PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY

HELD AT PHILADELPHIA

FOR

PROMOTING USEFUL KNOWLEDGE

Vol. XI

JANUARY 1869 TO DECEMBER 1870

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PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY.

Vol. XI. JANUARY, 1869. No. 81.

Stated Meeting, January 1, 1869.

Present, three members.

Mr. Eli K. Price, in the Chair.

A letter accepting membership was received from John Tyndall, dated London, May 21, 1868.

A request from Prof. Dawson for a set of the Transactions for the Montreal Natural History Society, was referred to the Committee of Publication.

The Surgeon General's Office, at Washington, was ordered to be placed on the list of correspondents to receive the Proceedings.

Donations for the Library were received from the Prussian Academy, Bureau des Ponts, Royal Astronomical and Geological Societies, Boston Natural History Society, Renselaer Polytechnic Institute, Franklin Institute, and Dr. Newberry.

The report of the Judges and Clerks of the Annual Election for Officers of the Society held this day, was read, announcing that the following named members were elected Officers for the ensuing year:

President.

George B. Wood.

Vice-Presidents.

John C. Cresson,
Isaac Lea,
Frederick Fraley.

Secretaries.

Charles B. Trego,
E. Otis Kendall,
John L. Le Conte,
J. P. Lesley.

Curators.

Franklin Peale,
Elias Durand,
Joseph Carson.

Treasurer.

Charles B. Trego.

Counsellors.

Frederick Fraley,
Robert Patterson,
Daniel R. Goodwin,
E. K. Price.

Pending nominations, Nos. 593 to 621 were read.
And the Society was adjourned.

Stated Meeting, January 15, 1869.

Present, ten members.

John C. Cresson, Vice-President, in the Chair.

Letters of acknowledgment were received from the Society of Emulation of Abbeville and the Royal Institution.

Letters of envoi were received from the Meteorological Office of the Royal Society, and from the Society of Physical and Natural Sciences at Bordeaux, requesting an exchange of publications, which was referred to the Secretaries with power to act.

A request for the loan of Mariana's History of Spain for six months from President Coppée, was referred to the Library Committee with power to act.

A copy of No. 80 of the Proceedings, just published, was laid on the table by the Secretaries.

Donations for the Library were received from M. Foucou, Mr. O. Warner, Secr'y Com. Massachusetts, Dr. B. A. Gould, Mr. S. Scudder, Boston Public Library, New Jersey Historical Society, Dr. Joseph Parrish, the Blind Asylum, Medical News, Librarian of Congress, Treasury Department, and Dr. Rushenberger.

The death of C. F. P. von Martius, at Münich, December 13, 1868, was announced by letter from his son, Dr. C. A. Martius.

The death of John Cassin, at Philadelphia, January 10, 1869, aged 55, was announced by Dr. Le Conte, and on motion of Dr. Rushenberger, Dr. Bridges was requested to prepare an obituary notice of the deceased.

The following communication was received from Prof. T. C. Porter, dated, Easton, Pa., Jan. 6, 1869.

Mr. Boyd's letter has arrived, and the following extracts contain all the information he can now give concerning the Indian inscriptions near Peach Bottom:

"The rocks from which I copied the figures sent you are granitic, very hard, and situated in the Susquehanna River about three miles below the Pennsylvania State-line and twelve or fourteen above Havre de Grace. During high freshets they are entirely submerged.

The inscriptions are numerous and in a fine state of preservation when not directly exposed to the abrading force of ice and drift-wood. They occur on the sides and tops of some half dozen rocks. Although at first sight they might seem to have no connection with each other, I have been able to trace an arrangement in horizontal and vertical lines. The grooves are semi-cylindric, and in some cases have a depth of half an inch or more.

My copies were taken by placing sheets of paper on the figures and coloring the portions lying immediately over the grooves. Thus, the outlines, if rude, are faithful and of full size.

Owing to the limited time at my command, I did not copy them all, but confined myself to the more curious.

The people of the neighborhood, although many of them are descended from early settlers who came into contact with the Indians then living there, seem to know nothing as to the origin or meaning of these figures.

I regret that the information I send you is so scanty, but, should the Philosophical Society desire it, it will give me great pleasure to make a thorough exploration of the rocks and their inscriptions, next July, when I expect to spend several weeks not far from the locality."

Dr. Brinton, present on invitation, addressed the Society upon the nature of the Maya group of languages, and, in his opinion, the great value of several manuscript grammars and vocabularies in the Society's Library. On motion of Mr. Fraley, the thanks of the Society were tendered to Dr. Brinton, and he was requested to furnish the Secretaries with an abstract of his remarks.

The Maya group of languages comprises those spoken in the old departments of Yucatan, Vera Paz, Chiapas, Guatemala, and Soconusco. The Huasteca also belongs to it, which was current in the province of Tamaulipas, about Tampico. The Natchez of Louisiana, and the Chahta-Muskoki family display some affinities with it, which have not yet been fully investigated. On the ethnological maps of Pritchard, Waitz, Bastian and Kiepert, and others, the Mayas are located on the Greater Antilles also, and it is the opinion of the Abbé Brasseur de Bourbourg, as well as some other writers, both ancient and modern, that the Mayas and Aztecs both look to the former inhabitants of Haiti—the so called Taini—as their common progenitors. For this opinion there is no sound foundation, as there can be brought abundant evidence to prove that both the tribes native in Cuba and Haiti, as well as those on the Bahamas, and those resident on the lesser Antilles before the arrival of the Caribs were Arrowacks, and came from South America.

The most important dialects of the Maya are the Yucatecan, the Quiche, the Cakchiquel, the Tzendal, the Pokonchi, the Huastecan and the Zahlopahkap. They are as closely allied one with another as the Romanic tongues of modern Europe, and have many points in common which give them peculiar interest, in fact the very highest interest, among American aboriginal languages.

Not merely were they the dialects of the most cultivated branch of all the red race, from which indeed the civilization of the whole Northern Continent probably proceeded, but they exhibit certain linguistic traits, allying them strangely to the more perfected tongues of the Old World. So strong are these resemblances that of recent writers Brasseur and Bastian both incline to hold them akin to the Aryan family, and possibly largely influenced by Scandinavian immigration in the eleventh century. This however is a baseless hypothesis.

The traits referred to are: 1st. Their less marked polysynthetic structure, approaching at times to a plainly inflectional character; 2d. Their harmonic repetition of vowels like that in Scythian tongues, the suffixes added to change the grammatical character of words often varying their vowel to agree with that in the terminal syllable of the root; 3rd. The pronominal affixes of the verbs, which are added to the verbal root to express the relation of the action, and form a regular conjugation precisely as was the case in the primitive Aryan tongue; 4th. The genesis of the pronouns, which as recently carefully investigated by M. H. de Charency has disclosed laws of growth of very general interest.

In these languages also, is found the only native American literature. The Mayas used a phonetic alphabet as well as ideographic writing, and thus preserved their chronicles and traditions for many centuries anterior to the discovery. At the Conquest, their chief literary monument, called the Book of the Mats (*i. e.* of the nobles, who sat on mats while the common people occupied the floors), the Popol Vuh, was written in Roman Characters in the Quiche dialect. This with several other similar works has been published in the original and with translations in Spanish and French.

