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PROCEEDINGS OF THE PALEONTOLOGICAL SOCIETY

PROCEEDINGS OF THE EIGHTH ANNUAL MEETING OF THE
PALEONTOLOGICAL SOCIETY, HELD AT ALBANY, NEW
YORK, DECEMBER 27, 28, AND 29, 1916.

R. S. BASSLER, *Secretary*

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SESSION OF WEDNESDAY, DECEMBER 27

The general session of the Society was called to order by President Rudolf Ruedemann at 2.30 p. m., December 27, in the west Archeology Mezzanine of the State Education Building. After welcoming the members to the new State Museum, Doctor Ruedemann spoke of the great and beneficent influence that has been exerted on the science by the paleontologists who have lived and worked at Albany and by others who received their training there and made honored places for themselves elsewhere. President Ruedemann then called for the report of the Council as the first matter of business.

REPORT OF THE COUNCIL

To the Paleontological Society in eighth annual meeting assembled:

The first regular meeting of this year's Council was held at Washington, D. C., December 30, 1916, on the adjournment of the Society. Be-

tween this and the second meeting of the Council, just before the present session, the business of the Society has been conducted by correspondence. A résumé of the administration for the eighth year of the Society is given in the following reports of officers.

SECRETARY'S REPORT

To the Council of the Paleontological Society:

Meetings.—The proceedings of the seventh annual meeting of the Society, held at Washington, D. C., December 29 and 30, 1915, have been published in volume 27 of the Bulletin of the Geological Society of America, pages 139 to 174. Besides this publication, the scientific papers of the Society published in this Bulletin during the year are seven in number and occupy a portion of number 2, all of number 3, and part of number 4 of volume 27. Copies of the Proceedings and these seven papers have been distributed to the members. An article by Prof. Joseph Barrell on "The influence of Silurian-Devonian climates on the rise of air-breathing vertebrates," published in number 2, volume 27, of the Bulletin of the Geological Society of America, was deemed of such importance to our own Society that copies were secured for all the members.

The Council's proposed nomination for officers and announcement that the eighth annual meeting of the Society would occur at Albany, New York, at the invitation of President John H. Finley, of the University of the State of New York, and Dr. John M. Clarke, Director of the New York State Museum, were forwarded to the members on March 20, 1916. Since that time the members have received all the announcements, preliminary programs, etcetera, of the Geological Society of America, in addition to those of our own Society.

Membership.—During the year the Society has lost by death Dr. Charles S. Prosser, Professor of Geology at the Ohio State University, who died September 11, 1916.

The thirteen candidates elected at the seventh annual meeting have been placed on the rolls, making the present enrollment 176. Five candidates are under consideration for the present meeting. Three members of the Society were elected to Fellowship in the Geological Society of America at the election just concluded.

Pacific Coast Section.—The seventh annual meeting of the Pacific Coast Section of the Society was held at Stanford University April 29, 1916, with Dr. J. C. Merriam presiding and twenty-four members and visitors present. Seventeen papers, dealing with both the Vertebrate and Invertebrate Paleontology and Stratigraphy of the West Coast especially,

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were read at this meeting. The minutes of this section are printed on pages 223 to 234 of this Bulletin.

Respectfully submitted,

R. S. BASSLER,
Secretary.

WASHINGTON, D. C., *December 27, 1916.*

TREASURER'S REPORT

To the Council of the Paleontological Society:

The Treasurer begs to submit the following report of the finances of the Society for the fiscal year ending December 26, 1916:

RECEIPTS

Cash on hand December 20, 1915.....	\$383.17	
Membership fees (1915), 1.....	3.00	
Membership fees (1916), 78.....	234.55	
Interest, Connecticut Savings Bank.....	6.00	
		<hr/>
		\$626.72

EXPENDITURES

Treasurer's office:		
Postage	\$3.00	
		<hr/>
		\$3.00
Secretary's office:		
Secretary's allowance.....	\$50.00	
Expenses	40.26	
		<hr/>
		90.26
Geological Society of America:		
For printing separates.....	\$35.55	
		<hr/>
		35.55
Pacific Coast Section:		
Secretary's expenses.....	\$16.26	
		<hr/>
		16.26
		<hr/>
		\$145.07
<hr/>		
Balance on hand December 26, 1916.....		\$481.65
<hr/>		
Net increase in funds.....		\$98.48
Outstanding dues (1915), 1.....	\$3.00	
Outstanding dues (1916), 8 ¹	24.00	
		<hr/>
		27.00

Respectfully submitted,

RICHARD S. LULL,
Treasurer.

NEW HAVEN, CONNECTICUT, *December 26, 1916.*

¹ Of this number, one member is a prisoner of war in France and a second is with the Canadian expeditionary force at the front.

APPOINTMENT OF AUDITING COMMITTEE

Next in order of business was the appointment of a committee to audit the Treasurer's accounts. W. H. Twenhofel and M. W. Twitchell were appointed after a motion to this effect had been voted on by the members.

ELECTION OF OFFICERS AND MEMBERS

The next matter of business was the announcement of the election of officers for 1917 and of new members. The results of the ballots were as follows:

OFFICERS FOR 1917

President:

J. C. MERRIAM, Berkeley, Cal.

First Vice-President:

W. D. MATTHEW, New York City

Second Vice-President:

E. W. BERRY, Baltimore, Md.

Third Vice-President:

A. W. GRABAU, New York City

Secretary:

R. S. BASSLER, Washington, D. C.

Treasurer:

R. S. LULL, New Haven, Conn.

Editor:

C. R. EASTMAN, New York City

NEW MEMBERS

JOSEPH A. CUSHMAN, Sharon, Mass.

CARL O. DUNBAR, Peabody Museum, New Haven, Conn.

RICHARD M. FIELD, Jamaica Plains, Mass.

WILBER I. ROBINSON, Vassar College, Poughkeepsie, N. Y.

EDWARD J. WHITTAKER, Geological Survey, Ottawa, Canada.

The President then called the attention of the Society to three nominations for membership which had been received too late for the printed ballot and which had been acted on favorably by the Council. Following a motion by Dr. John M. Clarke and the unanimous vote by the members,

the Secretary was instructed to cast the ballot of the Society for the election to membership in the Society of the following three nominees:

HENRY M. DU BOIS, A. B. (1913), A. M. (1914) Indiana University. Assistant in Paleontology, University of Illinois, Urbana, Illinois. Engaged in ecological and stratigraphic paleontology. Proposed by T. E. Savage and E. R. Cumings.

JOHN B. REESIDE, JR., A. B. (1911), Ph. D. (1915) Johns Hopkins University. Assistant Geologist, United States Geological Survey. Engaged in study of Cretaceous invertebrates and stratigraphy. Proposed by T. W. Stanton and R. S. Bassler.

CLIFTON J. SARLE, B. S. (1902), M. S. (1903) University of Rochester, Ph. D. (1906) Yale University. Professor of Geology, University of Arizona, Tucson, Arizona. Engaged in study of Paleozoic invertebrates, especially problematic forms. Proposed by George H. Chadwick and R. S. Bassler.

PRESENTATION OF GENERAL PAPERS ON VERTEBRATE PALEONTOLOGY

Doctor Matthew then took the chair and the reading of papers on vertebrate paleontology of a general nature was commenced. The first paper, which was a very important and interesting one, dealing with the stratigraphy and vertebrate paleontology of the Pliocene, was illustrated by lantern slides, showing the correlation and lists of the mammalian faunas of the various formations.

PLIOCENE MAMMALIAN FAUNAS OF NORTH AMERICA

BY JOHN C. MERRIAM

(Abstract)

Within the past decade we have come to know Pliocene mammalian faunas in at least six important localities of the Pacific Coast and Great Basin provinces. These faunas represent two or more zones. A third zone is possibly represented by faunas known at localities not included in the six stations to which reference has been made.

The Pacific Coast and Great Basin Pliocene faunas have many faunal elements known also in the Pliocene of the middle and southern Great Plains region and in that of the South Atlantic provinces. Although no one of these North American faunas is as yet known in full, sufficient evidence is at hand to advance somewhat our knowledge of these relationships and relative age.

The Pliocene mammal faunas of North America contain a considerable number of recently discovered elements, appearing also in late Tertiary formations of Asia and Europe. An assembling of evidence now available makes possible some advance in our knowledge of world relationships of Pliocene faunas.

This instructive paper was followed by two very interesting accounts of the geologic work and the results of studies on the Tertiary of western Nebraska by Doctor Matthew and Professor Osborn.

LATER TERTIARY FORMATIONS OF WESTERN NEBRASKA

BY W. D. MATTHEW

GEOLOGIC TOUR OF WESTERN NEBRASKA

BY H. F. OSBORN

A motion to the effect that the Vertebrate Section hold adjourned meetings at the American Museum of Natural History, in New York City, December 28, 29, as arranged in the program, was carried.

At 5 o'clock the session adjourned to attend a public address given in Chancellor's Hall, entitled

THE PULSE OF LIFE

BY R. S. LULL

Wednesday evening the members attended the annual dinner with the Fellows of the Geological Society of America at the Ten Eyck Hotel.

SESSION OF THURSDAY, DECEMBER 28

Thursday morning, at 9.30 o'clock, the Section of Invertebrate and General Paleontology met, with Vice-President Foerste in the chair.

The first paper on the program was of especial general interest on account of its bearing on the antiquity of man in America. It was presented by the author and was discussed by Messrs. Sellards, Schuchert, and Berry.

PLANTS ASSOCIATED WITH HUMAN REMAINS AT VERO, FLORIDA

BY E. W. BERRY

(Abstract)

The significance of the plants found at Vero, Florida, in association with human remains and a Pleistocene vertebrate fauna was discussed. These plants include numerous fragments of leaves and a great variety of fruits and seeds preserved in an impure peat, and seem to indicate slightly different physical conditions and vegetation from that prevailing at the present time in this region.

DISCUSSION

Mr. E. H. SELLARDS: Mr. Berry's contribution to the discussion of the age of the human remains at Vero is very welcome. One of the pleasant features in connection with these discoveries is the willing cooperation which has been extended by geologists, anthropologists, and paleontologists, and it would seem

that out of these combined efforts we are really making progress in assembling the evidence.

