

RECORD OF MEETINGS  
OF THE  
NEW YORK ACADEMY OF SCIENCES.

January, 1904, to December, 1904.

HENRY E. CRAMPTON, *Recording Secretary*.

BUSINESS MEETING.

JANUARY 4, 1904.

The Academy met at 8-15 P. M., President Wilson presiding. In the absence of the secretary, the reading of the minutes was dispensed with.

There being no business to come before the meeting, the Academy then adjourned.

CHARLES LANE POOR,  
*Secretary pro tem.*

SECTION OF ASTRONOMY, PHYSICS AND  
CHEMISTRY.

JANUARY 4, 1904.

Section met at 8:15 P. M., Vice-President Poor presiding. The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

**Herschel C. Parker**, ALTITUDE OBSERVATIONS WITH THE  
HYPSONETER IN THE CANADIAN ROCKIES.

**George F. Kunz** and **Charles Baskerville**, PHOSPHORESCENCE IN DIAMONDS PRODUCED BY PITCHBLEND.

**Bergen Davis**, LATEST THEORIES RELATING TO THE DISCHARGE OF ELECTRICITY IN HIGH VACUA, AND IONIZATION OF GASES.

SUMMARY OF PAPERS.

Professor **Parker** presented a brief outline of the various methods used in altitude determinations, showing that all are based on two general methods, triangulation or measurement of atmospheric pressure. In the latter method the determinations are made either by means of the several forms of barometer or the hypsometer. The difficulties attending the use of all of the different forms of barometer were pointed out and the advantages of portability and accuracy of the hypsometer shown. Examples were then given illustrating the extremely satisfactory results obtained with the hypsometer during mountaineering expeditions in the Canadian Rockies last summer.

Professor Parker has had many years' experience in mountain work, making numerous "first ascents" in British Columbia and Alberta, and he gave as his conclusion that the hypsometer is by far the most convenient and accurate instrument for the determination of altitudes under ordinary mountaineering conditions.

Dr. **Kunz** in presenting the second paper stated that a naturally fractured piece of pitchblende (uraninite), weighing 800 grams, from Pribram, Bohemia, caused the  $14\frac{1}{3}\frac{1}{2}$  carat diamond (tiffanyite),<sup>1</sup> to phosphoresce when laid upon it, or even when a piece of window glass, or a board three fourths of an inch thick was interposed. The diamond glowed, although more than one inch of space intervened between it and the pitchblende. We have in this instance a substance with a radio-activity of only 2 or  $2\frac{1}{2}$  affecting a radio-actively responsive substance, proving that there exists a body of the latter character in this case that responds almost to the unit one of radio-activity. The same specimen of pitchblende did not affect a platinum-barium cyanide screen. Another specimen of pitchblende from Pribram, and others from Johangeorgenstadt, Saxony, and

<sup>1</sup> *Science*, December 18, 1903.

Central City, Colorado, caused the diamonds to phosphoresce. It was further shown that if either kunzite (a variety of spodumene), pectolite or wollastonite, pulverized, were mixed with radium-barium carbonate, of 240 activity, the mixed powder became permanently luminous. When these mixtures were put in a Bologna flask and held on a metal plate, hot but not showing any color, they immediately became very luminous and remained so for a long time. Kunzite, pectolite and wollastonite became phosphorescent by heating alone, the kunzite showing an orange glow. When a kunzite crystal 5 cm. square and 5 cm. thick was exposed to the passage of an oscillating current, the entire crystal glowed an orange pink, losing its lilac color, a well-defined line through the center in the path of the current being much more brilliant; this phosphorescence lasted for quite a time after exposure. Further experiments were made with the same sensitive diamond mentioned above as to its tribo-luminescence. Prints were obtained from negatives made by laying the diamond face downward directly upon the photographic plate, and rubbing the back of the diamond with a stick coated with wool, in one instance for a quarter of a minute, in another for one half minute, the tribo-luminescence induced causing the printing. The same type of diamond from British Guiana, when heated on a metal plate below redness, phosphoresced distinctly, as also did pectolite and wollastonite. We have here, therefore, luminescence of the tiffanyite body in diamond, produced by radio-active pitchblende, by friction and by heat.

The paper by Dr. **Davis** was the first of a series of papers on "Recent Progress in Physical Science." Account was given of Dr. H. A. Wilson's investigation of the distribution of electrical intensity along the striated positive column, and his theory for the electrical intensity in a uniform positive column. An outline was also given of Professor J. J. Thompson's theory of the discharge through Geissler tubes. Dr. Davis also reviewed Professor J. S. Townsend's theory of the sparking potential, Professor Townsend having showed that the ionization is due to impact of both positive and negative ions with the neutral mole-

cule. The theoretical sparking potential thus deduced agrees very closely with the experimental value.

CHARLES C. TROWBRIDGE,  
*Secretary.*

## SECTION OF BIOLOGY.

JANUARY 11, 1904.

Section met at 8.15 P. M., Vice-President Underwood presiding. The minutes of the last meeting of the Section were read and approved.

The following program was then offered :

**Henry F. Osborn**, THE CLASSIFICATION OF THE REPTILIA.

**Adele M. Fielde**, THE SENSE OF SMELL IN ANTS.

### SUMMARY OF PAPERS.

Professor **Osborn** presented the history of the classification of Reptilia as follows : (1) Recognition of the Cotylosauria as the most primitive group of reptiles, by Cope and Baur. (2) The separation of the Anomodontia, Chelonia and Sauropterygia as reptiles with a single temporal arcade, by Smith Woodward and Broom. (3) The affiliation of the Ichthyosaur with the two-arched rather than the single-arched reptiles, by Baur and McGregor. (4). The recognition of *Sphenodon* as the ancestral type of the two-arched reptiles, by Baur and others. (5) Separation of the reptiles into two great groups of single-arched and two-arched types, by Smith Woodward and Broom. (6) The demonstration that reptiles are separated not only by the structure of the temporal arch but by many fundamental characters into two distinct groups, by Osborn and McGregor (1902). (7) Consequent division of the Reptilia into two subclasses Synapsida and Diapsida, by Osborn (1903). (8) The proposal of the Diaptosauria to include all of the most primitive two-arched reptiles without armature, by Osborn (1903). (9) The classification of the Reptilia according to the accompanying table (1903-4).

## CLASS REPTILIA.

## I. Subclass SYNAPSIDA, Osborn.

1. Order COTYLOSAURIA, Cope [= Pareiasauria, Seeley].
  - Family Diadectidae.
  - Family Pariotichidae.
  - Family Pareiasauridae.
2. Superorder ANOMODONTIA, Owen [= Theromorpha, Cope, in part].
  - Order I. THERIODONTIA, Owen.
    - Suborder I. Therocephalia.
    - Suborder II. Cynodontia, Owen.
  - Order II. DICYNODONTIA, Owen. Inc. Sedis.
  - Order III. PLACODONTIA, Owen.
3. Order SAUROPTERYGIA.
  - Suborder I. Simosauria, Gervais [= Nothosauria].
  - Suborder II. Plesiosauria.
4. Order TESTUDINATA.
  - Suborder I. Pleurodira.
  - Suborder II. Cryptodira.
  - Suborder III. Trionychia.

## II. Subclass DIAPSIDA, Osborn.

1. Superorder DIAPTOSAURIA, Osborn.
  - Order I. PROCOLOPHONIA, Seeley.
  - Order II. PROTOROSAURIA, Seeley.
  - Order III. PROGANOSAURIA, Baur.
  - Order IV. GNATHODONTIA, Owen.
  - Order V. PELYCOSAURIA, Cope.
  - Order VI. CHORISTODERA, Cope.
  - Order VII. RHYNCHOCEPHALIA, Günther.
2. Order PARASUCHIA, Huxley.
  - Suborder I. Aëtosauria.
  - Suborder II. Phytosauria.
3. Order ICTHYOSAURIA, Blainville, 1835 [= Ichthyopterygia, Owen, 1839]
4. Order CROCODYLIA.
  - Suborder I. Mesosuchia.
  - Suborder II. Eusuchia.
  - Suborder III. Thalattosuchia.
5. Superorder DINOSAURIA, Owen.
  - Order I. THEROPODA, Marsh.
    - Suborder I. Megalosauria [= Thecodontia, Owen].
    - Suborder II. Compsognatha, Huxley.
  - Order II. OPISTHOCELIA, Owen [= Sauropoda, Marsh].
  - Order III. ORNITHOPODA, Cope [= Predentata, Marsh].
6. Superorder SQUAMATA.
  - Order I. LACERTILIA.
  - Order II. MOSASAURIA.
  - Order III. OPHIDIA.
7. Order PREROSAURIA.

Miss **Field** described her experiments with many species of these insects. Each species appears to have its distinctive odor, discernible by other ants. Within each species there are also differences of odor, dependent on the age of the colony, and the age of the queen from whose eggs its inmates are produced. The ant's organs of smell are its antennæ, in which the joints are as a series of noses, each having a special function. The

- distal joint appreciates the nest-aura informing the ant whether it is in its own nest or in that of an enemy. The second joint discriminates between the odors of ants of the same species as itself, but of different colonies. The third joint discerns the scent of the track laid down by the ant's own feet, and enables the ant to return upon any route that has been previously traversed. The fourth and fifth joints smell the larvæ and pupæ, and the removal of these joints disables the ant from further care of the inert young. The sixth and seventh joints make known to the ant the presence of ants of other species than her own. So many as five joints may be retained by ants whose antennæ have normally eleven or twelve joints and these ants will live peacefully together though they be of different subfamilies. But if seven joints be retained, the ants, similarly grouped, will fight one another to the death. If ants make one another's acquaintance before they are twelve hours old they will thereafter live amicably together although they be of different species, genera or even of different subfamilies. But in three days after hatching their criterion of correct ant odor is established, and they refuse to affiliate with ants whose odor is not in accord with their standard.

M. A. BIGELOW,

*Secretary.*

## SECTION OF GEOLOGY AND MINERALOGY.

JANUARY 18, 1904.

Section met at 8:15 P. M., Professor James F. Kemp presiding.

The minutes of the last meeting of the Section were read and approved.

In the absence of the Secretary, Dr. A. A. Julien was appointed Secretary *pro tem*.

The following program was then offered :

**J. D. Irving**, MICROSCOPIC STRUCTURE AND ORIGIN OF CERTAIN STYLOLITIC STRUCTURES IN LIMESTONE.

**J. Howard Wilson**, RECENT JOURNEYS AMONG LOCALITIES NOTED FOR THE DISCOVERY OF REMAINS OF PREHISTORIC MAN.

## SUMMARY OF PAPERS.

From an extended examination of stylolitic limestones collected in Indiana and Wyoming, mainly by Mr. M. L. Fuller and himself, Dr. **Irving** has drawn the following conclusions regarding the origin of the peculiar structures :

1. They were initiated along a thin clay layer in limestone and have been produced by the interpenetration of the limestone material on either side of this clay seam.
2. They are entirely independent of the presence of fossils existing in the rock, for they occur equally in those portions of the rock where fossils are absent and where they are present.
3. They were not formed by metamorphic agencies, or by the weight of overlying strata, or by other causes which would tend to distort and crush the rock material.
4. They were produced by a cause which operated on the material of the rock while it was yet unconsolidated, and in a condition approximating that which obtained at the time of deposition.
5. They originated under great pressure, the rock material being sufficiently soft to allow the bending of individual stylolites, and yet potentially rigid so that organisms were sharply sheared off while held in the soft matrix.

While the cause of the pressure and the manner in which it had operated to produce these structures has not been determined, the author suggests that their production may be the result of the hydrostatic pressure of the sea water lying above the deposits. In the instances examined, stylolites are characteristic of marine deposits formed in water varying from 400 to 2,500 fathoms in depth. If sea water be taken to have an average specific gravity of 1.028, then a one-foot column of water exerts a hydraulic pressure of .434 lb. per sq. in. of area. This would give, for the depth stated, a hydrostatic pressure of from 1,041 to 6,408 lbs. per sq. in. Such a pressure as this, coupled with the soft unconsolidated nature of the rock at the time it might have been exerted, seems to fulfill better than any other the conditions demanded by the observed facts.

Mr. **Wilson** discussed Man in the earliest times before the Neolithic Age and afterwards illustrated his paper by nearly forty views of some of the most famous rock shelters, caves and deposits of Europe which have furnished remains of Palæolithic Man, including also slides of the type implements and weapons from which is derived the principal evidence of Man's existence in Quaternary times.

The paper recited briefly the history of the subject, the first finds, especially the work of Boucher de Perthes, and the gradual development of the science of prehistoric archæology. Reference was made to some of the disputed evidence of Man's existence in the Tertiary period, and then the subject of Man's undoubted existence as early as the Second Glacial period was treated more at length, with a consideration of the climate and physical conditions which prevailed in Palæolithic times.

The paper closed with an attempt at a realization of the great antiquity of Palæolithic Man as shown by the immense physical and geological changes which have taken place since he first made his undoubted appearance.

A. A. JULIEN,  
*Secretary pro tem.*



## SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

JANUARY 25, 1905.

The regular meeting of the section was held on January 25, at the American Museum of Natural History, in conjunction with the New York Branch of the American Psychological Association. Afternoon and evening sessions were held, the members dining together between sessions. The program was as follows:

**Henry Rutgers Marshall**, PRIMARY AND SECONDARY PRESENTATIONS.

**Margaret E. Washburn**, THE GENERIC RELATION OF ORGANIC SENSATION AND SIMPLE FEELING.

**Francis Burke Brandt**, THE UNIVERSE'S PLACE IN MAN.

**Walter F. Dearborn**, RETINAL LOCAL SIGNS.

**Henry Davies**, DEWEY'S "STUDIES IN LOGICAL THEORY."

**Robert MacDougall**, THE DISTRIBUTION OF ERRORS IN SPELLING ENGLISH WORDS.

**Irving King**, THE ULTIMATE RELATION BETWEEN MAGIC AND RELIGION.

## SUMMARY OF PAPERS.

Dr. **Marshall** in his paper aimed to present evidence that presentations are always new presentations, and that, therefore, images can not be properly said to be copies of impressions, nor can what we call representations be properly said to be duplications of any presentations which have previously existed. His paper was a summary of an article which is presently to appear in *Mind*.

In his paper Dr. **Brandt** emphasized the necessity for a fresh start in modern empirical investigation through a critical restatement of the postulates of experience. The starting point of every empirical science, it was contended, is individual conscious experience. The primary datum of individual experience is a perceptive and a conceptive consciousness combined organically in the unity of a personal life existent in a universe of persons. The material universe thus primarily takes its place in man rather than man his place in the material universe, for scientific philos-

ophy has demonstrated beyond criticism, first, that the visible universe always exists primarily in and for a momentary perceptive consciousness limited in space, and second, that the unseen universe is always primarily a conceptive construction whose validity is always verifiable within the realm of momentarily perceptive experience. The material universe, whether conceived phenomenally or existentially, participates in one case in the content, in the other in the being of absolute personality, and as such, so far as individual man is concerned, is the objectification of the conditions of higher individual development.

Mr. **Dearborn's** paper was offered as a critique of the first of the three Lotzean hypotheses concerning the nature of the retinal local signs. Experiments to determine the accuracy of the motor impulse, as shown by the ability to fixate directly eccentric visual stimuli forty degrees to the right of the primary line of regard, found an average error of corrective movements considerably in excess of the threshold value of local discrimination for the same part of the retina. These discrepancies between the accuracy of the motor impulse and the delicacy of local discrimination seem to necessitate some modification of the traditional view in regard to the nature of the local signs, or at least in regard to the relative importance of the motor factor.

In the paper by Dr. **Davies** only the four chapters contributed by Professor Dewey to the above work were considered.

Toward the right understanding of the work two conditions of a historical character must be borne in mind. One of these is the relation of recent logical theory to the Kantian dualism of sense and reason which tended to separate thought from its object. The other is the influence of the evolutionary method, which drives the investigator to study logical distinctions in the light of their genesis in experience.

Both of these conditions exert a profound influence over Dewey's thought. For it is the essence of his contribution to logical theory that he shows that the obstinate manner in which logicians have accepted the Kantian reading of experience is the most fruitful historical cause of the contradictions, *c. g.*, in Lotze's "Logic" as well as in that of Bradley and Bosanquet.

Dewey claims that this is a complete misreading of the thought situation.

On the other hand, common sense and empirical science with their pragmatic and evolutionary method disclose the real situation. Thought is a question of *specific* purposes, *specific* contexts and *specific* conflicts. Common sense and empirical science assume for these specific aims the unity and continuity of experience. The logical problem emerges when this is broken up by an inward conflict into fact and theory, datum and ideatum. The content of thought is just this conflict, which is only a temporary phase of the logical situation, the outcome of which must always be the reestablishment of the original unity in our experience.

It follows from this that logic cannot contemplate as its aim a completely rationalized metaphysics. Rather its function is to act as a philosophy of experience, as a *method* by which experience may be advanced towards better and more complete knowledge. But the rectification of experience and the complete correlation of all the functions of experience presuppose a logic of genetic experience. It is Dewey's merit to have pointed this out and to have, in large part, supplied the need in the present work.

Dr. **MacDougall** made a provisional report upon an investigation of the distribution of errors in spelling English words. These occur characteristically in the latter part of the word, but do not present a continuous increase from beginning to end. The curve of error is an anticlinal having its maximum in the third quarter of the word and its points of origin the initial and final letters, of which the latter is the higher in the scale of errors. Similar relations are presented by the component syllables, fewest errors occur in the initial, most in the median letters. Considered apart from their relation to the termination of the word, the frequency of error in successive letters is found to increase with each remove from the beginning of the word.

