neapel., 10 Bd., 1891–1893.

I was soon led to believe that in the early development of the buds Perophora presents novel and interesting features; moreover, some of the results arrived at are at variance with those which have been obtained by previous workers on this and other Ascidians.

The very young bud consists of two vesicles, one within the other, which enclose between them many free mesenchyme cells. The outer one is derived directly from the stolonic ectoderm, while the double-walled partition of the stolon gives rise to the inner or endodermal vesicle.

This partition, which is made up of flat cells, is continuous throughout the entire length of the stolon, as a double-walled plate which divides the stolon in half longitudinally and extends from one side to the other.

The buds always arise in the plane of the stolonic partition, but may appear on either side of the stolon. When the ectodermal wall of the stolon begins to push out to form the ectoderm of the bud, the free border of the partition evaginates at this point to give rise to the endodermal vesicle of the bud.

The bud-rudiment lies at first almost at right angles to the long axis, but soon becomes inclined towards the free tip of the stolon, the inclination being due to an elongation in this direction. Instead of having a spherical shape, as at first, the bud-rudiment now assumes the form of an ellipsoid. By this process of growth the connection with the stolon comes to be placed at the posterior portion of the bud, while the anterior end lies free along the surface of the stolon. The anterior end is, therefore, directed towards the free growing tip of the stolon; the side next the stolonic wall is the ventral surface, and that turned away from it is the dorsal.

If a transverse section of a bud, when it consists merely of two simple concentric vesicles, be examined, it will be found that the wall of the endodermal vesicle is thicker on the right side than elsewhere. In such a section, which is represented in Fig. 1, the ectoderm of the stolon is seen to be continuous with that of the bud-rudiment, and the connection of the inner vesicle with the stolonic partition is clearly shown.

At this stage there is found a collection of cells applied closely to the outer surface of the endodermal vesicle high up on the right side. These cells, Fig. 1, *pc.*, appear when the vesicle is still spherical, and form a somewhat elongated mass lying in the posterior portion of the bud; they give rise later to the *pericardium*, which is therefore the first organ to make its appearance. At first the rudiment consists merely of a single layer of cells joined loosely end to end, but it soon becomes thicker and more compact.

That the pericardium is formed by the coming together of *free mesenchyme cells* I believe there can be scarcely a doubt. At the stage represented in Fig. 1, the similarity between the cells scattered freely about in the space between the two vesicles, and those which form the rudiment of the pericardium, is perfectly apparent. And, moreover, I cannot find the slightest evidence that proliferation of the wall of the endodermal vesicle occurs at this place; the line of demarcation between the two structures is distinct throughout and shows no interruption in its continuity.

A peculiar change of position now takes place in the inner vesicle. By a process of rotation of this vesicle through 90° the thickened right wall is carried down gradually until it comes to lie along the ventral side, that is the side next the stolon, where it will later form the floor of the pharynx. The connection with the stolonic partition remains stationary, and the rotation occurs on this as a fixed point.

The pericardial rudiment, which is attached to the outer surface of the vesicle, is borne down towards the ventral side and during the rotation is increasing in size by cell division and by further additions of mesenchyme cells. The rudiment is at first solid, but sometime before the rotation is completed a lumen appears in the centre of the mass of cells. When it reaches the ventral side, the pericardium is seen as an elongated closed vesicle formed of a single layer of cells and lying at the posterior end of the bud-rudiment immediately to the right of the median line; this is the definitive position.

The heart is formed later in the usual way by invagination of the dorsal wall of the pericardium.

At the stage shown in Fig. 2, the rotation has proceeded to a considerable extent, and the pericardial rudiment has acquired a lumen.

Many transitional stages between Figs. 1 and 2 have been examined, and from these it is evident that the rotation is due to a rapid growth and flattening of the cells forming the inner vesicle, except on the side where the wall is thick; as development proceeds the relative difference in thickness of this portion and the rest of the vesicle becomes greater.

While the rotation is taking place the ventral wall of the inner vesicle in the posterior region is folded up at the point indicated in Fig. 2 by the line *l. pbc.* As this furrow deepens, a portion of the vesicle which is connected with the stolonic partition, is thus gradually folded off to form the *left peribranchial sac.*

Ritter,[1] in a recent note on the budding of Perophora, says that "When the differentiation of the 'endoderm' into the branchial and two peribranchial sacs takes place, it does so in such a way that the developing blastozooid is connected with the double-walled partition of the stolon, not by the branchial sac, as has been hitherto supposed, but by the left peribranchial sac." He, however, does not describe how the process takes place; from an examination of Figs. 2 and 3 this can be clearly seen.

I cannot confirm Ritter's statement, page 367 of the paper just referred to, that the connection between the stolonic partition and the left peribranchial sac is lost at an early stage, namely, "at a time when the two peribranchial pouches have merely begun to envelop the branchial sac." I find that it persists until a much later time, and is still present, although greatly constricted, at a stage when the gill-slits are about to be formed.

The *right peribranchial sac* is formed before the rotation is completed, at about the stage shown in Fig. 2, by a longitudinal folding-in of the right wall of the inner vesicle. The fold first appears anterior to the rudiment of the pericardium, and at about the level of the upper border of the latter structure; as it deepens and extends posteriorly, the portion of the inner vesicle thus folded off, is carried down towards the ventral side as the rotation continues, in the same way as the pericardial rudiment.

The section drawn in Fig. 2 is taken too far back to show the fold of the right peribranchial sac.

Fig. 3 represents a stage when the rotation is about completed, and the two folds of the peribranchial sacs are now symmetrically placed, one on each side of the median ventral line.

In this figure a collection of cells, *int.*, is seen lying against the outer surface of the left peribranchial sac; these represent the extreme tip of the intestine where the section has passed through the wall of the latter. At about the time when the fold of the right peribranchial sac first appears, the gut is formed as a blind diverticulum at the posterior end of the branchial sac. At the point of origin it turns sharply towards the left, and growing rapidly upwards and forwards against the outer surface of the left peribranchial sac, it finally reaches the mid-dorsal line where it opens eventually into the median portion of the peribranchial cavity.

In Fig. 2 is seen a groove, *end.*, on the inner surface of the endodermal vesicle just below the pericardium. This is the rudiment of the *endostyle*, but when it first appears its position is much higher up than it is in this figure; during the rotation the relative position of pericardium and endostyle is not changed.

By a study of a most complete series of stages I have been led to conclusions in regard to the origin of the common rudiment of the dorsal tube and nerve ganglion in Perophora, which agree neither with those of Hjort on Botryllus[2] and Glossophorum,[3] of Hjort and Bonnevie on Distaplia,[4] nor with the results obtained by Ritter on Perophora.[5]

In all of the above mentioned Ascidians except Perophora, the rudiment arises as evagination of the dorsal wall of the inner vesicle, and in Perophora, according to Ritter, by migration of cells from the dorsal portion of the endodermal vesicle into the rudiment. For the reasons given below I believe that in Perophora viridis the structures in question have a common *mesenchymatous origin.*

The first appearance of the rudiment is at a stage when the rotation of the endodermal vesicle is about half accomplished, and before there is any indication of the fold which is to give rise to the right peribranchial sac.

In the anterior region of the bud a little to the left of the median dorsal line there is seen a slender elongated mass of cells loosely grouped together and lying against the outer surface of the inner vesicle.

Although I have examined my sections with the greatest care, I have failed to find any indication of cell migration from the endodermal vesicle, and hence cannot confirm Ritter's statements that an "indistinguishable transition from the cells of the 'endoderm' to those of the neuro-hypophyseal

[1] Anatomischer Anzeiger, X Bd., No. 11, p. 367.
[2] Mitth. Zoöl. Stat. Neapel., X Bd.
[3] Anatomischer Anzeiger, X Bd., No. 7.
[4] Anatomischer Anzeiger, X Bd., No. 12.
[5] Anatomischer Anzeiger, X Bd., No. 11.

anlage is to be traced" and also that cells can be traced "in the act of migrating from the endoderm into the anlage."

In the first place, the line of separation between the rudiment and the vesicle is seen with perfect clearness to be everywhere intact, and, furthermore, the cells of the rudiment are identical in appearance with the free mesenchyme cells; the latter are, moreover, more numerous in this region than elsewhere. During the early stages of development, that is before the rudiment has become very compact, the similarity between these cells is very evident, Fig. IV, *A*. I therefore conclude that, just as in the case of the pericardium, the *common rudiment of the dorsal tube and nerve ganglion is formed by free mesenchyme cells.*

The cells of the rudiment are at first loosely and irregularly piled on one another, but soon the mass becomes more closely packed and assumes a cylindrical form, Fig. IV, *B*. Other mesenchyme cells are added to the string from the outside, and active cell division goes on within the mass.

When the rotation of the inner vesicle is completed, the nerve rudiment has been carried up from the left side to the dorsal mid-line. By this time a lumen has appeared in the centre, and around this the cells gradually arrange themselves into an epithelium to form the dorsal tube, Fig. IV, *C*. The latter fuses later at its anterior extremity with the dorsal wall of the pharynx, and an opening breaks through; at no time is there any communication posteriorly between the tube and the peribranchial cavity.

The nerve ganglion is formed by a thickening of the *dorsal* wall of the tube, which eventually becomes constricted off in the manner described by Hjort for Botryllus, although in the latter it is the ventral wall of the tube which gives rise to the ganglion.