It now seems pretty definitely established that the fossils of the deposits are those which we commonly assign to the Pleistocene period. I speak now of the fossils as such, omitting for the moment consideration of how or by what means they may have reached their present location. If it is true that the fossils are those of the Pleistocene, we then have to consider whether, on the one hand, the fossils are secondary and have been fossilized elsewhere and washed to their present location, or whether the human remains and artifacts are themselves not normal to the deposit, but have been introduced by recent burial or otherwise. That the fossils of strata 2 and 3 are secondary can not be maintained. Of mammals, we have taken from these deposits a practically complete and very fragile skull of a tapir, an equally fragile and approximately complete skull of an extinct wolf, as well as about thirty bones probably of the same individual; a considerable part of the skull of a mastodon; a considerable part of the skeleton of the extinct armadillo, *Chlamytherium*, as well as a large number of other mammalian bones, too perfect and too delicate to represent secondary fossils. Of birds, there have been obtained a number of wing bones of an extinct stork, as well as bones representing six or seven other species. Of turtles, which are numerous and varied, there have been obtained complete carapaces which are much too delicate to have been moved about after being fossilized. Lastly, the fossil leaves, of course, can not be secondary, and the testimony of these as presented by Mr. Berry is consistent with that of the other fossils, indicating the Pleistocene age of the deposits.

It is equally certain that the human remains and artifacts can not represent recent burials. The bones known to belong to a single individual are scattered in a way that excludes their interpretation as a burial. The second bone from skeleton number 2, found in place, was the proximal part of the shaft of the left femur. This was taken in April, 1916. In the following June, after having excavated farther into the bank, a part of the distal part of the shaft of this bone was obtained, the distance separating the two pieces being 8 feet. The break is clean and the fit perfect. The bone consisting of these two pieces is illustrated in the Eighth Annual Report of the Florida Geological Survey (plate 19, figure 3). The left ulna and left radius, both incomplete, are separated by a distance of 5 feet. The skull, of which scarcely half was obtained, was secured in the form of fragments extending over an area of not less than 6 by 3 feet. The distribution of the artifacts throughout the deposits is inconsistent with the idea that they represent burials. The pieces of pottery, as well as the bone implements, have been obtained one by one as the excavating progressed. Their distribution is general throughout the deposit, although they are more abundant near the base than elsewhere.

I am interested also in Mr. Berry's observation that there is probably no large time interval between strata numbers 2 and 3, since it agrees with a suggestion made by me in the paper last published relating to these deposits (*Journal of Geology*, volume 25, page 21, January-February, 1917). Personally I feel very much gratified at Mr. Berry's contribution to the discussion.

Following Professor Berry's paper was an interesting account of fossil rock-boring animals, read by the author and discussed by Messrs. Berry, Schuchert, Field, Bassler, and Vaughan.

GEOLOGIC SIGNIFICANCE OF FOSSIL ROCK-BORING ANIMALS

BY A. L. BARROWS

(Abstract)

Among the marine boring and burrowing animals of the present day there are certain genera of sea-urchins, *Echinus* and *Strongylocentrotus*, and pelecypod genera, *Adula*, *Lithodomus*, *Pholadidea*, and *Parapholas*, members of which habitually bore into rock and do not enter less compact materials, liable to crumble or collapse. These may be distinguished from mud and sand burrowers and from occasional borers into rock, both recent and fossil, by certain morphologic modifications known to be associated with the rock-boring habit, or by characters of the bore itself, showing that it was made in indurated rock rather than in sand or mud. The origin of the boring habit and the method of boring also strengthen confidence placed in the starfish and mytilid borers, and, to a certain extent, in some of the more highly specialized pholad genera as determiners of an indurated condition of the substratum in which they lived, when preserved as fossils in their native holes. The occurrence of fossil nestling shells in the holes of borers is even better evidence of the induration of the rock when the borers lived than the presence of the remains of the boring animals themselves. There is evidence to suggest that the exposed ledges which these borers and nestlers entered were located in access to fresh ocean water at no very great depth. Borers and nestlers may also be indicative of faults and disconformities, and may constitute the only relics of the previous fauna of the region which they occupied. In the history of deposition in a given locality the full significance of the former existence of an exposed ledge of rock must depend on further information concerning the faunas of the beds in question, the texture of the rock, their stratigraphic relations and correlations with other beds, and the recurrence of similar conditions in these respects over a wide range of territory.

The following paper on new genera of Paleozoic corals was then given and illustrated by sketches. Discussed by G. H. Chadwick, with reply by the author.

NEW GENERA OF CORALS OF THE FAMILY OF CYATHOPHYLLIDÆ

BY AMADEUS W. GRABAU

(Abstract)

The genera discussed were *Pinnatophyllum*, *Stereophyllum*, *Merophyllum*, and *Blothromisum*, among the simple *Cyathophyllidæ*, and *Pristiphyllum* and *Calvinastrea* among the compound ones. The structure, genetic relations, distribution, and migration were considered.

A second paper on fossil corals and their bearing on Tertiary paleogeography was presented next and was illustrated by lantern slides. Discussed by Messrs. Schuchert, Grabau, and the author.

*REEF CORAL FAUNA OF CARRIZO CREEK, IMPERIAL COUNTY, CALIFORNIA,
AND ITS SIGNIFICANCE*

BY T. WAYLAND VAUGHAN

(Abstract)

The paper was an abstract of a short monograph entitled "The reef-coral fauna of Carrizo Creek, Imperial County, California, and its geologic significance," in press as Professional Paper 98-T of the United States Geological Survey.

Carrizo Creek, along which the corals were obtained, is in the western part of Imperial Valley, about 15 miles north of the Mexican boundary and about 20 miles southwest of the southern end of Salton Sea. The geologic section comprises (1) a basal complex of granites and metamorphic rocks, (2) andesite extruded over the eroded surface of the basal complex, (3) a marine sedimentary series of clays, sands, and conglomerates which rest on the eroded surface of the underlying rocks and in the lower part of which are abundant reef corals, and (4) Pleistocene lake beds.

The conclusions resulting from the study are as follows:

1. The Carrizo Creek reef-coral fauna is Atlantic, not Pacific, in its affinities.
2. During Eocene and Oligocene time there was connection between the Atlantic and Pacific oceans across Central America, and there was no sharp differentiation between the Atlantic and Pacific fauna.
3. Upper Oligocene (Apalachicolan) time was closed by diastrophic and other geologic events of profound importance, which separated the Atlantic from the Pacific Ocean by a land area extending from North to South America. During Miocene time the sharp differentiation between the Atlantic and Pacific faunas took place, largely by the extinction of the Pacific elements in the former fauna.
4. The Pliocene coral fauna of Florida is purely Atlantic in its affinities, and since Pliocene time there has been only minor modification of the coral fauna in the western Atlantic, the Gulf of Mexico, and the Caribbean Sea.
5. The Carrizo Creek fauna is related to the Pliocene and post-Pliocene faunas of Florida and the West Indies and can scarcely be older than Lower Pliocene.
6. Subsequent to the differentiation between the Atlantic and the Pacific faunas there was interoceanic connection in Upper Miocene of Pliocene time which permitted the Atlantic fauna to extend into the Gulf of California and up to its head, and conditions which we do not understand excluded the Pacific fauna from that area.
7. The locus of the inferred interoceanic connection is not known. It was probably in the region of the Isthmus of Tehuantepec or farther southeastward.

The results of a study of the brachiopod genus *Platystrophia* were presented by the author, with lantern slide illustrations. Discussed by Messrs. Ulrich and Schuchert.

SOME MORPHOLOGICAL VARIATIONS IN PLATYSTROPHIA

BY MRS. EULA D. MCEWAN¹

(Abstract)

A study of the morphological variations of *Platystrophia* shows that the Ordovician forms have developed along three lines, two of which the writer calls the Uniplicate and the Bifurcate types; the third has been called the Triplicate type.

The *Uniplicate* type has one plication in the sinus and is called *P. uniplicata*. The *Bifurcate* type has one plication in the sinus in the nepionic stage; later this plication bifurcates. A great many individuals do not go beyond this stage; there are greater numbers in which a plication is intercalated in a median position. This is called *P. trentonensis*.

The first member of a third line of development passes through a uniplicate stage. After a short interval of growth a plication is intercalated in the sinus on one side of the median plication. A great many individuals were found which do not go beyond this stage in development. Another species adds a second lateral plication in the sinus on the opposite side of the median plication.

All three types are found in the Trenton; the triplicate type is characteristic of the Maysville and Richmond.

The Maysville and Richmond species which were studied fall conveniently into three groups. The *Ponderosa Group* is characterized by large size; the *Low Fold Group* has a long hinge relative to the height and retained the low fold of the nepionic stage throughout its entire life history; the *High Fold Group* has a long hinge relative to the height and develops at an early stage a high compressed fold on which the plications tend to disappear.

Seven species are placed in the *Ponderosa Group*, five of which are new. Three species are placed in the *Low Fold Group*. *P. sublaticosta* n. sp. is shown to be the ancestor of *P. clarksvillensis* and *P. acutilirata*, which are the other two members of this group. Four species were placed in the *High Fold Group*. Three of the members lose the lateral plications of the fold and sinus. *P. unicostata* loses them by retardation in development, while *P. crassa* and *P. cypha* lose them by obsolescence. This shows that the supposed identity of *P. unicostata* and *P. cypha* does not rest on sufficient grounds. Index curves do not support the supposed development of *P. cypha* from *P. unicostata*. It has been held that *P. acutilirata* developed from *P. laticosta* through *P. unicostata* and *P. cypha*. The stratigraphic position of these forms and the long hinge of *P. cypha* suggest this. These two species, however, represent the culmination of a development toward the excessive elevation of the fold, accompanied by the loss of the lateral plications of the fold and sinus. It is improbable that forms of this type should give rise to a species which retains

¹ Introduced by A. W. Grabau,

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the low fold and strong lateral plications throughout its entire life history. Index curves and the characters common to both and their common order of appearance suggest a common origin, and *P. sublaticosta* occupies the right stratigraphic position and has all the characters necessary to be an ancestor of these two species.

The Secretary next presented a discussion on American Silurian ostracoda for the author. Illustrated by specimens and lantern slides; discussed by Messrs. Grabau, Schuchert, Ulrich, and Bassler.