Dr. **King's** paper stated that magic and religion can not be legitimately distinguished on the side of the actual content of their respective practices, nor by using such notions as that of

the supernatural, unless they are critically reconstructed with reference to the type of culture in which they are applied. It seems more legitimate to differentiate magic and religion according to the types of situations within which they appear. Some tensions in the experience of the primitive man are merely occasional and appeal to him chiefly as an individual; others are more general and appeal more insistently to the consciousness of the social group. In connection with the former sort of tensions magical practices are developed, and in connection with the latter variety religion differentiates.

JAMES E. LOUGH,  
*Secretary.*

#### BUSINESS MEETING.

FEBRUARY 1, 1904.

The Academy met at 8.15 P. M., Vice-President Poor presiding. The minutes of the preceding business meeting were read and approved.

The Secretary reported from the Council that a letter had been received from Mrs. H. Carrington Bolton, informing the Council that Dr. Bolton had given to the Academy, for the Publication Fund, the sum of \$1,000.

The Academy then adjourned.

HENRY E. CRAMPTON,  
*Recording Secretary.*

SECTION OF ASTRONOMY, PHYSICS AND  
CHEMISTRY.

FEBRUARY 1, 1904.

Section met at 8:20 P. M., Vice-President Poor presiding. The minutes of the last meeting of the Section were read and approved.

The following program was then offered :

**D. S. Martin**, H. CARRINGTON BOLTON.

**Charles Lane Poor**, RESEARCHES AS TO THE IDENTITY OF LEXELL'S LOST COMET OF 1770 WITH THE PERIODIC COMET OF 1889, 1896 AND 1903.

**George B. Pegram**, THE YEAR'S WORK WITH RADIUM.

## SUMMARY OF PAPERS.

The biographical sketch of the late Dr. H. Carrington Bolton by Dr. **Martin** was read by Professor Crampton, the recording secretary of the Academy, in the absence of Dr. Martin. The section then passed a resolution, proposed by Mr. G. F. Kunz, to the effect that Dr. Martin's address should be published in the ANNALS of the Academy, together with a bibliography of Dr. Bolton's papers.

Professor **Poor's** paper gave the result of a new investigation of the motion of the periodic comet of 1889, 1896 and 1903 (Brooks), dealing especially with the great changes in its orbit caused by the close approach to Jupiter in 1886. The comet has now been seen at three returns to perihelion and the many observations made allow of a most accurate determination of the present orbit on which to base the investigation. Attention was called to the supposed identity of this body with the lost comet of Lexell, 1770, which disappeared after passing close to Jupiter in 1779, and this question was discussed at length.

Dr. **Pegram's** paper was the second of the series on "Recent Progress in Physical Science." Dr. Pegram gave a review of the most important experimental and theoretical advances made during the past year in the knowledge of radio-activity, especially the work of Rutherford and Soddy in formulating the atomic

disintegration theory of radio-active change, the discovery of Curie in regard to the heating effect of radium, and the experiments of Ramsay and Soddy bearing on the question of the continuous production of helium in radium compounds. An apparatus was exhibited like that of Mr. Strutt, to show by the alternate charging and discharging of an electroscope the production of electric charges by radium. The charging of the gold leaf in the apparatus shown by Dr. Pegram took place in about one minute.

CHARLES C. TROWBRIDGE,  
*Secretary.*

### SECTION OF BIOLOGY.

FEBRUARY 8, 1904.

Section met at 8:15 P. M., Vice-President Underwood presiding. The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

**O. P. Hay**, A NEW GIGANTIC TORTOISE FROM THE MIOCENE OF COLORADO.

**F. E. Lloyd**, THE FLORA OF DOMINICA.

### SUMMARY OF PAPERS.

Dr. **Hay** described a tortoise that was discovered during the year 1901 by Mr. Barnum Brown, of the American Museum of Natural History, in the Pawnee beds of the Miocene, in the northeastern part of Colorado. The remains consist of the shell complete; the skull, lacking the lower jaw; the pelvis and hind limbs; the terminal portion of the tail; and portions of the dermal armor. These materials were exhibited before the academy.

The length of the carapace is about 31 inches. It is high and tumid, with the sides at the bridge perpendicular, and with the hinder border little flaring. The outline is truncated in front, broadly rounded behind, and only slightly repand. The free edges are acute. The bridge peripherals rise somewhat above the middle of the height of the shell, their length transversely

to the animal being nearly equal to that of the costal plates. The nuchal scute is narrow; the vertebral scutes not so wide as the costal scutes. The anterior lip of the plastron is broad, rounded in front, and slightly notched in the midline. The posterior lobe has a broad, shallow notch. The pectoral scutes are extremely narrow.

The skull has the palate deeply excavated. The masticatory surface on each side is traversed by a prominent, sharp and dentated ridge. The oral surface of the premaxillaries is excavated for the reception of the tip of the lower jaw. The cutting border of the maxilla is coarsely dentated.

The exposed portions of the hinder limbs and probably of the fore limbs also, were protected by an armor of dermal bones, as in some living species of the genus. The extremity of the tail is expanded and covered on the upper surface by a plate composed of several bones joined by sutures. The skin of the region around the tail was provided with many pebble-like dermal bones. On the hinder part of each thigh there was a large bony spur. All these bones were covered in life with a thick layer of horn. This new species is named *Testudo osborniana*, in recognition of the interest of Professor H. F. Osborn in the fossil testudines.

Remarks were made by the author of the paper on the geographical and geological distribution of the genus *Testudo* and its related genera, and on their probable origin.

Professor **Lloyd** gave a general account of the vegetation of the Island of Dominica, which the author visited during last summer.

The Island is of volcanic origin, remarkably broken in contour, and very difficult for travel. The rainfall is excessive, but with considerable differences in distribution. For example, on the west coast there is a mean annual rainfall of 59.51 inches, while 239.50 inches were reported for Middleham in 1901, an amount not far from the mean. The eastern slopes of the island are exposed to the trade winds, and the vegetation, from the shore line to the top of the mountains, shows the effects in the peculiar moulding. The temperatures are not excessive, but the atmospheric humidity is great.

The vegetation, excepting in certain restricted areas, is of the tropical rain-forest type. The large trees are clothed with a heavy epiphytic growth chiefly composed of bromeliads, aroids, orchids, ferns and a *Cyclanthera*. At the higher levels the Hymenophyllaceæ, Musci and Hepaticæ predominate, among which, however, many larger ferns and small orchids find a place. Four species of tree ferns, and several species of palms are to be found. *Heliconia*, a plantain-like plant, is very abundant at high altitudes. Lianas and "ropes," as air roots are called locally, are abundant.

In the Grand Savannah, desert conditions prevail, caused by the small rainfall (59 inches), and the shallow soil underlaid by trap rock. The vegetation here, and along the rocky shores is quite distinct in character. A viviparous agave and four cacti are here to be found. The savannah is a sloping, grassy plain with scattered shrubs and small trees among which occur several Mimosoideæ.

The strand vegetation on account of the steep, gravelly character of the shore is meager in species. The sea-grape (*Coccolobis uvifera*) is everywhere, and *Ipomœa pes-capræ* and *Canavalia* are common. *Terminalia* occurs in some localities.

M. A. BIGELOW,  
Secretary.

## SECTION OF GEOLOGY AND MINERALOGY.

FEBRUARY 15, 1904.

Section met 8:15 P. M., Professor James F. Kemp presiding. The minutes of the last meeting of Section were read and approved.

Twenty-six members and visitors were present.

The following program was then offered:

**Alexis A. Julien**, THE OCCLUSION OF IGNEOUS ROCK WITHIN METAMORPHIC SCHISTS.

**W. D. Matthew**, OUTLINES OF THE CONTINENTS IN TERTIARY TIMES.



## SUMMARY OF PAPERS.

Dr. **Julien** stated that the term "inclusive" is commonly applied, by the petrograper, to ordinary dikes of igneous rock, surrounded by beds of sedimentary rock or of crystalline schists, intersecting them or intervening between their foliation planes. But for similar masses cut loose from all connection with the underlying magmatic source, swallowed up within strata of crystalline schists, and experiencing all stages in the process of reaction and final absorption, during metamorphic change, another term seems to be called for, viz., "occlusion," signifying shut or sealed up beyond escape. Although the word is borrowed from the physicist, this can produce no confusion when applied to petrographic phenomena. Occluded igneous rocks may belong to either the acid or basic class, as illustrated respectively, on Manhattan Island, by the earlier intrusions of pegmatite, never found as intersecting dikes, and by the intercalated sheets of diorite-schist. Occlusion is usually attended by mechanical and chemical processes. The former consists of thinning or thickening of igneous masses caught between the folia of schists, during orogenic movements, into lenticular masses; the crumpling and corrugation of sheets, and even rolling into cylinders; and the forcing of the pasty masses along foliation planes, in the form of intercalated or "secondary" dikes. The chemical processes usually consist of micaceous alteration and ultimate absorption by disintegration and dissemination through the surrounding country rock.

In discussing this paper, Professor Kemp spoke of the value of the interpretation to those who have studied the region.

Dr. **Matthew** presented a series of world-maps showing the hypothetical outlines of the continents during the Pleistocene, Pliocene, Miocene, Oligocene, later Eocene, and at the opening of the Tertiary period, as contrasted with the modern conditions. The series was got up for use in the Hall of Fossil Mammals, in the American Museum of Natural History, to illustrate the geographical distribution of different groups of mammals during the successive epochs of the Tertiary and Quaternary. It is intended to represent a somewhat conservative view of past

changes in world geography, and is regarded as a working hypothesis, based on our present knowledge of geology, palæontology and zoölogy, especial consideration being given to the mammalian palæontology.

The former extension of the Antarctic continent, so as to join Australia with South America, is regarded as occurring at the end of the Cretaceous period and is represented in the first map of the series. The connection with South Africa is regarded as too problematic to place on the map. The Eocene map shows the extreme of Tertiary submergence of the continents, which are represented as forming six isolated land masses. The three northern continents are connected throughout the Oligocene, Miocene, Pliocene, and Pleistocene, Africa being joined to them by the Miocene, South America by the Pliocene epoch. The Pleistocene map shows especially the simultaneous glaciation of both northern and southern regions, modified in the north by sinking of the old Arctic continent beneath the sea-level.

The supposed ancient continents of Lemuria, Atlantis, the Brazil-African land bridge, etc., are regarded either as proposed on insufficient data or outside the limits of this series.

In general it has been found possible to consider the true ocean basins (limited by the 1,000-foot contour) as permanent through Tertiary time. The union of Antarctica with Australia and South America is an exception to this rule, but is based on a large amount of evidence. It appears probable also that the disturbed belt which stretches through central Europe to south-central Asia, and ends perhaps in the East Indian islands, has been, in part, raised from abyssal depths to an equally stupendous height above the sea, since the beginning of the Tertiary.

*Discussion.* — Professor Osborn emphasized the value of these maps as expressing working hypotheses for the use of students of vertebrate palæontology.

Dr. Julien called attention to the evidences of glaciation in South Africa as having a bearing upon the question of a previous existence of land masses further south.

EDMUND OTIS HOVEY,  
*Secretary.*

## SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

FEBRUARY 29, 1904.

The regular meeting of the section was held on February 29, at the American Museum of Natural History, in connection with the American Ethnological Society.

The program was as follows :

**George H. Pepper**, ETHNOLOGICAL SURVEY OF THE PUEBLOS OF NEW MEXICO AND ARIZONA, DURING THE SUMMER OF 1903.

**Harlan I. Smith**, ARCHEOLOGICAL SURVEY OF THE INTERIOR OF THE STATE OF WASHINGTON DURING THE SUMMER OF 1903.

## SUMMARY OF PAPERS.

Mr. **Pepper** first went to Española and from there visited the pueblos of Santa Clara, San Ildefonso, Pojoaque, Nambe and Tesuque. One of the ceremonial dances at the pueblo of Santa Clara was witnessed. San Juan, Picoris and Tesuque next received attention. After this work was completed the Hopi region was visited, the time selected being the occasion of the Antelope and Snake dances at Walpi. In the pueblos of Hano, Sichomavi and Walpi, special attention was devoted to the work of the Hopi potters, particularly Nampayo of Hano, who is the only one living that has made a careful study of the old pigments and clays.

On the second mesa the pueblos of Mashongnavi and Shungopavi were visited, and the Snake Dance at Mashongnavi observed. Oraibi, the seventh of the Hopi pueblos, situated fifteen miles to the west of the second mesa, came next. During the stay in this pueblo the wonderful Flute ceremony was enacted. From the Hopi region the route taken led to the pueblo of Laguna in the western part of New Mexico, and from there to Acoma, where the Fiesta de San Esteban was seen. While in the pueblo of Isleta the Fiesta de San Augustine took place.

Visits to the pueblos of Jemez, Zia, Santa Ana, Ranchitas de Santa Ana, Sandia, San Felipe, Santo Domingo, Cochiti and Zuñi completed the season's work, which included all of the twenty-six "mother pueblos," now inhabited.

The subject of primitive pottery-making as represented in the various groups was carefully considered and the technique of each culture was investigated. Samples of the materials used in the manufacture of pottery were obtained as well as representative forms of finished vessels from each pottery-making pueblo. Nearly one thousand negatives were made to supplement the field notes, and to enhance the value of the exhaustive card catalogue pertaining to southwestern ceramics, which is now in the course of preparation.

Mr. **Smith** stated that archeological explorations of the Jesup North Pacific Expedition were carried on in 1897 by himself in the Thompson and Fraser River valleys of Southern British Columbia, and 1898-99 in the shell-heaps along the coasts of British Columbia and Washington. In continuance of the general archeological reconnoissance thus begun in the northwest, the Columbia valley was chosen as the field for research during the field season of 1903.

It was thought that by working in the Yakima Valley the boundary between the culture of The Dalles and that of the Thompson River region might be determined. The material, however, discovered by the expedition seems to prove that the Yakima Valley was inhabited by people having a culture which previously had been unknown to science.

In the region were found numerous evidences of the close communication of the people of this culture with tribes of the Thompson River region. Underground house sites, tubular pipes, engraved detaliu shells, a decoration consisting of a circle with a dot in it, and rock-slide sepulchres, each of a particular kind, were found to be peculiar to both regions.

Considerable material of the same art, as that found in the Dalles region was seen. It is clear that the people living in the Yakima valley had extensive dealings both with the tribes northward, as far as the Thompson valley, and southward, as far as The Dalles of the Columbia. In this connection it is interesting to note that the present Indians of the region travel even more extensively than would be necessary to distribute their artifacts this far. Much less evidence of contact between

the prehistoric people of the coast of Washington and that of the Yakima valley was discovered. A pipe, however, was seen which is clearly of the art of the northwest coast. It was found far up the Toppenish River (one of the western tributaries of the Yakima).

From the Yakima valley the expedition was transferred to the lower Cowlitz River for work down that stream and along the Columbia from Portland to its mouth, partly to determine whether or not a portion of the evidences of coast culture which were found in the Yakima valley had not come up the Cowlitz and down the Toppenish River, since the headwaters of the Cowlitz and the Toppenish are near each other. In this region many specimens were secured. The main work, however, was done in the Yakima valley, where many photographs were taken, not only of archeological sites but also of the country in general. Human remains, which are useful in determining the type of these old people, were also collected.

The most remarkable specimen secured was a piece of antler carved in human form. This was very thin and when found it was nearly as soft as so much sawdust or moulder's sand pressed together tightly. Proper treatment has rendered the object quite hard and able to bear handling. It was found under the vertebræ of a child in a grave. The grave was of peculiar interest, because, contrary to usual practice, the body had been enclosed in a rude box made by placing about it thin slabs of stone, and the cist thus formed had been covered with jagged fragments of rock, over which earth was spread. This doll-like carving of antler is considered to be one of the finest pieces of prehistoric art ever found in northwestern America.

JAMES E. LOUGH,  
*Secretary.*

## BUSINESS MEETING.

MARCH 7, 1904.

The Academy met at 8:15 P. M., Vice-President Poor presiding.

In the absence of the Recording Secretary, the reading of the minutes of the preceding Business Meeting was dispensed with.

No business was reported from the Council, and the Academy adjourned.

C. C. TROWBRIDGE,  
*Secretary, pro tem.*

SECTION OF ASTRONOMY, PHYSICS AND  
CHEMISTRY.

MARCH 7, 1904.

Section met at 8:20 P. M., Vice-President Poor presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered :

**S. A. Mitchell**, THE RESULTS OF THE OBSERVATIONS OF THE  
LAST SOLAR ECLIPSE.

Dr. Mitchell gave an interesting résumé of the results obtained by the different expeditions which made observations in the island of Sumatra on May 18, 1901.

CHARLES C. TROWBRIDGE,  
*Secretary.*

## SECTION OF BIOLOGY.

MARCH 14, 1904.

Section met at 8:15 P. M., Professor Underwood presiding.  
The minutes of the last meeting of the Section were read and approved.

The following program was then offered :

**A. W. Grabau**, INTRA-COLONIAL ACCELERATION AND RETARDATION IN DEVELOPMENT.

**F. B. Sumner** and **R. C. Osburn**, THE ESTABLISHMENT OF A PERMANENT RECORD OF SYSTEMATIC AND ECOLOGICAL DATA FOR WOODS HOLE.

No abstracts of these papers have been received.

M. A. BIGELOW,  
*Secretary.*

## SECTION OF GEOLOGY AND MINERALOGY.

MARCH, 21, 1904.

Section met at 8:15 P. M., Professor James F. Kemp presiding.

The minutes of the last meeting of the Section were read and approved. Twenty-two members and visitors were present.

The following program was then offered :

**H. H. Wotherspoon, Jr.**, THE RECENT ADVANCES IN THE UTILIZATION OF PEAT AND LIGNITE.

**Charles P. Berkey**, A GEOLOGICAL RECONNOISSANCE OF THE UINTAH RESERVATION, SOUTHEASTERN UTAH.

## SUMMARY OF PAPERS.

Mr. **Wotherspoon** showed that the derivation of the fuel supply of the world is becoming more and more important. For years Europeans have been striving to devise a fuel to take the place of wood and coal. Recent advances in the price of coal in the United States have directed attention in this country along the same lines. In Europe and particularly

in Germany, many factories have been established for the compression of lignite, or brown coal, and peat into briquettes.