Summary.

1. By a peculiar process of rotation of the endodermal vesicle through 90° the thickened right wall of the vesicle is carried down to the ventral side of the bud-rudiment, where it forms the floor of the future pharynx. This process seems to be due to rapid growth and flattening of the cells composing the vesicle except in the thickened portion.

2. The pericardial rudiment, which is the first organ to appear, is formed from the free cells of the blood. It arises on the right side of the inner vesicle, and through the rotation of the latter is brought down to the ventral side.

3. The peribranchial sacs arise asymmetrically. As the rotation takes place, the ventral wall of the inner vesicle is folded up immediately to the right of the point where the stolonic partition joins the vesicle, to form the left peribranchial sac. The portion of the vesicle thus folded off is continuous with the stolonic partition; the connection with the latter persists until quite a late stage. A fold appearing on the right side of the vesicle, gives rise to the right sac, which then moves ventrally, as the rotation continues.

4. No epicardium is present; in this respect Perophora differs strikingly from Clavelina and some other Ascidians.

5. The endostyle appears early as a longitudinal groove in the middle of the thickened portion of the inner vesicle. From its position on the right side it is moved down to the ventral mid-line by the rotation of the vesicle.

6. The common rudiment of the dorsal tube and nerve ganglion arises as a solid string of mesenchyme cells, which are closely applied to the outer surface of the inner vesicle a little to the *left* of the median dorsal line. The cord acquires a lumen, which later communicates with the pharynx. When the rotation is completed, the dorsal tube lies in its definitive position in the median line. The nerve ganglion is constricted off from the dorsal wall of the tube.

BOTRYLLUS.

In the latter part of the summer of 1894 I was given an opportunity through the kindness of Col. Marshall MacDonald, the Commissioner, to work in the laboratory of the U. S. Fish Commission at Woods Holl, Mass. While there I collected material for the study of the bud-development of a species of Botryllus, *B. Gouldii*, Verrill, which was found in great abundance.

The results of my work on this Ascidian show such a complete agreement with Hjort's description of the bud-development of this genus, that scarcely a word need be added. The inner vesicle of the bud is derived from the wall of the peribranchial sac in both larvae and buds, and gives rise to all the important organs. As the peribranchial sacs in the larva are derived from the ectoderm, it follows that all the important organs of the bud are ultimately of ectodermal origin.

The peribranchal sacs are formed, as Hjort states, by two parallel ventral in-foldings, which cut off from the inner vesicle a saddle-shaped bag surrounding the median vesicle dorsally and laterally. The dorsal portion connecting the lateral sacs is not formed by a fusion of the latter, but is present from the beginning. The dorsal tube is formed as an anteriorly directed diverticulum of the dorsal wall of the inner vesicle in the region which becomes the median portion of the peribranchial cavity. The tube secondarily acquires an opening into the pharynx before the communication with the peribranchial cavity is lost.

I might also state that my sections entirely confirm Hjort's description of the formation of the ganglion, and directly contradict Pizon's statement[1] that the constriction of the ganglion from the dorsal tube cannot be established.

In Fig. V. are shown two sections of the tube and ganglion taken from the same bud, *A* being more anterior than *B*. The series of sections, from which these are taken, shows a gradual transition from the one to the other, and establishes in the clearest way possible that the ganglion is pinched off from the thickened ventral wall of the tube, the constriction beginning posteriorly and gradually proceeding towards the anterior end. This fact I have verified not only on *B. Gouldii*, but also on an undetermined species of Botryllus obtained in Jamaica.

EXPLANATION OF FIGURES.

Ec., Ectoderm. *End.*, Endostyle. *En. v.*, Endodermal vesicle. *Int.*, Intestine. *L. pbc.*, Left peribranchial sac. *R. pbc.*, Right peribranchial sac. *Pc.*, Pericardium. *Ph.*, Pharynx. *Pt.*, Double walled partition of stolon. *St.*, Stolon. *T.*, Test.

All the figures are drawn with the camera.

Figs. 1, 2 and 3 are transverse sections of the posterior region of buds of Perophora viridis, Verrill.

Fig. 5 is taken from a specimen of the Jamaica species of Botryllus.

FIG. 1.—Very young bud. Shows connection with the stolon, rudiment of the pericardium and thickened wall of inner vesicle. This figure differs from Figs. 2 and 3 in that its right side is the left side of the latter, and vice versa; in Fig. 1 the face of the section is towards the anterior end of the bud, whereas in Figs. 2 and 3 it is towards the posterior end.

FIG. 2.—Somewhat older bud. Rotation of the inner vesicle has proceeded to some extent. Formation of left peribranchial sac is beginning.

FIG. 3.—Still older bud. Rotation is nearly completed; right peribranchial sac is present.

FIG. 4.—Shows three stages in development of rudiment of nerve ganglion and hypophysis in Perophora viridis, V.

FIG. 5.—Transverse sections of dorsal tube and ganglion of a Botryllus bud, showing constriction of ganglion from thickened ventral wall of the tube. *A* is more anterior than *B*.

Description of Two New Chaetognaths: Spadella schizoptera and Sagitta hispida. By F. S. CONANT. (*With Figs. VI and VII.*)

While at Bimini, one of the Bahama Islands, in June, 1892, Dr. Andrews obtained three specimens of an unknown Chaetognath, which have been very kindly placed at my disposal. As it proves to be a somewhat aberrant form, a description may be not without interest; to it may be added a description of another new species, which we found in abundance at Beaufort, N. C., from April to July of 1894.

I. SPADELLA SCHIZOPTERA (Sp. nova.)

The specimens were taken in the tow-net at rising tide, and belong to that class of Chaetognaths whose life is spent for the most part near the bottom among the algae, to which they have the power of attaching themselves, undoubtedly in order to escape observation. Their color seems to be appropriate to this habitat, for while most of the Chaetognaths live on or near the surface and are very transparent, these are opaque or only slightly translucent, of a yellowish-brown color. The tactile prominences appear as spots of darker brown, and there are irregularly distributed areas having a reddish tinge resembling a calcareous alga common to the region. Their length is 4 mm., and the breadth unusually great in proportion to the length. The caudal segment is half the total length. Fins 5: two paired lateral and the unpaired caudal. The anterior extend on each side from a point a little posterior to the abdominal ganglion to the openings of the ovi-sperm ducts. The middle fins are connected with the anterior by a

[1] Ann. Sciences Nat., 1892 and 1893.

narrow area where the ovi-sperm ducts open, and extend along the caudal segment as far as the spermatic vesicles. Posteriorly each is split up into four villus-like processes, which extend backward and downward below the level of the rest of the fin, and have at their tips masses of adhesive cells for attachment. In this splitting up of the middle fins S. schizoptera is unlike any Chaetognath described, and upon it accordingly the name has been based. The regularity of the processes in all three specimens and the arrangement of the adhesive cells show beyond question that the structure is normal.

The caudal fin begins at the posterior margin of the spermatic vesicles, and is spatulate, as in the spadellas ordinarily. Jaws: 8. Anterior teeth: 2–3 on each side, according to the specimen; long and recurved. Posterior teeth wanting. Corona ciliata (Hertwig's "Geruchsorgan") of a peculiar three-cornered shape, and limited to the head and neck. It is unlike any form heretofore figured. There are no diverticula from the intestine anteriorly. The ovaries extend the entire length of the body segment, and contain ova nearly mature. The ovi-sperm duct shows a marked difference from all other Chaetognaths in being connected in the posterior part of its course with its fellow of the other side. It runs as follows: beginning as a blind tube at the anterior end of the ovary, midway between dorsal and ventral surfaces of the body, it passes backward, at first ventral to the ovary, then lateral and external, to its funnel-shaped opening between the anterior and middle lateral fins. At a point a little anterior to the septum between body and caudal segments, it gives off a branch of comparatively wide lumen, which seems to contain spermatozoa like a receptaculum seminis, and which passes inwards and downwards to join a similar branch from the ovi-sperm duct of the opposite side, the two growing narrower as they approach and finally fusing to form a small blind tube, directed anteriorly, on the mid-line underneath the intestine.

The spermatic chambers of the caudal segment are without accessory longitudinal septa, but nevertheless show the peculiar circulation of the masses of developing spermatozoa. There is a transverse musculature in the anterior part of the body segment, limited to the ventral half. The dorsal surface of the lateral fins, and the adjoining surface of the body bear heavy masses of glandular cells.

II. Sagitta hispida (Sp. nova.)

The form taken at Beaufort last year leads an active life on the surface, and was an almost constant factor in the tow. The length of mature specimens varies from 7 to 11 mm. Fins 5: the anterior long and rather slender, the middle always broader than the anterior, both broadest in their posterior part. Caudal segment one-third total length. The anterior fins extend from near the level of the abdominal ganglion to a point posterior to the centre of the total length. The middle are completely separated from them by a clear space, and are situated more on the caudal than on the body segment. Jaws: 8–9. Anterior teeth: 4–5. Posterior vary from 8 to 14 or 15. Corona ciliata extends from a point on the head anterior to the eyes along the dorsal mid-line almost to the level of the abdominal ganglion. Its outline is narrow and sinuous. The mature ovaries may extend beyond the anterior extremity of the anterior fins. The intestine has two well marked lateral diverticula at its beginning. The spermatic chambers of the caudal segment are divided by incomplete accessory longitudinal septa, about which the spermatic masses circulate. The spermatic vesicles have a kind of cap such as described by Grassi for S. bipunctata.