As the Maya group may thus be considered the key to the civilization, the mythology, the literature, and earliest possible history of the red race, it is most desirable that any valuable manuscripts which throw light upon it shall be published. Two such exist in the Library of the American Philosophical Society, both short, both of the highest value, both unique and entirely unknown to scholars. One of these is a grammar covering 54 small 4to pages of the Cakchiquel dialect, the other still shorter, embraced on 32 small pages, and is the only existing grammar of the Chol or Putum dialect, spoken by the Lacandones, among the mountains of Vera

Paz. The former dates from 1692, and the author is unknown; the latter is a copy of the grammar of the Dominican missionary Francisco Moran, and is dated 1695. It is in duplicate, by different hands, and as the only known work on the Chol, deserves by all means to be placed within the reach of linguists. A quite full vocabulary is appended, and a sufficient number of prayers and dialogues in the dialect to allow a very satisfactory exhibit to be made of the whole structure of the dialect.

The longer Cakchiquel grammar could likewise be rendered extremely useful by the proper use of other manuscripts in that dialect now in possession of the Society, and which have not hitherto been used. These include several dictionaries, books of sermons, Confessionaries, and a copy of the earliest volume printed in any Central American dialect, the *Doctrina Christiana* of Marroquin, printed at Mexico, 1556.

The enlightened attention which this Society has always given to American linguistics, and the great benefit which the publication of these two small works, enriched by the notes and illustrations for which the Society's Library offers such abundant material, lead me to hope that your honored body will take the necessary steps to render them thus available to the learned world.

Mr. Lesley was nominated and elected Librarian for the ensuing year.

The Standing Committees were chosen for the ensuing year as follows:

Finance—Mr. Fraley, Mr. J. F. James, Mr. Marsh.

Publication—Mr. T. P. James, Dr. Carson, Prof. C. B. Trego, Mr. E. K. Price, Mr. Tilghman.

Hall—Mr. Peale, Mr. P. E. Chase, Mr. S. W. Roberts.

Library—Dr. Bell, Dr. Coates, Mr. Price, Mr. Barnes, Mr. Briggs.

The list of surviving members was read.

On the list, January 1,	1868,	U. S. 281,	Foreign,	142—423.
Elected in	1868,	U. S. 10,	Foreign,	1— 11.
Deceased in	1868,	U. S. 11,	Foreign,	5— 16.
On the list, January 1,	1869,	U. S. 280,	Foreign,	138—418.

Nominations Nos. 593—621 were read and spoken to.

The Committee on the Michaux Legacy reported a resolution for empowering M. Carlier of Paris, which was adopted.

New nominations Nos. 622, 623 were read.

The Publication Committee reported a recommendation to send the second series of the Transactions, complete, to the N. H. S. of Montreal, which was so ordered.

The ballot boxes were then opened by the presiding officer, and the following named gentlemen were declared duly elected members of the Society.

George H. Horne, M. D., of Philadelphia.
William M. Gabb, of Philadelphia.
Hakakian Bèy, of Cairo.
Linant Bey, of Cairo.
Auguste Mariette Bey, of Cairo.
Dr. Ceselli, of Rome.
Emmanuel De Rougé, of Paris.
Henri Brugsch.
Johannes Dümichen.
Françoís Chabas, of Chalons sur Sâone.
Samuel Birch, of London.
Edward Lartêt, of Paris.
Joseph Prestwich, of London.
Carl L. Rütimeyer, of Basel.
William H. Flower, of London.
George Rolleston, of Oxford.
Thomas H. Huxley, of London.
Joseph D. Hooker, M. D., of Kew Gardens.
John Phillips, of Oxford.
J. J. A. Worsaae, of Copenhagen.
Sven Nillson, of Lund.
Auguste Carlier, of Paris.
Benjamin S. Lyman, of Philadelphia.
Henry C. Baird, of Philadelphia.
Samuel J. Reeves, of Philadelphia.
Hector Tyndale, of Philadelphia.
Joshua B. Lippincott, of Philadelphia.
Horace Binney, Jr., of Philadelphia.
William Blackmore, of Salisbury (London) England.

And the Society was adjourned.

Stated Meeting, February 5, 1869.

Present, fifteen members.

Dr. GEORGE B. WOOD, President, in the Chair.

Mr. Binney, Gen. Tyndale and Mr. Lyman, new members, took their seats.

Letters of acknowledgment were received from the Academy at Amsterdam, Royal Library at the Hague, Batavian Society at Rotterdam, Zoölogical and Statistical Societies at London, Leeds Philosophical Society, American Statistical Society, Massachusetts and New Jersey Historical Societies, Boston City Library, Yale College, Peabody Institute, and also from the Philadelphia College of Physicians, returning thanks for a donation of duplicate pamphlets.

Letters of envoi were received from the Geog. Soc., Vienna, June 30; Holl. Soc., Harlem, May 20; Acad., Amsterdam, Sep. 2; Central Bureau of Statistics, Sweden, Nov. 25, 1868.

Donations for the Library were received from Prof. Zantedeschi; the Geographical Societies of St. Petersburg, Vienna and London; Academies and Societies of Amsterdam, Rotterdam, Harlem and Nürnburg; Antiquarian Societies at Copenhagen and London; Central Bureau at Stockholm; Astronomical and Geological Societies at London; Nat. Hist. Soc. and Pub. Lib., Boston; Amer. Oriental Society; Silliman's Journal; Medical News; Acad. Nat. Sci., Philadelphia; Dr. Carson; Wisconsin Historical Society; and Fendall's executors at Washington.

The Librarian communicated for publication in the Proceedings a vertical section of the coal measures of the Georges Creek portion of the Cumberland Basin, made some years ago, with great care, by the State Chemist and Geologist of Maryland, Mr. Philip T. Tyson of Baltimore. On motion it was referred to the Secretaries with power to publish.

SECTION OF CUMBERLAND COAL BASIN.

By Philip T. Tyson of Baltimore.

It contains the position and thickness of rocks of the entire "Potomac Coal Field," amounting to about 1400 feet.

In order to have a fixed base I have made the heights on the left hand margin from the level of tide water, beginning at 670 feet. This was obtained from the maps and profiles of the Baltimore and Ohio Railroad, of which I had copies.

I had also those of the Georges Creek Coal and Iron Company, which connected with the Baltimore and Ohio Railroad. In addition to these I caused numerous other levelings and measurements to be made between Georges Creek and the Savage Mount, and was therefore enabled to construct the entire section from actual measurement, with the aid of very extensive diggings, whilst making Geological Surveys for the Georges Creek Coal and Iron Company in 1852.

This section extends down to the Devonian, and I have also examined and find its beds precisely like those below the Yohogheny Coal Field and the Great Western Field, as seen in the Gap a few miles east of Connellsville.

The measurements from 670 to 1120 feet were taken on the Savage river and Potomac. From thence to 1349 feet on Mill run, which flows into Georges Creek. From thence to 1443 feet on Laurel run, which also flows into Georges Creek. From 1443 feet on the S. E. face of Dug hill, at the foot of which is Lonoconing.

Feet above Tide.	*Thickness.*	*Character of Rock.*
	1′ 6″	Shale.
	2′ 0″	Coal.
2050	19′ 0″	Shaley Sand Stone.
	23′ 6″	Shale.
	6′ 0″	Coal.
	12′ 0″	Limestone with Shale seams.
2000	13′ 9″	Fire Clay.
	3′ 9″	Unknown.
	27′ 3″	Nodules of Iron in Shale.
1950	27′ 9″	Shale.
	3′ 6″	Sand Stone, fine grain.
	2′ 6″	Shale.
	4′ 3″	Coal (2″ shale parting).
	10′ 0″	Fire Clay.
	3′ 6″	Coal.
1900	3′ 0″	Fire Clay.
		Sand Stone Shaley.
	51′ 0″	Sand Stone Micaceous.
1850		Sand Stone Coarse.
	42′ 6″	Shales, not fully examined.
	4′ 6″	Coal.
	2′ 0″	Shale.