The principal deposits of lignite are near Berlin and Cologne. The larger of these is south and east of Berlin and is known as the Lausitz district. About 280 factories for the manufacture of briquetted fuel, with a total of 680 presses, have been established in these two regions, and their output in 1902 was approximately 12,438,000 metric tons. The briquettes are about 7 inches long, 2½ inches wide, and 1½ inches thick, with rounded corners. Their wholesale price in the larger German cities is between \$2.10 and \$2.25 per metric ton.

Excellent briquettes have been made from the lignite of Alabama; but the experiments with the lignites of North Dakota have been less successful. The calorific value of the German briquettes is from 7,500 to 9,000 B.T.U.'s. True peat and other bog matter is becoming of importance in the manufacture of briquetted fuel. The process of manufacture which has been employed in Canada has depended upon heat for the expulsion of the major part of the contained moisture. This has been an unsatisfactory method, because the temperature (280° F.) necessarily employed has weakened the natural cementing qualities of the bog material.

The German method which has been very successful is to break up rapidly and thoroughly the cellular structure of the partly decomposed vegetable matter. This sets free the water from the plant fiber without injuring the cementing material. In the process, part of the moisture is squeezed out of the mass, and the remainder evaporates rapidly on exposure to the air. The briquettes are ready to use in about two weeks after leaving the machine. Their calorific value is greater than that of the briquettes made from lignite.

The briquettes made from American bog matter seem to be as good as the European. The percentage of ash is high, but the ash is very free in character. This characteristic together with the absence of sulphur, makes the fuel work well under boilers. Wherever transportation charges bring the cost of



coal up to seven or eight dollars a ton, it is advisable for Americans to investigate the matter of utilizing neighboring bogs as a source of fuel supply. Mr. Wotherspoon's paper was illustrated by a series of briquettes manufactured from European and American lignites and peats. He also exhibited a machine by means of which he manufactured, in the presence of the Section, briquettes from peat, which originated in Danbury, Conn. The paper was actively discussed, and many questions bearing upon the economic features brought forward by the author, were asked.

Dr. **Berkey** spoke of his observations, made in connection with other lines of work last summer, that have shown an erosion unconformity in the Carboniferous strata of the western Uintahs. It is marked on the south side of the range by an unevenness in the floor and a development of conglomerate, the pebbles of which are of the preceding formation. The break comes just above the chief limestone member of the series.

The junction between the great basal quartzite of the United States and the overlying strata is marked by a fault in this region with sufficient throw to bring two quartzite beds together on the higher plateaus and be easily overlooked. This makes it impossible to confirm Powell's unconformity at the top of the quartzite as described by him in the eastern Uintahs.

The discovery, however, of the Carboniferous erosion interval a little higher in the series, throws additional doubt upon the assumed Carboniferous age of the great quartzite member. Allowing the break to cut out a part of the "Wasatch" limestone and the "Weber" quartzite, as developed in the Wasatch uplift, the lithologic succession is satisfied better by assuming Cambrian age for the lowest member in the Uintahs.

There is no other break to the close of the Cretaceous. A progressive unconformity, which increases in value against the flanks of the range, marks the development of Tertiary sediments in the Duchesne Valley. A conglomerate, formed in progressive overlap from the stream valleys to the higher mountain tops of the flanks, has peculiar characters near the limestone belt on account of which King called it "Wyoming"

conglomerate. These characters are too local to give it the assumed stratigraphic importance, while the flanking conglomerates are really of great range. EDMUND OTIS HOVEY,

*Secretary.*

## SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

MARCH 28, 1904.

Section met at 4:30 and 8:15 P. M., in conjunction with the New York Branch of the American Psychological Association, F. J. E. Woodbridge, presiding.

The afternoon session was held at the Psychological Laboratory of Columbia University, and the evening session at the American Museum of Natural History.

The following program was offered:

**E. L. Thorndike**, MENTAL RESEMBLANCES OF TWINS.

Miss **Naomi Norseworthy**, MEASUREMENTS OF THE MENTALLY DEFICIENT.

**R. S. Woodworth**, COLOR CONTRASTS.

**J. McK. Cattell**, NEW APPARATUS AND METHODS.

**V. A. C. Henmon**, THE TIME PERCEPTION AS A MEASURE OF DIFFERENCES IN SENSATION.

**H. H. Marsh**, THE DAILY CURVE FOR EFFICIENCY.

**C. H. Judd**, HABITS BASED ON ANALOGY.

**W. P. Montague**, A NEGLECTED POINT IN HUME'S PHILOSOPHY.

**J. E. Lough**, THE DETERMINATION OF THE HABIT CURVE FOR ASSOCIATIONS.

**P. Hughes**, ACTION AS THE CONCEPT OF HISTORICAL SYNTHESIS.

### SUMMARY OF PAPERS.

A report was made by Professor **Thorndike** on the general results of a comparison of twins in tests of attention, perception, association, rate of movement, addition, multiplication and stature. The resemblances as measured by a rough, preliminary method, were about .75. The amount of this resemblance that should be attributed to similarities in home training was apparently slight. There was no evidence in the results to support the theory that

twins fall sharply into two species, those very closely alike and those no more alike than ordinary brothers and sisters.

Miss **Norseworthy's** paper was a report of some work done among one hundred and fifty mentally deficient children in two state institutions for the feeble-minded and in two of the special classes organized in the New York schools. The measurements taken were physical, such as height, height and temperature, tests of maturity, as perception of weight and of form, tests of memory and tests of intelligence or the ability to deal with abstract ideas. The main conclusion reached was that the difference between idiots and people in general is less than has been commonly supposed, and is a matter of degree rather than of kind.

Dr. **Woodworth** presented a modification of Hering's binocular demonstration of the "physiological" origin of simultaneous contrast. If monocular fields of different colors, with a gray spot on each, be combined by the stereoscope, each gray retains the contrast color suitable to its own field, however the conscious background may vary as the result of fusion or rivalry of the two fields. The demonstration is readily extended to cover brightness contrast, by placing gray spots on white and black fields which are combined as before. To show that these effects are not the result of a binocular mixture of the gray with the opposite field, a number of gray spots may be scattered over one field, and the other field made particolored; the gray spots appear all alike, or nearly so, though binocular mixture would have made them differ.

Professor **Cattell** gave an exhibition of some new apparatus and methods as follows:

1. Kymographs were exhibited in which typewriting ribbons were applied to secure the records. Electro-magnetically moved points strike the paper tape, whose rate of movement may be adjusted, and a record is left by the slowly moving typewriter ribbon. Two forms were exhibited, in one of which the kymograph was driven by an electric motor and in the other by clock-work. In the latter the clock-work could be started and stopped by an electric current by an observer in another room. The kymographs, while not especially suited for drawing curves, are much

more convenient than smoked paper or siphon pens for time records, such as rhythms, conflict of the visual fields, after-images, etc.

2. Instruments were shown by which a number of faint clicks could be given at intervals of a second for testing sharpness of hearing and defective hearing. Instead of giving the observer a continuous sound, such as from the ticking of a watch, two, three, four or five faint sounds are made, and the observer is asked how many he hears. By this method errors from the common illusion in the case of faint sounds are avoided.

3. A method was exhibited for testing color blindness by the time it takes to distinguish one color from another. By the normal individual red can be distinguished from green in about the same time as blue from yellow, but it takes longer to distinguish red from orange. If the observer belongs to the red-green class of the color blind, he can distinguish blue from yellow as quickly as others, but not red from green. An instrument was shown by which the conditions of the railway service can be imitated, it here being necessary first to distinguish a certain color and then to make the proper movement.

The aim of the investigation upon which Mr. **Henmon's** paper is based is to measure qualitative differences in color by the time of perception. The colors taken as standards were red, orange and yellow, whose wave-lengths had been definitely determined. Equal intermediate steps between orange and red were produced by the mixture of pigments. Small squares of each of these colors, 3 x 3 cm., were mounted on cards side by side with red, and exposed to the subject by means of a drop-screen so arranged as to give almost instantaneous exposure. The subject reacts with the right or left hand according as the predetermined stimulus appears to the right or left. The registration is made with the Hipp chronoscope. The results of 6,000 reactions gave evidence of the validity of the method and the fruitfulness of the problem. Equal objective differences are correlated with differences for consciousness, showing a definite increase as the magnitude of difference is decreased.

Professor **Lough** presented a report of experiments made in the psychological laboratory of the school of pedagogy. It was found that the time required to write series of letter-equivalents when the "key" of equivalents was not memorized, but was consulted as frequently as necessary, diminished as the associations between the letter equivalents became more habitual. The curves representing the results of these experiments exhibit all the characteristics of the typical habit curve. Repetition of the experiment using new "keys" shows little or no interference due to earlier associations, while with each succeeding "key" the physiological limit was reached after a constantly diminishing number of trials.

The paper by Dr. **Montague** aimed to show (1) that Hume (in Part IV, Section II, of the "Treatise") had quite unwittingly furnished what from his own point of view should have been regarded as a logical deduction and justification — rather than the mere psychogenetic description, which it purported to be, — of the realistic belief in the independent and uninterrupted existence of sensible objects; and (2) that the *naïve realism* or positivism thus accidentally promulgated was from both the scientific and the popular standpoint, a far sounder and more inviting doctrine than the empirical idealism or sensationalism with which Hume's name is usually associated.

Mr. **Hughes** said that Rickert's description of the content of history as a reality is amended to read *past reality*, the past of evidence. From this definition the individual, objective, moving and continuous character of historic content follows; and further, the conception of action as descriptive of both historic content and historic synthesis. An historical synthesis is a past action that itself has created a certain synthesis of evidence, which the historian discovers. In such synthetic actions, "simple" actions retain their individuality as means, stimuli or hindrances to the main action, *i. e.*, in a functional relation.

At the close of the afternoon session the members were invited to attend a lecture given in Columbia University by Professor John Dewey on "The Psychologist's Account of Knowledge."

JAMES E. LOUGH,

*Secretary.*

## BUSINESS MEETING.

APRIL 4, 1904.

The Academy met at 8:20 P. M., Vice-President Poor presiding.

The minutes of the preceding business meeting were read and approved.

The following candidates for election as Active Members, approved by the Council, were duly elected :

Thomas Hunt Morgan.

Charles B. Davenport.

The Academy then adjourned.

HENRY E. CRAMPTON,  
*Recording Secretary.*

SECTION OF ASTRONOMY, PHYSICS AND  
CHEMISTRY.

APRIL 4, 1904.

Section met at 8:20 P. M., Vice-President Poor presiding. The minutes of the last meeting of the Section were read and approved.

The following program was then offered :

**J. K. Rees, Harold Jacoby** and **Herman S. Davis**, THE VARIATION OF LATITUDE AT NEW YORK CITY ; Part 2, VARIATION OF LATITUDE AND CONSTANT OF ABERRATION.

**George B. Pegram** and **Harold Webb**, ENERGY LIBERATED BY THORIUM.

**Wallace Goold Levison**, NOTE ON A TRIBOPHOSPHOROSCOPE, AND THE DURATION SPECTRUM OF TRIBOPHOSPHORESCENT LIGHT.

## SUMMARY OF PAPERS.

In the first paper Professor **Jacoby** presented the results of seven years' continuous observations for a study of latitude variation and the aberration of light, which results will be published as the second and last part of Vol. I, in the Academy's

Series of Memoirs. To that publication the reader is referred for complete details and results; it is not possible here to do more than mention very briefly the plan of the work and to state the fact of its completion.

The simultaneous and continuous observation of the same stars at stations situated on a single parallel of latitude, but separated widely in longitude, has long been recognized as the best method of attacking the problem under consideration. The first actual practical application of the method is the one treated in the present paper. The other participating observatory is the one at Capodimonte, near Naples, where simultaneous observations were made by Professor Fergola and his associates.

The New York and Naples work was continued until a similar, but a more elaborate, plan was put in operation by the International Geodetic Association, which includes all civilized governments. This plan involved the establishment of four suitable special latitude stations, and rendered further work at New York and Naples unnecessary.

The method used by Messrs. **Pegram** and **Webb**, in this investigation of the energy liberated by thorium due to its radio-activity, was to measure the difference between the temperature of three kilograms of thorium oxide, enclosed in a Dewar bulb, and that of a surrounding ice-bath, by means of a set of iron-constantin thermo-electric couples. Uniformity of temperature in the bath was secured by means of a rotating stirrer and careful heat insulation. The thorium oxide was cooled, so that its initial temperature was below that of the surrounding bath. Readings were taken at frequent intervals, and after several days the difference of temperature became constant, with the oxide  $.04^{\circ}$  warmer than the bath. Several such series of observations were made. From the rate of change of temperature and from an approximate calculation of the heat capacity of bulb and oxide, a tentative value of the heat liberated was found;  $8 \times 10^{-5}$  gram-calories per gram of thorium oxide per hour (.93 ergs per gram per second), or  $9 \times 10^{-5}$  gram-calories per gram of pure thorium per hour. Further investigation is being made to determine these values more accurately.

Mr. **Levison** presented the following note on a Tribo-phosphoroscope :

Discs of thick pasteboard about 15 cm. in diameter are evenly sanded on one or both sides on a coating of liquid glue with the materials to be examined in powder, narrow bands being sufficient and only small quantities of the materials required.

The disc selected is then rotated at a known and usually moderate speed (twelve revolutions per second, for example) by any convenient mechanism, such as an ordinary rotator used for illustrating the recomposition of light.

A point or brush of wire or other material, or a piece of the same material with which the disc is coated, being pressed against the sanded surface, produces a trail of light which extends from the point of contact in an arc more or less around the disc ; varying in color with different materials and in length with the speed, and is maintained for some time unless the material is rubbed off by extreme friction. A grindstone or corundum wheel may often be used to advantage with hard substances as a substitute for the disc, since a specimen held against it soon coats it with a trace of the material which shows its luminous trail beautifully.

By means of the device described, the intensity of the light may be determined with a photometer, its duration from the length of the trail, and its spectrum delineated with a spectro-scope.

The following approximate tentative results of the examination of a few minerals are given to illustrate its applicability.

1. Sphalerite (1) from Utah. Light yellow concretions in gray massive sphalerite. Visible trails of a yellow orange color of respectively increasing brilliancy and length are produced with the tip of the finger ; a wooden match ; the finger nail ; a brass wire brush ; and a steel wire brush, or point ; visible, with the latter, at a distance of several yards and extending about one quarter around the disc at the above speed. Hence, the duration is about 0.02 s. The spectrum is short, extending from about the line *C* to the line *E* and embracing some red, orange, yellow, yellow-green and green. (2) From another



locality very similar to the above in character, and afforded like results. (3) Of several dark colored sphalerites some showed a little light at the point of contact of the brush, but no trail.

2. Quartz. (Sandpaper disc or grindstone.) No light from brushes (except incandescent sparks from hard steel). A piece of quartz, however, gives a bright yellow light, and if of rock crystal is luminous within by internal reflection. Very short trail and duration.

3. Corundum. (Emery paper disc or corundum wheel.) No light from brushes (except as above). A piece of ruby or ruby corundum against the corundum wheel or a grindstone evokes a brilliant crimson light and short trail and is luminous within by internal reflection. Duration about 0.005 s. A piece of emery against a corundum wheel gives a like trail but is not itself luminous.

4. Pectolite, Woodcliff, N. J. Wire brush. Light greenish-blue trail only medium bright but extending completely around the disc. Duration over 0.08 s.

5. Limestone, Hellfire Rock, Utah. Feeble greenish-blue but similarly long trail. Duration over 0.08 s.

6. Willemite. (1) Hard yellow-green gem material, Franklin, N. J. Short greenish-yellow trail. Duration very short. (2) Opaque, massive green variety. Feeble short green trail. Duration about 0.02 s. Best obtained with a specimen pressed against a corundum wheel or grindstone. Various specimens give somewhat different effects. (3) Pink or brown variety. Longer and brighter green trail. Duration about 0.03 s.

7. Chlorophane. (1) Violet from Trumbull, Conn. Bright green and very long trail; best obtained by friction of a specimen against a grindstone or corundum wheel or a disc coated with the same material. Duration over 0.40 s. Spectrum broad band in the yellow-green and green. (2) Green from Amelia Co. Courthouse, Va. Trail similar but brighter; spectrum similar. (3) Red from Haddam Neck, Conn. Trail similar.

In the discussions that followed the papers, Dr. George F. Kunz stated that Professor Baskerville and himself had under

examination a zinc-blende from Utah, the natural mineral varying in color from yellow to fawn and to pale brown. This was the most intense tribo-luminescent substance that they had yet investigated. Two bits one fourth the size of a pea, if pressed together lightly with the fingers, caused a brilliant yellow-green light to glow as long as the pressure lasted; and it also possessed the property of becoming radio-responsive to the beta and gamma rays of radium; that it was the first natural zinc-blende they had examined that showed this remarkable property.

Mr. W. J. Hammer showed a sample of artificial blende made by Mr. W. S. Andrews, of Schenectady, N. Y., which gave very strong tribo-luminescence.

C. C. TROWBRIDGE,  
*Secretary.*

## SECTION OF BIOLOGY.

APRIL 11, 1904.