The tactile prominences, with the sensory hairs springing from them, are especially numerous and manifest, and give the species the bristling appearance from which it is named. In the anterior part of the body they are arranged in some twelve more or less definite longitudinal rows. Each of the middle fins has a tactile prominence on its posterior third, on both upper and lower surfaces; and the caudal has six on each surface, almost constantly, arranged as in the figure.

S. hispida closely resembles S. bipunctata and S. minima, but differs too much to be classified with either, as a comparison of Grassi's description will show.

Notes on the Classification of Chaetognaths.

Three systems have been advocated by the writers, and as none of them seems satisfactory when tested by Spadella schizoptera it may be appropriate to review them briefly.

Langerhans (Zeitschr. für Wissensch. Zool., Bd. 34, p. 132–36; 1880.) forms three genera based on fins and teeth: Sagitta, with five fins (a caudal and two pairs of lateral) and two series of teeth; Krohnia, with three fins (caudal and one pair of lateral) and one series of teeth; and Spadella, with three—the caudal and lateral, however, being connected and lying wholly on the tail segment—and two series of teeth. Strodtmann (Archiv für Naturgesch. Year 58; 1892) follows Langerhans.

O. Hertwig (Die Chaetognathen: Jenaische Zeitschr., Bd. 14; 1880) makes two genera on the basis of fins alone: Sagitta, with five fins; Spadella with three.

Grassi (Fauna und Flora d. Golfes von Neapel, No. 5; 1883) takes the ground that fins and teeth are not of sufficient morphological importance, and bases his two genera on the following anatomical characteristics: Sagitta; transverse musculature, adhesive and glandular cells present, some tactile prominences somewhat buried in the epidermis. The lack of these features characterises the genus Spadella.

Since the Chaetognaths that have these three features are in general those that have three fins, it will be seen that while this classification of Grassi's does not affect the constituency of the two genera it interchanges the names, so that a Sagitta of Hertwig is a Spadella of Grassi. This reversion of the accustomed names gives rise to unfortunate confusion.

The difficulty with Spadella schizoptera, now, is that it has the fins of one genus with the morphological characteristics of the other. According to Langerhans' or Hertwig's systems it would have to be called a Sagitta as having five fins, in spite of its distinctively Spadella characteristics. On the strength of a single external resemblance it would thus be separated from its nearest allies. Grassi's system, while keeping it in the same genus as its fellows, would reverse the usual name of that genus and call it Sagitta. As the distinctive features of the new form did not appear to warrant establishing a new genus, it seemed best to classify it, at any rate provisionally, according to a combination of Hertwig's and Grassi's systems—determining its genus according to the morphological characteristics of Grassi, so that it might be kept with its nearest allies, but retaining for that genus the name (Spadella) it would have in the classification of Langerhans or of Hertwig.

Fig. VI.—Spadella schizoptera (reduced from camera drawing): T. anterior teeth; J. jaws; E. eye; TP. tactile prominences; CC. corona ciliata; I. intestine; O. ovary; S. septum between body and caudal segments; A. anus (ventral); AF. anterior fin; O. OV. external opening of ovi-sperm duct; SC. spermatic chamber; MF. middle fin; SV. spermatic vesicle; CF. caudal fin. (Magnified 24 ×.)

Fig. VII.—Sagitta hispida (reduced from camera drawing of a small specimen): AT. anterior teeth; PT. posterior teeth; D. diverticula of intestine; C. cap of spermatic vesicle; AS. accessory longitudinal septa of spermatic chambers. Other letters as in Fig. I. (Magnified 26 ×.) The tufts of sensory hairs springing from the tactile prominences have been exaggerated in both figures.

The Pholadidae. Note on the Early Stages of Development. By C. P. Sigerfoos. (*With Fig. VIII.*)

During the summer of 1894, while with the Johns Hopkins Marine Laboratory at Beaufort, I was employed by the U. S. Fish Commission to study the natural history of the ship-worms on account of their great economic importance. While so engaged I observed the early stages in the development of four species of the Pholadidae. These were Pholas truncata, Teredo navalis, T. norvegica and T. (Xylotrya) fimbriata. T. navalis is the common ship-worm of Europe and has been frequently studied. It is found but sparingly at Beaufort and is of little economic importance there. The other two species have been little studied. They are very abundant at Beaufort, and in the warm waters of our southern coast grow with great rapidity, so that they are extremely destructive to all kinds of woodwork. T. norvegica may, under favorable conditions, attain a length of four feet in two years, in hard piles. Its burrow is almost or quite an inch in diameter so that a few of them may soon ruin a heavy pile.

The present note is published through the courtesy of the U. S. Fish Commission. A fuller account of the natural history of the ship-worms will be published by the Commission.

Pholas.

Pholas is found in the stiff mud between tide marks. It spawns the latter part of April and during May, so that the breeding season is limited to a period of a few weeks. The sexes are separate and found in about equal proportions. The eggs are rather transparent and hence favorable for study among marine Lamellibranchs, though their small size and the uniformity in the size of the micromeres make them unfavorable objects for studies of cell-lineage. Artificial fertilization is easy and the embryos develop with great uniformity. Development is very rapid, and on warm days the embryos may be free-swimming within three hours of the time the eggs are fertilized.

The first two planes of cleavage are meridional, giving rise to the four-cell stage which has so often been described and figured for various Lamellibranch eggs. The next plane of cleavage is equatorial, giving rise to an eight-cell stage, consisting of a large macromere and seven micromeres of almost, if not quite equal size. A sixteen-cell stage and a seventeen-cell stage are formed just as Lillie has recently described for Unio (Jour. Morph., Jan., 1895). In fact, his description for Unio of the formation of the blastomeres to the seventeen-cell stage applies strictly also for Pholas, except in the size of the micromeres.

After the seventeen-cell stage, I could not follow cleavage with certainty as to the lineage of the cells. The axes of the embryo are approximately indicated by the position of the polar bodies which persist till after the embryo has become free-swimming. The posterior mesoderm arises as a single cell, as usually described; and soon afterwards the macromere divides into right and left entoblasts. Soon afterwards the mesoblast also divides into right and left halves, and bilateral symmetry is established.

The two entoblasts soon divide into anterior and posterior portions, the latter somewhat larger than the former. The left entoblast always divides first. The cilia appear at the stage with two entoblasts. The two or three apical cilia are more than twice as long as the embryo. The pre-oral cilia are not arranged on circles of cells. Each cell which bears them has three or more. The apical cilia turn spirally, causing the embryo to rotate on its long axis in the direction of the hands of a clock.

Gastrulation is partly epibolic, partly by invagination. The entoblast cells continue to divide. The spindles are always transverse to the long axis of the cells, so that the primitive gut comes to be formed of very high cells. Small cells are not separated from them into the cleavage cavity. After gastrulation begins, the ectoblast continues to grow forward slightly at the posterior border of the blastopore, so that it becomes crescent-shaped. It does not close, but persists as the mouth.

Professor Brooks several years ago pointed out a transitory change in shape of the oyster embryo. This is present in all of the four species I studied, and I believe to be connected with the formation of a second mesoblastic element. In addition to the mesoblast as usually described, there is an anterior mesoblastic element, formed at about the time that the entoblast consists of four cells. The embryo becomes flattened in its dorso-ventral axis, and while so a pair of ectoblast cells *migrate* from the surface and are deposited on the summit of the entoblast. The point on the surface from which they migrate soon closes over and leaves no trace of their inwandering. The embryo soon afterwards resumes its spherical shape.

Summing up: The first two planes of cleavage are meridional, followed by an equatorial. Segmentation is such that bilateral symmetry is not established till after the formation of the germ layers. The entoblast cells divide into almost equal parts, and gastrulation is partly epibolic, partly by invagination. The blastopore persists as the mouth. The first cilia are irregularly arranged; the apical cilia are very large; the embryo rotates on its long axis, in the direction of the hands of a watch. In addition to the mesoblast, as usually described, there is a second factor derived from the ectoblast after the embryo is free-swimming.

TEREDO NORVEGICA.

I am indebted to Professor Dall for the determination of this species. It is found abundantly at Beaufort, grows rapidly to great size, and is very destructive. The sexes are separate and of about equal proportions. I found specimens sexually mature during the spring and until the middle of July. The breeding season probably lasts all summer. The eggs are cast into the water, and if the sexual products are mature, they are extruded through the siphons when the animals are taken from their tubes. The eggs are of about the same size as those of Pholas, but more opaque and of somewhat slower cleavage. The segmentation of the egg and the derivation of the germ layers are step by step as in Pholas, so that to describe them would be but a repetition of every detail—planes of cleavage, establishment of bilateral symmetry, gastrulation and division of the entoblast cells, double origin of the mesoblast, ciliation and rotation of the embryo, persistence of the crescent-shaped blastopore as the mouth.

The accompanying figure represents a longitudinal section of an embryo of T. norvegica with eight entoblast cells. The apical end is to the right. The posterior mesoblast, Pm, lies in the cleavage cavity, as does also the smaller anterior mesoblast, Am, upon the entoblast cells. The four entoblast cells shown are of subequal size. The shell-gland is just beginning to form.

TEREDO (XYLOTRYA) FIMBRIATA.