THE OSTRACODA AS GUIDE FOSSILS IN THE SILURIAN DEPOSITS OF THE
APPALACHIAN REGION

BY E. O. ULRICH

(Abstract)

The exact time relations of the Silurian deposits of the Appalachian Valley with respect to the standard section of the interior of the continent have long been conjectural, but it has always been recognized that the ostracoda, on account of their exceeding abundance and excellent preservation, would seem better for correlation than almost any other group of fossils. Another reason for the use of this group in correlation is that the same species will occur indiscriminately in limestone, shale, or sandstone, and so well preserved in each case that exact determinations are possible. Even when preserved as molds in sandstone a gutta-percha squeeze will give all the essential features of the carapace.

Hitherto less than half a dozen Appalachian Silurian ostracoda have been recognized, but as a result of the present work no less than twenty-seven new genera and several hundred species are known. An interesting feature has been the discovery that species and genera otherwise quite similar can readily be distinguished by the form and position of the swelling on one of the lobes of certain individuals which are considered the female forms. On the assumption that this swelling is the brood pouch, the long controversy as to which is the anterior and posterior end of these Paleozoic ostracoda can now be settled, since the swelling always marks the posterior end of the carapace.

REPORT OF THE AUDITING COMMITTEE

At this point the Auditing Committee gave notice that their report on the accounts of the Treasurer was ready. The correctness of the accounts was attested by the committee and the Society voted that their report be accepted.

The reading of papers was then resumed with the presentation of the following, which was illustrated by lantern slides. Discussed by Messrs. Mook, Schuchert, and Twenhofel.

*AGE OF THE AMERICAN MORRISON AND EAST AFRICAN TENDAGURU
FORMATIONS*

BY CHARLES SCHUCHERT

(Abstract)

The very interesting dinosaur-bearing Morrison formation is underlain by the Sundance and overlain by the equivalent of the Washita. The latter is the last series of the Comanchian, though some European stratigraphers regard it as of early Upper Cretaceous time. On the other hand, the Sundance is regarded by some paleontologists as of early Upper Jurassic age and by others as late Upper Jurassic; the evidence of the ammonites and saurians appears to indicate the Kimmeridgian rather than the Oxfordian. Between the Sundance and the Morrison, it is now widely held, there is a time break and the two series of deposits overlap from opposite directions. It appears that during this interval there occurred the Sierra Nevada orogeny, and accordingly, on the basis of diastrophism, the Morrison should be of Comanchian age. The floral and faunal evidence of the Morrison is also rather in harmony with this conclusion, and is further supported by that of the East African Tendaguru series, which has Jurassic and Lower Cretaceous marine and dinosaur faunas. This conclusion also falls in line with the decision of the Committee on Geological Names of the United States Geological Survey, who early in 1916 deemed the evidence sufficient to warrant the classification of the Morrison as of Lower Cretaceous age.

The excellent results obtained by special methods of study were described in the next paper, which was illustrated by photographs and a stereoscope. Discussed by A. F. Foerste.

*EXTERNAL STRUCTURE OF STEGANOBLASTUS AS REVEALED THROUGH GUM
MOUNTINGS AND PHOTOMICROGRAPHIC STEREOGRAMS*

BY GEORGE H. HUDSON

(Abstract)

The writer has made a complete analysis of the surface with all sutures clearly revealed. It has large deltoids, sagittate, with a small group of plates in the sinus. The distal extensions of the deltoids pass into the sinus of the radials by a diagonal and adjustable sliding suture, as in *Pentremites* only the deltoids reach nearer the arm tip. The deep groovings on the plate surfaces were for branching epispires, which were protected by a forest of spines. The floor and cover plates rested directly against the deltoid, and under these was a double sublancet plate. The "pore plates" had no pores, but were covered with spines.

A second study by the same author, in which the same methods of research were employed, was then presented.

SOME STRUCTURAL FEATURES OF A FOSSIL EMBRYO CRINOID

BY GEORGE H. HUDSON

(Abstract)

A fossil embryo crinoid is described as a new genus and species and named *Embryocrinus problematicus*. The arm structure, as shown by enlargements ($\times 20$) taken through cover-glass and gum mounting, is seen to consist of a linear series of thin, irregularly formed discs or lunate pieces of stereom, in an otherwise fleshy extension of epidermal or associated tissues. The structure revealed is precisely like that of the spines and spinelets of *Urasterella medusa*, as shown in plates accompanying the report of the New York State Director of Science and State Museum for 1915.

The methods of study and the progress made in the preparation of a monograph on American Tertiary Bryozoa were outlined by the junior author. Illustrated by specimens and lantern slides; discussed by R. M. Field.

METHODS OF STUDY AND THE CLASSIFICATION OF AMERICAN TERTIARY BRYOZOA

BY F. CANU AND R. S. BASSLER

(Abstract)

The junior author showed, with the aid of specimens and lantern slides, the methods of collecting, the preparation for study, and the characters employed in classification of American Tertiary bryozoa now under monographic study. Until recent years the post-Paleozoic bryozoa have been considered more as perforated stones than as well organized creatures in which the perforations and ornamentation of their surface had definite physiological purposes. The relation between the morphological and skeletal variation and their physiological purposes was determined in the case of the fossil forms by the close study of the most nearly related living species. This study showed that (1) a family is characterized by having the same larval form, or, since the larva and ovicell are in rapport, by the same kind of ovicell; (2) that the genera differ from each other by possessing different functions. These functions, common to all bryozoa, are as follows:

1. Passage of eggs and escape of the larvæ (= rapport of the operculum and the ovicell).
2. Hydrostatic system and extrusion of the polypide (= form of the aperture and rapport of the operculum with the compensatrix).
3. Calcification and chitization (= nature of the skeleton and of the frontal considered as immediate deposits of the endocyst).

At 1 p. m. the Society adjourned for luncheon.

PRESIDENTIAL ADDRESS

At 2.30 p. m. the Society convened to hear the address of the retiring President on the subject,

THE PALEONTOLOGY OF ARRESTED EVOLUTION

BY DR. RUDOLF RUEDEMANN

Following Doctor Ruedemann's address the presentation of papers on General and Invertebrate Paleontology was resumed. The first paper was a report of progress and was illustrated by lantern slides. Discussed by Charles Schuchert.

PRESENT STATUS OF AREAL MAPPING IN THE COASTAL PLAIN AND OF THE PALEONTOLOGIC INVESTIGATIONS IN THE COASTAL PLAIN, PANAMA, AND THE WINDWARD ISLANDS

BY T. WAYLAND VAUGHAN

(Abstract)

This paper presented in outline the purpose and plan of the studies in areal geology and paleontology in the Coastal Plain of the Atlantic and Gulf States, in the Canal Zone, and in the West Indies. The present status of the investigations was indicated by maps and tables, which were shown on the screen.

An interesting and ingenious interpretation of the stratigraphic relations of certain graptolite shales and continental deposits of Great Britain was given by Doctor O'Connell, who presented the following paper, illustrated by charts. Discussed by Messrs. Ruedemann, Grabau, Twenhofel, Schuchert, and Bassler.

WERE THE GRAPTOLITE-BEARING SHALES, AS A RULE, DEEP OR SHALLOW WATER DEPOSITS?

BY AMADEUS W. GRABAU AND MARJORIE O'CONNELL

(Abstract)

By most authors graptolite shales have been considered as deep water deposits. This interpretation is questioned on the following grounds: (1) An examination of the most important graptolite-bearing formations of Europe and of North America shows a vast preponderance of clastic material of very shallow water, if not of actually continental origin, the graptolite-bearing beds being very thin intercalations in each series. Often evidence of shallow water conditions is shown in the beds themselves. (2) The great scarcity of normal marine organisms and their very frequent absence in the beds between the graptolite layers negatives the marine origin of these sediments. (3) The improbability of graptolite remains sinking to the floor of the relatively deep ocean, especially where strong surface currents transport them, seems generally

not to have been considered. The interpretation of the graptolite beds as delta deposits formed near the mouths of large rivers and repeatedly flooded by the sea, resulting in the stranding on the mud-flats of the planktonic or epi-planktonic graptolites, will be discussed in the light afforded by such sections as those of the Moffat district of Scotland, the Scandinavian region, Bohemia, Wales, and North England, and the Hudson River region of North America.

A second paper on the subject of graptolites completed the program for the day. Discussed by Messrs. Grabau, Schuchert, and Chadwick.

GRAPTOLITE ZONES OF THE UTICA SHALE

BY RUDOLF RUEDEMANN

(Abstract)

Four zones have been distinguished in the Utica shale of the Upper Mohawk Valley and Black River Valley. The type section in the city of Utica is within the third zone; the fourth zone is found in the Black River Valley.

After deciding to attend the Symposium on Sedimentary Rocks, on the program of the Geological Society of America at 10 o'clock the following morning, the Society adjourned at 5.30 p. m.

At 8.15 o'clock the members convened in Chancellor's Hall of the Education Building and listened to the address of Dr. John M. Clarke, retiring President of the Geological Society of America.

At 9.15 the members joined the Fellows of the Geological Society of America at the smoker given at the University Club.

SESSION OF FRIDAY, DECEMBER 30

The Society did not meet until 11.30 a. m. to continue the regular program on account of attendance at the Symposium on Sedimentary Rocks, under the auspices of the Geological Society of America. The subjects and speakers of this symposium were as follows:

SYMPOSIUM ON THE INTERPRETATION OF SEDIMENTARY ROCKS

THE PROBLEMS STATED

BY A. W. GRABAU

SIGNIFICANCE OF SEDIMENTARY RHYTHM

BY JOSEPH BARRELL

DIAGNOSTIC CHARACTERISTICS OF MARINE CLASTICS

BY E. M. KINDLE

CHARACTERISTICS OF CONTINENTAL CLASTICS AND CHEMICAL DEPOSITS

BY ELIOT BLACKWELDER

SIGNIFICANCE OF SORTING IN SEDIMENTARY ROCKS

BY E. W. SHAW

CHEMICAL AND ORGANIC DEPOSITS OF THE SEA

BY T. WAYLAND VAUGHAN

PRESENTATION OF PAPERS

The first paper of the Society's regular program was illustrated with lantern slides and was discussed by Messrs. Grabau, Bassler, Schuchert, Perdue, and Ulrich.