Feet above Tide.	*Thickness.*	*Character of Rock.*
1800	1′ 0″	Coal.
	4′ 9″	Shale.
	10″	Coal.
	1′ 3″	Shale.
	1′ 0″	Shaley Sand Stone.
	4′ 8″	Shale ferruginous.
	14′ 0″	MAIN COAL.
	4″	Bands of Iron ore.
	11′ 8″	Shale.
	3′ 0″	Fire Clay.
1750	1′ 6″	Limestone.
	15′ 6″	Shale.
	29′ 0″	Sand Stone, fine grain.
1700	27′ 6″	Shale.
	2′ 6″	Coal.
	4′ 0″	Shale.
	16′ 8″	Shale. Ore No. 20 at its top.
	1′ 0″	Shale ferruginous.
	3′ 9″	Coal.
	1′ 0″	Shale.
	1′ 0″	Coal.
1650	2′ 6″	Ore Nos. 17, 18 and 19 in Shale.
	3′ 0″	Ore No. 16 in Fire Clay.
	6″	Shale.
	1′ 0″	Coal.
	7″	Ore No. 15 in Shale.
	2′ 0″	Ore balls in stratum of Fire Clay.
	6″	Shale.
	1′ 6″	Coal.
	2′ 6″	Shale.
	5′ 6″	Ores No. 13 and 14 in Fire Clay.
	1′ 6″	Sand Stone.
	6′ 6″	Ores 12, 11, 10, 9 in Shale.
	6′ 6″	Shale with ore balls Nos. 8 and 7.
	7″	Ore No. 6.
	4′ 3″	Shale with ore No. 5.
	6″	Coal.
	6″	Ore No. 4 in Shale.
	1′ 6″	Coal.
	2′ 0″	Shale.
	2′ 3″	Shale and Coal together.
	2′ 2″	Ore No. 3 in Shale.
	2′ 1″	Coal.
	6″	Shale.
1600	2′ 8″	Ore No. 2 in Fire Clay.
	4′ 10″	Ore No. 1 in Shale.

Feet above Tide.	*Thickness.*	*Character of Rock.*
	2′ 6″	Ore in Shale.
	1′ 6″	Upper black band Ore. — Undermine in the 3″ Coal and all the Ore above for 4′ will come down. If stacked in rows and self-washed for a month, it will yield 40 0-0.
	3″	Coal.
	2′ 0″	Shaley Sand Stone.
	4′ 6″	Shale.
	2′ 6″	Coal.
	3′ 0″	Limestone.
	3′ 6″	Fire Clay.
	8″	Coal.
	1′ 6″	Shale.
	1′ 6″	Shale ferruginous.
	1′ 0″	Shale.
	1′ 3″	Coal.
	1′ 3″	Shale.
	1′ 6″	Coal.
	1′ 6″	Shale.
	1′ 6″	Coal.
	2′ 8″	Shale, brown.
	5′ 0″	Shale, sandy with balls.
1550	8′ 0″	Shaley Sand Stone.
	4′ 6″	Shale.
	1′ 6″	Coal.
	7′ 4″	Fire Clay.
	5′ 0″	Shales ferruginous.
	7′ 0″	Shale with balls.
	2′ 0″	Shale ferruginous.
	1′ 0″	Shale.
1500	39′ 0″	Sand Stone.
	15′ 0″	Shale.
	3′ 0″	Ore in Fire Clay.
	6′ 0″	Limestone.
	2′ 0″	Ore in Fire Clay.
1450	10′ 0″	Shale.
	44′ 0″	Sand Stone.
1400	8″	Coal.
	10″	Shale.
	2′ 2″	Limestone
	23′ 6″	Sand Stone.

Feet above Tide.	*Thickness.*	*Character of Rock.*
	6′ 0″	Shale.
	6′ 0″	Hard black band.
	6′ 0″	Shale very ferruginous.
	4′ 6″	Shale.
1350	1′ 8″	Coal Shaley.
	1′ 0″	Coal hard. } 5′ 8″
	3′ 0″	Coal good.
	4′ 0″	Sandy Fire Clay.
	6′ 0″	Ore in Shaley Fire Clay.
	6′ 0″	Limestone.
1300	33′ 0″	Sand Stone.
	9′ 6″	Shale.
		{ Ore balls.
	11′ 0″	{ Marine shells.
		{ Balls in Shale.
	2″	Coal.
	6′ 0″	Shale.
	2′ 2″	Coal.
	14′ 0″	Shale.
1250	4′ 0″	Coal.
		{ Shales.
		{ Fire Clay.
	25′ 6″	{ Sand Stone.
		{ Not explored.
	2′ 0″	Coal.
		{ Unknown.
1200	102′	{ Coal crop near top.
1150		{ Sand Stone at bottom.
		{ Ferruginous Shale.
	24′ 0″	{ Grey Shale.
1100		{ Black Shale.
	2′ 0″	}
	6″	} Six feet Coal.
	3′ 6″	}
	3′ 0″	Fire Clay.
	6′ 0″	Shales with balls of ore.
	27′ 0″	Unknown.
	3′ 0″	Coal.
1050	4″	Shale.
	19′ 0″	Sand Stone.
	8″	Coal.
		{ Shales.
		{ Fire Clay.
	20′ 0″	{ Shales.
		{ Fire Clay.
	1′ 6″	Coal.

Feet above Tide.	*Thickness.*	*Character of Rock.*
1000	10′ 0″	Fire Clay.
950	92′ 0″	Sand Stone [XII]. This rock is constant. It makes the flat summit of the west mountain; and, north of Savage creek, has lying on it isolated cubic blocks, fragments of itself, as large as three story houses, very remarkable objects.
	3′ 0″	Large balls of ore.
900	14′ 6″	Shale.
	3″	Shale Coal.
	12′ 3″	Sand Stone, thin layers.
	2′ 0″	Coal.
	2′ 6″	Shale.
850	42′ 6″	(Sand Stone, &c., not explored.)
	7′ 6″	Ore in Shale.
800	83′ 0″	(Principally Sand Stone, ?)
750	2′ 6″	Coal.
	? ?	Shale. Small interval.
	27′ 0″	Sand Stone, thin bedded.
	2′ 0″	Lowest known coal bed.
	160′ 0″	Principally Sand Stone, but not much
550		explored.
	90′ 0″	Green Shale of XI.
450	? ?	Grey Limestone of XI.

Mr. Chase communicated the results of a careful discussion of Philadelphia Life Tables, extending through 62 years, and including more than 400,000 lives.

On motion of the Librarian, the subject of the propriety of publishing the MSS. grammars of the Chol and Cokchiquel languages, in the Society's Library, was referred to the Publication Committee, to report thereon, after consultation with Dr. Brinton.

Pending nominations Nos. 622, 623 were read.

At Prof. Coffin's request and on motion of Prof. Kendall, the Officers of the Society were authorized to sign a memorial to Congress praying for a sufficient appropriation for observing properly the total eclipse in August next.

On motion of Mr. Fraley the renting or otherwise disposing of the Hall was referred to a committee consisting of Messrs. Price, Fraley, Welsh, Rushenberger and Cresson.

And the Society was adjourned.

Stated Meeting, February 19, 1869.

Present, fourteen members.

Mr. Fraley, Vice-President, in the Chair.

Dr. Horn, a newly elected member, took his seat.