This species is equally as abundant at Beaufort as the preceding, but of smaller size. The sexes are separate and of about equal proportions. The eggs develop in the water, but are not extruded as are those of T. norvegica. They are easily fertilized artificially and develop rapidly. The embryos are hardy in aquaria. Except for the greater opacity of the egg, I think it impossible to distinguish the segmenting egg and embryo from those of Pholas. All of the features summarized for Pholas are true for this species.

TEREDO NAVALIS.

As is well known, the eggs and embryos of this species are retained in the gills till the larvae have reached a somewhat advanced stage of development. It is found but sparingly at Beaufort, so that my observations on this form were not extensive. However, one set of embryos which I secured were just at the end of segmentation and at the time of the derivation of germ layers. In most of the eggs, the large mesoblast was already formed; but in one, more tardy than the others, it was derived from the right entoblast. The two large entoblasts are of equal size. The left in all cases divides first, into two cells, the anterior slightly the smaller. The right soon follows dividing like the left. Soon those of the left divide again, followed by division of the right, so that the entoblast consists of eight subequal cells, each quite high, bordering on the blastopore, and with the nucleus nearer the outer end. The ciliation of the embryo is less perfect and developed later than in the preceding three species. It is flattened as in the other forms, but I could not observe with certainty the inwandering of the ectoblast cells to form mesoblast. Soon after this stage the embryos became irregular.

The actual migration of ectoblast cells to form part of the mesoblast, I believe, has not been described before. Lillie traces a "larval mesoblast" to one of the ectoblasts for Unio. This migration of cells from the surface into the cleavage cavity is present in great uniformity as to time and position of formation in the first three species I have described, and I think we must believe that a like condition holds for T. navalis.

This second origin of the mesoblast I take to be of double significance, in so far as it touches Hatschek's description for T. navalis (Arbeiten Zool. Inst. Wien, Vol. 3, 1881). The early stages in the formation of the gut (the division of the entoblasts) are exactly like those of the other three forms—like all marine Lamellibranchs which have been accurately studied. At least during the early stages, there is an invagination of the entoblasts, and there is no evidence that small cells are formed from the single large entoblasts of either side, which later arrange themselves to form the gut. Hatschek says he had no stages between those he represents in Figs. 13 and 14 A. The embryos I had bridge this gap. His error in describing the formation of the gut arose, I believe, from his finding small cells lying on the entoderm in slightly later stages. These, as I have shown, are mesodermal elements derived from the ectoderm, which come to lie on the entoderm. I think the evidence is that the Pholadidae in their early stages develop in the same manner, even to minute details. I see no reason to believe that T. navalis departs from the other species so much as to have different planes of cleavage of the egg, a different derivation of the germ layers and a different mode of formation of the gut. Nor do I think its egg and embryo are symmetrical before the germ layers are differentiated.

In his accurate study of the cell-lineage of Unio, Mr. Lillie finds that each of the cells of the four-cell stage contains entodermal elements. In the marine forms the derivation of the entoderm from the large macromere alone is interesting, since in the early stages of cleavage, the lineage of the cells in the various Pholadidae is so like that in Unio, even to minute details.

Note on the Origin of the Bell-nucleus in Physalia. By Seitaro Goto.

At the beginning of the present academic year Dr. Brooks kindly placed at my disposal specimens of Physalia, which had been collected and preserved by him some years ago, with the desire that I should make a study of them with special reference to the nature of the so-called female gonophores (Haeckel). I also had occasion to make observations on the development of the male gonophores; and it has turned out that there is a peculiar feature in the formation of the bell-nucleus, to which attention has, so far as I know, never been called. In this short preliminary note I propose to describe the process briefly. In the accompanying diagram (Fig. IX) I have represented a longitudinal section of an early stage in the development of the male gonophore. In this particular specimen the bell-nucleus forms a flattened conical mass, but in most other specimens that have come under my observation it is more elongated at this stage. The migration of the germ nuclei have already begun. These are characterized by having their chromatic substance concentrated in a comparatively small number of large pieces, one of which usually occupies the centre of the nucleus and is larger than the rest, while the others are in most cases situated close to the nuclear membrane. The germ nuclei are, as a rule, considerably larger than those of the ordinary entodermal cells, and are spherical in form. In the accompanying diagram four germ nuclei have already passed into the bell-nucleus, and a fifth is just passing the supporting layer.

Now the point to which I wish to call special attention is *the formation of the bell-nucleus by the wandering in of interstitial cells from the ectoderm.* This fact I believe to have satisfactorily proved, at least to myself, by a comparison of a large number of sections. I have never seen any of the definitive ectoderm cells undergoing mitosis; but, on the contrary, the interstitial cells can be observed in all stages of migration to form the bell-nucleus. In the section from which the accompanying diagram has been drawn a stream of protoplasm could be observed around many of the migrating nuclei; and in most of the sections numerous interstitial cells with amoeboid processes are everywhere present in the ectoderm of the gonophoral bud. This indicates that they are in active migration. I believe also that some of the interstitial cells divide in the gonophore; for, in some sections I have observed spherical nuclei with a vesicular appearance and with a small number of large chromatin pieces. This I take to be an indication that they are undergoing reconstruction from a recent mitosis. Two such nuclei are drawn in the diagram at the entrance of the bell-nucleus.

The youngest stage of the so-called female gonophore that I have been able to obtain was far more advanced than the male gonophore represented in the diagram. The cavity of the bell-nucleus has been formed, and is lined by a distinct epithelium of columnar cells. But exactly the same process that takes place in the male gonophore can be observed to occur with even greater distinctness. The interstitial cells of the ectoderm crowd in towards the entrance of the bell-nucleus and are there seen to arrange themselves one by one into a distinct epithelium and form a part of the lining of the cavity of the bell-nucleus. In the so-called female gonophore the cells that have wandered in and formed a part of the epithelium afterwards undergo repeated division, while in the male gonophore no such has been observed.

It seems to me that Physalia presents in this respect an intermediate stage between those forms in which the bell-nucleus is formed as a solid mass of cells from the ectoderm and such form as *Coryne pusilla*, in which, according to Weismann, cells migrate singly into the endoderm and there form the bell-nucleus afterwards.

Fig. IX.—Longitudinal section of a young male gonophore. EL—Entodermal lamella. GN—Germ nucleus.

Note on the Protoplasmic Connection of Lasso-cells in Physalia. By Seitaro Goto.

In view of the facts that have been brought out on the subject, there are, as it seems to me, three possibilities in the mechanism by which the cnidoblasts are discharged. One is to suppose that the stimulation of the protoplasm of the lasso-cells by foreign bodies coming in contact with the cnidocil causes it, or more accurately speaking its muscular portion, to contract, and brings about the discharge of the cindoblast. Another is to suppose that the contact of the cnidocil with foreign bodies is transmitted as a sensation to the ganglionic cells of the subepithelial layer, and that from these cells a new impulse goes out to the lasso-cells and causes the latter to discharge. This, however, is regarded by Von Lendenfeld (Zeitschr. f. wiss. Zool., Bd. 38, p. 366, ff.) as highly improbable. A third way is that the stimulation of the cnidocil be transmitted to the subepithelial ganglionic cells and there converted into a reflex which causes the discharge of lasso-cells. We may, however, suppose that the stimulation proceeds from the sensory cells instead of from the cnidocils. Considering the fact that a mere contact with inert foreign body such as a grain of sand does not bring about the discharge of lasso-cells, it seems to me very probable that this last alternative is what takes place in the seizure of prey.

During my study of the gonophores of Physalia, I had also occasion to make some histological observations, so far as the condition of my materials permitted. One of the most interesting of these is the protoplasmic connection of the lasso-cells with each other. This I first observed in some siphons mounted *in toto*. In these, four or five, or sometimes more, cells were distinctly seen to be connected with each other by means of protoplasmic processes. These cells were generally arranged in a line parallel to the long axis of the siphon, and each cell was therefore bipolar. In some of the cells, however, I have observed one or more lateral processes; but whether these proceeded to other lasso-cells or to ganglionic cells I have not been able to make out. All the lasso-cells that I have observed connected together were not yet fully developed; some of them were still very young, but in others the vacuole which afterwards becomes the capsule had already attained a large size, and contained a horse-shoe-shaped deeply-staining body which is so characteristic of the lasso-cells in this species. I have tried to demonstrate the same connection in the ripe lasso-cells, but hitherto I have not been successful. This I think can hardly be surprising when we consider how reduced the cytoplasmic mantle of the capsules finally becomes, and how comparatively far they stand from each other, thus necessitating a considerable lengthening and consequent diminution in thickness of the protoplasmic processes. I have observed the same connection in sections of young siphons, although, as is to be expected, I have in this case never seen more than two cells connected together. One or both of them, however, had usually a second process.

The facts already known afford a sufficient clue to the probable mechanism by which a large number of lasso-cells are discharged simultaneously; for, the connection of the ganglionic cells with each other as well as with the lasso-cells being proved, we have only to assume the transmission of impulse from one ganglionic cell to another in order that a simultaneous discharge of numerous lasso-cells should take place. But the observation above recorded requires a certain modification of our conception of the matter, in that it does not necessitate us to assume the connection of every lasso-cell with a ganglionic cell. It perhaps justifies us in supposing that the protoplasmic connection among lasso-cells subsists to the last and furnishes the passage for the direct transmission of impulse from one cell to another, whether this impulse be originally supplied in one or the other of the ways above mentioned. Further observation will perhaps bring to light a similar connection of lasso-cells in other forms.