Section met at 8:15 P. M., Professor Underwood presiding. The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

**Gary N. Calkins**, THE EVIDENCE OF A SEXUAL CYCLE IN *AMEBA* *PROTEUS*.

**E. B. Wilson**, THE CLEAVAGE-MOSAIC IN *PATELLA*.

**D. T. MacDougal**, THE ECOLOGICAL CONDITIONS IN A LOCAL DESERT IN LOWER CALIFORNIA.

### SUMMARY OF PAPERS.

Professor **Calkins** presented "The Evidence of a Sexual Cycle in *Amaba Proteus*" as shown by nuclear changes, including the processes of mitosis and nuclear multiplication by this method, the fragmentation of the multiple nuclei, the mitotic division of the chromatin fragments, and the formation of the secondary nuclei, and subsequent encystment of the parent form. The entire process was regarded by the speaker as indicating a series of changes leading up to the formation of

conjugating gametes and exactly analogous to the formation of gametes in allied rhizopods such as *Polystomella*, *Centropyxis*, and *Chlamydothrys* as recently worked out by Schaudinn. Lantern slides were used for illustrations.

Professor **Wilson**'s subject was "The Cleavage-Mosaic in *Patella* ; with remarks on the Mosaic-Theory of Development." This paper will soon be published in full in the *Journal of Experimental Zoology*.

Professor **MacDougal** gave a short talk on the topography, water-fall, drainage, botanical and zoological conditions in a local desert in Lower California.

GARY N. CALKINS,  
*Acting Secretary.*

## SECTION OF GEOLOGY AND MINERALOGY.

APRIL 18, 1904.

Section met at 8:15 P. M., Professor James F. Kemp, presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered :

**Arthur Hollick**, A CANOE TRIP DOWN THE YUKON RIVER FROM DAWSON TO ANVIK.

**Edmund Otis Hovey**, THE GRAND SOUFRIÈRE OF GUADALOUPE, AN ANALOGUE OF MONT PELÉ.

### SUMMARY OF PAPERS.

Dr. **Hollick** said in brief: The trip was made under instructions from the United States Geological Survey, with the special object of collecting palæobotanical material, from which to determine the age of certain exposures in central Alaska.

The party consisted of Dr. Hollick, Mr. Sidney Paige, field assistant, and Mr. John Rentfro, cook and general camp assistant. The start was made from Seattle, Wash., on June 1, 1903, by steamer to Skagway, Alaska, where they arrived on

June 5, and remained until June 11, waiting for the ice to break up in the Yukon River. On June 11, the route was by railroad to Whitehorse, Yukon Territory; June 12-15, by steamboat down the upper waters of the Yukon to Dawson, Yukon Territory, where a nineteen-foot, Peterboro' canoe was purchased and the trip down the river begun. The trip was ended at Anvik, Alaska, August 12, after about 1,100 miles of the river had been explored, and about 1,800 lbs. of specimens had been collected and shipped. The highest point north was reached at Fort Yukon, July 2, just beyond the Arctic Circle.

The Yukon River occupies what was until quite recently a broad estuary. Subsequent elevation of the land resulted in the draining of the estuary and the formation of the present river valley, which has cut its way down through the estuary deposits, leaving these as broad benches or terraces. Mastodon and other remains of extinct animals indicate the Pleistocene age of the deposits. One of the finest exposures is at the "Palisades," just below Rampart.

The width of the river varies from one to ten miles, and the main channel is constantly shifting. It pursues a meandering course, sometimes impinging on the side of the old valley, sometimes on the other, and for long distances flows through the middle. Where it occupies the latter position, it is generally broad, with a current of about four miles per hour, and filled with innumerable wooded islands, mud flats and sand and gravel bars, which render navigation more or less a matter of guesswork, on account of the impossibility of telling where the main channel flows, and the liability of running into a blind slue or a long circuitous channel around an island. It was often found advisable to climb up the river bank to a considerable elevation in order to determine, by means of an extended view, where the correct course lay. Where hard rocks were exposed along the river banks, or a short distance away, these were subjected to careful examination in regard to their lithologic, palæontologic and stratigraphic characters.

Amongst the interesting results obtained were (1) the determination of the Tertiary age of certain sandstones above Ram-

part; and (2) the determination of the Cretaceous age of other sandstones and shales further down the river in the vicinity of Nulato. At one locality, a unique fossil flora was found, totally different from any heretofore known in America, consisting of Cycads of Lower Cretaceous types, mixed with Angiosperms belonging to what have always been considered Upper Cretaceous types.

Only a preliminary study has been made of the material collected, which will eventually be carefully examined and reported upon for the United States Geological Survey.

The paper was illustrated with about seventy lantern slides, showing the principal topographic and geologic features of the route.

Dr. Hovey showed twelve lantern slides illustrating the Grand Soufrière of Guadeloupe, and stated that the field evidence indicated that the present active cone of this volcano was closely analogous to the new cone and spine of Mont Pelé, Martinique; that is to say that it had been pushed up bodily into its present position, or had welled up through the conduit in such a viscous condition that contact with the atmosphere rendered it too rigid to flow. At the base of the cone, on the north, there is a gently rising flat area, apparently the segment of a circle, indicating the position of a part of the rim of a crater in existence before the construction of the present cone.

The map shown in connection with the paper was prepared by M. Léon Le Boucher for the Club des Montagnards of Guadeloupe. This Club has recently celebrated the first anniversary of its founding, and its report shows that it has done a great deal in a short time toward the opening up of roads and paths to the Soufrière, making the highest and one of the most interesting mountains of the Lesser Antilles readily accessible to visitors.

Sixty members and visitors were present at the meeting of the Section.

EDMUND OTIS HOVEY,  
*Secretary.*

## SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

APRIL 25, 1904.

Section met at 8:15 P. M., Professor F. J. E. Woodbridge, presiding. The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

**William Jones**, NOTES ON AN ALGONKIN DIALECT.

**Franz Boas** and **Clark Wissler**, ON THE GROWTH OF CHILDREN.

**Marshall H. Saville**, PAPER-MAKING IMPLEMENTS OF ANCIENT MEXICO.

**Waldemar Jochelson**, THE GRAMMAR OF THE YUKAGHIR LANGUAGE.

## SUMMARY OF PAPERS.

Dr. **Jones** presented a brief report of the method of word formation of the Fox dialect. The dialect is Algonkin and belongs to the group now inhabiting, or that once inhabited, the country contiguous to Lake Huron, Lake Michigan and Lake Superior. Among the other dialects of the group are Ojibway, Ottawa, Pottowatomie, Menomonie, Kickapoo, and Sauk. Morphologically all these dialects stand in an intimate relation to one another. The absolute forms of much of the vocabulary are the same, but varying differences in the way of intonation, articulation and grammar, make some of these dialects seem somewhat removed from one another. Fox is near to Sauk and Kickapoo, and farther removed from Ojibway.

The structural peculiarities of word building, as shown in the Fox, would come out much the same in the other related dialects. The system of forming words is by composition. The elements entering into composition are formatives and stems. Some formatives are prefixes but most are suffixes. Some of the suffixes refer to the pronoun and gender in the same form. Stems fall into two general classes, initial and secondary. Initial stems come first in a combination and secondary stems come after. Secondary stems can be subdivided into at least two

groups, one of the first order and another of the second: the former stand next to initial stems, and the latter, when in composition, stand next to terminal pronouns.

The stems refer to general notions. Initial stems usually express subjective states and secondary stems generally refer to objective relations. The meaning of one stem modifies the meaning of another in a reciprocal manner, with a result of greater specialization. Initial stems have greater extension and can often occur alone as adverbs.

A number of particles precede the terminal pronouns. The particles refer to causal relations. Some have the special office of instrumentality, as with the hand, foot, mouth, voice and ear.

The dialect makes a distinction between two opposing categories. Objects that have life and movement come in one class, and objects without those attributes fall in another. The distinction is maintained with great vigor throughout the dialect. A force like personification sometimes interferes with it.

Professor **Boas** and Dr. **Wissler** presented a joint paper, in which they discussed the causes of the increased variability during the period of growth. On the basis of the results of previous investigations, it had been suggested that the increased variability may be due to differences in the rapidity of development. The authors have followed out this line of investigation by collecting material regarding the variability of the period at which certain physiological changes take place. The times of dentition, the beginning of puberty, the appearance of the wisdom teeth, and the beginning of senility, were selected for this purpose, and it was shown that the variability of time at which these phenomena take place increases with increasing age, and apparently the rate of increase is proportional to the age. Furthermore it was shown that during the period of growth all the coefficients of correlation between the sizes of different parts of the body are increased. This can also be best explained by the theory that the phenomena of growth are largely due to acceleration and retardation. The paper by Professor Saville was illustrated by specimens.

The paper by Mr. **Jochelson** reported the results of several

years' study of the Yukaghir language, being mainly a sketch of the Lolyma dialect. The phonetic and morphological peculiarities of the former are rather insignificant, but the Tundra dialect has absorbed a considerable number of Tungus stems, which in their use in word-formation have been subjected to the rules of the Yukaghir grammar. These investigations show that the Yukaghir language stands isolated from the Siberian languages of the so-called Ural-Altaic group, and that it has many similarities to the languages of the American Indians.

The chief phonetic and morphological differences that distinguish the Yukaghir languages from the Ural-Altaic languages are the following: 1. It has not the intricate system of vowel harmony that is found in Ural-Altaic languages. 2. We do not find that the vowel of the root is unchangeable — an important rule in Ural-Altaic phonetics. 3. The Ural-Altaic possessive suffixes of nouns and verbs are wholly absent in Yukaghir verbs, and present in nouns only for the purpose of expressing ownership of the third person. 4. Words are formed by means of suffixes and prefixes, while the Ural-Altaic languages use suffixes only.

The chief points of similarity between the Yukaghir language and Indian languages are: 1. The existence of a simple harmonic law in the use of vowels. 2. The use of prefixes. 3. Adjectives are morphologically identical with verbal forms. 4. The verb-bases are mostly stems, consisting of a single vowel or a small group of consonants, while the noun bases are almost always derivatives of verbal-forms. 5. The conjugation of transitive verbs is clearly distinguished from that of intransitive verbs. 6. Transitive verbs may be changed into intransitive verbs by means of suffixes, and vice versa. 7. We find in the Yukaghir language the polysynthesis of the American languages. 8. Although there is not the actual incorporation of the American languages, the syntactical construction of the Yukaghir sentence is akin to it.

JAMES E. LOUGH,  
*Secretary.*



## BUSINESS MEETING.

MAY 2, 1904.

The Academy met at 8:15 P. M., Vice-President Poor presiding.

The minutes of the preceding business meeting were read and approved.

The following candidate for election as an Active Member, recommended by the Council, was duly elected :

William L. Osgood Field.

The following Active Members recommended for election as Fellows, were duly elected :

Professor Thomas Hunt Morgan.

Professor Charles B. Davenport.

The Secretary reported from the Council as follows :

That the Council had voted to return to the former method of publishing, three or more parts to be issued annually.

That a special committee appointed to consider the best method of combining the libraries of the Academy and of the American Museum, has reported as follows :

" 1. That the Library Committee be authorized, in coöperation with the American Museum of Natural History, to set aside and dispose of such volumes in the library of the Academy as may not in their judgment be needed for the proper utilization of the two libraries ; provided, that the proceeds derived from the sale of such volumes be devoted to the purchase of additional books and that books so purchased shall be a part of the Academy library.

" 2. That the Library Committee be authorized in coöperation with the American Museum of Natural History to revise the exchange list of the Academy in such a way as to avoid such duplication of exchanges by the two institutions as may in their judgment seem undesirable."

It was voted that the recommendations of the Council be approved.

The Academy then adjourned.

HENRY E. CRAMPTON,  
*Recording Secretary.*

SECTION OF ASTRONOMY, PHYSICS AND  
CHEMISTRY.

MAY 2, 1904.

Section met at 8.25 P. M., Vice-President Poor presiding. The minutes of the last meeting of Section were read and approved.

The following program was then offered:

**R. S. Woodward**, THE THEORY OF A DOUBLE SUSPENSION PENDULUM.

**C. C. Trowbridge**, MEASUREMENTS OF THE PRIMARY FEATHERS OF RECENTLY KILLED HAWKS, AND THEIR BEARINGS UPON THE PROBLEM OF BIRD FLIGHT.

**George B. Pegram**, THE GENERATION OF ELECTRICAL CHARGES BY RADIUM.

**P. H. Dudley**, BENDING MOMENTS IN RAILS, FOR THE SAME SUPERSTRUCTURE, UNDER DIFFERENT TYPES OF LOCOMOTIVES.

## SUMMARY OF PAPERS.

Professor **Woodward** described a double suspension pendulum apparatus for determining the acceleration of gravity and gave a brief outline of the theory of the apparatus. The latter consists of two rectangular bars of brass, about twenty kilograms mass each, connected by two steel tapes of equal length in such a way that when one bar is held rigidly horizontal, the other bar will be suspended horizontally by the equal and parallel tapes. It was shown that when the suspended bar vibrates longitudinally through small amplitudes its motion is very nearly the same as that of a simple pendulum whose length is equal to that of the tapes. It was shown also how small corrections due to the mass of the tapes and to their rigidity may be applied in order to get from the actual apparatus results in conformity with those of a simple pendulum.

Dr. **Trowbridge** stated that during the spring he had succeeded in obtaining a series of measurements of the primary feathers of the hawk's wings, immediately after the death of the birds, and secured additional proof of his theory that certain

birds of prey habitually interlock their primary feathers in flight.

It was found that when hawks are examined immediately after they have been killed, there usually appear deep depressions in the edge of the posterior webs of the emarginate primary feathers, where the feathers have been in contact, which are caused by the interlocking of the primaries.

The measurements consisted in determining the width of these depressions at short intervals of time immediately after the death of the hawks. It was found that the depressions gradually disappeared, both in cases where the feathers were found locked and were then unlocked, and in cases where the feathers were found unlocked. Data were thus obtained from which well-defined curves were constructed, showing the recovery of the web of the feathers after the pressure caused by the interlocking feathers was relieved. A number of life-size photographs were taken of the primary feathers immediately after the hawks were killed and the photographs of the depressions in the feathers when measured by a Repsold measuring machine, gave curves which agreed very well with those obtained by direct measurement. Similar curves were obtained by artificially interlocking the primaries for several hours and then measuring the recovery of the web of the feathers with a micrometer microscope. It was found that artificial locking of the feathers for ten minutes produced very slight or no depressions and locking them for several hours produced depressions only about one half as deep as those found when the hawks were killed. In the latter case they were from 2 to 3.5 millimeters deep, and required from one to five hours to be reduced to twenty per cent. of the original depth, the rate of change of the depth of depression being most rapid at first.

It was concluded from the measurements and photographs that the primary feathers found with the depressions in the web had been interlocked several hours or more, previous to the death of the hawks, which were killed while sailing in a strong wind, and that the theory of interlocking of the primaries of the wing in flight had been conclusively confirmed.

Dr. **Pegram's** paper related to the generation of electrical charges by radium, with special reference to the suggestion of Soddy that when the  $\alpha$  particles, carrying their positive charge, are expelled from the radium, there is no corresponding negative charge left behind in the mass. A few milligrams of radium bromide were enclosed in a thick lead capsule, which was supported on a quartz rod in an exhausted vessel. Gold leaves attached to this capsule gave no indication of a charge, showing either that there was the usual generation of equal amounts of positive and negative electricity when the  $\alpha$  particles are thrown off, if, as has been supposed, the number of  $\alpha$  particles is much greater than the number of negatively charged particles, or else that the number of  $\beta$  particles is about equal to the number of  $\alpha$  particles. It remains to try a similar experiment with radium bromide which has been recently in solution, and, therefore, sends off few of the  $\beta$  particles.

Dr. **Dudley** referred to his previous communications to the Academy, describing the stremmatograph tests, which afforded tabulations of the recorded unit fiber stresses in the base of rails, and their distribution under moving locomotives and cars.

The determination from the unit fiber strains, of the negative and positive bending moments of the rails, due to the passing wheel effects, indicates that for a definite construction of the superstructure of the permanent way, they are independent, partially, of the total load of the locomotive or car, but dependent upon the type of each, in construction of wheel base and wheel spacing, in loading the foundation.

In a series of stremmatograph tests, on the New York Central and Hudson River Railroad, near mile post No. 10, December 23 and 30, 1899, locomotive No. 870, an eight-wheel type of engine, weight, 220,000 pounds, drawing the "Empire State Express" of four cars, weight, 430,000 pounds, at speeds of 42 and 44 miles per hour, the average positive bending moments for the engine were 12.40 inch-pounds per pound of static load, for one rail, constrained by a negative bending moment of 1.88 inch-pounds.

The average positive bending moments for the entire loco-

motive were 11.48 inch-pounds, per pound of static load, constrained by a negative bending moment of 1.71 inch-pounds.

On December 30 locomotive No. 2032, a ten-wheel type of engine, with closer wheel spacing, weighing 283,900 pounds, drawing the "Southwestern Limited" of ten cars weighing 910,000 pounds, at a speed of 40 miles per hour, at the same place as the preceding tests, the positive bending moment for the engine was 10.80 inch-pounds per pound of static load, for one rail, constrained by a negative bending moment of 2.18 inch-pounds — a more favorable result than for the eight-wheel type.

For the entire locomotive, the positive bending moment — for normal tender wheels — was 9.82 inch-pounds, for one rail, constrained by a negative bending moment of 1.90 inch-pounds, indicating a more favorable loading of the foundation. The bending moments of different types of locomotives on the same superstructure are a measure of the relative efficiency of the distribution of their loads to the foundation; while with the same type of engine the relative efficiency of the construction of the superstructure of the permanent way can be measured. These are first bending moments measured in rails under moving locomotives and cars.

**Dr. H. G. Piffard** exhibited an electrometer specially designed for use in measuring radioactivity, and showed the action of the instrument by lantern projection.

C. C. TROWBRIDGE,  
*Secretary.*

#### SECTION OF BIOLOGY.

MAY 9, 1904.

Section met at 8:15 P. M., Vice-President Underwood presiding. The minutes of the last meeting of Section were read and approved.