Letters accepting membership were received from Samuel Birch, dated British Museum, London, February 2d, and William H. Flower, dated College of Surgeons of England, London, February 1, 1869.

Letters of acknowledgment were received from the London Antiquarian Society, Nov. 23, 1868, for No. 77, the Essex Institute, Rhode Island Historical Society and University of New York City, all for No. 80 of the Proceedings.

A letter from M. Chevalier announced the transmission of a set of the reports of the Jury of the International Exposition of 1867.

A letter from Prof. Coppeé enclosed a receipt for Mariana's History of Spain.

Donations for the Library were announced from Prof. Zantedeschi, the Russian Academy, French Geographical Society, B. N. H. Society and Public Library, Mr. Eli K. Price, Dr. Kirkbride, Prof. Cope and Hon. Charles Sumner.

The death of Charles N. Bancker, at Philadelphia, February 16, 1869, aged 91, was announced by Dr. Hays with appropriate remarks, and on motion of Mr. Fraley, Judge Cadwallader was requested to prepare an obituary notice of the deceased.

Mr. Lea communicated for publication in the Transactions "Remarks on Thirteen New Species of Crinoidea, from the

Palæozoic rocks of Indiana, Kentucky and Ohio, &c. By Sidney S. Lyon of Louisville, with 4 plates," which was referred to a committee consisting of Mr. Lea, Mr. Cope and Mr. Lesley.

The Secretary, in the absence of Dr. Leidy, communicated for publication a memoir "On the Geological Age and Equivalents of the Marshall Group. By Prof. A. Winchell." Which was referred to a committee consisting of Mr. Lesley, Dr. Le Conte and Dr. Leidy.

A letter from Prof. F. V. Hayden communicated "Notes on the Geology of Wyoming and Colorado Territories, No. 2, with 6 wood cuts, already cut, and two ink sketches," which was referred to the Secretaries with power to act.

Prof. Cope exhibited and described a jaw of *Mylodon annectens* from the post-tertiary rocks of South America.

Prof. Cope exhibited the mandible of a gigantic sloth from the post-tertiary of the Banda Oriental in South America. He stated that it belonged to the genus Lestodon (Gervais) but approached in its characters the Myodon of Owen. He pointed out the anterior canine teeth of Megalonyx, the posterior canines of Lestodon, and the reduction of the same in Mylodon to the character of small premolars, less than the molars. In the species exhibited, the canine is removed to close proximity to the molars, and was as large as the first, immediately following it. The species differs not only in this respect, but in the form of this and other teeth from the Mylodon robustus (Owen), to which it is nearly related. The form of the symphysis is not very different, but is turned outwards at the anterior angles and emarginate medially. The lateral margin concave. The canine directed upwards, and more outwards than the molars. Its section presents longer straight inner and anterior sides, and a short convex outer side, which is connected to the inner by an oblique, slightly concave side. The second tooth or molar about the same size, and of subtrifoliate section, the outer lobe more obtuse, and less strongly separated by alveolar ridges than the two inner from each other. Third molar quite oblique, directed backward and inward, the section composed of four arcs separated by alveolar ridges. Posterior part of alveolus of last molar broken away, the anterior part narrower and more oblique than any other tooth.

Prof. Cope stated that the species seemed to be near the Lestodon myloides of Gervais, which was however so briefly described as to be scarcely recognizable. According to the characters of Lestodon, the canine tooth appears to be at a greater distance from the molar than in the present animal, where that distance is only twice as great as that between the first and second molars.

Prof. Cope described several points of novelty and importance in the memoir on the Fossil Batrachia of North America, which the Society is publishing in Part 1 of Vol. XIV. of its Transactions; and expressed a desire that the Society should permit him to illustrate the memoir with additional plates.

He pointed out that all the tortoises of the Cretaceous yet discovered were fresh water forms, many allied to Chelydra, and that there were no extinct land tortoises or Testudinidae in North America, the species from the Western Territories referred hitherto to Testudo being in fact Emydidæ. He called attention to the peculiar characters of the Mosasaurs and of the Streptosauria, as not having been previously pointed out, and stated there were eleven species of the first named group known to him from North America. One of these, M. depressus Cope, common in New Jersey, is defined by the transverse ovate form of the vertebral centra throughout the column, and the presence of a prominent rib of the outer face of the quadrate bone, throwing the meatal pit inward, and not reaching the proximal articular face.

He mentioned also the modifications of form in the Dinosaurian skeleton, by which an approach to the Birds was indicated. Thus the ilium from a vertical, assumed a transverse position, the acetabulum being thrown upward and forward, while the great size and inferior and posterior position of the other pelvic elements transformed the weight of the viscera posteriorly, to beneath the support. The consequence of this was the inclosure of a longer series of vertebræ as sacral, derived from the lumbar series, and the support of the body by a powerful hind limb, more nearly beneath the centre of gravity than in other types of reptiles. An additional approximation to the birds was seen in the hind limbs. The head of the femur was transverse to the condyles, and the crest of the ilium furnished with a very elevated crest. In the more quadrupedal forms as Iguanodon and Hadrosaurus the crest was much curved outwards, while in the biped types as Laelaps and Pœcilopleurum the crest projected more forward. In the latter also the astrogalus embraced the tibia in the closest manner, and presented to the foot at a remarkable angle. In Compsognathus this element had united with the tibia as in birds. The latter and Stenopelix Myo, he stated to be the best preserved in pelvic characters. He stated that these affinities had been explained by him at a meeting of the Academy of Natural Sciences of Philadelphia, in Feb., 1867, and had since been confirmed by other authors.

Nominations Nos. 622 and 623, and new nominations Nos. 624, 625, 626 were read.

And the Society was adjourned.

PHILADELPHIA LIFE TABLES.

By Pliny Earle Chase.

More than forty years ago Dr. Gouverneur Emerson, in the American Journal of the Medical Sciences, began his discussion of the vital statistics of Philadelphia.* His connection with the Board of Health gave him ready access to the original returns, and after subjecting them to a rigid scrutiny, he became satisfied that the sanitary condition of the city was remarkably good.

Doctors W. S. W. Ruschenberger, Wilson Jewell, James N. Corse and W. Lehman Wells, on behalf of the Committee on Epidemics and Meteorology, of the Philadelphia College of Physicians, subsequently published some interesting local nozological tables and conclusions. I cannot find that any other noteworthy use has been made of a valuable mortuary record, which has been kept with great care, and without interruption, from the commencement of the year 1807 until the present time.†

At the request of the Provident Life and Trust Company of Philadelphia, I have recently computed two comparative life tables, from the

* Among the results developed by Dr. Emerson's investigations connected with the movement of population and vital statistics of Philadelphia, embracing a period of about thirty years from the year 1807, when the first official Bill of Mortality was issued, are the following:

1. Great healthfulness of the city proper, in which the annual proportion of deaths to the population was only 1 in 56 (See Am. Med. Journal for Nov. 1827).

2. Excessive mortality in the colored population (Ibid).

3. Improved condition of colored population as indicated by reduction of mortality.

4. Excessive mortality of children in the warm months, and demonstration of the fact that the deleterious operations of heat are almost entirely confined to the first months of life, the influence of the seasons upon infantile mortality being scarcely perceptible after the first year of life has passed.

5. The excessive mortality of male over that of female children in the first stages of infancy, and demonstration that this is not owing, as commonly supposed—to greater exposure of male children to accidents, but to diseases and physiological causes peculiar to each sex (Am. Jour. of Med. Sciences, 1827 to 1831).