Seed-development in the Scitamineae. By J. E. Humphrey.

(Abstract of a paper to appear in the "Annals of Botany" for September, 1895.)

The results of these studies, begun in Bonn and completed at this University, may be briefly summarized as follows:

Except in two aberrant cases, to be mentioned later, the outer integument of the ovule gives rise to the coat of the seed. As a rule, the outer and inner cell-layers of this coat are correlatively developed—the high development of the one being accompanied by slight development of the other. In *Canna* and in *Musa* the outer layer is most developed, and, taking the form of a palisade-layer, is backed by several layers of sclerotis cells.

In the *Zingiberaceae* the inner layer is highly developed, while in the *Marantaceae* and *Strelitzia* each layer is moderately developed. In the presence of a "nutrient layer" in the testa, these plants agree with numerous others of most various affinities.

FIG. I.

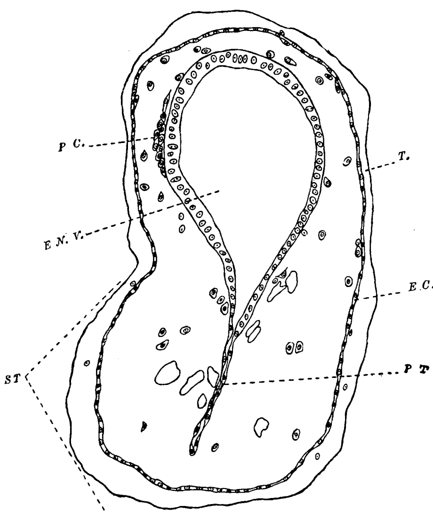


FIG. II.

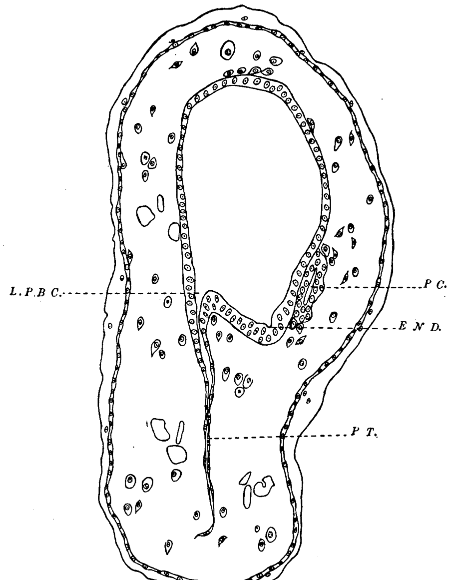


FIG III

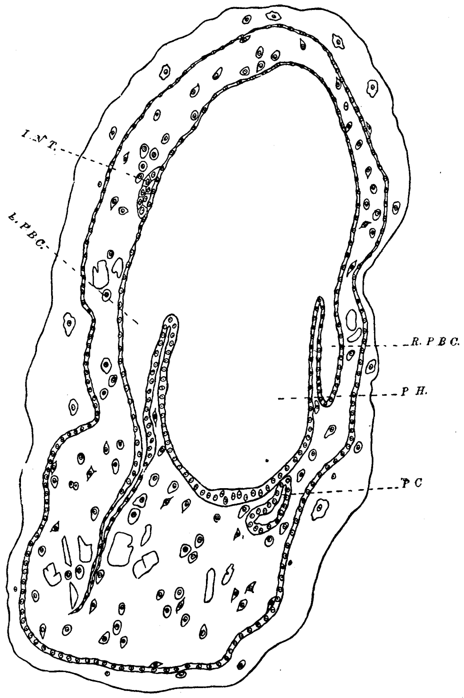
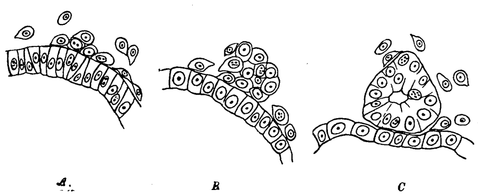


FIG. IV.



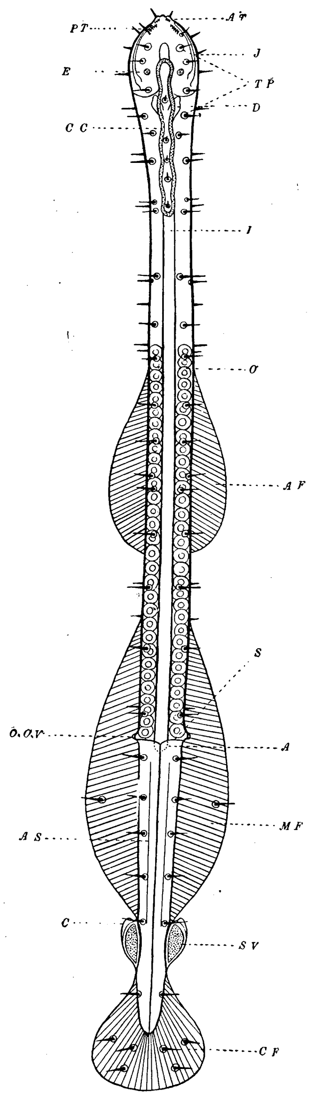
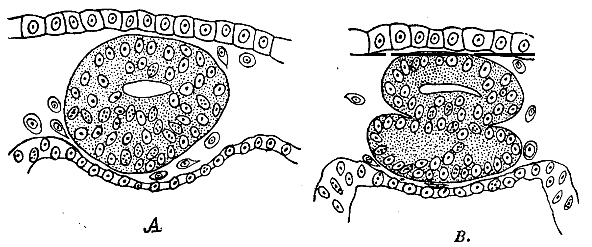


FIG. V.



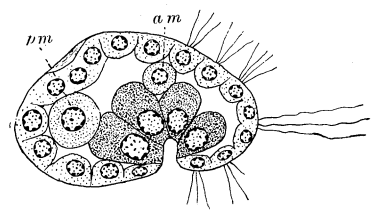


FIG. VIII.

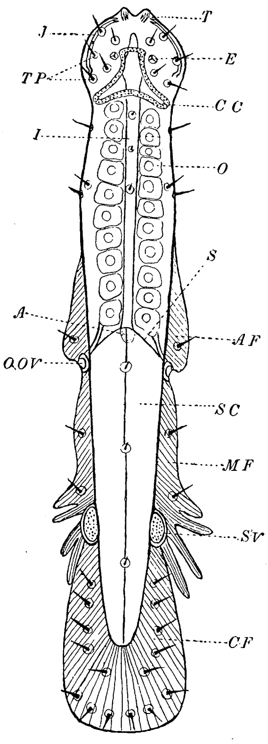


FIG. VI.

FIG. VII.

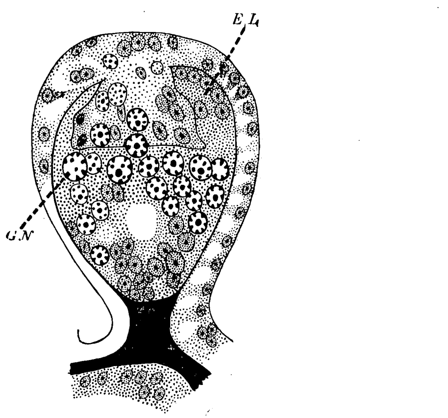


FIG. IX.

FIGURES WITH NOTES FROM THE BIOLOGICAL LABORATORY.

Perhaps the most striking feature of the Scitamineous seed is the characteristic presence of a micropylar collar and germinal lid. The evident purpose of the lid is to facilitate germination, and that of the collar is to ensure the efficient connection of the plantlet with the food-supply in the seed.

Arillar structures, always of micropylar origin, are very general in the members of this group with dehiscent fruits. In the *Marantaceae* and *Costus* the aril is a fleshy mass at the micropylar end of the seed; in *Strelitzia* it takes the form of a woolly mass of fibres at the same end; in all *Zingiberaceae* examined, except *Costus*, it forms a double veil-like envelope about the whole seed.

The "perisperm-canals" of the *Marantaceae* appear to be composed partly of specially differentiated nucellar tissue and partly of chalazal tissue enclosed during the campylotropic development of the seed. Peculiar differentiation in the chalazal region of the seed in several *Musaceae* and *Zingiberaceae* may be homologous with the chalazal portion of the perisperm canal.

Except in the *Musaceae* the starch-bearing tissue of the seed consists wholly of perisperm. In this family the perisperm is thin, being reduced in *Strelitzia* to a functionless remnant; and there is a massive starch-bearing endosperm. From this extreme a progressive reduction of the endosperm may be traced. In the *Zingiberaceae* it is still several cells thick in the lower part of the embryo-sac, but contains only aleurone. In *Canna* it forms a permanent simple aleurone-layer, lining the embryonal cavity; and it is doubtful if the *Marantaceae* possess any permanent endo-sperm.

The embryo of each species examined is formed directly from the fertilized egg-cell, without any suspensor.

The uniformity in the structure of the ovules and seeds of the *Marantaceae* marks this family as a natural and compact one.

The seed of *Canna* is developed chiefly from the chalazal part of the ovule; the preformed germinal lid is replaced by a "germinal slit," formed by the coalescence of the micropyle and hilum of the ovule, and the testa contains numerous stomata. All these features justify the separation of the genus as the type of a distinct family, as has been done by various writers on other grounds.