The following program was then offered:

**E. W. Berry**, THE CYCADOPHYTES AND THE ORIGIN OF THE SEED PLANTS.

**D. T. MacDougal**, MORPHOGENIC CHANGES CAUSED BY THE TRANSPOSITION OF AQUATIC AND TERRESTRIAL PLANTS.

After the stated papers were presented Professor Dean exhib-

ited and read an interesting letter signed by Lamarck in 1796, at the Museum of Natural History in Paris. Professor Lloyd described a species of violet with a tendency to form three spurs of equal radial symmetry. Dr. MacDougal described the primrose plants, illustrating the mutation theory of de Vries, which are now growing at the New York Botanical Garden.

MAURICE A. BIGELOW,  
*Secretary.*

#### SECTION OF GEOLOGY AND MINERALOGY.

MAY 16, 1904.

Section met at 8:15 P. M., Professor James F. Kemp presiding. The minutes of the last meeting of the Section were read and approved.

On motion, duly seconded, it was voted that the Academy apply for registration in the Eighth International Geographic Congress to be held in Washington, New York, etc., in September, 1904, and that the Chairman appoint the allowed number of delegates, himself to be one of the number. The Chairman appointed Professor J. J. Stevenson and Dr. E. O. Hovey to serve with him as delegates, three appearing to be the number allowed to the membership of the Academy.

In the absence of Mr. J. W. Gidley, who was to have read a paper entitled "Some Observations on the So-called Tertiary Lake Basins of Western North America," the program of the evening was necessarily changed from that which had been given in the printed announcement.

The following program was offered:

**W. D. Mathew**, EXHIBITION OF A SERIES OF FOOT-BONES ILLUSTRATING THE EVOLUTION OF THE CAMEL, RECENTLY INSTALLED IN THE HALL OF VERTEBRATE PALEONTOLOGY OF THE AMERICAN MUSEUM OF NATURAL HISTORY.

**E. O. Hovey**, SOME EROSION PHENOMENA IN ST. VINCENT AND MARTINIQUE.

**J. Howard Wilson**, SOME OF THE LOCALITIES IN FRANCE AND ENGLAND WHERE MONUMENTS OF THE LATE STONE AND BRONZE AGES HAVE BEEN FOUND.

## SUMMARY OF PAPERS.

Dr. **Mathew** described a series corresponding to that illustrating the evolution of the horse, and which is almost equally complete.

It shows the derivation of the camel from small primitive four-toed ancestors which were exclusively North American in habitat. The earliest known ancestors are tiny animals no larger than a rabbit. The camels reached their maximum size and abundance in the Pliocene epoch, when they were much larger than the modern camels. Then they spread to the other continents, disappeared entirely from North America and became smaller in size and far less numerous in species elsewhere.

Dr. **Hovey** showed lantern slides from some of the photographs taken by him in St. Vincent and Martinique in 1902 and 1903, for the American Museum of Natural History, which illustrated the development of the new drainage systems and the reinstatement of old channels in regions which were most thickly covered by the 1902 and 1903 eruptions of the Soufrière and Mont Pelé.

In considering the subject of stone monuments, Mr. **Wilson** confined himself to those found in Northern France and Southern England, and especially to the great groups near Carnac in Morbihau, and the well-known temples of Stonehenge and Avebury, in Wiltshire.

The monuments were divided according to type into several classes, and a description of each of these given briefly with their comparative ages and the probable purposes for which they were constructed. Legends concerning these monuments were cited, and mention was made of the superstition and veneration with which they have been regarded by some of the more conservative peasants, causing the worship of stone to be kept up to the present day in some remote districts.

Before closing the paper, attention was called to the engineering skill required in placing and erecting some of the monuments and the early age at which it made its appearance. The paper was followed by slides showing photographic views of

some of the most famous monuments, with maps and with drawings of several of the curiously engraved stones.

EDMUND OTIS HOVEY,  
*Secretary.*

#### BUSINESS MEETING.

OCTOBER 3, 1904.

The Academy met at 8:15, Vice-President Poor presiding.

The minutes of the preceding business meeting were read and approved.

There being no business to come before the meeting, the Academy adjourned.

HENRY E. CRAMPTON,  
*Recording Secretary.*

#### SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

OCTOBER 3, 1904.

Section met at 8:25 P. M., Vice-President Poor presiding.

The minutes of the last meeting of Section were read and approved.

The following program was then offered :

Reports of summer work were presented by several members of the Section, after which an informal address was given by Dr. C. D. Perrine of the Lick Observatory, on "Recent Progress made in the Study of Nebulæ by Photographic Methods."

CHARLES C. TROWBRIDGE,  
*Secretary.*

#### SECTION OF BIOLOGY.

OCTOBER 10, 1904.

Section met at 8:15 P. M., Professor F. B. Sumner presiding.

The minutes of the last meeting of Section were read and approved.

The meeting was devoted to reports on summer work by members. Professor E. B. Wilson worked at the Naples, Sorbonne and Roscoff laboratories, continuing his studies of ger-



minal localization in mollusks. Professor Bashford Dean attended the zoological congress at Berne and the British Association meeting in Cambridge, and later visited places of scientific interest in France. Professor Bristol worked at the Bermuda Biological Station, of which he was one of the directors. Mr. Yatsu worked at the Tufts College laboratory in Maine. Mr. Kellicott worked at the Cedar Point laboratory, in Ohio, completing his studies of the development of the vascular system of *Ceratodus*. Dr. Dublin continued his studies of germ cells at the Cold Springs Harbor laboratory. Dr. Townsend superintended the remodeling of the water-supply apparatus at the New York Aquarium. Mr. Bigelow conducted special courses for teachers in the summer-school of Columbia University. Professor Sumner directed the laboratories and the biological surveys of the Bureau of Fisheries at Woods Hole.

M. A. BIGELOW,  
*Secretary.*

#### SECTION OF GEOLOGY AND MINERALOGY.

OCTOBER 17, 1904.

Section met at 8:15 P. M., Professor James F. Kemp presiding.

The minutes of the last meeting of the Section were read and approved. The following program was then offered:

The special business of the evening was the nomination by the Section of officers to serve for the calendar year 1905. The following officers were unanimously nominated by the Section:

For Chairman and Vice-President of the Academy, E. O. Hovey, of the American Museum of Natural History.

For Secretary, A. W. Grabau, of Columbia University.

The program of the evening was then taken up. It was as follows:

**E. O. Hovey**, ST. VINCENT, BRITISH WEST INDIES. THE ERUPTIONS OF 1902 AND THEIR IMMEDIATE RESULTS.

## SUMMARY OF PAPERS.

Dr. Hovey gave a summary account of the results obtained on two expeditions undertaken by him for the American Museum of Natural History in 1902 and 1903, for the study of the volcanic eruptions of the Soufrière, which began in May, 1902. Particular attention was devoted to the heavy coating of volcanic ash deposited upon the northern portion of the island of St. Vincent and the ash-filling of the gorges of the Wallibou and Rabaka Dry Rivers, the devastation wrought in the forests and on the plantations within a radius of about five miles from the crater, the phenomena of primary eruptions observed in the crater and of secondary eruptions observed in the Wallibou and Rabaka ash-beds. The nature of the exploding eruption cloud was discussed, and it was shown how the heavily dust-laden steam cloud kept close to the surface of the ground under the influence of gravity, while its initial velocity was furnished by the horizontal component of the explosion.

About eighty lantern slides were used in illustrating the speaker's remarks.

E. O. HOVEY,  
*Secretary.*

## SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

OCTOBER 24, 1904.

The Section met, in conjunction with the New York Branch of the American Psychological Association, at 4:30 P. M., and at 8:15 P. M. Vice-President Woodbridge presided.

The following program was offered:

**R. S. Woodworth**, THE CORRELATION BETWEEN MOTOR STRENGTH, QUICKNESS AND ACCURACY.

**Robert MacDougall**, ORGANIC LEVELS IN THE DEVELOPMENT OF THE NERVOUS SYSTEM.

**Irving King**, SOME PROBLEMS OF THE FRINGE OF CONSCIOUSNESS.

**E. L. Thorndike**, A COMPARISON OF THE MENTAL AND PHYSICAL RESEMBLANCES OF TWINS.

**F. J. E. Woodbridge**, NOTE ON THE NATURE OF CONSCIOUSNESS.

Proceeding to the election of officers for the coming year, the following were elected :

Chairman — Professor F. J. E. Woodbridge.

Secretary — Dr. R. S. Woodworth.

R. S. WOODWORTH,  
*Secretary, pro tem.*

### BUSINESS MEETING.

NOVEMBER 7, 1904.

The Academy met in Fayerweather Hall, Columbia University, at 8:30 P. M., Vice-President Poor presiding.

The minutes of the preceding business meeting were read and approved.

The following candidates, approved by the Council were duly elected as Active Members :

Fred. A. Lucas,

C. William Beebe.

There being no further business to come before the meeting, the Academy adjourned.

C. C. TROWBRIDGE,  
*Secretary, pro tem.*

### SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

NOVEMBER 7, 1904.

Section met at 8:25 P. M., Vice-President Poor presiding. The minutes of the last meeting of Section were read and approved. The names of candidates for active membership were read and referred to the Council according to the By-Laws.

The following program was then offered :

**F. L. Tufts**, THE RELATION OF KATHODE RESISTANCE TO THE SO-CALLED SATURATION CURRENT IN THE DISCHARGE THROUGH GASES.

**C. C. Trowbridge**, THE DURATION OF THE AFTERGLOW  
ACCOMPANYING THE ELECTRODELESS DISCHARGE AT LOW  
PRESSURE.

The regular annual election of officers of the section was then held, which resulted as follows :

Chairman — Ernest von Nardroff.

Secretary — C. C. Trowbridge.

SUMMARY OF PAPERS.

Mr. **Tufts** pointed out that the so-called saturation currents, obtained by Wilson and other investigators of the phenomena of electrical conduction through flame gases, were not true saturation currents, but only apparently so, owing to the development at the kathode of a high resistance, when the impressed electromotive forces were over a few volts. By the use of a kathode coated with calcium oxide and heated by a separate flame, it was shown that the resistance of a flame connecting this with the flame remained practically constant. In other words, the current through the connecting flame increased directly as the potential gradient for gradients ranging from a few tenths of a volt to the centimeter up to gradients of as much as fifty volts to the centimeter. It was stated that experiments had been tried with the ordinary luminous gas flame as well as with flames rendered nonluminous by the admixture of air, and the relation between current and potential gradient was found to be the same for both kinds of flames. It was stated that experiments were in progress in which higher gradients than fifty volts to the centimeter were to be used.

Dr. **Trowbridge** stated that the purpose of the investigation was to determine the nature of the glow that often appears after the cessation of the electrodeless discharge in gases at low pressures. Measurements made thus far on the duration of the glow in air, show a sharp maximum of duration between .1 and .05 millimeter pressures and that this maximum point varies with the electrical conditions of the experiment. It was also determined that there is a critical point between .7 to .3 millimeter pressures where the glow is only occasionally formed,

after which, as the pressure is further reduced the duration of the glow increases rapidly to the maximum. The electrodeless discharge was also made to take place at liquid air temperature, and it was found that the afterglow accompanying the discharge, while still fairly strong, was diminished considerably in duration and intensity at the low temperature of about  $-186^{\circ}\text{C}$ .

The meeting then adjourned.

C. C. TROWBRIDGE,  
*Secretary.*

## SECTION OF BIOLOGY.

NOVEMBER 14, 1904.

Section met at 8:15, Professor Underwood presiding.

The minutes of the last meeting were read and approved.

The following program was then offered:

**W. E. Kellicott**, DEVELOPMENT OF THE VENOUS SYSTEM OF CERATODUS.

**M. A. Bigelow**, SOME PRESSURE-EXPERIMENTS ON THE EGGS OF THE CRUSTACEAN HIPPOLYTE.

## SUMMARY OF PAPERS.

**F. E. Lloyd**, BOTANICAL RESEARCH AT THE DESERT LABORATORY IN ARIZONA.

Dr. **Kellicott's** paper, on the "Development of the Venous System of *Ceratodus*," pointed out many similarities to the amphibian. These similarities are so numerous and exact, that it seems impossible to believe that the Dipnoi and Amphibia have not arisen as a common stock which has separated later into these groups. The adult relations and the mode of development of the vena cava of *Ceratodus* indicate that this vessel is not to be looked upon as one of the hepatic veins which has made a new connection with the posterior cardinal vein, but that its anterior portion develops as a short cut by way of which the blood from the mesonephros may be carried to

the heart after the atrophy of the pronephros and the associated veins.

Mr. **Bigelow** briefly described some observations on eggs of the crustacean *Hippolyte* subjected to slight pressure during cleavage. While the normal cleavage is total, pressure prohibited the formation of cell-boundaries, and unsegmented eggs with 2, 4, 8, 16 and 32 nuclei were obtained. When the pressure was removed the cell-boundaries soon appeared. The cleavage of this egg under pressure exhibits some striking resemblances to the normal superficial cleavage of eggs of allies.

Professor **Lloyd** described the conditions for botanical research at the Desert Botanical Laboratory in Arizona. Many photographs were exhibited to illustrate descriptions of the peculiar flora in the vicinity of the laboratory and of the method of conducting experiments, especially those concerned with the relation of desert plants to water.

Dr. W. M. Wheeler, of the American Museum of Natural History, was elected chairman, and M. A. Bigelow, of Teachers College, Columbia University, secretary of the section for the year 1905.

M. A. BIGELOW,  
*Secretary.*

#### SECTION OF GEOLOGY AND MINERALOGY.

NOVEMBER 21, 1904.

Section met at 8:15 P. M., Professor James F. Kemp presiding.

The minutes of the last meeting of Section were read and approved.

The following program was then offered:

#### SUMMARY OF PAPERS.

**John J. Stevenson**, THE ISLAND OF SPITZBERGEN AND ITS COAL.

**James F. Kemp**, THE TITANIFEROUS MAGNETITE IN WYOMING.

In introducing his subject Professor **Stevenson**, described briefly the coast of northern Norway and its geology and referred in some detail to Bergen, Hammerfest and other cities. Spitzbergen was then taken up and its coals and their geological relations were passed in review. The coal beds are of Jurassic age and the coal is peculiar in that it partakes of the characters of the lignites as well as of the true coals.

The second paper on the program, by Professor **Kemp**, was presented only in abstract. The magnetite occurs in two places, fifteen and twenty miles north of Laramie, Wyoming, the former and smaller occurrence being near the Shanton ranch, the latter and larger being on Chugwater Creek. Both are in wall rock of anorthosite which is practically indistinguishable from anorthosite occurring in the Adirondacks. The ores range from 20 per cent. to 40 per cent.  $\text{TiO}_3$ . Thin sections show that they contain green spinels, and one slide presents much olivine. They can be most reasonably explained as intrusive dikes. In this view the speaker agreed with Waldemar Lindgren who has published a brief note regarding them.

The Section then adjourned.

JAMES F. KEMP,  
*Secretary, pro tem.*

#### SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

NOVEMBER 28, 1904.

Section met at 8:15 P. M., F. J. E. Woodbridge presiding.

The minutes of the last meeting of Section were read and approved.

The following program was then offered :

**A. M. Tozzer**, SURVIVALS OF ANCIENT RITES AMONG THE LACANDONE AND MAYA.

**Clark Wissler**, CEREMONIAL LIFE OF THE BLACKFOOT.

#### SUMMARY OF PAPERS.

Mr. **Tozzer** held that the unity of origin of the Lacandones of Chiapas and the early inhabitants of Yucatan seems established by the fact of the many relevant survivals of rites and

customs connected with the older culture as described by the early inhabitants and missionaries, as, for example, the cosmical conceptions, the use of incense-burners identical with some found in the ruins of Yucatan, the piercing of the ear with a stone knife, and the worship of jade and other idols of stone, long identical with Magle culture. That the Lacandones are the descendants of a lower stratum in the social organization of the Magas, the "gens rustica," seems evident from the lack of anything approaching skill either from an architectural or an artistic standpoint, the probable absence of a priestly class and along with this a seemingly complete ignorance of the ancient system of writing used among the Magas.

Dr. **Wissler** discussed the general results of research in the religious life and practices of American Plains Indians, showing that the idea that supernatural power was received by the individual in a vision, dream or inspiration, led to the conception of an individual right to the use of such power, and that even in religious rites recognized as tribal, the formal ownership was vested in a single individual, and that the power of such rites in the affairs of men could work through his consent alone. It further appears that the right of the owner to transfer the religious rite was recognized and that this had a commercial aspect. This reached such a complex stage of development that it practically determined the whole economic organization of the people. On the subjective side, it appears that the real power sought and operated through the songs making up the ritualistic rites and that material objects and dance evolutions were regarded as secondary. The songs were regarded as prayers that the supernatural giver would always heed.

R. S. WOODWORTH,  
*Secretary, pro tem.*



## SECTION OF GEOLOGY AND MINERALOGY.

DECEMBER 2, 1904.

Section met at 8:25 P. M., Vice-President Kemp presiding. The minutes of the last meeting of the Section were read and approved.

The Section held a special meeting, at which 200 members and visitors were in attendance. The meeting was called to order at 8:25 P. M., and the programme of the evening was at once taken up. This consisted of a lecture by Professor Albrecht Penck, of the Imperial University at Vienna, who is an Honorary Member of the Academy.

The speaker discussed "The Glacial Surface Features of the Alps," and gave a brief summary of some of the results of the twenty years of masterly work which has been done by him and under his direction in the Tyrol. Professor Penck discussed in popular language the nature of the valleys of the Alps and showed by means of lantern slides and a diagram how the glaciers have widened and deepened portions of their rocky basins and produced lakes.

After a vote of thanks to the distinguished guest of the evening, the Section adjourned.

EDMUND O. HOVEY,  
*Secretary.*

## BUSINESS MEETING.

DECEMBER 5, 1904.