7. Practical conclusions drawn from results last mentioned (Ibid).

8. Seasons when most births take place (Ibid. Nov., 1845).

9. Influence exerted through epidemic cholera and other depressing agencies, tending to reduce the preponderance of male births (Same Journal for July, 1848, p. 78).

† "From authority vested in the Board of Health, this municipal power makes it obligatory upon physicians to give certificates designating the name, age, and sex of all who die under their care, and sextons are bound by still heavier penalties not to permit the interment of any dead body until such certificate is obtained, which he returns to the Health Office on the last day of every week, for publication" (Emerson; op. cit., vol. I, p. 117).

returns of the Board of Health, and of the several monthly meetings of the Society of Friends in the city and its immediate neighborhood.

The general Philadelphia table is more extensive than any table hitherto published for a single locality, being based upon records of 425,502 interments, 265,590 births, and seven successive decennial census enumerations.

The Friends' table is based upon records of 14,666 interments, 4,264 births, and eight enumerations of membership. This is the first table ever published that affords any basis for estimating the sanitary advantages of moderation, temperance, and a general regard for the laws of health and morality. The tables which have been constructed from the experience of different Tontines and Life Insurance Companies exhibit some of these advantages, with the added indeterminate advantage of medical selection.

The following definitions and explanations may facilitate the study of the tables :

The *possible life*, is the limit which is sometimes attained in a given district.

The *probable life* ("*vie probable*"), is the term at which one half of those who are born alive will have died. It is the age, the probability of living beyond which is as great as that of dying before the age is attained.

The *probable life at any age*, is the term at which one half of those who are living at that age will have died.

The *expectation of life* ("*vie moyenne*"), is the average age which will be attained by all who are born.

The *expectation of life at any age*, is the average after life-time of *all* who are living *at that age*.

The *mean expectation* is the average after life-time of *all* who are living.

The *proportionate mortality* at any age, is the ratio of the number dying during the year following that age to the number living at the precise age.

The *vitality* at any age, is in inverse ratio to the proportionate mortality at that age. If, for example, out of 1000 children born alive the average number of deaths under 1 year of age is 180.38, the proportionate mortality per 1000 is 180.38, and the vitality is $\frac{1000.00}{180.38}$ or 5.54.

Neither the *mean age at death* nor the *mean age of the living* furnishes a sufficient clue to the expectation of life, or any independent criterion of salubrity. Emigration, immigration, excess of births over deaths or of deaths over births, zymotic diseases, and other circumstances, variously disturb the normal values which are embraced in a perfect life table. Such a table represents an ideal stationary population, or one in which the number of annual births is exactly equal to the number of annual deaths, and one which is not affected by emigration or immigration.

By a joint examination, in accordance with the formulas of De Morgan, Davies and Farr, of the numbers living at any given age and the numbers dying at the same age, the disturbances to which all populations are subject can be mostly eliminated, and results obtained which will afford a proper basis for comparisons.

There are, however, some elements of uncertainty which cannot be removed by any method hitherto proposed. Among these are the following:

1. The old and still mooted doctrine of climacterics, or critical periods of life in which some great constitutional change is supposed to take place, appears to derive some confirmation from such irregularities as the alternate diminution and increase of proportionate mortality, in the Carlisle table, at the ages 21, 22, 31, 33, 46, 50, 89, 90, as well as from the increase of expectation, in the Carlisle table from 91 to 95, in Quetelet's Belgian table from 89 to 91, and in the Philadelphia table from 91 to 100.

2. Wherever a population is affected by immigration, two classes of disturbance may be looked for; one arising from the poorer class of immigrants, who live in the most unhealthy neighborhoods, exposed to privations and hazards which increase the mortality of infancy and youth; the other from a better class, like our house servants, the agents of importing houses, and persons of some property, who increase the average vitality towards the close of life.

3. In many places, especially in cities, almshouses and asylums for the aged furnish comforts which tend to prolong life. The tendency is aided by the freedom from care and anxiety, the infrequency of exhausting mental effort, and the watchfulness of friends or nurses.

4. In a Society with birthright membership, like the Society of Friends, nearly all the deaths in infancy and youth may be entered on the records. But after reaching maturity the ties of membership are often sundered for various reasons, and many of the deaths in old age may escape notice. The ratios of apparent mortality will thus be affected unfavorably, during the whole course of life.

According to the census of 1860, the foreign-born residents of Philadelphia constituted nearly thirty per cent. of the entire population. On this account any comparisons with other life-tables either in infancy or old age might convey an erroneous impression. But the mean expectation is probably but little affected by the foreign element, and it may very properly be considered in the following comparison with two of the most celebrated and one of the most unfavorable foreign tables.

Comparative mean expectations:

Price's London	23.70	years.
Philadelphia	31.46	"
Farr's English, No. 3, male	31.77	"
" " " female	32.33	"
Carlisle	32.66	"
Friends'	33.11	"

Notwithstanding the increased juvenile mortality consequent upon immigration, the Philadelphia table shows a possible life of 114, a probable life of 33.44, and an expectation of 35.09. I know no other city of much magnitude in which so favorable vital conditions have ever been reported.

In preparing the Philadelphia table the following values were ascertained:

Ratio of deaths of colored persons to entire number of deaths; for 62 years	8.7 per cent.
Do. from 1863 to 1867, inclusive	6.7 "
Average mortality, 62 years	1 in 47.836.
" Colored mortality, 62 years	1 in 27.763.
" " " 1858 to 1862, inclusive	1 in 34.780.
Ratio of still-births to total births	4.3 per cent.
" " " " deaths	5.8 "
" " living births to population	2.8 "
" " deaths to births	74.5 "
Natural annual increase	$\frac{5}{7}$ "
Average " "	3.3 "
" " immigration	2.6 "
Mean age at death	23.57 years.
" " of the living	24.29 "

Dr. Emerson's discussions showed a ratio of deaths of colored persons, as great as 16 per cent. of the entire number of deaths; an average white mortality varying between 1 in 38.25 and 1 in 56.53; an average colored mortality of 1 in 19 from 1807 to 1820 inclusive, and of 1 in 27.2 from 1821 to 1830 inclusive. We have no means of determining the ratio of colored mortality since the close of the war, but even if it should show a temporary increase, there can be little doubt that the general sanitary improvement noted by Dr. Emerson still continues. The diminution in the per centage of colored deaths, from 16 per cent. to 6.7 per cent., is attributable in part to this general improvement, and in part to the preponderating increase of the white population.

The advantages of regular habits are shown by the following comparisons:

	Friends.	*Philadelphia.*	*Advantage.*
Maximum vitality (age 12)	310.56	257.74	20.49 per cent.
Average proportionate mortality from 20 to 60 years of age	14.25	17.58	23.37 "
Expectation of life	43.73	35.09	24.62 "
Probable life	48.08	33.44	43.78 "
Proportionate mortality at birth	124.66	180.38	44.70 "

PHILADELPHIA GENERAL LIFE TABLE.