The variations in the aril and chalazal mass in the *Zingiberaceae* make further studies in this family very desirable.

The *Musaceae* form a heterogeneous group in respect to seed-development. In *Heliconia* all the normal developments of the ovular integuments are suppressed by the evolution of a hard, dense endocarp. This adds another to the few known Monocotyledonous stone-fruits.

NOTES ON PHILOLOGY.

An Attempt to give a more Satisfactory Definition of Sound-Rhythm. By C. W. E. MILLER.

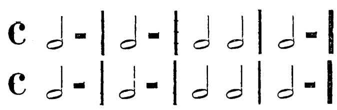
(Abstract of a paper read before the University Philological Association, March 15, 1895.)

Among the ancient Greeks, three kinds of rhythm were distinctly recognized—the rhythm of motionless bodies, that of moving bodies and that of sound. Of these three kinds, the first and the second primarily appeal to the eye, while the third is in the first instance perceived through the medium of the ear. But people of modern times are not in the habit of associating the term rhythm with a body at rest, and though we do speak of rhythmical motion such as that of the dance, yet the idea of rhythm is more generally connected with the phenomenon of sound, and it is to this species of rhythm that the following remarks are confined.

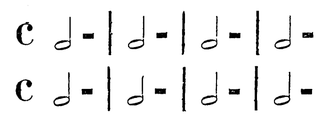
Both ancients and moderns agree as to the fact that this kind of rhythm is not limited to the sounds of music and of poetry, but that it is a characteristic which may be possessed by other sounds also. It is furthermore conceded that rhythmical perception is to a greater or less extent quite universal. It would seem therefore that rhythm must be a comparatively simple thing.

Now the sounds of language as compared with those of a ticking clock or of a drum, or even of music, are very complex. Not only do they vary individually as to pitch, intensity, duration and quality, but these individual variations are further modified by environment, individuality of the speaker, continuity and velocity of utterance, and difference of rhythmical basis of different languages. Moreover, the difficulties arising from an unstable and at times ambiguous nomenclature, serve to render the problem more complex still. Under these circumstances, it is not at all surprising to find that the above-mentioned four characteristics of sound are constantly confounded even by distinguished investigators, and it will be seen that any treatment of rhythm based solely on language must be more or less unsatisfactory. What is needed is a simpler basis of investigation, and this is readily supplied by the drum.

Everybody is familiar with the following simple march movement as performed upon the drum:



For convenience of reference this movement will be denominated movement No. 1. If in the third bar of each of the above series, the second minim be replaced by a rest, the following, which will be known as movement No. 2, will result:

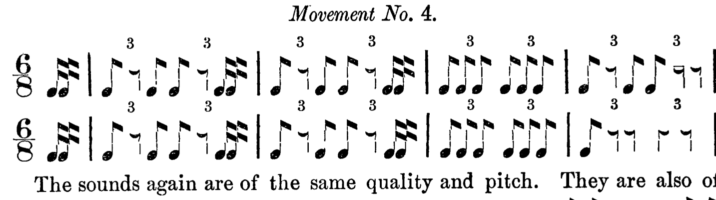


This affords an example of the very simplest kind of rhythm. The sounds are all of the same pitch, of the same intensity, of the same quality, of the same duration; the same, in short, in every respect, except in point of succession in time. Manifestly, then, the rhythm consists of nothing but the recurrence of the sounds at equal intervals of time. But a rhythm like that of movement No. 2 is painfully monotonous and is not likely to be used to any extent for artistic purposes, Tennyson's "Break, break, break," being a familiar example of its use in poetry. As a rule a certain amount of variety is indispensable, as for instance in movement No. 1. Here again the sounds are all of the same quality, pitch, stress and duration—of the same duration since all are staccato. The rhythm, as before, consists of the repetition of sound at equal intervals of time, but to relieve the monotony of the rhythm and give character to it, the third interval of each series is divided into two equal parts by the insertion of a second sound.

The following two march movements will serve as instances of a more complicated succession of sounds.

Movement No. 3.

Movement No. 4.



The sounds again are of the same quality and pitch. They are also of the same intensity, except that the sound following the or the may receive a greater stress. The sounds of the above movements are furthermore of the same absolute duration, but some of them differ greatly from others in the amount of time elapsing between any two consecutive sounds. The rhythm, however, as before, consists of the repetition of certain of the above sounds at equal intervals of time. There will be four bars in each line, or, as there is a sound at the middle of each interval, the lines may with perfect propriety be considered as made up of eight bars each. The

 and  and the pauses, serve as secondary means of grouping, the movement of the feet in marching constituting the primary means.[1]

The conclusions arrived at on the basis of the above four movements may be summed up as follows:

1. An absolutely perfect rhythm may be produced without any variation in the quality or in the pitch of the sounds.

2. Physical stress, which is generally considered the *sine qua non* of rhythm, is not an indispensable factor of rhythm. What is commonly called the rhythmical "accent" (ictus, stress) is in many cases simply the result of a mental process of grouping in accordance with certain psychological tendencies[2] or with a clue furnished in one or more of various ways.

3. Rhythm is not necessarily dependent on the actual duration of the sounds themselves. The sounds may be staccato and therefore practically instantaneous. What is essential is that there be a repetition of equal and readily appreciable intervals of time. Such an interval, which for the sake of convenience has been denominated a *bar*, may be taken up by a single sound, or by a combination of sounds, or by a combination of one or more sounds with one or more silences, or by a single silence, and the bars of a given rhythmical series need not be of a uniform composition. The composition of the several bars determines the type of rhythm, but does not constitute the essence of rhythm.

If the above conclusions be correct, the definition of rhythm must be something like as follows: Roughly speaking, *Rhythm is the recurrence of sound at equal and appreciable intervals of time;* or, more accurately, *Sound-rhythm is that property of a certain series of sounds by virtue of which it is so constituted that the time occupied by its sounds and silences* (*if any*) *is resolved by the mind of the hearer into equal and appreciable intervals, each interval beginning with a sound, or else the exact initial point of intervals starting with a pause, being determined by the intervals starting with a sound.*

It yet remains to be pointed out how the above definition of rhythm differs from that of scholars whose definitions are not too vague to define or too unscientific to merit attention. The chief point of difference lies in the fact that the definition here given makes the bar the starting-point of rhythm, while the most distinguished writers on rhythm from Aristoxenus down to Gleditsch agree in making a smaller unit than the bar the basis of rhythm. They do, it is true, emphasize the importance of the bar, yet according to their conception, rhythm primarily depends on the division of time by any particular rhythmizomenon into the aforesaid smaller primary units. To this theory of a primary unit smaller than the bar, there are at least two grave objections. Firstly, the theory is impracticable in a large number of cases, and secondly, it violates the organic unity of the bar.

The impracticability of the theory has been largely shown by what has already been said, but it may not be amiss to reiterate a point or two and to call attention to one or two additional facts. Without laying undue stress on the lack of consensus of opinion on the part of eminent scholars with reference to Aristoxenus' theory of the χορεῖος ἄλογος and the precise application of his theory of the *chronos protos* in the case of episynthetic and mixed rhythms, for this lack of consensus is partly due to the fragmentary nature of what we possess of the rhythmical writings of Aristoxenus, it cannot be denied that in modern music, in which subdivision is practised to an extent that seems to have been unknown in the time of Aristoxenus, a *chronos protos* of Aristoxenus' conception would be only a theoretical possibility. To use such a unit would often be like measuring miles by inches. Furthermore, there are in modern rhythms bars that are distinctly felt as unbroken units. Thirdly, in the case of mixed rhythms, the bar often unmistakably forms the primary unit of time, and the smaller units of which it may be composed are measured by the bar as the standard. Lastly, it is a matter of every day observation that, while it is comparatively easy to produce a certain rhythmical succession of sounds in accordance with certain quantitative values, it is much more difficult and sometimes wholly impossible to recognize those quantitative values when assigned by others or when unconsciously assigned by oneself. This applies especially to the sounds of poetry. Yet, in all such cases, the repetition of the groups of sounds (or sounds and silences) is readily discernible.

As to the validity of the other objection, to wit: that the current definitions violate the organic unity of the bar, that is too evident to require further proof. The writer would only say that an attempt to frame a definition of rhythm upon the basis of a primary unit smaller than the bar, would seem to him to resemble an attempt to define a language sentence by means of the syllables or the letters instead of by the words of which the sentence is composed.

[1] The lines of movement 3 constitute what in ancient rhythmic would be called Anapaestic Tetrameters Acatalectic, whilst the first line of movement 4 is in reality an Iambic Tetrameter Acatalectic, the second line being a catalectic variety.

[2] These tendencies seem to be regulated by a simple principle, the thorough discussion of which belongs elsewhere. Suffice it to say that the bar apparently covers about as much time as the mind conveniently grasps. When the mind undertakes to measure sounds that are emitted in rapid succession, two or more are grouped together in one interval of time, and when they succeed one another slowly the mind may be obliged to divide the interval elapsing between any two consecutive sounds.

The History of Greek Noun-formation. By A. W. Stratton.

[Abstract of a paper read before the University Philological Association, May 17, 1895.]