The Academy met at 8:30 P. M., Professor William Hallock presiding.

The minutes of the previous business meeting were read and approved.

The Secretary reported from the Council as follows:

That it was proposed to amend Chapter V, Section 1, of the By-Laws, by omitting the words "Every Active Member shall pay an initiation fee of \$5, within three months of his election or such election shall be void."

That the Council, as required by the By-Laws, had prepared the following nominations for officers for the coming year:

President — James F. Kemp.

Vice-Presidents — Edmund O. Hovey, Ernest R. von Nardoff, F. J. E. Woodbridge, William M. Wheeler.

Corresponding Secretary — Richard E. Dodge.

Recording Secretary — Henry E. Crampton.

Treasurer — Charles F. Cox.

Librarian — Ralph W. Tower.

Editor — Charles L. Poor.

Councilors — Emerson McMillin and F. H. Wiggin.

The following candidates for election as Honorary Members had been approved by the Council:

Hugo de Vries.

G. Johnstone-Stoney.

W. C. Brogger.

Karl von der Steinen.

Ferdinand Zirkel.

That the Annual Meeting would consist of a formal session for the presentation of the reports of officers and election of officers for 1905, and that this would be followed by a subscription dinner, at which the address of the President would be delivered. Due notice would be given the members regarding time and place of this meeting.

The Academy then adjourned.

HENRY E. CRAMPTON,  
*Recording Secretary.*

#### SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

DECEMBER 5, 1904.

Section met at 8:30 P. M., Professor William Hallock presiding.

The minutes of the last meeting of Section were read and approved.

The following program was then offered:

**C. W. Kanolt**, THE COMBINATION OF IONS WITH THE SOLVENT IN SOLUTIONS.

**Bergen Davis** and **C. W. Edwards**, CHEMICAL COMBINATION OF KNALL-GAS UNDER THE ACTION OF RADIUM.

## SUMMARY OF PAPERS.

The object of Dr. **Kanolt's** investigation was to determine whether or not the ions of a salt in solution are combined with the solvent. The method used was the electrolysis of a salt dissolved in a mixture of two solvents, with the subsequent analysis of the portions of the solution around the two electrodes. If the ions are combined with either of the solvents, this solvent will be carried from one electrode to the other, and changes in the proportions of the two solvents are to be expected. Positive results were obtained with silver nitrate dissolved in a mixture of pyridine and water, indicating that pyridine was combined with silver ions. With the same salt in a mixture of alcohol and water, only negative results have so far been obtained. Other salts are being investigated.

The experiments of Professors **Davis** and **Edwards** relate to the chemical combination of hydrogen and oxygen under the action of radium rays. The gases were enclosed in a vessel in such a way that a small change of pressure could be observed. About four milligrams of radium bromide were dissolved in alcohol and deposited on the surface of a small sheet of platinum which was placed in the vessel.

By means of electrodes the amount of ionization produced in the gas by the radium was measured. While the rate of formation of water was quite slow; yet the number of molecules of water formed for each physical ion produced, was very large. The experiments are being continued by Professor Edwards.

C. C. TROWBRIDGE,

*Secretary.*

## SECTION OF BIOLOGY.

DECEMBER 12, 1904.

Section met at 8:15 P. M., Vice-President Underwood presiding.

The minutes of the last meeting of Section were read and approved.

The following program was then offered:

**Henry F. Osborn**, RECENT DISCOVERIES OF EXTINCT ANI-

MALS IN THE ROCKY MOUNTAINS AND THEIR BEARINGS ON THE PRESENT PROBLEMS OF EVOLUTION.

**F. B. Sumner**, EXPERIMENTAL STUDIES OF ADAPTATION AND SELECTIVE ELIMINATION IN FISHES.

#### SUMMARY OF PAPERS.

Professor **Osborn** exhibited the newly prepared skulls of *Diplodocus*, *Morosaurus* and *Cresosaurus* from the Bone Cabin Quarry, Wyoming. The skull of *Morosaurus* is new to science, and is of a short-skulled type with a very prominent and convex forehead. Like *Diplodocus* it exhibits a large pineal foramen.

Under the title "Recent Discoveries of Extinct Animals in the Rocky Mountain Region and their Bearings on the Present Problems of Evolution," Professor Osborn exhibited a series of skulls of the Eocene ancestors of the Oligocene Titanotheres, stating as a result of recent investigation that the Oligocene Titanotheres were found to represent four distinct lines of descent, in each of which horns independently developed, and that the Eocene Titanotheres also represented four distinct lines of descent, two of which became extinct, namely, the extremely short-skulled *Palæosyops*, and the extremely long-skulled *Dolichorhinus*, while the intermediate forms *Telmatotherium* and *Mantoceras* gave rise to the Oligocene forms *Titanotherium* and *Megacerops* respectively. As bearing upon the general problem of evolution, it was pointed out that the palæontologist enjoys the peculiar advantage of following a series through the origin and development of organs to their subsequent progression or decline. As early as 1888 the speaker had taken the ground that various palæontological series demonstrate the *definite or determinate variations* of certain kinds. In 1892 he connected with this the idea that certain series of animals related by descent from a common stem form exhibit the *potential of similar evolution*, describing this as a law of latent or potential homology. It is now found in this series of Titanotheres that there is more than a potential of similar evolution; there is evidence of a *pre-disposition to similar evolution* as shown in the wholly independent development in two distinct series of horns from hornless types

at exactly similar points on the skull, namely, at the lateral junction of the frontals with the nasals.

The communication had been in part presented before the Brooklyn Institute of Arts and Sciences, and before the Zoölogical Congress at Berne.

Dr. **Sumner** described his experiments that were undertaken in order (1) to determine the relative sensitiveness to asphyxiation of the three commoner species of *Fundulus*; (2) to determine the relative ability of these and some other fishes to survive transfer to fresh water; (3) to determine the minimum salinity which certain salt-water fishes could withstand; (4) to determine the effect upon these fishes of gradual and of abrupt changes in the density of the water.

The results of extended biometric studies were set forth, from which (1) it was shown that when a given species was subjected to destructive conditions, and the mean characters of the more and the less resisting individuals were compared, differences were evident both in respect to type and to variability; (2) that when different methods of elimination were employed with the same species, selection had reference to different characters; (3) in the only case in which this question was tested, that the selective elimination of two closely related species, under the same conditions, appeared to have reference to the same characters; (4) that specimens of *F. heteroclitus* inhabiting brackish water of low salinity differed in all of the measured characters from those living in pure salt water. (5) It was shown, nevertheless, by comparison with the more and the less fit individuals of those experiments where fresh water was employed as the eliminative agent, that the fishes inhabiting brackish water could not have owed their modification to the natural selection of those individuals better adapted to a life in water of a lower density. (6) It was shown by comparing the mean characters of the three species of *Fundulus* and by taking into account their relative fitness to withstand certain conditions, that these differences of type could not have been due to natural selection acting with reference to these particular conditions.

Dr. Hornaday, director of the New York Zoölogical Park, and

Dr. Townsend, director of the New York Aquarium, called attention to some of the animals recently added to the collections in their charge.

MAURICE A. BIGELOW,  
*Secretary.*

### ANNUAL MEETING.

DECEMBER 19, 1904.

The annual meeting of the New York Academy of Sciences was held on December-19, at the Hotel Endicott, at 7:30 P. M. Professor Edmund B. Wilson presided. A formal session was first held, for the transaction of the regular business of the Academy, and this was followed by a dinner at which sixty-six members and their friends were present.

The appended reports of the Corresponding Secretary, Recording Secretary, Treasurer, Librarian and Editor were presented, and by vote placed on file. The report of the Treasurer was formally referred to the Finance Committee for audit.

The Academy then proceeded to elect officers for the year 1905, tellers being appointed, official ballots prepared by the Council according to the provisions of the by-laws, being distributed, and the votes counted. The following officers were declared elected:

President — James F. Kemp.

Vice-Presidents: Section of Geology and Mineralogy, Edmund O. Hovey.

Section of Astronomy, Physics and Chemistry, Ernest R. von Nardroff.

Section of Biology, W. M. Wheeler.

Section of Anthropology and Psychology, F. J. E. Woodbridge.

Corresponding Secretary — Richard E. Dodge.

Recording Secretary — Hermon C. Bumpus.

Treasurer — Charles F. Cox.

Librarian — Ralph W. Tower.

Editor — Chas. Lane Poor.

Councilors (to serve three years)—Emerson McMillin, F. H. Wiggin.

Finance Committee—John H. Hinton, C. A. Post, Henry F. Osborn.

Proceeding to the election of Honorary Members, the following eminent men of science were formally presented, each by a Fellow of the Academy engaged in scientific work of the same nature as that of the nominee, and were duly elected:

Hugo de Vries, presented by N. L. Britton.

G. Johnstone-Stoney, presented by R. E. Dodge.

W. C. Brögger, presented by J. F. Kemp.

Karl von der Steinen, presented by Franz Boas.

Ferdinand Zirkel, presented by J. J. Stevenson.

Dr. Frederick A. Lucas was elected a Fellow of the Academy, being presented by the Recording Secretary.

Professor Cattell then proposed the health of Professor R. S. Woodward, a past-president of the Academy, recently elected to the presidency of the Carnegie Institution.

The President, Professor Edmund B. Wilson, then delivered his address upon "The Problem of Development," at the close of which a vote of thanks, proposed by Professor H. F. Osborn, and seconded by Professor J. J. Stevenson, was tendered to him.

The Academy then adjourned.

HENRY E. CRAMPTON,  
*Recording Secretary.*

## REPORT OF THE CORRESPONDING SECRETARY.

DECEMBER 19, 1904.

The Corresponding Secretary makes the following report as to the status of the Honorary and Corresponding Members.

A little over a year ago letters were sent to all the Honorary and Corresponding Members on the lists of the Academy. As a result from the returns of these letters the lists have been greatly improved in accuracy and completeness.

At present there are forty-five honorary members. One honorary member, Professor Von Zittel, has died since the last annual meeting.

The list of Corresponding Members numbers one hundred

and eighty-three, of whom one hundred and forty-four have answered the communication sent a year ago. There are, therefore, thirty-nine who have not been heard from. Another letter of inquiry will be sent out in the spring and a failure on the part of these thirty-nine to answer this second communication will be considered sufficient reason for the dropping of the name, unless the person is known to be alive.

Very respectfully,

RICHARD E. DODGE,  
*Corresponding Secretary.*

#### REPORT OF THE RECORDING SECRETARY.

During the year 1904 the Academy met in business session on eight occasions, and the several sections held thirty meetings, at which seventy-six stated papers and lectures were presented upon the following subjects :

Astronomy	2	papers, 1 lecture.
Physics	11	"
Chemistry	1	"
Botany	5	"
Palæontology	2	"
Zoölogy	10	"
Geology	6	"
Mineralogy	2	"
Physiography	2	" 2 lectures.
Anthropology and Archæology	8	"
Psychology	16	"
Philosophy	6	" 1 lecture.
Biography	1	"

Particular mention must be made of the lecture upon the Physiography of the Alps by Professor Albrecht Penck, an Honorary Member of the Academy.

At present there are 278 Active Members, of whom 132 are Fellows; the election of one Fellow is pending. During the year two members have died, six have resigned, while six have



been dropped on account of non-payment of dues. As five new members have been elected during the same period, there has been a net loss of nine.

In accordance with a recommendation offered by the Library Committee, a more permanent union of the libraries of the Academy and the American Museum of Natural History has been effected, to their mutual advantage. In regard to publications, it may be stated that the former method according to which papers presented before the Academy could be published in journals other than the *Annals* with the financial support of the Academy has been set aside. In the future, under an earlier method of publication, a volume of the *Annals*, to consist of three or four parts, will be issued during a calendar year.

Particular attention is now being given by the Council to the matter of membership, and efforts are to be directed in the near future towards increasing the list of Active Members. As stated above there has been a loss of nine during the year, although the members that resigned exceed the new members by one only. Maintenance, however, is not progressive development unless in the face of adverse conditions. The situation that confronts us is in some respects a difficult one, though not peculiar to the Academy. The special societies, each dealing with some restricted branch of science, will tend more and more in the future as they have in the past to draw away active workers from general bodies such as the Academy. Support for the Academy may therefore be sought with a fairer prospect of success from those upon whom demands are not made by professional duties that their activities shall be centered in the special organizations for scientific work. With such support, publication as one of our two main objects may be furthered. Efforts should none the less be made to draw into the Academy the younger men in active work who must carry forward the activities of scientific nature in the future, thus subserving the second purpose of the Society.

One other subject of general interest must be mentioned. The Council has decided that the routine work connected with the several offices of the Academy shall be performed by a

clerical assistant, with an office at the American Museum of Natural History, who shall be under the general supervision of the Recording Secretary. This arrangement provides for a still further centralization of the activities of the Academy in the Museum, where the Library is already housed, and where the scientific meetings are now being held.

HENRY E. CRAMPTON,  
*Recording Secretary.*

### REPORT OF THE TREASURER.

NEW YORK, DECEMBER 17, 1904.

TO THE NEW YORK ACADEMY OF SCIENCES.

*Gentlemen:* As required by the by-laws, I herewith submit a statement of my receipts and disbursements since my last annual report, and a balance sheet from my ledger, as of this date.

Respectfully yours,

C. F. COX,  
*Treasurer.*

#### RECEIPTS.

Balance as per last Annual Report.....	\$5,364.62	
Bequest of Dr. H. Carrington Bolton for Publication Fund.....	1,000.00	
One year's interest at 4½ per cent. on St. Ann's Ave. Mortgage, \$12,000.....	540.00	
Interest on Deposits in Bank.....	172.67	
Initiation Fees .....	30.00	
Annual Dues, 1901.....	\$30.00	
"    1902 .....	60 00	
"    1903 .....	120.00	
"    1904 .....	1,750.00	
"    1905 .....	10.00	1,970.00
Receipts from Annual Dinner, 1903.....	102.00	
		<u>\$9,179.29</u>

## DISBURSEMENTS.

Invested in Bond and Mortgage at 5 per cent. on 468 East 135th St. ....	\$5,200.00	
For Publications .. . . .	\$949.18	
Less Sales .. . . .	87.94	861.24
Expenses of Recording Secretary .. . . .		286.57
" Corresponding " .. . . .		28.00
" Treasurer .. . . .		65.96
" Librarian .. . . .		191.01
General Expenses .. . . .		79.00
Assessments of Scientific Alliance .. . . .		101.07
Cost of Annual Dinner, 1903 .. . . .	100.20	6,913.05
Balance on hand .. . . .		\$2,266.24
Ordinary Receipts .. . . .	\$2,812.67	
" Expenses .. . . .	1,612.85	
Gain .. . . .	1,199.82	
Cash on hand .. . . .	\$2,266.24	
Invested .. . . .	1,076.07	
Accumulated Income .. . . .	\$3,342.31	

## BALANCE SHEET.

## DR.

## Investments :

St. Ann's Ave. Mortgage, \$12,000 at 4½ per cent. ....	\$12,000.00
135th St. Mortgage, \$5,200 at 5 per cent. ....	5,200.00
Bills Receivable .. . . .	130.00
Cash on Hand .. . . .	2,266.24
	\$19,596.24

## CR.

Permanent Fund .. . . .	\$11,226.68
Publication Fund .. . . .	3,000.00
Audubon Fund .. . . .	1,897.25
Income, Audubon Fund .. . . .	183.49
" Publication Fund .. . . .	218.77
" Permanent Fund .. . . .	1,131.31
General Income .. . . .	1,938.74
	\$19,596.24

NEW YORK, December 17, 1904.

## REPORT OF THE LIBRARIAN.

TO THE NEW YORK ACADEMY OF SCIENCES:

The status of the Library has changed but little during the last year. The new accessions have been 354 volumes and pamphlets and 2,283 numbers. A detailed and accurate account has been kept of all accessions so that a revision of the exchange list can be undertaken in the near future. Of special interest is the gift from Professor Gustav Retzius of an entire set of his publications. The library is catalogued and open to the public on week days from 9:30 A. M. to 5 P. M.

Respectfully submitted,

R. W. TOWER,  
*Librarian.*

## REPORT OF THE EDITOR.

During the year 1904 the Academy printed and issued the following publications:

*Annals.* — Vol. XIV, Part IV, containing a paper by George I. Finlay entitled, "The Geology of the San Jose District, Tamaulipas, Mexico." This was issued in March and consisted of 71 pages, ten plates and one double page map. Vol. XV, Part II, containing the records of the meetings of the New York Academy of Sciences, January 1903 to December 1903, by Henry E. Crampton, Recording Secretary. This was issued in May and consisted of 62 pages. Vol. XV, Part III, containing a paper by Charles Lane Poor entitled, "Researches as to the Identity of the Periodic Comet of 1889-1896-1903 (Brooks) with the Periodic Comet of 1770 (Lexell)." This was issued in December and consisted of 82 pages and two plates.

These papers were mailed to every active member of the Academy. Besides the above named papers the Academy assisted in the publication of a paper by Franz Boaz and a paper by Wm. Jones. These papers appeared in the publications of the American Anthropological Association.

Vol. XVI, Parts I and II, of the *Annals* and Vol. II, Part

III, of the Memoirs are in press and will be issued soon after the beginning of the year.