Age.	Living, Number.	Dying, Number	Proportionate Mortality, per 1000.	Expectation, Number of years.	Age.	Living, Number.	Dying, Number	Proportionate Mortality, per 1000.	Expectation, Number of years.
0	100,000	18,038	180.38	35.09	58	30,799	891	28.93	15.97
1	81,962	7,540	92.00	41.71	59	29,908	905	30.25	15.43
2	74,422	4,427	59.48	44.88	60	29,003	918	31.65	14.89
3	69,995	2,982	42.60	46.59	61	28,085	931	33.18	14.36
4	67,013	2,039	30.43	47.74	62	27,154	946	34.84	13.84
5	64,974	1,387	21.35	48.23	63	26,208	961	36.66	13.32
6	63,587	943	14.83	48.27	64	25,247	978	38.72	12.81
7	62,644	651	10.40	47.99	65	24,269	996	41.04	12.30
8	61,993	470	7.58	47.49	66	23,273	1,016	43.64	11.81
9	61,523	362	5.88	46.84	67	22,257	1,036	46.55	11.32
10	61,161	297	4.88	46.12	68	21,221	1,055	49.75	10.85
11	60,864	251	4.14	45.34	69	20,166	1,073	53.22	10.39
12	60,613	236	3.88	44.53	70	19,093	1,087	56.94	9.95
13	60,377	238	3.95	43.70	71	18,006	1,096	60.88	9.52
14	60,139	255	4.24	42.87	72	16,910	1,101	65.08	9.11
15	59,884	278	4.64	42.05	73	15,809	1,098	69.48	8.71
16	59,606	307	5.18	41.24	74	14,711	1,090	74.10	8.32
17	59.299	343	5.76	40.45	75	13,621	1,076	78.96	7.94
18	58,956	378	6.40	39.69	76	12.545	1,054	84.06	7.58
19	58,578	414	7.10	38.94	77	11.491	1,028	89.44	7.23
20	58,164	456	7.83	38.21	78	10.463	995	95.14	6.89
21	57,708	493	8.55	37.51	79	9.468	959	101.20	6.57
22	57,215	529	9.24	36.83	80	8,509	916	107.66	6.25
23	56,686	560	9.88	36.17	81	7,593	870	114.56	5.94
24	56,126	587	10.48	35.52	82	6,723	819	121.92	5.65
25	55,539	610	11.00	34.89	83	5,904	767	129.80	5.36
26	54,929	629	11.45	34.28	84	5,137	710	138.18	5.09
27	54,300	643	11.83	33.67	85	4,427	651	147.08	4.82
28	53,657	653	12.18	33.07	86	3,776	591	156.57	4.57
29	53,004	662	12.50	32.47	87	3,185	539	169.20	4.32
30	52,342	672	12.84	31.87	88	2,646	484	183.42	4.10
31	51,670	681	13.18	31.28	89	2,162	439	203.10	3.91
32	50,989	689	13.52	30.69	90	1,723	389	225.54	3.78
33	50,300	698	13.88	30.10	91	1,334	319	239.32	3.63
34	49,602	706	14.24	29.52	92	1,015	247	243.00	3.75
35	48,896	716	14.63	28.94	93	768	187	244.22	3.79
36	48,180	722	15.00	28.36	94	581	142	244.22	3.85
37	47,458	730	15.38	27.79	95	439	107	243.36	3.94
38	46,728	736	15.76	27.22	96	332	80	239.67	4.04
39	45,992	743	16.15	26.64	97	252	59	234.40	4.16
40	45,249	748	16.53	26.07	98	193	43	225.54	4.28
41	44,501	754	16.94	25.50	99	150	31	205.67	4.38
42	43,747	760	17.38	24.93	100	119	23	192.76	4.39
43	42,987	766	17.83	24.36	101	96	18	186.42	4.31
44	42,221	772	18.30	23.79	102	78	14	182.86	4.19
45	41,449	778	18.78	23.23	103	64	12	180.78	4.01
46	40,671	784	19.28	22.66	104	52	9	179.65	3.79
47	39,887	789	19.78	22.10	105	43	8	178.90	3.51
48	39,098	795	20.33	21.54	106	35	6	178.60	3.16
49	38,303	800	20.90	20.97	107	29	5	181.54	2.75
50	37,503	807	21.50	20.41	108	24	6	189.04	2.25
51	36,696	813	22.15	19.85	109	18	6	205.12	1.74
52	35,883	821	22.88	19.28	110	12	5	. .	1.37
53	35,062	830	23.66	18.72	111	7	4	. .	1.05
54	34,232	840	24.54	18.17	112	3	2	. .	.80
55	33,392	851	25.50	17.61	113	1	1	. .	.50
56	32,541	865	26.56	17.06	114				
57	31,676	877	27.70	16.51					

PHILADELPHIA FRIENDS' LIFE TABLE.

Age.	Living, Number.	Dying, Number	Proportionate Mortality, per 1000.	Expectation. Number of years.
0	10,000	1247	124.66	43.73
1	8,753	511	58 38	48.89
2	8,242	272	33.06	50.89
3	7,970	192	24.08	51.61
4	7,778	137	17.62	51 87
5	7,641	99	12.95	51.79
6	.7,512	72	9.55	51.46
7	7,470	53	7.12	50 95
8	7,417	40	5.40	50.32
9	7,377	31	4 25	49.59
10	7,346	27	3.56	48 80
11	7,319	23	3.24	47.97
12	7,296	24	3 22	47.12
13	7,272	25	3.42	46.27
14	7,247	27	3.80	45.43
15	7,220	31	4.28	44.60
16	7,189	35	4 85	43.79
17	7,154	39	5.48	43.00
18	7,115	44	6.18	42.24
19	7,071	49	6.90	41.50
20	7,022	54	7.66	40.78
21	6,968	58	8.38	40.09
22	6,910	62	9.00	39.43
23	6,848	66	9.55	38 78
24	6,782	68	10.00	38.15
25	6,714	69	10.40	37.53
26	6,645	72	10.72	36.92
27	6,573	72	11 00	36 31
28	6,501	73	11.24	35 71
29	6,428	74	11 48	35 11
30	6,354	74	11.70	34.51
31	6,280	75	11 90	33.92
32	6,205	75	12.10	33.32
33	6,130	75	12 31	32.72
34	6,055	76	12.48	32.12
35	5,979	76	12.65	31.52
36	5,903	75	12 84	30 92
37	5,828	76	13 02	30.32
38	5,752	76	13 18	29.71
39	5,676	76	13 32	29.10
40	5,600	75	13.45	28.49
41	5,525	75	13.58	27.87
42	5,450	75	13 72	27.25
43	5,375	74	13.85	26 62
44	5,301	74	14.00	25.99
45	5,227	74	14.13	25 36
46	5,153	74	14 28	24.71
47	5,079	73	14.46	24 06
48	5,006	74	14.68	23 40
49	4,932	73	14 95	22 74
50	4,859	75	15.30	22.08
51	4,784	75	15 78	21.41
52	4,709	77	16 40	20 75
53	4,632	79	17 15	20.09
54	4,553	83	18 02	19 43
55	4,470	85	19.04	18.78
56	4,385	89	20 20	18.13
57	4,296	92	21 48	17.49
58	4,204	96	22.90	16.87
59	4,108	101	24.45	16.25
60	4,007	104	26.12	15.64
61	3,903	109	27.95	15.05
62	3,794	114	29 90	14.47
63	3,680	118	32 00	13 90
64	3,562	122	34 26	13.34
65	3,440	126	36.72	12.80
66	3,314	130	39.40	12.27
67	3,184	135	42.32	11.75
68	3,049	139	45.50	11 25
69	2,910	142	48.94	10.76
70	2,768	146	52.68	10.29
71	2,622	149	56.70	9.83
72	2.473	151	61.04	9.39
73	2,322	152	65.65	8.97
74	2,170	153	70.58	8.56
75	2,017	153	75.82	8.18
76	1,864	152	81.32	7.81
77	1,712	149	87 10	7 45
78	1,563	145	93.14	7 12
79	1,418	141	99.42	6.80
80	1,277	136	105.96	6.49
81	1,141	128	112 72	6 20
82	1,013	122	119 72	5.93
83	891	113	126.94	5.67
84	778	104	134.40	5 42
85	674	96	142.10	5 18
86	578	87	150 00	4.95
87	491	77	158.10	4 74
88	414	69	166 42	4 54
89	345	61	174 93	4.34
90	284	52	183.66	4.16
91	232	44	192 62	3.98
92	188	38	201 80	3 81
93	150	32	211 25	3.65
94	118	26	220.98	3.49
95	92	21	231.02	3.34
96	71	17	241.38	3.20
97	54	14	252 14	3.05
98	40	10	263.30	2.91
99	30	9	274.92	2.78
100	21	6	287.02	2.64
101	15	4	299.66	2.50
102	11	4	312.92	2.35
103	7	2	326.85	2.19
104	5	2	341 54	2.01
105	3	1	356.75	1 80
106	2	1	372.87	1.52
107	1	0	389 96	1.12
108	1	1	. .	50
109				
110				
111				
112				
113				
114				

Stated Meeting, March 5, 1869.