Mr. Stratton described the method he is following in a study of the history of noun-formation in Greek, of which the chapters dealing with suffixes in *-m-* are almost complete. Under each suffix vocalic and accentual relations are discussed and an attempt is made to explain variations from the norm where possible. Special attention is given to the development of new suffixes through the incorporation of other elements. Variations in meaning as well as in form are considered. Notice is also taken of the freedom with which any class of forms is used at various times and in the several departments of literature. To the discussion of each of the more widely used groups are appended lists of the writers (before 280 B. C.) in which each word of the group occurs, arranged under the six categories of Epic, Lyric and Dramatic poetry, History, Oratory and Philosophy. The suffixes are grouped according to their initial letters, *e. g.*, -μεν-, -μον-, -μων-, -ματ-, -μο-, -μενο-, -μονο-, -μνο-, -ματο-, &c. Other relations, *e. g.*, the relations of -μον-, -ϝον-, -ον-, are considered under the simpler forms. The extent to which similar relations and developments appear in other Indo-European languages is also considered in connection with each group of suffixes.

The Position of the Secondary Accent in French Etymons having more than two Pretonic Syllables. By E. C. Armstrong.

(Abstract of paper read before the University Philological Association, April 19, 1895).

Darmesteter's Law, announced twenty years ago, proved by the French development that the Latin etymons with two pretonic syllables had a secondary accent on the first syllable. There is still, however, much divergence of opinion concerning the position of the secondary accent in etymons with more than two pretonic syllables. Three views are held: (1) that the secondary accent is always initial: (2) that it is always on the second pretonic syllable, counting back from the main accent: (3) that it is on the second pretonic syllable when this is long by nature or position (a mute + a liquid counting also as making a vowel position—long), otherwise on the third pretonic syllable. No proof has been given, so far as I know, to establish any one of the theories, hence the question has remained in doubt. For this reason I attempted, by a study of French etymons with more than two pretonic syllables, to reach definite conclusions. This examination has established the following law: the secondary accent is initial save in words easily recognized as composita; there it is on the first syllable of the second member.

Such accentuation accords with the initial accent of the Old Latin; there is nothing to disprove that the trace of this old accent was preserved in later periods by a secondary accent on the same syllable; and on the other hand if it be definitely established that the Saturnian verse is accentual, a secondary accent on the first syllable is established for the Latin of the period at which it was written. The Folk Latin recomposition and shifting of the principal accent from the first member of composita favors the second portion of the law.

The testimony furnished by the French developments was viewed at first from the standpoint suggested by Mr. Darmesteter's explanation of the fall of protonics.[1] This is that the protonic vowel falls from the same cause

[1] By the *pretonic* syllable is meant any syllable which precedes the accent; by the *protonic*, that which directly precedes.

as the final vowel, for it follows the secondary accent just as the final follows the main accent. According to this, if the secondary accent be initial, then in a word with three pretonic syllables the intermediate one should fall absolutely, just as the atonic penults do. If on the other hand this intermediate syllable is the true place of the secondary accent, then it should of course be just as universally preserved. But an examination of the examples shows that the vowel of this syllable neither falls invariably nor remains invariably. Nor was there sufficient proof to establish the theory which accents the second syllable if it is long, otherwise the preceding one. These disagreements satisfied me that we must modify Mr. Darmesteter's explanation of the reduction of protonic syllables wholly by the influence of the secondary accent. Since the tonic accent exercises so great an effect on the syllables which follow it, it is to be expected that it have some influence over the syllable which precedes it; and it does, for in certain portions of the Romance field it has so much power over what precedes that instances occur where even initial protonic vowels disappear under the influence of the accent. It is perfectly natural, however, that the influence of the accent should be greater over the syllables that follow than over those that precede it. In words with two pretonic syllables the protonic vowel was directly between the tonic and the secondary accent, and the fact of its being before the strong tonic had an effect at least as great as that caused by its being just after the weaker secondary accent, so that it is the conjoined effect of the two that causes its fall. To apply this conclusion: in words with three pretonic syllables, if we grant that secondary accent is initial, the second pretonic vowel, being next to the secondary accent, should show signs of weakening, but since it is separated from the tonic accent it need have no such absolute tendency to fall as does the protonic. And since even the protonic is preserved when surrounded by consonants demanding a supporting vowel, certainly as much should be expected of the second pretonic. All the examples collected coincide completely with this test: in some cases the second pretonic vowel falls; in others where it is surrounded by consonant groups not readily coalescing, it remains as *e*. The composita also invariably support the portion of the law that affects them. Hence, since the law agrees with the Latin background and the French developments, and since it alone explains these developments satisfactorily, we may safely accept it as the true solution.

PROCEEDINGS OF SOCIETIES.

Scientific Association.

(*See pp.* 69–71 *of this Circular*.

Philological Association.

April 19.—One hundred and forty-second regular meeting. Professor Gildersleeve in the chair. Thirty-one members present.
A Study of Wolfstan's Homilies with Respect to Style and Sources, by J. P. KINARD.
The Position of the Secondary Accent in the Etymons of French Words, by E. C. ARMSTRONG. (*Abstract on p.* 82).

May 17.—One hundred and forty-third regular meeting. Professor Gildersleeve in the chair. Thirty-two members present.
The History of Greek Noun Formation, by A. W. STRATTON. (*Abstract on p.* 82).
Breaking before *h* + consonant in Anglo-Saxon, by C. G. CHILD.

Historical and Political Science Association.

April 19.
History of Slavery in New Jersey, by H. S. COOLEY.
New London: Her Parliament and its Work, by L. N. WHEALTON.
State of the National Finances, by J. W. CHAPMAN, Jr.
University Ideals, by H. S. COOLEY.
Newcomb's Views of a National University, by C. F. ZIMMELE.

April 26.
Christian Missions in China, by C. S. ESTES.
Depew's Chicago University Address, by J. M. CALLAHAN.
Southern Economic History, by F. L. RILEY.
Rectifications of History, by T. F. MORAN.

May 3.
History of Maryland and Virginia Boundary Line, by L. N. WHEALTON.
E. C. Bancroft's Monograph on "The Chicago Strike," by R. D. HUNT.
E. D. Warfield on "The Teaching of History," by F. H. MCLEAN.
Andrew Stephenson's View of the "Transition from Communism to Private Property in Land," by J. A. C. CHANDLER.
Taxation of Street Railways, by A. C. BRYAN.
Ingram's "History of Slavery," by E. W. SIKES.

May 17.
The Provisional Government in Maryland (1774–1777), by J. A. SILVER.
Review of Walker's "Making of the Nation," by S. E. FORMAN.
Markham's "Peru," and Hancock's "Chile," by F. R. RUTTER.
"Greek Factors in Social Progress," by H. E. CHAMBERS and W. S. LEWIS.
The Gibbon Commemoration, by W. H. FORSYTHE, Jr.
The Catholic University Bulletins, by E. F. DUBRUL.
The Pope and the New Era, by F. E. SPARKS.
The University of Tennessee, by E. W. KENNEDY.
Was Washington a Marshal of France? by J. M. VINCENT.

Naturalists' Field Club.

April 9.
Horned Owls in Captivity, by C. B. WILSON.
The Species of Aspidium in Gray's Manual, specimens shown by C. E. WATERS.

May 14.
Seining in Gwynn's Falls, by C. B. WILSON.
Some Hepaticae found near Baltimore, by J. E. HUMPHREY.
The Stems of Asplenium Bradleyi and its Allies, by C. E. WATERS.

Mathematical Seminary.

Directed by Professor CRAIG.
April Meetings.—In charge of N. A. PATTILLO.
April 10.—Pentaspherical Coordinates, by N. A. PATTILLO.
April 24.—The Kinematical Method Applied to the Theory of Surfaces, by R. DE SAUSSURE.
May Meetings.—In charge of C. E. COMSTOCK.
May 1.—Surfaces of Constant Curvatures, by J. EIESLAND.
May 8 *and* 15.—Some Points in the Theory of Functions, by J. EIESLAND.

Young Men's Christian Association.

March 24.—Public lecture on "The Ethics of the Bible," by Professor GRIFFIN.
April 23.—Business Meeting. Dr. BERNARD C. STEINER, Associate in History and Librarian of the Pratt Library, elected President to succeed Dr. LEARNED.
April 26.—Public Reception tendered to Dr. MARION DEXTER LEARNED, the retiring President, in the parlors of Levering Hall.
April 30.—Meeting for Undergraduates, led by Dr. STEINER.
May 2.—Public Lecture on "Palestine and Local Verification of Bible Stories," by REVERDY JOHNSON.
May 16.—Address before the Association on "The Origin and Growth of the Devotional Meeting," by Dr. LEARNED.

PUBLIC MEETINGS AND SOCIAL ASSEMBLIES.

Held in the University buildings from April 26 to June 3, 1895:
The Baltimore Society of the Archæological Institute of America, April 26 [McCoy Hall].
Reception in honor of Dr. M. D. Learned, by the Young Men's Christian Association of the University, April 26 [Levering Hall].
Matriculate Society of the University, April 26 [McCoy Hall].
Annual Meeting of the American Academy of Medicine, May 4 and 6 [Levering Hall].
Annual Meeting of the American Gynecological Society, May 28, 29, 30 [Levering Hall and Hopkins Hall].
Meeting of the Friendly Visitors of the Charity Organization Society, June 3 [Levering Hall].
Meeting of the Good Government Club of the 12th ward, June 7 [Levering Hall].

Professor W. H. WELCH was elected a member of the National Academy of Sciences at its recent meeting in Washington, April 16–19, 1895.

Dr. LOUIS DUNCAN, Associate Professor of Electricity, has recently been elected President of the American Institute of Electrical Engineers.