DEVONIAN AND BLACK SHALE SUCCESSION OF WESTERN TENNESSEE

BY CARL O. DUNBAR¹

(Abstract)

Along the western valley of the Tennessee River the Lower Devonian begins with massive crystalline limestone of Coeymans age. The Decatur limestone, generally assigned to the Silurian, seems to be of this time. The New Scotland is represented by the well known and next higher Linden shale and limestone. Succeeding the Linden is the remnant of a southward extension of the New York Oriskany, for which the name Cypress Creek chert is proposed. This is a white or yellowish chert carrying *Spirifer arenosus*, *S. arrectus*, *Rensseleria ovoides*, *Plethorhyncha speciosa*, *Platyceras gebhardi*, etcetera.

The Cypress Creek is separated by a long time break from the Linden below and by a lesser one from the Camden chert above. The Camden chert is, then, very late Oriskany, and Savage's evidence that it goes unbroken into the Onondaga is thus corroborated.

The Camden chert is followed by the Chattanooga shale of the early Kinderhookian, and this in turn by the fossiliferous Ridgetop shale of later Kinderhookian time.

The next paper was presented extemporaneously by the author and illustrated by diagrams. Discussed by Charles Butts.

STRATIGRAPHIC RELATIONS OF THE TULLY LIMESTONE AND THE GENESEE SHALE OF NEW YORK AND PENNSYLVANIA

BY AMADEUS W. GRABAU

(Abstract)

The Tully limestone is a calcilutite, the material of which was derived from the north, probably from coral or algal reefs which lay to the north of the

¹ Introduced by Charles Schuchert.

present line of outcrop and have been since entirely removed by erosion. The Genesee shale is the mud brought by a river from the south into Pennsylvania and New York. The relationship of the two formations is that of replacing overlap—the muds gradually advancing from the south over the limestone. A recent study of the sections near Ithaca has furnished abundant evidence of such replacement.

A second paper on the classification of Silurian and Devonian corals was then given under the following title. Discussed by A. W. Grabau and the author.

AMERICAN DIPHYPHYLLOID CORALS

BY GEORGE H. CHADWICK

(Abstract)

A critical review of the half hundred specific names proposed for American Silurian and Devonian corals of the genera *Diphyphyllum*, *Diplophyllum*, *Eridophyllum*, *Craspedophyllum*, *Synaptophyllum*, and their allies, with discussion of the synonymy and classification within the group thus indicated. On the basis of well marked natural characters, it is shown that there are several definite generic types passing current under the name *Diphyphyllum* as broadly used, none of which are strictly referable to this European Carboniferous genus. *Diplophyllum* and *Eridophyllum* are each restricted to the type species, while the remaining forms are found to fall readily into *Synaptophyllum*, *Craspedophyllum*, or a Silurian group, possibly the *Donacophyllum* of Dybowski, and a small Devonian group, probably satellite to that. The unlike structures possessed by some of these genera indicate that their mutual affinities are of not nearer than family rank, so that the expression "diphyphyllid" is merely one of convenience for the present study.

Following this paper was one on methods of determining the attitude of strata, delivered by the author, and followed by remarks by E. B. Branson.

CRITERIA OF ATTITUDE IN BEDDED DEPOSITS

BY LANCASTER D. BURLING

(Abstract)

The criteria of attitude may be defined as those evidences by which a field observer may determine which is the bottom and which the top of a given bed, or series of beds, and something as to the history of past changes in the attitude of such a section. These criteria are classified and discussed, with bibliographic references to typical examples.

The final paper of the program was read by E. B. Branson in the absence of the author.

DEVONIAN OF CENTRAL MISSOURI; FAUNA OF THE COOPER LIMESTONE

BY DARLING K. GREGER¹

(Abstract)

This paper includes a discussion of the region in which the formation occurs, its lithologic character and distribution as defined by Meek and Swallow, a description of the fauna and correlation of the formation.

The following papers were read by title:

ALBERTELLA FAUNA

BY CHARLES D. WALCOTT

SOME FUNDAMENTAL POINTS IN THE CLASSIFICATION OF TRILOBITES

BY PERCY E. RAYMOND

At 1.30 p. m. the Society adjourned.

SECTION OF VERTEBRATE PALEONTOLOGY

The minutes of the meeting of the vertebrate paleontologists with the general society at Albany, Wednesday afternoon, December 27, are given on a preceding page. At this session papers dealing with vertebrate paleontology, but of general interest, were presented, the special papers being reserved for the sectional meeting at New York City.

SESSION OF THURSDAY, DECEMBER 28¹

At the American Museum of Natural History, Thursday, December 28, at 10 o'clock, Doctor Matthew called the section to order for the reading of papers, the general business session being postponed to Friday afternoon. The following papers were presented:

FOSSIL MAMMALS FROM PORTO RICO

BY H. E. ANTHONY

(Abstract)

A discussion, illustrated by lantern slides, was given of the cave deposits of the island, in which were found the remains of ground-sloths, hystricomorph rodents, and a peculiar type of insectivore, besides birds, bats, etcetera, more nearly related to continental mammals. The deposit is of late Pliocene or early Pleistocene age.

¹ Introduced by E. B. Branson.

¹ Prepared from the minutes of the session by W. D. Matthew and E. L. Troxell.

In the discussion which followed Dr. W. D. Matthew spoke of the importance of this new fauna, so different from that of the mainland. It is comparable to the relation of Madagascar and the African continent. Others who spoke on the subject were Messrs. Osborn, Gilmore, Gregory, Barbour, and Merriam.

*SECOND REPORT OF THE COMMITTEE ON NOMENCLATURE OF SKULL
ELEMENTS IN TETRAPODA*

BY W. K. GREGORY

(Abstract)

Doctor Gregory read briefly from the report of the committee consisting of Doctor Broom, Professors Case, Moodie, Williston, and himself, illustrating his remarks by lantern slides. Through their conferences, carried on in part by correspondence, they were able to further the work of last year in the effort to secure a uniform system of names for skull elements in the several classes of vertebrates which would be generally acceptable and, so far as possible, in accord with the current usage of earlier writers.

The discussion was led by Messrs. Barnum, Brown, Merriam, Gregory, and the Chair, and the following points were brought out: An entirely harmonious nomenclature could never be devised, for there can not even be complete unanimity within the committee. However, a system, even though somewhat arbitrary, if once decided on, would ultimately be used by most morphologists and would be of the utmost value. It was recommended that the results so far attained should be printed for the reference of the members. A motion made by Doctor Merriam was passed, instructing the committee to continue its very useful services, and the Chair expressed the sentiment of appreciation of the Society for the faithful work on a very difficult, though extremely important, subject.

SESSION OF FRIDAY, DECEMBER 29

At 10 o'clock Friday morning, Doctor Matthew presiding, the program was resumed, and, excepting the hour for lunch, the time was filled with the reading and discussion of interesting papers until 4.30 p. m. The remaining papers were then read by title and the business session was called. The papers presented were as follows:

SOUTH CAROLINA MASTODON

BY F. B. LOOMIS

(Abstract)

A mastodon skeleton, which has been lying untouched for many years in the Museum of Amherst College, was rediscovered recently. It not only proved to be a nearly complete specimen, but probably a new form as well. Two complete tusks about 15 inches long were found in the lower jaws. The skeleton,

which came from the (?) Ashley River beds of South Carolina and constitutes a part of the famous Shepard Collection, is now mounted in the Museum at Amherst.

This paper was illustrated by drawings and photographs and was discussed as follows by Messrs. Matthew, Brown, and Merriam: This skeleton may be of the species recently described by Doctor Hay as *Mammot progenium*, from a lower jaw out of the Aftonian beds of Iowa. The same species is recorded by Doctor Sellards in late Tertiary beds of Florida. Teeth and incomplete jaws from the phosphate beds of South Carolina may also belong to it. It is clearly a species distinct from the American mastodon.

HORNED ARTIODACTYL FROM THE TERTIARY OF NEBRASKA

BY R. S. LULL

(Abstract)

The expedition of 1914 from Yale University, while hunting over Marsh's old fields along the Niobrara River, found a very unusual horned animal, probably related to the giraffe, and certainly never known in America before. Several skulls were exhibited with the horn cores arising immediately back of the orbits. One specimen, probably a female, showed the merest beginning of a rudimentary horn, "a rectigradation." Since discovering the importance of this new material it is planned to send another party to the place to search for other specimens.

Doctor Merriam expressed great interest in anything like a horned artiodactyl of this type because of the abundance of antelope forms in the Pacific Coast region. Doctor Sinclair felt the need of caution in any attempt to classify the Artiodactyla on the character of the horn cores. Doctor Matthew believed that its nearest relative was probably the Miocene genus *Blastomeryx*, of which it might be a descendant.

FELIDÆ OF RANCHO LA BREA

BY J. C. MERRIAM

(Abstract)

This was an interesting talk, with lantern slides, about the varieties of fossil cats from the asphalt deposits of California. The nature of the large saber-like canine teeth—in the manner of their succession, deciduous to permanent; their progressive protrusion, the great variation in the cusps of the molars and premolars, and the brachy- and dolichocephaly—was dwelt on. The differences in these respects would warrant separate species, according to our usual way of thinking; but, because in the hundreds of skulls at hand he finds a most perfect gradation, Doctor Merriam hesitates to separate the groups except in the most extreme cases.

Professor Osborn emphasized the importance to paleontology that this wonderful Rancho la Brea material should have fallen into the capable hands of Doctor Merriam.

GIGANTIC MEGATHERIUM FROM FLORIDA

BY W. D. MATTHEW

(Abstract)

During the summer of 1916 Mr. Heller presented to the Museum a small collection of fossil bones believed to be from Zolfo, Florida. Some of the remains are cetacean and may be of Tertiary age; the rest are apparently Pleistocene, and most of them, probably all, belong to a gigantic ground-sloth. The only complete bone is an astragalus; the proximal half of a femur, distal half of a radius, parts of tibia, and other unrecognizable fragments may very probably belong to the same individual, as they all agree well in characters with the skeleton of *Megatherium* described and figured by Owen and are about one-fifth larger in lineal dimensions.

The only point of especial interest about these remains is the size. *Megatherium* has been recorded from South Carolina, Georgia, Florida, Mississippi, and Texas, and no doubt its range extended throughout the Southern States in the Pleistocene; but I have found no record of any specimens materially larger than Owen's type. The present specimen, averaging one-fifth larger lineally, would have been about $1\frac{3}{4}$ as large in bulk or weight, and must have equaled or exceeded in bulk any known land mammal, living or extinct. It is to be hoped that the better specimens of this imposing beast may be secured through the active explorations now being conducted by the Florida State Geological Survey.