Present, eighteen members.

Dr. Wood, President, in the Chair.

Mr. Baird, lately elected a member, was introduced to the presiding officer and took his seat.

Letters accepting membership were received from J. J. A. Worsaae, dated Castle of Rosenborg, Copenhagen, February 4, 1869; from J. Chabas, dated Chalon sur Saône, Feb., 1869; from Ed. Lartêt, dated Paris, No. 25 Rue Lacépède, February 15, 1869; from T. H. Huxley, dated Royal School of Mines, Jermyn Street, London, February 16, 1869; and from W. M. Gabb, dated Philadelphia, February 19, 1869.

A letter declining appointment to prepare an obituary notice of John Cassin was received from Dr. Bridges, dated Philadelphia, February 20, 1869.

Letters acknowledging the receipt of the published Proceedings of the Society, Nos. 75, 76, 77, were received from G. Kirchhoff, dated Heidelberg, October 22, 1868; from Professor Hornstein, Director of the Prague Observatory, dated November 5, 1868; and from the Royal Society of Antiquaries, Copenhagen, September 1, 1868.

Letters of invoice were received from the Royal Society of Antiquaries; the Jablonowsky Society of Leipsic, November 11, 1868; the Academy of Sciences at Vienna, November 4, 1868; the Swiss Polytechnic School at Zurich, November 27, 1868; the Royal University at Norway, Christiania, November, 1868; and the United States Legation at Paris, February 8, 1869.

A letter was read from M. A. Carlier to Mr. Durand, respecting proceedings taken in the case of the Michaux Legacy.

Donations for the Library were received from the Natural History Society at Moscow, the Geographical Society and Physical Observatory at St. Petersburg, the Royal University of Norway, the Royal Saxon Society, the Prince Jablonowsky Society at Leipsic, the Societies at Görlitz, Emden, Lausanne, and Geneva, the Academy of Sciences at Vienna, the Geographical Society and Bureau des Ponts et Chaussées at Paris, the Royal Astronomical, Meteorological and Chemical Societies of London, Sir John F. W. Herschel, the Boston Natural History Society, the New York Lyceum, the Franklin Institute, the Medical News, the Episcopal Church Hospital, Gen. W. F. Palmer, the Rev. Albert Barnes of Philadelphia, the Peabody Institute of Baltimore, the Public Library of Cincinnati, the University of Michigan, and the California Academy of Sciences at San Francisco.

A record was made of the decease of J. K. Paulding and Alexander Stevens, M. D., of New York.

The committee to which was referred the paper on thirteen new species of Crinoidea, in the Palæozoic rocks of North America, in Kentucky, Indiana and Ohio, by Col. S. S. Lyon of Louisville, presented their report, recommending its publication in the Transactions of the Society, which, on motion, was so ordered.

The committee to which was referred the paper on the Marshall Group, by Prof. A. Winchell, reported, recommending its publication in the Proceedings; on motion, it was referred to the Secretaries with power to act.

Pending nominations Nos. 622 to 626 were read.

And the Society was adjourned.

NOTES ON THE GEOLOGY OF WYOMING AND COLORADO TERRITORIES.

No. 2.

By F. V. Hayden.

Before describing the geological character of the Laramie Plains and the country to the west of it, I will attempt to present a resumé of the physical geography of that very interesting region. If we look at the profile of the route constructed by the Union Pacific Railroad for their road from Omaha to Fort Bridger, we shall find that at Omaha, the initial point, the altitude is 968 feet above tide level. At the mouth of Lodge Pole creek, a distance of 377 miles, we have an elevation of 3528 or a gradual rise in that distance of 2560′ or a grade of about 7 feet to the mile. From the mouth of Pole creek to Crow creek crossing near Cheyenne 513.76 miles west of Omaha we have reached an elevation of 6019 feet, or an average grade of over 9 feet to the mile for the entire distance.

At Evans' Pass on the summit of the Laramie range, we have reached the highest point in the Rocky Mountains, 8248′, a distance of 545.62 miles west of Omaha. The average grade is over 13 feet to the mile. But for 100 miles west of Omaha the average grade of ascent increases as we approach the mountains.

If we take the distance from Crow Creek Crossing at the foot of the mountains to Evans' Pass, "the Summit," a distance of 31.86 miles, we have an average grade of ascent of nearly 70 feet to the mile. We can see clearly by these figures the plan of growth of that portion of our continent west of the Mississippi. A number of these profiles have been constructed across the continent from the Mississippi to the Pacific ocean, from the north line to the south, all pointing to the same result, and all agreeing substantially in the aggregate results.

Passing over this first range of mountains to the Laramie plains, from Crow Creek Crossing to Laramie river 57.53 miles, and 571.39 miles west of Omaha, the elevation is 7175 feet above tide water. Showing that even in the plain country on the west side of the first range the elevation is over 1000 feet higher than at the base of the mountains on the east side.

From the latter point westward there is a continued line of ascent and descent produced by the same forces that elevated the whole Rocky Mountain Chain. Passing the Humbolt mountains we then descend by a moderate grade to the Pacific ocean. The intermediate portions are occupied by a continued series of more or less elevated mountain ranges with intervening valleys which are always at a considerable height above the sea, but vary at different points from east to west. For example the elevation of the Laramie plains near Fort Sanders is 7175 feet, at Salt Lake Valley 4285, making a difference of 2990 feet. We shall endeavor to show hereafter that this difference in the elevation of the two localities of nearly 3000 feet operates most favorably upon the agricultural resources of Salt Lake Valley. While the summers in the Laramie plains are very brief, and it will always be difficult under the most favorable circumstances to produce crops to any extent, the productions of Salt Lake Valley are among the finest in the world.

We can see at a glance therefore that the whole country west of the Mississippi is as it were an elevated Plateau, out of which rise, as if by the bursting of the crust, a vast series of ranges of mountains, trending in the aggregate nearly north-west and south-east, and each of the series made up of an infinite number of minor ranges trending in almost every possible direction. In many instances important ranges of mountains are separated from the main chain by extended plains composed of cretaceous or tertiary formations, and without a knowledge of the geological structure of the country, they would seem to be entirely disconnected.

The Black Hills of Dakota, occupy an area of 6000 square miles. If we examine the map this important range seems to be entirely isolated from the main range, but from the south-western side extends a low anticlinal valley, just exposing the tertiary and for a portion of the distance the cretaceous beds, and linking the Black Hills with the Laramie range near Fort Laramie.