Respectively submitted,

CHARLES LANE POOR,

*Editor.*

### THE ANNUAL ADDRESS OF THE PRESIDENT.

#### **Edmund B. Wilson, THE PROBLEM OF DEVELOPMENT.<sup>1</sup>**

The selection of such a subject as the problem of development for a general address to this Academy as a whole suggests a word of explanation. Within the privacy of our sectional meetings we are permitted to dig and delve as much as we please among the dry bones of specialization; but on this occasion a righteous tradition imposes upon the president the duty of laying aside his special tools in order to address the whole scientific body over which he has for a time had the honor to preside. In offering a brief general discussion of some latter day problems of embryology and cytology I shall endeavor not to violate the spirit of this tradition. The task is not an easy one, owing to the complexity of the data and their strangeness to those who have not closely followed the details of modern biological work; yet I am encouraged to make the attempt by the belief that the problem of development belongs to those

<sup>1</sup> The critical reader will, I hope, be willing to bear in mind the condition under which this address was delivered. My endeavor was to convey to a scientific body, composed only in part of biologists, some individual impressions of a student of embryology and cytology regarding the general bearings of recent researches in his special field. It was not consistent with this purpose to give a critical résumé for biologists, nor could authorities be cited in detail. The general conception here developed will recall certain views contained in Driesch's "*Analytische Theorie der organischen Entwicklung*," published in 1894 (themselves traceable to earlier conclusions of de Vries), but afterwards rejected by him in favor of an explicit theory of vitalism. The rediscovery of Mendelian inheritance, the newly produced evidence, on the one hand, of morphological and physiological diversity among the chromosomes; on the other, of protoplasmic prelocalization in the egg, have, however, placed the whole problem in a new light. I wish to acknowledge my indebtedness to Professor Whitman's fine essays on the questions that center in Bonnet's doctrines, published in the "*Wood's Hole Biological Lectures*," for 1893, which suggested the quotation from Huxley.

larger scientific questions that are of enduring interest to all students of nature. It is only fair to point out, however, that a consideration of recent advances in this subject necessarily and speedily leads us into a region that lies remote from everyday experience, surrounded by arid wastes of technical detail, and inhabited by folk who speak an uncouth foreign tongue. With the best of intentions, therefore, the native guide and interpreter has need of some forbearance on the part both of his countrymen and of the outlanders whom he attempts to lead.

I need not dwell on the absorbing, almost tantalizing, interest with which the problem of development has held the attention of naturalists from the earliest times. Twenty centuries and more have passed since Aristotle first endeavored to trace something like a rough outline of its solution. The enormous advances of our knowledge during this long period have taken away nothing of the interest or freshness of the problem; they have left it, indeed, hardly less mysterious than when the father of science wrote the first treatise on generation. I will not dwell on the epoch-making work of Harvey, Wolff and von Baer, or the curious, almost grotesque controversies of the eighteenth century, when embryology invaded the field of philosophy and even of theology. I will only point out that even at that time, when embryology was almost wholly limited to the study of the hen's egg, embryologists were already occupied with two fundamental questions, which still remain in their essence without adequate answer, and though metamorphosed by the refinements of more modern observation and experiment still stand in the foreground of scientific discussion. The first of these is the question of preformation *versus* epigenesis — whether the embryo exists preformed or predelineated in the egg from the beginning, or whether it is formed anew, step by step, in each generation. The second question is that of mechanism *versus* vitalism — whether, development is capable of a mechanical or physio-chemical explanation, or whether it involves specific vital factors that are without analogy in the non-living world. It is especially to some modern aspects of these two questions that I invite your attention; and I shall

also consider briefly their relation to recent conclusions affecting our theories of heredity and evolution.

Let us first seek to define more clearly the meaning of our terms. The embryologists of the pre-Darwinian period, unhampered by historical conundrums, fixed their attention on the single objective problem of the nature of the germ and its mode of development. The hen's egg contains something which, though not visibly a bird or even an embryo, will when maintained at a temperature of about  $37^{\circ}$  C. for 21 days, cause a living chick to step forth from the shell. What is that something and what manner of machinery (if machinery it be) is set in motion to work such a marvel? The early embryologists found no real answer to this question. They determined the fact that at the beginning the egg contains nothing even remotely resembling a bird; that as early as the second day a rudely fashioned embryo is visible in the egg: and that day by day, as the incubation proceeds, this embryo becomes more complex. The bird appears to be progressively created out of something that is without form, and void of visible structure. Its development, said Harvey and Wolff, is essentially a process of "epigenesis"—a successive formation and addition of new parts not previously existent as such in the egg. This conclusion, roughly outlined by Aristotle, was apparently established on an irrefragable basis of observation, long afterwards, by Harvey and Wolff. In its superficial aspects the doctrine of epigenesis is no more than a statement of universally admitted fact. When followed to its logical end, however, this conception has failed, and will always continue to fail, to satisfy the mind; and some of the most acute of modern embryologists have expressed the opinion that no thoroughgoing hypothesis of epigenesis can be so framed as to be logical, or even conceivable. Even in the eighteenth century this doctrine was met by the opposing one of preformation and evolution. Advocated by such men as Malpighi, Haller and Leibnitz, this conception underwent its fullest development in the hands of the eminent Swiss naturalist Bonnet. Developed with great logical acuteness and set forth with captivating literary skill, Bonnet's theory was based on the fundamental assump-

tion that the embryo, though invisible, really exists preformed in the egg before development begins. The preformed germ was not conceived to be an exact miniature model of the adult. On the contrary, Bonnet thought of the germ of the fowl, for example, as differing widely in form and proportions from an actual bird, still the original preformation was assumed to be composed of parts that correspond, each for each, to the parts of the chick. Development, accordingly, was conceived to be only the unfolding and transformation of a preëxisting structure, not the successive formation of new parts—a process of “evolution,” not of epigenesis. In this particular form the doctrine of preformation was conclusively overthrown by Wolff; but the principle underlying it has repeatedly and persistently reappeared in later speculations on development, and still contests the field of discussion with its early antagonist.

Hand in hand with this controversy has gone one of still more general scope between the two opposing conceptions that I have referred to as mechanism and vitalism. Is development at bottom a mechanical process? Is the egg a kind of complex machine, wound up like a piece of clockwork, and does development go forward like the action of an automaton, an inevitable consequence of its mode of construction? Or, on the other hand, does development involve the operation of specific vital entelechies or powers that are without analogue in the automaton and are not inherent in any primary material configuration of the egg? This question, I hardly need say, is included in the larger one, whether the vital processes as a whole are or are not capable of mechanical explanation. As a problem of embryology it is very closely connected with that of preformation or epigenesis, and in point of fact the two have always been closely associated. Evidently, by its very form of statement, any theory of preformation or prelocalization in the germ assumes at least a mechanical basis for development, *i. e.*, a primary material configuration upon which the form of development in some measure depends. With theories of epigenesis the case is not so clear; for such theories may or may not be mechanical. Without further preamble I now ask your attention to certain



facts which will place clearly before us the form in which these time-honored problems appear to us to-day.

It is a familiar fact that development begins with the progressive segmentation or division of the egg into cells, which, continually increasing in number, finally build up the body of the embryo. Until comparatively recently it was not suspected that the cells thus formed in the earliest stages had any constant and definite relation to the parts of the future body. The fact has now been established, however, that in a large number of forms (though apparently not in all) such a definite relation exists, both the form of division and the prospective values of the cells being constant. In the egg of the ascidian, for instance, the first cleavage-furrow passes pretty accurately through the future median plane of the body, and the two cells thus formed give rise respectively to the right and left sides of the embryo. In a snail's egg the relation is a different one, but is no less definite and constant; in the four-cell stage, for instance, the material that will produce the shell and foot is located, mainly at least, in one of the four cells. Again, in a worm's egg, after its segmentation into sixteen or more cells, we know very exactly how the materials for the head, the segmented trunk-region, the digestive tract, the muscles and the ganglia, are distributed among these cells. In all such cases the embryo seems comparable to a piece of mosaic-work, each cell apparently having its own inherent particular character, and its own specific rôle to play.

These facts place very conspicuously before us a modern form of the problem of preformation which we may conveniently call the problem of "germinal *prelocalization*." Does this mosaic-like character of the early embryo mean that the cells are inherently different? Are they in any degree individually predestined for their future development; and if such be the case, can this predestination be traced back to protoplasmic regions in the egg before it has divided into cells? In other words, does the egg, or does it not, contain prelocalized, predetermined areas that have any necessary or causal relation to the parts of the future embryo? This is the first guise in which the old

question of preformation presents itself to us to-day. I ask you to glance at the results of a few very simple experiments designed to test this question. They will give apparently quite contradictory results.

Experiments on the eggs of certain animals, such as ctenophores or mollusks, seem to give an unequivocal answer to our questions. If, for example, the cells of the segmenting egg of the mollusk *Dentalium* or *Patella* be separated from one another, at the two-cell stage or any later period, they continue to develop and produce living, actively swimming structures; but these creatures are not completely formed whole embryos, but monsters that in many respects resemble pieces of a single embryo (Fig. 1, A). It is true that the wounds usually close and heal; but these structures, nevertheless, remain monstrous and defective, and if they are carefully studied it is found that only when taken collectively can they be said to constitute a single whole embryo. The cells are thus proved to be in some measure inherently different, and to this extent the cell-mosaic is shown to be a real mosaic. If we now extend our operation to the undivided egg, a result in harmony with this is reached. If certain portions of the egg of *Dentalium* be artificially cut off, the remaining portion, upon fertilization, regularly gives rise to a defective and monstrous creature that is not a whole embryo, but resembles a piece or fragment of an embryo. It is evident that this experiment seems to show pretty clearly that even before the egg has begun to divide into cells the parts of the future embryo are in some measure definitely prelocalized and predetermined in its different protoplasmic regions; and evidently, if this be the case, we seem further to have good ground for the mechanistic assumption that the undivided egg contains some kind of structural or material configuration upon which the character of the development depends.

But let us not on this account too hastily accept a theory of preformation or prelocalization. Let us first look at the results of an exactly similar experiment performed on the egg of certain other species of animals, for example, *Amphioxus*, a sea urchin, or a nemertine worm. Separate here the first two or

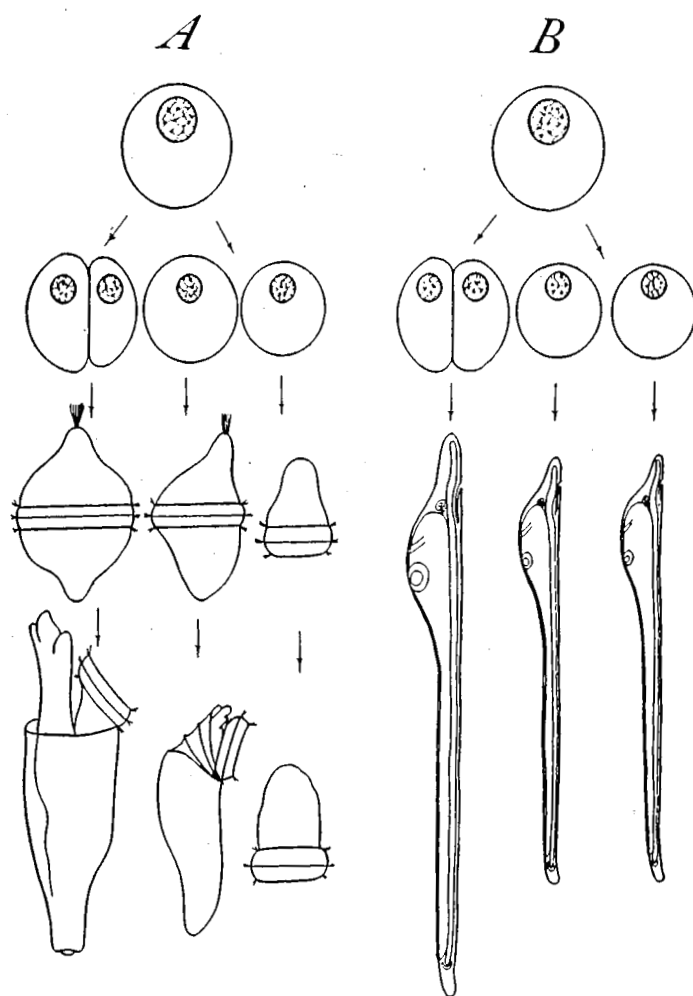


FIG. 1. — Development of entire eggs and of isolated blastomeres of two-cell stage. *A*, *Dentalium*; at the left, development of the whole egg; at the right, development of the isolated first two cells, producing two defective larvæ. *B*, *Amphioxus*; the corresponding experiment, isolated cells producing two perfect dwarfs.

four cells, and each develops, not into an abortive monster, but into a perfectly formed though dwarf larva (Fig. 1, *B*). Thus it is possible to produce from a single egg from one to four perfect animals; and in case of certain species (hydromedusæ) it is theoretically possible by a similar method to produce from a single egg as many as eight or even sixteen perfect dwarfs. Again, in some of these cases, for instance in the nemertine, the undivided egg may be cut to pieces in any planes taken at random; yet every piece, if of sufficient size, may upon fertilization develop as if it were a whole egg and produce a perfect dwarf. Here is an astounding contrast to the results of our first experiment. What becomes of our theories of prelocalization here, and what becomes of our mechanical theory of development, if we hold such a theory? Neither the cells nor the regions of the egg seem to have any predestination such as is shown in the molluscan egg. It is the essence of a machine or automaton that its operation is due to its structural configuration. Impair or destroy that configuration and the action ceases. But from these eggs we may take away any of the parts, or the whole may be cut to pieces, yet there is no impairment of action, but only a readjustment to form smaller systems like the original whole. The egg, therefore, says the vitalist, can not be an automaton and its development is inexplicable upon a mechanical theory.

Such is the paradoxical result to which a superficial comparison of these two cases leads us — a kind of embryological antinomy, as it were, which at first sight may seem to take away all hope of finding law or order in these phenomena. I will undertake to show you speedily that the apparent contradiction is easily explicable. I have placed the two cases side by side because each seems to demonstrate the truth of one side of an ancient embryological controversy; and we shall presently find reason for the conclusion that each of the opponents, like the two knights and the shield, have recognized but a part of the truth.

The probable explanation of the difference of the behavior between the eggs of *Dentalium* and of *Amphioxus* is a very simple one. When we closely study eggs of this type we find

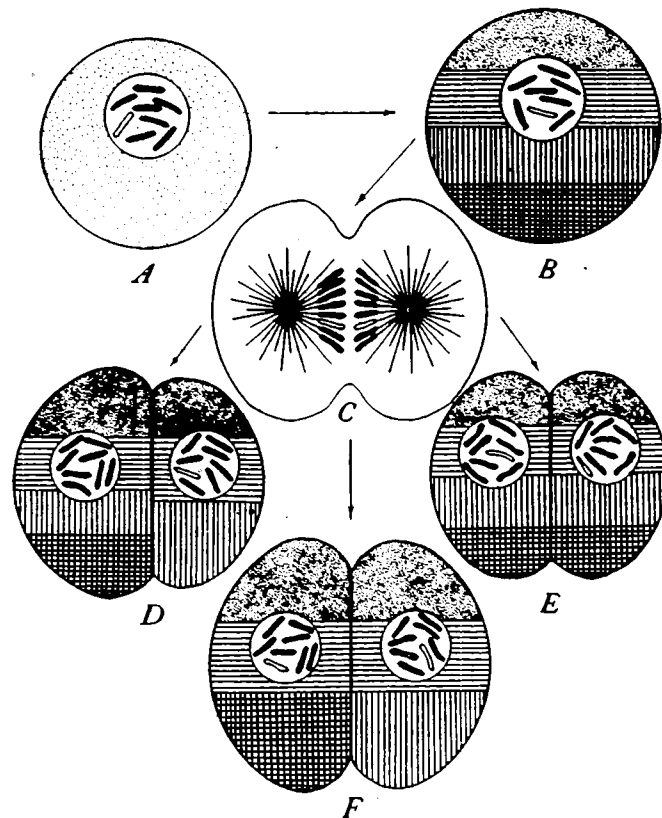


FIG. 2. — Diagram of protoplasmic zones and their distribution at the first cleavage in different forms. *A*, immature egg, assumed to have no definite segregation of protoplasmic stuffs. *B*, mature egg, with protoplasmic zones of horizontal stratification. *C*, first cleavage, division of the chromosomes. *D*, *E*, *F*, different types of two-cell stage. *D*, *Dentalium* type, the lower zone isolated in one cell. *E*, *Amphioxus*, nemertine, or echinoderm type; equal division of the zones. *F*, hypothetical type with complete separation of two zones at the first cleavage.

that they do not consist of homogeneous protoplasm, but of different kinds of protoplasmic materials or stuffs that are at the outset arranged, roughly speaking, in horizontal bands or strata, as indicated in the diagram (Fig. 2, *B*), where the number of strata is arbitrarily assumed to be four. Now, an examination of the manner in which the egg divides gives strong reason for the conclusion that in such forms as *Amphioxus* the first division bisects these stuffs, so that each of the first two cells receives one half of each stratum (Fig. 2, *C, E*). In the egg of *Dentalium*, on the other hand, this is demonstrably not the case, for the lower stratum passes over bodily into one of the cells and is quite excluded from the other (Fig. 2, *D*). The symmetrical division in *Amphioxus*, the sea-urchin, or the nemertine, gives the immediate possibility of producing two smaller systems similar to each other and to the whole egg. The symmetrical or qualitative division in *Dentalium*, on the other hand, does not give such an immediate possibility, for it produces two different systems neither of which is identical with that of the entire egg. It is highly probable that we find here a proximate explanation of the fact that each of the two cells in *Amphioxus* may produce a perfect dwarf, while in *Dentalium* neither produces such a larva. Facts like these are leading us to the conclusion that the immediate determining causes of development are to be sought in specific protoplasmic stuffs, or organ-forming materials, that are distributed to the cells in a definite way during division. These materials, definitely arranged, are sometimes plainly visible in the undivided egg. I have, for instance, been able to show that the egg of *Dentalium* contains an area of protoplasm at the lower pole that has a causal connection with the formation of the foot and shell, and probably also of the principal part of the mesoblast structures; for if this area be cut off from the unsegmented egg the resulting embryo regularly lacks these structures. In like manner, Professor Conklin has recently been able to recognize in the protoplasm of the unsegmented egg of a species of ascidian the material of the future tail-muscles of the larva; and though no necessary connection between this material and the muscles has thus far been experimentally proved, my experi-

ments on *Dentalium* leave by analogy little doubt that such a causal connection exists. We do not in the least know how these protoplasmic stuffs or materials act. We can hardly imagine how it is that one kind of stuff involves the development of muscles, others that of nerves, ciliated cells, or shell-secreting cells. We may guess that these stuffs may be analogous to the so-called internal secretions, formed in the adult organism by such organs as the thyroid or the sexual glands, which are known to produce quite specific morphological effects on the body. A second guess is that the formative stuffs may be related to the soluble ferments or enzymes, which in other ways play so great a rôle in the economy of plants and animals.