SKELETON OF DIATRYMA, A GIGANTIC BIRD OF THE LOWER EOCENE

BY W. D. MATTHEW AND WALTER GRANGER

(Abstract)

The discovery of a nearly complete skeleton of this extremely rare bird in the Wasatch formation of the Bighorn basin, Wyoming, was quite unexpected. It equaled the Moa in bulk, but had a gigantic head, with enormous compressed beak like the South American *Phororhachos*. It is not nearly related to any known type of bird.

AN OKLAHOMA PLEISTOCENE FAUNA

BY E. L. TROXELL

(Abstract)

A number of extinct animals were found in a refilled channel near Mulhall, Oklahoma. The list includes tapir, bison, mammoth, mastodon, horn, deer, giant sloth, and the ever-present turtle. The horns of the bison measure about 3 feet from tip to tip. Only one tapir has heretofore been reported from the Great Plains region. The collection, as a whole, indicates Osborn's second faunal zone, or else a forest group, the counterpart of the plains fauna of the *Equus* beds.

Dr. O. P. Hay added some very important points to the discussion of the *Bison*, of which he has made a special study. It is difficult to identify species

on the horns alone, and yet there is little doubt but that *Bison latifrons*, with a spread of 6 feet and more, is distinct specifically from the modern animal, with short, inward curving horns, and it is quite impossible to assemble the intermediate forms in less than four or five harmonious groups. A recent discovery by Doctor Hay of the undoubted remains of *Bison* in association with those of *Camelus* marks the earliest known specimen in the Western Hemisphere.

FIRST RECORDED AMPHIBIAN FROM THE TERTIARY OF NEBRASKA

BY HAROLD J. COOK¹

(Abstract)

Something over a year ago the writer was examining the dump of a series of excavations made in the Lower Pliocene Snake Creek beds by a party from an institution, and among other interesting things picked up what was clearly a portion of a jaw, of peculiar type. Both ends bore evidence of being freshly broken off, and so a careful search of the surface immediately surrounding was made, but without success.

The part secured was sent to Doctor Matthew for examination and comparisons, and apparently this specimen pertains to the group of giant salamanders not previously reported from the American Tertiary. Its closest known relative is the famous Oenigen fossil, now known as *Andrias scheuchzeri*, from the Upper Miocene of Switzerland. The present specimen greatly exceeds that form in size and was probably at least 5 feet in length, if we may judge from the size of the jaw. It is evidently a distinct form, for which the name *Plicagnathus matthewi* is proposed. The generic name is in reference to the folded appearance of the internal surface of the lower jaw and the specific name as a tribute to Dr. W. D. Matthew. Detailed descriptions and figures will shortly appear. The part preserved is 61 mm. long, 22 mm. deep, and 12 mm. in greatest transverse diameter.

Professor Loomis mentioned another in his possession; these two are probably the only known specimens.

LABYRINTHODONT FROM THE NEWARK SERIES

BY W. J. SINCLAIR

(Abstract)

The author exhibited the lower jaw of a gigantic Stegocephallan from the Brunswick horizon of the Newark of New Jersey and discussed its affinities.

Professor Lull, speaking from his experience and interest in the Triassic of the Connecticut Valley, emphasized the importance of anything which adds to our knowledge of the very meager fauna of the Newark series and called attention to the marked difference of the older Newark fauna from the Dinosaur fauna found in the upper beds.

¹ Presented by W. D. Matthew.

FOSSIL VERTEBRATES FROM FLORIDA

BY E. H. SELLARDS

(Abstract)

This paper, illustrated by maps and diagrams, brought out additional facts of great interest on a subject discussed by Doctor Sellards in the July number of the American Journal of Science, concerning human bones and artifacts found in association with a number of extinct animals. The mineralized character of the bones, their scattered condition—in these respects resembling the other fossil animals—the undisturbed stratum, and the unbroken continuity of the overlying rock, all indicate the undoubted presence of man in this country during the Pleistocene period.

Dr. O. P. Hay vouched for the authenticity of this discovery, even though anthropologists are wont to question the association of the human remains with the true Pleistocene forms. He considered the fauna as of early Pleistocene age and cited evidence for this view. Doctor Matthew observed that he regarded the opinions of expert collectors of fossil vertebrates as to the validity of this discovery as carrying great weight, more probably, than the stratigraphic data.

CAMPODUS AND EDESTUS REMAINS

BY C. R. EASTMAN

(Abstract)

The very peculiar dentition of a shark was exhibited, which, being coiled, resembled more the form of an ammonite, and would hardly be taken for a vertebrate specimen by the casual observer. The teeth of the modern shark also come in succession, but this primitive animal had a great battery or coil situated anteriorly in its mouth, which furnished a constant supply of dental armature.

BRONTOTHERIUM: A NEW MOUNT IN THE YALE MUSEUM

BY R. S. LULL

(Abstract)

This specimen, shown by lantern slides, recently mounted in the posture of the famous model by Charles R. Knight, is the holotype of *Brontops robustus* Marsh (*Brontotherium robustum* Marsh). It is a specimen in excellent preservation and one unusually complete, which lay in the Yale Museum, spread out on the shelves, since 1875. It is one of the largest and finest of the Titanotheres, but not the most extremely specialized.

BAROSAURUS: A GIGANTIC SAUROPOD DINOSAUR

BY R. S. LULL

(Abstract)

Barosaurus is one of the gigantic dinosaurs of which a large portion of the backbone is known. It resembles *Diplodocus*, which it rivals in size. The

specimen was found in 1898 by Doctor Wieland and it is hoped that more of it may be secured. The great size of the beast may be judged by the length of one cervical centrum, which measures about one meter; posteriorly the vertebrae are not so large relatively.

OSTRICH DINOSAUR STRUTHIOMIMUS AND A RESTUDY OF ORNITHOLESTES

BY H. F. OSBORN

(Abstract)

This paper, which has since been published in *Bulletin American Museum of Natural History*, volume XXXV, 1917, pages 733 to 771, was discussed, as follows: Mr. Granger added to the four theories of the adaptation and habits of the animal a fifth, that of egg-sucking, which may have some bearing on the extinction of the larger reptiles. Professor Lull questioned the theory of the browsing habit of the animal and also the one advanced relating to its speed adaptation.

SKELETON AND RESTORATION OF CAMARASAURUS

BY H. F. OSBORN AND C. C. MOOK

(Abstract)

In the discussion by Messrs. Lull, Hay, Barbour, and Franklin it was shown that the lizards and crocodiles, which we usually think of as crawlers, sometimes get up on their feet and walk in a recognized quadrupedal manner. From this it was argued that the dinosaurs at times walked like mammals, and, again, may have sprawled like a crocodile.

Doctor Barbour has observed that crocodiles may walk leisurely, bearing the whole weight on their feet; but if hurried they drop down and wriggle along, using the tail and limbs, just as in swimming.

SUCCESSION OF THE MIOCENE FAUNAS IN THE JOHN DAY REGION

BY J. C. MERRIAM, CHESTER STOCK, AND CLARENCE L. MOODY

(Abstract)

Doctor Merriam read the paper, which was a discussion of the problems of stratigraphy of this Oregon region. Some excellent photographs, stratigraphic columns, and faunal lists were shown by lantern slides. Professor Osborn directed attention to the great advance in exact stratigraphic and faunal work in the John Day region since the early reports of Marsh and Cope.

RESTORATIONS OF THREE PLEISTOCENE SKULLS FROM EUROPE

BY J. H. MCGREGOR

(Abstract)

Perhaps the most interesting paper was this discussion of the early types of man in Europe. Professor McGregor illustrated with casts both the original fossil skulls and his restorations. He pointed out the characteristic features

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of the Heidelberg and male and female Neanderthal skulls, and the known or inferred differences between these primitive men and *Homo sapiens*.

Professor Osborn remarked that these restorations are the finest ever made; they set a new standard and are a real contribution to the hypothetical knowledge of the Hominidæ. Doctor Merriam expressed great pleasure in hearing the paper and said that it was worth coming across the continent just to see the restorations. He deplored the lack of material which would show us something of the evolution of the foot in man. Doctor Merriam congratulated the author of the paper, hoping that the results of his work will soon be accessible in publications.

CLASSIFICATION AND PHYLOGENY OF THE REPTILIA

BY S. W. WILLISTON

(Abstract)

The paper, illustrated by lantern slides and presented by Doctor Gregory, is the result of thirty years of research. Only the novel phases of the subject were brought out in particular, and to these Doctor Gregory made some valuable criticisms and additions. Doctor Matthew characterized the paper as a contribution of high importance.

The following papers were read by title:

CORRELATION OF THE UPPER CRETACEOUS IN MONTANA AND ALBERTA

BY BARNUM BROWN

EOCENE FAUNAL HORIZONS OF THE NORTHERN SAN JUAN BASIN IN NEW MEXICO

BY WALTER GRANGER

STRATIGRAPHY AND FAUNAL HORIZONS OF THE HUERFANO BASIN, COLORADO

BY WALTER GRANGER

HOMOLOGIES OF THE BORDERS AND SURFACES OF THE SCAPULO-CORACOID IN REPTILES AND MAMMALS

BY W. K. GREGORY AND CHARLES L. CAMP

USE OF FOSSIL FISHES IN CORRELATING STRATA

BY E. B. BRANSON

ORGANIZATION OF THE VERTEBRATE PALEONTOLOGISTS

The chairman read communications from various members who were compelled to be absent, namely, Dr. Roy L. Moodie, Dr. Wm. J. Holland, Mr. O. A. Peterson, Prof. E. C. Case, Dr. George F. Eaton, and Dr. W. K. Gregory, giving their views on the status of the organization of

the vertebrate paleontologists and making recommendations for the future. Among the members present, Professor Osborn, Professor Lull, and Doctor Merriam spoke regarding the same matters.

On a motion of Professor Lull, the chairman was directed to appoint a committee, including the Chair, to formulate and submit to the Council of the Society recommendations in conformity with the opinions expressed at the meeting. On motion by Mr. Barnum Brown, this committee was given full power to act in all matters respecting the reorganization of the section.

On motion by Professor Osborn, the meeting was adjourned.