AT THE RECENT COMMENCEMENTS of the several departments of the University of Maryland, the following graduates and former students of the Johns Hopkins University received degrees:

LL. B.—H. N. Abercrombie (Special Student, 1891–92), C. G. Baldwin (A. B., 1892), G. Stewart Brown (A. B., 1893), H. B. Dowell (A. B., 1893), J. H. Edmondson (A. B., 1893), A. D. Foster (Special Student, 1890–92), L. E. Greenbaum (A. B., 1892), L. L. Jackson, Jr. (A. B., 1893), J. M. Moses (A. B., 1893), A. R. Riggs (Graduate Student, 1892–93), M. A. Soper (A. B., 1893).

The prize for the best scholarship was awarded to L. E. Greenbaum, and the thesis prize to J. M. Moses. Messrs. Edmondson, Dowell, and Soper received honorable mention for scholarship.

M. D.—J. R. Abercrombie (A. B., 1893), H. Adler (A. B., 1892), E. E. Gibbons (Special Student, 1891–92), J. L. Hirsh (A. B., 1892).

The SURGICAL PRIZE was awarded to J. L. Hirsh; the MILTENBERGER PRIZE to H. Adler, who also received honorable mention.

OBITUARY.

Dr. ARTHUR R. OPPENHEIMER, of Baltimore, died April 29, 1895, at the age of 23 years. Dr. Oppenheimer graduated in 1890 as a Bachelor of Arts of the Johns Hopkins University, and then entered the University of Pennsylvania, graduating as M. D. in June, 1893. During the last two years he was an Assistant Resident Physician in the Johns Hopkins Hospital.

THE JOHNS HOPKINS PRESS.

MEMOIRS FROM THE BIOLOGICAL LABORATORY OF THE JOHNS HOPKINS UNIVERSITY.

VOLUME I.

SELECTED MORPHOLOGICAL MONOGRAPHS.

EDITED BY W. K. BROOKS, PH. D.

Three hundred and seventy pages and fifty-one plates, quarto.

CONTENTS.

Lucifer: a Study in Morphology, with 11 plates. By W. K. BROOKS.
The Development of Renilla, with 16 plates. By E. B. WILSON.
The Life-History of the Hydro-Medusae: a Discussion of the Origin of the Medusae, and of the Significance of Metagenesis, with 8 plates. By W. K. BROOKS.
Report on the Stomatopoda, with 16 plates. By W. K. BROOKS.
This volume is no longer sold separately.

VOLUME II.

MEMOIR ON THE GENUS SALPA.

BY PROFESSOR W. K. BROOKS.

Two parts, one part of text with three hundred and ninety-six pages large quarto, and one part with fifty-seven large colored plates.

CONTENTS.

I.—A General Account of the Life History of Salpa.—Chapter I. Introductory. Chapter II. The Development of the Solitary Salpa from the Egg. Chapter III. The Morphological Significance of the Salpa Embryo. Chapter IV. The Origin of the Proliferous Stolon. Chapter V. The Transformation of the Stolon into the Series of Aggregated Salpæ.

II.—The Systematic Affinity of Salpa in its Relation to the Conditions of Primitive Pelagic Life; The Phylogeny of the Tunicata; and the Ancestry of the Chordata.—Chapter VI. The Systematic Position of Salpa. Chapter VII. Salpa in its Relation to the Evolution of Life. Chapter VII. The Origin of the Chordata, considered in its Relation to Pelagic Influences.

III.—A Descriptive and Critical Discussion of the Asexual and Sexual Development of Salpa.—Chapter IX. The Origin and Maturation of the Egg of Salpa. Chapter X. Sex in Salpa. Chapter XI. The Fertilization and Segmentation of the Egg. Chapter XII. The Accessory Parts of the Embryo. Chapter XIII. The Follicle and the Placenta. Chapter XIV. The Ontogeny of the Organs of Salpa.

IV.—By M. M. Metcalf. The Eyes and Subneural Gland of Salpa.

Price for the two parts, $7.50, net.

The two volumes of Memoirs, bound in cloth, will be sent together for Fifteen Dollars, net, transportation paid.

Contributions to Assyriology and Comparative Semitic Philology.

(BEITRÄGE ZUR ASSYRIOLOGIE UND VERGLEICHENDEN SEMITISCHEN SPRACHWISSENSCHAFT.)

Edited by Professor FRIEDRICH DELITZSCH of Breslau and Professor PAUL HAUPT of Baltimore.

Two volumes of this important publication are now completed.

Volume I contains 636 pages, royal 8vo., 2 portraits and 14 plates of inscriptions. The price of Volume I is $10.00. (I, 1, $5.75—; I, 2, $4.25.)

Volume II contains 645 pages, royal 8vo., 2 portraits and 83 plates of inscriptions. The price of Volume II is $10.50. (II, 1, $4.25—; II, 2, $5.00—; II, 3, $1.25.)

Volume III, Part 1, 188 pages, royal 8vo., 3 plates (price $3.25) is now ready.

THE MALARIAL FEVERS OF BALTIMORE.

An Analysis of 616 cases of Malarial Fever, with special reference to the Relations existing between different Types of Haematozoa and different Types of Fever.

By WILLIAM SIDNEY THAYER, M. D., and JOHN HEWETSON, M. D.,
Assistants in the Medical Clinic of the Johns Hopkins Hospital.

[Forming part of the *Johns Hopkins Hospital Reports*, Vol. V, 1895.]
218 pages, quarto, with plates and charts. Price $2.00, postage paid.

THE JOHNS HOPKINS UNIVERSITY STUDIES IN HISTORY AND POLITICS.—1895.

I–II. Government of the Colony of South Carolina. By EDSON L. WHITNEY. 75 *cents.*
III–IV. Early Relations between Maryland and Virginia. By J. H. LATANÉ. 50 *cents.*
V. The Rise and Development of the Bicameral System in America. By THOMAS F. MORAN. 50 *cents.*
VI–VII. White Servitude in the Colony of Virginia. BY JAMES C. BALLAGH. 50 *cents.*
VIII. The Genesis of California's First Constitution (1846–1849). BY ROCKWELL DENNIS HUNT. 50 *cents.*
IX. Benjamin Franklin as an Economist. BY W. A. WETZEL. 50 *cents.*
X. The Provisional Government of Maryland (1774–1777). BY J. A. SILVER. 50 *cents.*
Financial History of Baltimore. BY J. H. HOLLANDER.
The City Government of Baltimore. BY THADDEUS P. THOMAS.
Social Condition of Textile Labor. By E. R. L. GOULD.

Other papers will be from time to time announced.

Subscription for the year, $3.00.

The set of twelve series is now offered, uniformly bound in cloth, for library use, for $36, and including subscription to the current (thirteenth) series, for $39.00.

The twelve series, with thirteen extra volumes, altogether twenty-five volumes, in cloth as above, for $55.

THE NEW POLYCHROME EDITION OF THE SACRED BOOKS OF THE OLD TESTAMENT.

A Critical Edition of the Hebrew Text, printed in Colors, with Notes. Prepared by Eminent Biblical Scholars of Europe and America, under the Editorial Direction of Professor PAUL HAUPT.

NOW READY.

Part 3: **Leviticus**, by Professor S. R. DRIVER (and Rev. H. A. WHITE), Oxford.
Part 6: **Joshua**, by Professor W. H. BENNETT, London.
Part 8: **Samuel**, by Professor K. BUDDE, Strassburg. English Translation of the Notes by Rev. B. W. BACON, Oswego, N. Y.
Part 11: **Jeremiah**, by Professor C. H. CORNILL, Königsberg. English Translation of the Notes by Dr. C. JOHNSTON, Baltimore.
Part 17: **Job**, by Professor C. SIEGFRIED, Jena. English Translation of the Notes by Professor R. E. BRÜNNOW, Heidelberg.

A detailed prospectus of this publication will be sent on application.

American Chemical Journal.

CONTENTS OF VOL. XVII, No. 7, JULY, 1895.

Some Notes on Molecular and Atomic Refraction. By W. F. EDWARDS.
A New Apparatus for Determining Molecular Weights by the Boiling-Point Method. By H. B. HITE.
Contribution from the Chemical Laboratory of Cornell University: A New Apparatus for the Determination of Molecular Weights by the Boiling-Point Method. By W. R. ORNDORFF and F. K. CAMERON.
Glutarimide. By R. SELDNER.
On the Oxidation of Complex Carbohydrates. By G. DE CHALMOT.
On the Determination of Formic Acid by Titration with Potassium Permanganate. By HARRY C. JONES.

This Journal contains original articles by American Chemists; reviews of works relating to Chemistry; reports on progress in the various departments of Chemistry; and items of general interest to Chemists. Ten numbers of about 80 pages each are published annually, at regular intervals, and form a volume. A number is issued each month except August and September. The subscription price is $4.00 a volume in advance; single numbers 50 cents.

The Johns Hopkins University Circulars are issued monthly. They are printed by Messrs. JOHN MURPHY & CO., No. 44 West Baltimore Street, Baltimore, from whom single copies may be obtained; they may also be procured from Messrs. CUSHING & CO., No. 34 West Baltimore Street, Baltimore. Subscriptions $1.00 a year, may be addressed to THE JOHNS HOPKINS PRESS, BALTIMORE; *single copies will be sent by mail for ten cents each.*