But, aside from this question, the evidence is steadily increasing, I think, that such stuffs exist, that they have a definite arrangement in the egg, and that in cases where the form of cleavage is constant they are distributed in a definite way to the cells into which the egg splits up. The cleavage-mosaic is accordingly to be conceived as an actual mosaic of different materials that are somehow causally connected with development of particular parts. When these materials are equally distributed by the earlier divisions, as in *Amphioxus*, each of the resulting cells may upon isolation produce a perfect larva; when they are unequally distributed, as in *Dentalium*, the cells are no longer equivalent, and upon being isolated produce the structures corresponding to the particular stuffs allotted to them.<sup>1</sup> These facts will presently bring us to our first general conclusion. First, if the protoplasm contain such stuffs, grouped and distributed in a definite way, to just this extent may development receive a mechanical interpretation — that is, be conceived as the result of an antecedent material configuration in the egg-protoplasm. We have as yet no very distinct idea regarding the degree of complexity of this initial protoplasmic configuration, though there are facts that indicate that it may not be very

<sup>1</sup> It will appear in the sequel that even in the latter case the potentiality of producing a complete embryo may still be present in the nucleus. It is important to distinguish between such primary or original nuclear potentiality, which may be common to all the cells, and the secondary or immediate potentiality determined by protoplasmic specification. The relation between these is still an unsolved problem.

great, *i. e.*, that the prelocalization is of a somewhat general character. This question appears, however, to be of relatively minor importance in view of an additional conclusion given by detailed studies on the formation, maturation and early development of the egg. These studies leave no doubt that the grouping of materials observed at the time the egg begins its process of division is not, in some cases at least, a primary or original one, but is of secondary origin. They indicate further that early in the development the egg contains only a few of these specific stuffs, at the very beginning possibly none, and that as development goes forward new stuffs are progressively formed and distributed. Now, if this conclusion is well founded, the actual progressive development of the protoplasm must be conceived as a process of *epigenesis*, not of preformation and evolution. This is the first general result that I desire to emphasize; and it is in harmony with the fact, on which all embryologists have been agreed, since the time of Wolff, that in its obvious features development is by the formation and addition of new parts not previously existent as such in the egg. The embryo is not actually preformed or even predelineated in the protoplasm from the beginning. The protoplasmic stuffs appear to be only the immediate means or efficient causes of differentiation; and we have still to seek its primary determination in causes that lie more deeply. We are thus led to a brief consideration of the question of the physical basis of heredity, which will direct our attention to an element that has hitherto been disregarded, namely, the nucleus, and bring us to a second general result.

It was long since suggested by Nägeli that there is a particular substance or "idioplasm" peculiar to each species of plant or animal that is transmitted in the germ-cells and has the power to determine the development of the egg according to its nature. Later research has given very strong reason to accept this view in principle, and for the further conclusion that this physical basis is represented by a substance contained within the nucleus and known to cytologists as "chromatin." Passing over the cogent, and I believe steadily accumulating, evidence on which



this conclusion rests, let us ask how the idioplasm is to be conceived. Some of those who have accepted the general conception of the idioplasm have endeavored to think of it as a very complex but still single and homogeneous substance—the frog's egg, for example, might be conceived as containing a frog-determining substance, the human germ a man-determining substance, and so on. The most recent researches are, however, continually strengthening the ground for a quite different conception, indicating that the chromatin does not operate as a simple substance, but is built into a complex fabric having a definite architecture. We are not here concerned with the particular form of this conception developed by Weismann in his well-known work on the *Germ-plasm*, and elsewhere. I am referring to more recent results of observation and experiment which are giving new and more concrete evidence that the nucleus possesses a complex organization, and apparently one that must be conceived as a kind of primary or original preformation, which bears a certain analogy to that assumed by Bonnet, though quite distinct from it.

We may perhaps most readily approach the grounds for this conclusion by considering, first, an example of the indirect evidence drawn from recent experiments on inheritance. I give a single example, typical of a large number of known cases, of the heredity of single or unit characters in the so-called Mendelian inheritance. If pure gray mice be crossed with pure white albino forms, the hybrid offspring are all gray without visible trace of white. But if these gray hybrids be now paired with each other, both parents being gray, approximately 25 per cent. of their progeny are pure white without a trace of gray, and they continue to produce pure white offspring thereafter. Many similar cases are known, the same proportion of approximately 25 per cent. of the "recessive" character in the third generation holding true, sometimes with great precision. What does this prove? First, that the white character is not really absent in the gray hybrids but only masked or concealed—"recessive," in Mendel's terminology; secondly, that the latent white character may in the following generation be completely disentangled

or extracted from the gray; thirdly, since the proportion is definite, that the extraction takes place by means of some definite mechanism. We are at present, I think, unable to imagine an explanation of these truly astonishing facts save by the assumption that the gray and white characters are borne in the egg by corresponding discrete bodies or entities of some kind, that may be mixed and unmixed without fusion, shuffled and unshuffled like cards in a pack. The evidence is so far wholly indirect, though I think none the less cogent. But now, bearing in mind that the case of the gray and white mice is but a single example of a widespread phenomenon, let us ask whether we can actually find any definite structures in the egg, and particularly in the nucleus, that may be assumed to represent such entities. One of the most significant and remarkable discoveries of modern biology is the fact that such entities exist, though it is important not to forget that their significance in heredity is as yet only an assumption, not a completely demonstrated fact.

These entities are bodies known as "chromosomes," and are represented in the diagrams by the rods in the nuclei.<sup>1</sup> I can not within the limits of this address attempt to do more than touch on a few of the discoveries of recent years regarding the chromosomes, though I think they may fairly be claimed to constitute one of the most brilliant chapters in the whole history of biology. The number of the chromosomes is constant in each species and, only with a few exceptions of such a kind as to emphasize the rule, the number in sexually produced organisms is always an even one. It has been proved that during the fertilization of the egg one half of the chromosomes are derived from the father and one half from the mother (Fig. 3, *A*), and the still more suggestive fact has been established — with probability through the study of normal development, with almost complete demonstration through the study of hybrids — that at every division of the egg the chromosomes also divide (Figs. 2, *C*, 3, *B*, *C*,) in such a manner that their progeny are

<sup>1</sup> In point of fact the chromosomes are, as a rule, only distinctly visible at the period of cell-division. In the diagram they are represented quite schematically, as if visible in the resting nuclei.

distributed in equal number, step by step, to all the cells of the body. The remarkable conclusion is thus reached that the fertilized egg, and all the cells derived from it, contain a double set of chromosomes, paternal and maternal (Fig. 3, *D*). The no less interesting result has been experimentally reached that either set—paternal or maternal—is sufficient for complete development (at least as far as the larval stages); for the egg may be caused to develop without the paternal chromosomes, while conversely the paternal chromosomes alone will suffice for the development of an egg from which the maternal nucleus has been removed. Here for the first time we catch a glimpse of the probable physical explanation of the phenomena of dominance and recession that have of late so greatly aroused the interest of experimenters on inheritance; but above all, here is found our first definite basis of observation for the assumption that the nuclear organization is not merely a chemical or molecular one, but represents beyond this some kind of definite material configuration of the nuclear substance.

The time will not allow me to do more than touch on the very recent work that has confirmed and extended this conclusion. It has been found, first, that in some species the chromosomes show constant differences of shape and size, which points towards the conclusion that they may possess specific individual characters. But beyond this indirect evidence, and quite independently of it, Boveri has shown by direct experiments of great ingenuity and beauty that qualitative physiological differences among the chromosomes actually exist: for complete development is only possible in the presence of a particular combination of chromosomes. Hence the conclusion becomes probable that there is a definite causal relation of some kind between the individual chromosomes and the development of corresponding characters or groups of characters; or, in other words, that the hereditary characters are in some manner distributed among the chromosomes which form their physical basis in the egg. We do not yet know in precisely what form this conclusion should be formulated. We do not know, for instance, whether a single unit-character, such as color, is determined by a single chromo-

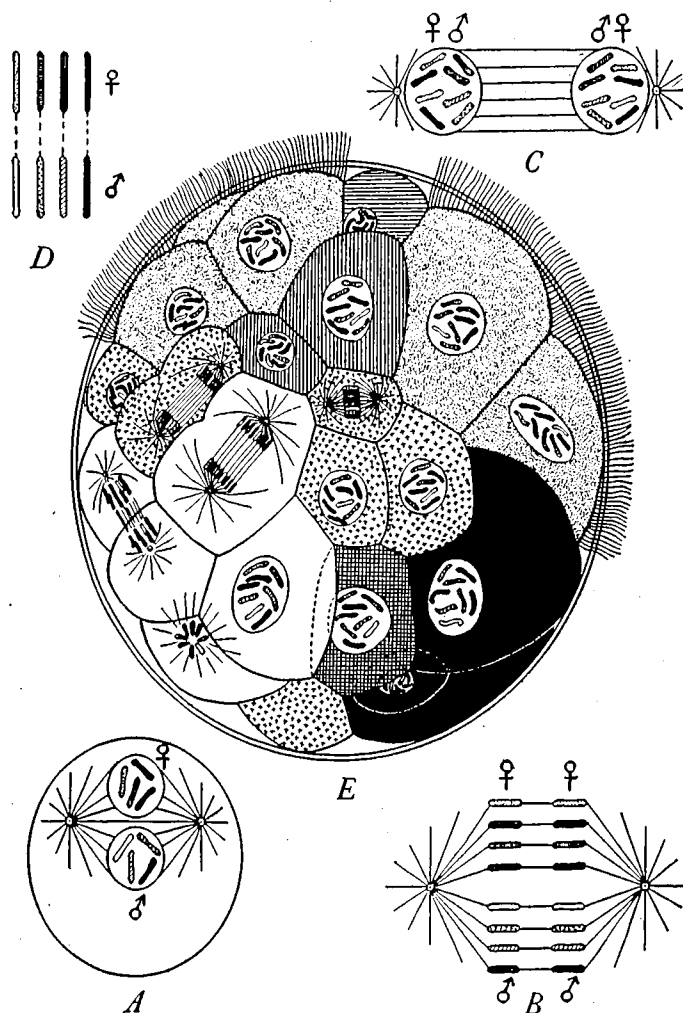


FIG. 3.—Relations of the chromosomes; formation and distribution of protoplasmic stuffs in later stages. *A*, union of the germ nuclei (each assumed to have four chromosomes). *B*, *C*, division of the chromosomes, with equal distribution of the paternal (♂) and maternal (♀) products. *D*, scheme of nucleus at any later stage, with four paternal and four maternal chromosomes (corresponding or homologous chromosomes connected by dotted lines). *E*, actual outline (after Mead) of egg of *Amphitrite* consisting of upwards of 64 cells (nuclei schematized). Entoblast-cells unshaded, primary mesoblast cross-hatched, trochoblasts (ciliated cells) dotted, cells of ventral plate (ventral nervous system, etc.) black; the other cells belong to the ectoblast.

some, or by a combination of chromosomes, or whether this may vary in different cases. In this direction we have taken but the first uncertain steps towards a new horizon of discovery. But the point I wish to emphasize is that if we admit such a distribution of characters among the chromosomes in any measure and in any form, to just this extent have we admitted the principle of preformation as applied to the nuclear substance or idio-plasm. To this extent do we admit, for example, that the physical basis of inheritance in a frog's egg is not simply a frog-determining *substance*, but is, in close analogy with Bonnet's conception, a kind of original preformation or microcosm, in which the individual frog-characters are in some unknown manner represented by corresponding chromosome-characters. We can hardly imagine at present how this is possible; and it must be freely admitted that such a conclusion has an appearance of artificiality and crudeness that almost inevitably creates a certain feeling of scepticism. Nevertheless, to a conclusion similar in principle to this the facts seem to be pretty definitely pointing.

And now, finally, let us see how this conception, if accepted, is to be united with that of specific protoplasmic stuffs, as already outlined. We do not know in any positive way, but we may roughly present the facts to our minds by a kind of artificial hypothesis—somewhat as Ehrlich and his followers endeavor to present the side-chain theory of immunity by means of rough and crude diagrams. Let us assume, for example, that the specific protoplasmic stuffs are formed one after another by means of substances like enzymes that emanate from corresponding chromosomes.<sup>1</sup> Putting the matter in the sharpest and crudest way, let us assume that each of the chromosomes in our diagram is responsible for the formation of the stuff correspondingly shaded. A few of these stuffs, formed and distributed as the egg ripens, determine the initial stages of development. In later stages other stuffs are formed by other chromosomes and progressively distributed to the cells by division. Thus the cleavage-mosaic grows progressively more complex and definite as development advances. Each nucleus still contains the germ

<sup>1</sup> Cf. Driesch's "Ferment Fiktion," *Analyt. Theorie*, pp. 87-92.

or potentiality of the whole organism, but the cells assume specific characters according to the protoplasmic stuffs allotted to them (Fig. 3, *E*).

This attempt to portray briefly the *modus operandi* of development is doubtless an excessively naïve mode of formulating a highly complex and subtle process, concerning the real nature of which we still know very little. Even if literally correct it would still leave quite out of account some of the most important elements of our problem. I do not offer it as a well-established or fully rounded conclusion, but rather as a convenient way of placing before you one fundamental result, towards which I believe the drift of recent research is tending. This is that the germ consists of two elements, one of which undergoes a development that is essentially epigenetic, while the other represents an original controlling and determining element. The first is represented by the protoplasm of the egg. The second is the nucleus, which, as I have attempted to show, must apparently be conceived as a kind of microcosm or original preformation, consisting of elements which correspond, each for each, to particular parts or characters of the future organism. The actual development of the embryo, which is manifested by progressive changes in the protoplasm, is by epigenesis, as Harvey and Wolff maintained. Its primary determination is by means of a preformed apparatus, handed on to the egg from preceding generations in the nucleus, which, though not in any sense a miniature model of the adult, yet somehow embodies in infinitesimal compass, the heritage of the race. And thus the most recent discoveries in this difficult field of research are bringing us to a position which can hardly be better stated than in the words written by Huxley more than thirty years ago: "The process which in its superficial aspect is epigenesis appears in essence to be evolution. . . . and development is merely the expansion of a potential organism or original preformation according to fixed laws." We should not, with the advantage of our present standpoint, read into these words of Huxley's a meaning which it was impossible that he should have had in mind in writing them; yet without yielding to this temptation we may fairly

pay our humble tribute of admiration and homage to a scientific insight that was capable of reaching such a conclusion in the far away prehistoric period when chromosomes and Mendelism were unsuspected, when the nature of fertilization was unknown, and the internal mechanism of development was a wholly unsolved riddle.

I will in conclusion add only a few words on the question of vitalism and mechanism in the light of the foregoing results. In so far as development may be conceived as the outcome of an original material configuration in the nucleus, and a secondary configuration in the protoplasm, it may be conceived as a mechanical process. But it must be admitted that this conception leaves quite unsolved certain fundamental elements of our problem — such for instance, as the manner and order in which the protoplasmic stuffs are formed and assume their characteristic configuration, whether in the whole egg or in the isolated blastomere or egg-fragment; or again, how the wonderful phenomena of the regeneration of lost parts in the adult organism can be explained. We have at present no positive data for an answer to these questions. But it can hardly be disputed that we have already made a considerable advance towards a mechanical solution of the problem, and if this be so, by what right does the vitalist demand that we shall adopt his hypothesis for the portions still unsolved? Let us seek an answer to this question in the answer to a broader one. What is the object of the study of development? I should state this object somewhat as follows: First, to observe and to describe as completely and simply as possible the actual phenomena of development; secondly, to determine to what extent, from its beginning in the egg to its completion in the adult organism, the process can be formulated in terms of the elementary laws of matter and of motion. But this is only a different way of stating that our object is to ascertain in what measure the operations of development, under given external conditions, are the result of an original configuration of material particles in the egg.

Now, I do not need to say that even the approximate accomplishment of these aims is still very remote, their complete

accomplishment impossible. I am fully in accord with the neo-vitalists in their assertion that the phenomena of development and of life generally have not yet been reduced to a mechanical basis, that they can not at present be fully described in physico-chemical terms. It is certain that living beings exhibit structures more complex than any existing in the inorganic world, and different from them in kind. It is possible, probable I believe, that living bodies may be the arena of specific energies that exist nowhere else in nature. I admit fully that the interpretation of development I have endeavored to outline does not exclude, but in some ways actually suggests, the existence of such energies. I should, therefore, even admit that the vitalists are wholly right in their contention that the vital processes are not at present explicable as the direct result of such energies as are observed in the non-living world. To prejudge this question would set up a dogmatic barrier to progress, not only in biology but also in chemistry and physics. If this be vitalism there are probably many of us who must be enrolled as "vitalists," however doubtfully we may regard the honor of bearing such a title. But if the word "vitalism" be used in any other sense than as a convenient phrase, an *x* by which to designate an unknown quantity, if it be taken in a positive sense to imply in the living organism any negation of the fundamental laws of matter and of motion, the existence of any distinctive entity, or principle that does not fall within the chain of physical causation or that contravenes the general laws of physics, then, I protest, to accept "vitalism" as a principle of interpretation is deliberately to abandon the scientific method in biological study.