REGISTER OF THE ALBANY MEETING, 1916

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CORRESPONDENT DECEASED

E. KOKEN, died November 24, 1912.

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SAMUEL CALVIN, died April 17, 1911.
ORVILLE A. DERBY, died November 27, 1915.
WILLIAM M. FONTAINE, died April 30, 1913.
THEODORE M. GILL, died September 25, 1914.
ROBERT H. GORDON, died May 10, 1910.
J. C. HAWVER, died May 15, 1914.
C. S. PROSSER, died September 11, 1916.

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MINUTES OF THE SEVENTH ANNUAL MEETING OF THE PACIFIC COAST
SECTION OF THE PALEONTOLOGICAL SOCIETY

BY CHESTER STOCK, *Secretary*

The seventh annual meeting of the Pacific Coast Section of the Paleontological Society was held at Stanford University April 29, 1916. The meeting was called to order by Dr. John C. Merriam at 10.30 o'clock, in room 334 of the Department of Geology.

ELECTION OF OFFICERS

The following officers were elected for the ensuing year:

President, CHARLES E. WEAVER, University of Washington.

Vice-President, JOHN P. BUWALDA, University of California.

Secretary-Treasurer, CHESTER STOCK, University of California.

GENERAL BUSINESS

It was moved and carried that the President and Secretary be designated as official representatives of the Society on the Affiliation Committee of the Pacific Division of the American Association for the Advancement of Science. It was moved and carried that the next regular meeting of the Society be held in the San Francisco Bay region at a time agreed on by the officers of the Society. It was moved and carried that the Executive Committee be empowered to arrange for a special meeting at San Diego, if such meeting is possible.

The following papers were then read:

TITLES AND ABSTRACTS OF PAPERS PRESENTED

REVIEW OF PROGRESS IN PALEONTOLOGIC RESEARCH IN THE PACIFIC
COAST REGION

BY JOHN C. MERRIAM

(*Abstract*)

An outline of advances in the study of extinct faunas in the area west of the Wasatch Range. Brief discussion of the most significant paleontologic problems touched by research in this area.

AN APALACHICOLA FAUNA FROM LOWER CALIFORNIA

BY RALPH ARNOLD AND BRUCE L. CLARK

(*Abstract*)

A collection of marine invertebrate fossils from near Magdalena, Lower California, was placed in the hands of the writers for determination by Arnold

Heim. Doctor Heim has recently completed a study of the geology of a portion of Lower California. Certain of the species, which come from beds described by him as *Purissima nueva* formation, are common to the Apalachicola horizon at a number of localities around the Caribbean Sea. Some of these species are *Pecten condylomatus* Dall, *Pecten oxygonum optimum* Brown and Pilsbry, *Ræta gibbosa* Gabb, *Mastra dariensis* Dall, *Turritella tristis* Brown.

Pecten condylonatus is found in the Chattahoochee and Chipola beds of Florida and, according to Dr. R. E. Dickerson, is present also in the Tuxpan beds of Mexico. *Pecten oxygonum optimum* is common in the Gatun beds at Panama. *Ræta gibbosa* was described from the Peruvian Tertiary and is also found, according to Doctor Dickerson, in the Miocene of the United States of Colombia, the fauna of which is considered by him to be a phase of the Gatun fauna. *Mastra dariensis* is found in the Gatun beds. *Turritella tristis* was described from the Miocene of Costa Rica.

The recognition of this fauna in Lower California is important in that it apparently indicates a direct connection between the Pacific and Atlantic oceans somewhere in the region of Central America during the Apalachicola period of deposition.

TERTIARY MOLLUSKS AND ECHINODERMS FROM THE VICINITY OF TUXPAN,
MEXICO

BY R. E. DICKERSON AND W. S. W. KEW

(Abstract)

An interesting fauna has been collected recently by Prof. E. T. Dumble and Prof. W. F. Cummins from the Tertiary of the Gulf coast of Mexico. In this collection are several echinoderms which were described by Cotteau from formations of the islands of Cuba, Anguilla, and Saint Bartholomew. These were assigned to the Eocene by P. T. Cleve.

The echinoderm fauna was collected from seventeen localities north and south of Tuxpan. Of the fourteen forms found, *Clypeaster cubensis* Cotteau, of the Cuban Miocene, is most common. It is associated with *Agassizia clevei* Cotteau, from Saint Bartholomew, and *Macropneustes antillarum* Cotteau, from questionable Eocene of Saint Bartholomew and Cuba. Associated with the Antillean species are *Schizaster scherzeri* Gabb and Horn, from the Costa Rican Miocene; *Lovenia*, new species; *Clypeaster*, cf. *rogersi* (Morton); *Scutella*, new species; *Metalia*, new species. These forms are associated with *Pecten condylomatus* Dall, of the Chipola horizon of Florida; *Pecten oxygonum optimum* Brown and Pilsbry, *Pecten gatunensis* Toula, *Pecten levicostatus* Toula, *Clementia dariana* Conrad, *Turritella altalira* Conrad, *Malea ringens* Swainson, of the Gatun beds; *Ficus mississippiensis* Conrad, of the Vicksburg and Bowden horizons; *Conus interstinctus* Guppy, of the Bowden beds; *Hemipristis serra* Agassiz, of the Maryland and the California Miocene, and several other species which are characteristic of the Gatun beds. The fauna, as a whole, is littoral and is apparently an inshore facies of the Bowden and Chattahoochee horizons.

The fauna submitted by Professor Dumble and Professor Cummins suggests that certain so-called Eocene beds of Cuba, Anguilla, and Saint Bartholomew

which yielded *Agassazia clevei* Cotteau may be a stage of the Bowden (Miocene) of Jamaica. The presence of certain forms which are reported from Costa Rica and Panama show that an intimate relation exists also with these Tertiary horizons.

STRATIGRAPHY AND PALEONTOLOGY OF THE SALINAS AND MONTEREY
QUADRANGLES, CALIFORNIA

BY H. J. HAWLEY

(Abstract)

The Salinas and Monterey quadrangles cover the northern part of Monterey County, California, and include the northern termination of the Santa Lucia Range, a small part of the broad alluvial plain of the Salinas Valley, and a small part of the western slope of the Gabilan Range.

The basement complex of gneisses, schists, granite, and crystalline limestone, on which all of the younger sedimentary formations were deposited after a long period of erosion, is of doubtful age.

The oldest sedimentary rocks exposed within these quadrangles are a series named by Lawson the "Carmelo Series," consisting of 1,320 feet of conglomerate interbedded with blue and brown sandstones and clay shales. These strata are unfossiliferous and their age placed as Chico because of the marked lithological resemblance to the Chico of the Santa Cruz quadrangle. Their relation to the Monterey shale is masked by intrusion of lava and by the overlying mantle of Paso Robles.

The oldest definitely known sedimentary formation is the Temblor sandstone, made up of 2,300 feet of red, blue, and green concretionary sandstone, which contains numerous forms of *Pecten andersoni*, *Turritella ocoyana*, and *Agassoma barkerianum*. Conformably overlying this sandstone is the typical siliceous diatomaceous Monterey shale, with a thickness of 3,500 feet. In the Corral de Tierra this shale is represented by a near-shore sandy phase. Many well preserved forms of *Arca montereyana*, *Pecten discus*, *Yoldia impressa*, and *Pecten peckhami* characterize this horizon. The Santa Margarita formation, of a thickness of 1,400 feet of white, coarse calcareous sandstone, with lenses of siliceous limestone and brown micaceous sandstones, overlies the Monterey shale with no angular unconformity, but the presence of pholas borings indicate a time lapse. From these sandstones specimens of *Pecten estrellanus* and *Ostrea titan* were collected in great number. This upper micaceous sandstone is conformable with the overlying Paso Robles formation. This unfossiliferous formation was correlated with the Paso Robles of the San Luis quadrangle and the Salinas Valley on a purely lithologic basis. It consists of a very coarse, unsorted, loosely consolidated conglomerate in the steep mountains, passing gradually into a light brown to yellow fine-grained concretionary sandstone in the northern part of the Monterey quadrangle.

A flow of basic lava exposed in small patches about the mouth of the Carmel River poured out after the deposition of the Monterey and before the Paso Robles was laid down.

*SUPPLEMENTARY DATA BEARING ON THE COMPOSITION AND AGE OF THE
THOUSAND CREEK PLIOCENE FAUNA*

BY JOHN C. MERRIAM, CHESTER STOCK, AND E. M. BUTTERWORTH

(Abstract)

The material obtained by a recent expedition to the Thousand Creek Pliocene deposits of Nevada had made possible a more minute analysis of the faunal relations of these beds.

CLIMATIC RELATIONS OF THE TERTIARY OF THE WEST COAST

BY JAMES PERRIN SMITH

(Abstract)

An exhibit was made of columnar sections from Eocene to Recent in five climatic zones from Panama to Alaska, showing the actual specimens characteristic of the climatic zones, as well as of the geologic horizons. A chart was also exhibited, showing the stratigraphic relationships of the faunas and the shifting of the isotherms in geologic time.

*RECENT ADDITIONS TO OUR KNOWLEDGE OF CALIFORNIA CENOZOIC
ECHINOIDS*

BY W. S. W. KEW

(Abstract)

The large collections of California echinoids acquired during the past few years permit a more accurate determination of the geologic range of genera and species. The number of species is greatly increased and the status of the known forms more satisfactorily determined. Prior to the year 1913 thirty-one species of echinoids and stelleroids were described; since then twenty-one additional forms have been added to this list. Undescribed forms in the collections of California institutions will increase the number at least 60 per cent. The geologic range of some of the more important genera on the Pacific coast, including also the undescribed species, is as follows: *Cidaris*, Eocene, with the exception of one species in the Oligocene and one in the Pliocene; *Strongylocentrotus*, Pleistocene and Recent; *Scutella*, mainly throughout the Miocene, with fragmentary specimens from the Eocene; *Dendraster*, Pliocene, with the exception of *Dendraster excentricus*, which is living, and *Astrodapsis*, confined to the Upper Miocene and Lower Pliocene.

*STRUCTURE OF THE PES IN MYLODON HARLANI AND ITS BEARING ON THE
PROBLEM OF SUPPOSED HUMAN ORIGIN OF FOOTPRINTS OCCURRING NEAR
CARSON, NEVADA*

BY CHESTER STOCK

(Abstract)

In the restoration of the pes of *Myiodon harlani*, based on the material from Rancho La Brea, the second and third phalanges of digit 3 are identified with

the corresponding phalanges of digit 2, manus of *M. robustus*, as interpreted by Owen. In Owen's reconstruction of *M. robustus* the second and third phalanges of digit 2, manus, have undoubtedly been interchanged with the corresponding phalanges of digit 3, pes.

In 1882 H. W. Harkness described what he believed to be imprints of a sandaled human foot occurring in Pleistocene strata near Carson, Nevada. These footprints were exposed, together with those of other animals, in the stone quarries of the Carson State Prison yard. Shortly following this description Joseph Le Conte pointed out obvious objections to the theory of the human origin of these footprints, namely, the large size of the individual imprint and the span of the straddle. He suggested that the imprints were made by a large quadruped, most probably a ground-sloth. The latter view was entertained also by O. C. Marsh, who made comparison between the imprint and the outlines of the pes of *Myiodon*.

An interesting verification of the views of Le Conte and Marsh is suggested by the restoration of the pes of *Myiodon harlani* from Rancho La Brea. The posterior foot of this species corresponds very closely in size and shape with the imprints found in the Pleistocene of Carson City, Nevada.

TERTIARY NASSIDÆ OF THE WEST COAST OF AMERICA

BY STANLEY C. HEROLD

(Abstract)

A review of West Coast Tertiary species of the family Nassidæ (Alectrioidæ), ranging from Puget Sound to Ecuador, prepared in conjunction with a discussion of the living Nassidæ from the same region by Mrs. Ida Oldroyd. Their synonymy and stratigraphic range is established, certain forms are differentiated and specifically named, and new species are described. An attempt is made to determine their phylogenetic relationships, as evidenced by stratigraphic and geographic distribution and faunal variations of the individual species.

ASTORIA SERIES (OLIGOCENE) IN THE REGION OF MOUNT DIABLO, MIDDLE CALIFORNIA

BY BRUCE L. CLARKE

(Abstract)

The formations in the region of Mount Diablo, here referred to the Oligocene, until comparatively recently were included in the Lower Miocene, being correlated with the Temblor (*Turritella ocoyana* zone), as described by F. M. Anderson from the region of the Temblor Mountains and near Kern River, in the vicinity of Bakersfield, California. The beds of this horizon, as mapped in different parts of the State by the United States Geological Survey, are referred to under the name of Vaqueros, which is the equivalent of the Monterey group of Prof. A. C. Lawson.

The first announcement of the separation of these Oligocene beds from the Miocene was made by the writer in a short paper entitled "Occurrence of

Oligocene in middle California.”¹ Briefly stated, the conclusions were as follows: At the base of the Monterey group, in certain localities to the west of Mount Diablo in the Concord quadrangle, as described and mapped in the San Francisco Folio,² a portion of the lower sandstones, designated as the Sobrante formation, contains a very distinct fauna from that found in the sandstones and shales immediately above; the paleontologic and stratigraphic evidence indicates that these lower beds belong to a distinct period of deposition, there being a marked stratigraphic, as well as a faunal, break between the two. The name *Agasoma* zone was applied to the lower beds; the fauna in the beds immediately above the break was referred to the *Arca montereyana* zone. The fauna of the *Agasoma gravidum* zone was correlated with that of certain beds in Washington and Oregon, which beds have been referred to the Oligocene by different writers.

Since the publication of this paper more extensive field-work has been done and the writer has been able to get much better acquainted with the Oligocene fauna of Oregon, Washington, and Vancouver Island. The term Astoria series, as used here, was first applied by Arnold and Hannibal as a general name for the Oligocene of the west coast in their paper entitled “The marine Tertiary stratigraphy of the North Pacific coast.”³ This name is synonymous with the term Clallam formation, as used by Prof. C. E. Weaver in his recent paper entitled “Tertiary faunal horizons of western Washington.”⁴

Beds in the region of Mount Diablo, referable to the Astoria series, are found in two general sections—one to the west and one to the north of the mountain. These two sections are very different, both lithologically and faunally. The beds to the west of the mountain in the Concord quadrangle have a maximum thickness of only a little more than 500 feet. To the west and south of the Concord quadrangle they disappear and the beds of the *Arca montereyana* zone (Monterey) rest directly on the Tejon (Upper Eocene) or older formations. The Oligocene formations north of the mountain (Mount Diablo quadrangle) have a maximum thickness of over 3,500 feet. They are more heterogeneous than those found in the Concord quadrangle and contain at least one disconformity; they are overlain unconformably by the San Pablo group, the Monterey group being absent. The fauna obtained from these beds on the north side of the mountain and on which the determination of their age is based came from near the top of the series. At the present time something like forty marine invertebrate species have been found in the Oligocene beds to the north of Mount Diablo, while over one hundred species have been obtained from the beds to the west of the mountain.

The fauna obtained from the Astoria series in the region of Mount Diablo, considered as a whole, appears to be more closely related to the Lower Oligocene of Washington and Oregon than to the Upper, a number of identical or very closely related forms being common to these beds and the beds in Washington assigned by Weaver to the Lower Oligocene, the “Lincoln horizon” (*Molopophorus lincolniensis* zone), which in part is the equivalent of the San

¹ B. L. Clarke: Univ. Calif. Publ., Dept. Geol., vol. 9, no. 2, 1915, pp. 19-21.

² A. C. Lawson: U. S. Geol. Surv. Atlas, San Francisco Folio (no. 193), 1914.

³ Ralph Arnold and Harold Hannibal: Proc. Amer. Phil. Soc., vol. III, 1913, pp. 576-585.

⁴ C. E. Weaver: Univ. Wash. Publ. in Geol., vol. I, no. 1, 1916, p. 4.

Lorenzo formation of Arnold and Hannibal. Some of these common forms are fairly highly ornamented gastropods, and it might be expected that they would have a rather limited geologic range. It should be remembered, however, that the work of describing the faunas of the Oligocene has only begun and the range of many of the described species has not been established for a certainty. For this reason the writer hesitates to say that the *Agasoma gravidum* beds are certainly as old as the Lincoln beds of Weaver, but there seems to be no doubt that they belong to the same general period of deposition, if not to the same faunal horizon. The San Lorenzo formation in the region of the Santa Cruz Mountains, described and referred to the Oligocene by Dr. Ralph Arnold, belongs to this same period, as do also the Kreyenhagen shales recently described by Robert Anderson and Robert W. Pack and referred tentatively to the Oligocene.⁵

Sufficient faunal evidence has now been obtained to show that these shales belong to the Astoria series. The Astoria series is also known to be represented by beds at the south end of the San Joaquin Valley in the San Emigdeo Hills. In this general locality the Oligocene strata are separated from those of the Miocene (Monterey group) by volcanics of considerable thickness.

FAUNA OF THE ETCHEGOIN PLIOCENE OF MIDDLE CALIFORNIA

BY J. O. NOMLAND

(Abstract)

Results of studies on the Etchegoin Pliocene in the region of Coalinga, California, may be summarized as follows:

1. Pliocene sediments have accumulated to the thickness of over 10,000 feet in this area under shallow marine or terrestrial conditions.
2. While marine accumulation prevailed the floor of the basin of deposition was raised locally several times above sealevel; after terrestrial conditions became predominant brief periods of marine deposition occurred.
3. In post-Pliocene time diastrophic movements of great magnitude occurred in the Coalinga region.
4. The strata above the Santa Margarita (?) and below the Tulare belong to one period of deposition.
5. The Santa Margarita-San Pablo fauna is distinctly different from that of the Etchegoin.
6. As shown by the invertebrate and vertebrate faunas, the whole Etchegoin is of Pliocene age.
7. An unconformity in the lower part of the section heretofore grouped with the Etchegoin southeast of Coalinga is probably the line of division separating the Etchegoin from the Santa Margarita (?)
8. An unconformity above the "Glycimeris zone" in the Etchegoin north of Coalinga is probably only of local importance.
9. Four distinct faunal zones have been recognized in the Etchegoin formation.

⁵ Robert Anderson and R. W. Pack: Geology and oil resources of the west border of the San Joaquin Valley north of Coalinga, California. Bull. U. S. Geol. Survey, no. 603, 1915, pp. 77-78.

10. The Lower Etchegoin is most closely related to the Lower Fernando Pliocene near Newhall, while the Upper Etchegoin is most closely related to the Lower Pliocene beds at Sargent.

FAUNA OF THE PINOLE TUFF

BY JOHN C. MERRIAM AND CHESTER STOCK

(Abstract)

The fauna of the Pinole tuff has been known by a small number of invertebrate forms from the type locality near Rodeo Station, on San Pablo Bay, in middle California. Vertebrate remains discovered in a section of loose gravels and tuffs near the town of Pinole, on San Pablo Bay, have recently been shown to represent the Pinole Tuff stage. Recent collections from the Pinole locality have added to the vertebrate fauna several genera not previously known at this horizon and much better material of several forms represented at the type locality. The collections now available make possible a much more satisfactory correlation than that heretofore proposed.

LOWER AND MIDDLE CAMBRIAN FAUNAS OF THE MOHAVE DESERT

BY C. W. CLARK

(Abstract)

Lower and Middle Cambrian sedimentary rocks occur on the Mohave desert near Cadiz, California. The Lower Cambrian rests here on the Precambrian granites and schists. Late Paleozoic, marbleized limestone, probably Carboniferous in age, rests conformably on the Middle Cambrian. The general distribution of these formations is shown in the Guide Book to Geology, etcetera, Santa Fe Railroad. All the localities of sedimentary rocks noted in the Guide Book as occurring near Cadiz were visited, excepting those in the Providence Range, but fossils were obtained only from the Bristol Mountains (Iron Mountains).

The Lower Cambrian is represented by the *Olenellus* fauna, to which one new genus and three new species of trilobites have been added. Several specimens of *Bathyriscus* mark the Middle Cambrian. A few species of Carboniferous fossils were found near the top of the marbleized limestone, which is the uppermost formation of the sedimentary series in this region.

ANCIENT PANAMA STRAITS

BY ROY E. DICKERSON

(Abstract)

According to Stanton, the Pacific and Texas Cretaceous have no species in common, and although he recognizes the presence of an Upper Cretaceous series containing a Pacific fauna resting on a Lower Cretaceous, Comanchian stage at Catorce, he states that in no place in the entire region has a commingling of Upper Cretaceous faunas of these two provinces been found.

Beds of Eocene age containing several species common to the Tejon of California occur along the Mexican Gulf border. White limestones in the Isthmus

of Tehuantepec may be of Eocene age. The faunal relationships between the Mexican Coastal Plain and the Tejon of California indicate that there were straits which were probably situated in the Isthmus of Tehuantepec during Upper Eocene time. The lack of a close relationship between the faunas of the Martínez-Eocene stage and the Midway indicates the opposite conclusion. The evidence concerning the Lower Oligocene or Vicksburg stage is quite deficient and it is impossible to determine any connections at this time.

Spencer postulates Pliocene canals through the Isthmus of Tehuantepec. Bose and Toula, who have studied the Isthmus of Tehuantepec, disagree entirely with Spencer's geologic data, and state that it is impossible to trace marine terraces across the Isthmus, although they recognize the presence of stream-laid deposits resting on rocks bearing a Bowden fauna. The faunal evidence along the various lines discussed below in no manner indicates any recent connections.

Faunal relations of the living mollusks, fishes, echinoderms, and corals from the Panamic and Caribbean provinces indicate that no connection existed between the Atlantic and Pacific during the Pliocene or Pleistocene. A study of the mammals of North and South America demonstrates that a barrier was present during the Miocene. The recent Panamic marine invertebrate fauna is related to that of the Bowden horizon of Jamaica, and straits probably existed at various times during the deposition of the Bowden beds.

According to Hill, during Cretaceous time the major islands of the Antilles were started on the crests of oceanic volcanoes. These land-masses thus built up were submerged in part and the sediments deposited from their erosion contain a fauna of Upper Cretaceous age. At the end of Cretaceous time these strata were folded along a northwest-southeast axis. In late Eocene and early Oligocene time a profound regional subsidence occurred, during which all but the highest tips of the Antilles were covered by the waters of the Caribbean. This subsidence was followed by an uplift in Oligocene time, during which great orogenic movements along east-west axes took place. This was the stage, if at all, of an Antillean continent. Possibly many of the larger islands were connected at this time, and the southern portion of Florida may have been linked with this large Antillean island. This event was succeeded by another great submergence, and portions of Mexico and Central America, as well as the major portions of the Antilles, were largely covered with oceanic waters—the Bowden stage.

According to the work of Scott and Matthew in the study of recent and fossil mammals, any connection of the mainland with the Antilles is very unlikely. The species of small sloth found in the Pleistocene beds of Cuba sprang from a single form which may have emigrated there by way of a raft. Scott shows that during Miocene time the mammalian fauna of North and South America were entirely distinct. These facts indicate that a period of wide-spread submergence occurred during the Miocene, and on this account the beds bearing the Bowden fauna might well represent this era of subsidence.

Recently a fauna collected from the vicinity of Magdalena Bay, Lower California, was submitted to Dr. Ralph Arnold and Dr. B. L. Clark for determination. This fauna contains *Pecten condylomatus* Dall, of the Chipola horizon of Florida and the Tuxpan beds of Mexico; *Pecten oxygomum optimum* Brown and Pilsbry, of the Gatun beds, Panama; *Rata gibbosa* Gabb, of the Peruvian

Tertiary and the Miocene of the United States of Colombia—a phase of the Bowden fauna; *Mastra dariensis* Dall, of the Gatun beds; *Turritella tristis* Brown and Pilsbry, of the Costa Rica Miocene. The rest of this fauna contains casts of forms which represent typical Bowden genera. The fauna, beyond doubt, is some phase of the Bowden or associated horizon, and straits connecting the Atlantic and Pacific at this stage of the Tertiary is thus conclusively proven.

Doctor Dall has compared the Bowden fauna to that of Bordeaux and the Aquitanian. Guppy has also compared the fauna to the Dax Miocene and the Bordeaux. The age of the Aquitanian has not yet been definitely settled. De Lapparent places it as Lower Miocene and the Stampian and Tongrian in the Oligocene. Most of the faunal comparisons made by Guppy indicate the same stage, but the Antillean fauna may have developed by convergent evolution from an earlier somewhat cosmopolitan fauna of Upper Eocene age, or we may be dealing with a case of parallel evolution. Most of the European forms identified in the Antilles—the corals, for example—by early investigators have been rejected by the investigators of today. Thus Vaughan rejects all Duncan's European species as occurring in the Antilles. It seems that an Atlantis is quite unnecessary to account for the faunal relationship between the West Indies and the Miocene of Europe. According to Hill, *Orbitoides mantelli*, a characteristic Oligocene form, does not occur in the Bowden beds. Thus the best evidence for Oligocene age has disappeared or is rendered doubtful. Hill states the exact date of this fauna as follows: "In my opinion, it was during late Miocene and Pliocene time, beginning with the Bowden epoch of the Jamaican sequence. Doctor Dall holds that the age of the Bowden beds is late Oligocene. It is my opinion that the stratigraphic relations of these beds in Jamaica indicate a later age. Deferring to Dall's opinion, I have tentatively accepted his conclusions, however, until more field-work can be done. Thus diastrophism indicates a Miocene age for Bowden fauna, as shown above. The lack of relationship between Miocene mammalian faunas of North and South America indicates a wide-spread submergence at this time. The Oligocene of the Pacific contains no forms common to the Bowden fauna. All investigators have recognized a number of living species in this fauna—Gabb, 30 to 40 per cent; Moore, 8 to 9 per cent; Guppy, 20 per cent; Brown and Pilsbry, about 5 per cent."

The following is a summary of the conclusions reached:

(1) No connections between Atlantic and Pacific oceans in the vicinity of Central America occurred during Cretaceous time.

(2) The Panama and Tehuantepec portals were closed during the Lower Eocene, but were open during the Middle or Upper Eocene.

(3) Straits existed during that portion of the Tertiary which is characteristically represented by the Bowden horizon.

(4) The Bowden fauna was probably evolved in part from a somewhat cosmopolitan Middle or Upper Eocene fauna and in part from Miocene or Oligocene faunas of provincial Pacific origin.

(5) The diastrophic record, the relations of Miocene mammalia of North and South America, the stage of evolution of the Bowden fauna in terms of the Recent, and the presence of several living species indicate that the age of the Bowden is probably Miocene and not Oligocene of some authors.

OCCURRENCE OF *NOTHROTHERIUM* IN PLEISTOCENE CAVE DEPOSITS OF
CALIFORNIA

BY CHESTER STOCK

(*Abstract*)

The ground-sloth *Nothrotherium* was originally described from material found in cave deposits of Brazil. A recent study of the ground-sloths from the Pleistocene deposit of Samwel Cave, Shasta County, California, has shown the presence of *Nothrotherium* associated with *Megalonyx*. *Nothrotherium* is known also from Potter Creek Cave, in Shasta County, and from Hawver Cave, in Eldorado County. The range of this ground-sloth in North America is apparently more restricted than that of *Myiodon* or *Megalonyx*. Except for its occurrence in California, the genus is known only from the Pleistocene of Texas, where it has recently been recognized by O. P. Hay.

CRETACEOUS AND TERTIARY HORIZONS IN THE MARYSVILLE BUTTES

BY ROY E. DICKERSON

(*Abstract*)

Recent investigations at Marysville Buttes, an ancient volcano of the Sacramento Valley, have revealed the presence of the Knoxville and Chico groups. The areas mapped as Ione in the Marysville folio are composed, in part at least, of four different terrains—the Knoxville, the Chico, the Tejon (*Siphonalia sutterensis* zone), and the Sutter formation. The last is a land-laid deposit consisting largely of rhyolitic debris of the first volcanic eruption. These terrains were in turn disturbed by an andesitic intrusion, thrown on edge and faulted in places.

The sequence of events which gave us the Marysville Buttes in their present form appears to be as follows:

(1) The accumulation of limestones and shales of Knoxville age in a great geosyncline, the eastern border of which was probably in the vicinity of the present site of the Marysville Buttes.

(2) A recession of the sea from the eastern border of the geosyncline during the deposition of the Horsetown horizon.

(3) The lowering of the continental margin and the deposition of Chico-Cretaceous strata by a transgressing sea from the west.

(4) A great time interval during which this site was land.

(5) Submergence at the end of Tejon time, which resulted in the deposition on the outer edge of the continental shelf of Eocene strata composed of foraminiferal shales, the deep-water equivalents of the inshore Ione of the Sierran foothills.

(6) Uplift.

(7) An intrusion of rhyolite and consequent upturning and faulting of Cretaceous and Eocene strata and outpouring of rhyolitic flows and ash deposits (the Sutter formation) on these faulted and folded sedimentaries.

(8) A period of erosion during which a large portion of the Sutter formation was removed.

(9) An intrusion into these older formations mentioned above and outpouring of andesitic materials from a great central volcano.

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(10) A long erosion interval during which short streams consequent on the lava slope cut through the andesitic lava into the softer underlying deposits. Of these deposits the softest is the Sutter. The pass between the towns of West Butte and Sutter City was cut in this material. The "secondary craters" described in the Marysville Buttes Folio appear to be erosion valleys formed in the Sutter formation by subsequent tributaries of consequent streams.

In conclusion, there does not appear to be any formation in the Marysville Buttes except the Tejon Eocene strata which could possibly be the equivalent of the Ione of the Sierran foothills. It has been shown above that these Eocene strata are the offshore equivalents of the inshore Ione.

FAUNA OF THE FERNANDO FORMATION OF LOS ANGELES, CALIFORNIA

BY CLARENCE L. MOODY

(Abstract)

An excavation near the center of the city of Los Angeles in 1913 brought to view a fossiliferous stratum about 15 feet from the surface which yielded a large marine molluscan fauna. Collections were made by Mr. J. Z. Gilbert, of the Los Angeles High School, and the material was intrusted to the University of California for study.

The fauna contains a number of forms of boreal habitat, while not a few subtropical species are represented. About 15 per cent of the fauna is extinct. Restricted Pliocene species are *Thracia trapezoides* Conrad, *Turris mercedensis* Martin, *Natica orbicularis* Nomland, *Pecten healeyi* Arnold, *Pecten opuntia* Dall, and *Pecten bellus* Conrad, beside ten species regarded as new.

The fauna has affinities with the Middle Fernando of Santa Clara Valley and with the San Diego Pliocene of San Diego and San Pedro. It seems to represent a higher zone in the Pliocene Fernando than has heretofore been recognized.

At the conclusion of the reading of the papers the meeting adjourned and the members of the Paleontological Society attended the dinner of the Le Conte Club at the Stanford Union.

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Notes