Again, the same may be said of the Big Horn range, from the south-east end of which along the valley of Poison Spring creek extends an anticlinal valley, joining the Big Horne range with the Laramie near the Red Buttes. All these isolated ranges, however distant they may appear to be from the main range, or however small they may be, are really connected to the eye of the geologist. It is thus that the anatomy of this great mountain system can be worked out in detail. Never can it be well done, so as to command the unqualified approbation of the scientific world, until the minutest topography and the geology are united together.

The northern portion of the Laramie range properly commences near the Red Buttes. Here the nucleus of feldspathic granite or syenite is concealed by the overlying unchanged beds, and a broad interval occurs which is occupied by a great variety of formations, ranging from the carboniferous to the most recent tertiary. In its southward extension this range seems to flex around from an almost easterly trend to a south-west direction, forming almost a half circle. It then joins on to the main range in the neighborhood of Long's Peak. Thus the Laramie range constitutes the east side and the greater part of the north side of the Laramie plains which forms, thus enclosed, a huge park. On the south side is the Medicine Bow range, the loftiest ridges covered with perpetual snow. Connected with this range also are numerous minor ranges. The west side is an open rugged barren sage plain, with here and there detached small mountains extending far westward toward Salt Lake valley.

The Laramie range forms the most beautiful illustration of an anticlinal ridge I have ever met with in the Rocky Mountains, with the exception of the Black Hills of Dakota. Either one of these ranges if thoroughly studied, would form excellent monographs of the physical geography and geology of the mountain region.

The nucleus of the Black Hills is composed of red feldspathic granite and other metamorphic rocks, and inclining from the flanks may be seen the upturned edges of the Potsdam sandstone, Carboniferous limestones, brick red sands and sandstones. Triassic, Jurassic marls, Cretaceous and Tertiary rocks, all dipping at various angles, but in such a way as to be easily accessible to the student.

The Laramie range is equally systematic in its plan of development but rather more complicated, and the results of erosive action are much more strongly shown and the superficial deposits or drift in many places conceal the underlying rocks. Like the Black Hills the Lamarie range does not give rise to any important streams of water. Myriads of little streams originate in or near the dividing ridge and cut their channels down the slopes and flow into the North or South forks of the Platte.

The main branch of the North Platte rises in the range of mountain which forms the north side of the Middle Park, very near Long's Peak. It takes a course a little west of north, flows through the middle of the north park, cutting its way through immense canons between the North Park and the Laramie plains. It then continues nearly a north course through tertiary as well as cretaceous rocks to its junction with the Sweet Water, when it bends around to the eastward so that near the Red Buttes its course is nearly south-east until it reaches the main Platte near Long. 101°.

The Sweet Water, which is the principal branch of the North Platte, rises in the southern end of the Wind river mountains, and flows nearly east and unites with the North Platte near Independence. These streams flow through nearly every variety of geological formations which occur in the West. From the junction of the Sweet Water to Red Buttes, it flows through granite, carboniferous limestone, red beds, jurassic marls, and White river tertiary beds. From the Red Buttes, through lignite-tertiary to a point about 100 miles north-west of Fort Laramie. There the White river tertiary beds overlap the lignite-tertiary, and then contiuue to the forks of the Platte.

The Medicine Bow and the two Laramies are important branches of the North Platte, and take their rise in the lofty snow capped mountains on the south side of the Laramie plains. The region north of the North Platte is mostly a vast sage plain and but few small branches flow in from that direction, but a multitude of small streams cut deep channels through the sides of the Laramie range and flow into the North Platte.

From Red Buttes to Fort Lamarie, a distance of 150 miles, many beautiful little streams rise in the Laramie and pour a good volume of water into the Platte. These creeks occur every few miles, and in their passage from the mountain they have not only worn a deep channel in the steep side of the mountain, sometimes 1000 feet or more in depth, but they have also scooped out a wide deep valley which affords the best of pasture, ground for stock in summer and warm sheltered places in winter.

The main branch of the South Platte rises in the range of mountains which bounds the west side of the south park, and flows about north-east to Cache la Poudre, and there bends round slightly toward the east and joins the main Platte. The little branches that flow from the mountain sides are very numerous, and each one cuts a tremendous channel through the sides of the mountain, affording most excellent sections of the strata for the geologist. Nearly all the branches that rise in the plains have very wide valleys, but are mostly dry, especially in the latter part of the summer and autumn. Although the Platte river is never navigable at any season of the year, yet the area drained by it is immense, at least 800 miles from east to west and 350 from north to south, or an area of nearly 300,000 square miles; and yet the North Platte is one of the minor branches of the Missouri river.

The South Platte flows through the different formations along the flanks of the mountain; and in its course through the plains cuts the lignite-tertiary for 50 miles or more, when the White river tertiary overlaps the plains to the junction.

The above brief remarks are intended principally to show by the geography the gigantic scale upon which every thing in this Western Country is planned, that even the district drained by the Platte and its branches is larger than all New England, New York and Pennsylvania.

September 1st, I left Fort Sanders with my party to examine the country along the southern border of the Laramie plains. We passed over the different beds of the cretaceous period for about 30 miles, until we reached a point near Cooper's creek, when indications of the tertiary begin to overlap the cretaceous.

The examples of the erosive action of water along the northern side of the mountains that border the Laramie plains are numerous. In the valley of Cooper's creek near the foot of the mountains there is a triangular space about five miles long, and two or three miles wide on the south-west side. On the south side there is a hill 500 feet high, the summit of which is composed of drift, and the surface paved with partially worn rocks. On the north-west side there is a long ridge, the top of which is composed of the yellowish sandstones of cretaceous formation No. 5, in which a few characteristic species of fossils, like *Inoceramus*, occur. These ridges seem to converge about two miles below the Stage Station, so that the creek passes through a sort of gorge. The valley of the creek is covered quite extensively with drift materials derived from the neighboring mountains.

Six miles west of Cooper's creek we find the first good exposure of coal. The upper cretaceous beds crop out occasionally in that vicinity, but are overlapped by the coal bearing strata.

The slopes are all so gentle and the superficial drift covers the country to such an extent that I found it difficult to get a good section. No. 5 (cretaceous) seems to pass gradually up into the coal-bearing beds, and the change in the sediments of the two systems is slight.

What appears to be the lowest bed of the coal-bearing series in this region, is a brown grit, very loosely aggregated with, sometimes, irregular layers of sandstones ; at other times inclosing concretions, with concentric layers or composed of thin laminæ and readily cleaving in pieces on exposure to the atmosphere. Immediately underneath the coal lies a bed of drab clay varying in thickness from three to five feet. The first locality where the coal is exposed by the uplifting of the beds is near a small lake. The dip is about 10° towards the north-east and from the mountains. There is about six to eight feet of pure and impure coal together. Above, is a bed of drab clay ; and over this again a layer of fine grit, capped with hard sandstone. The clay over the coal is full of small rounded nodules of iron and yellow sandy concretions.

About a mile west from this locality is another outcropping of coal. The bed is here separated by about 2½ feet of drab arenaceous clay, with five feet of excellent coal above and six to eight feet below, making in all from ten to twelve feet of solid coal. Some of it has a dull bituminous look, other portions are as glistening and black as anthracite. Above the coal is the usual clay bed, many layers in which are largely composed of the stems and leaves of plants. Above this there are beds of loose rusty brown sand and sandstone with some ferruginous concretions ; and a layer of light brown very compact silicious rock caps the hill. The dip of the beds is not more than 3° to 5°. At the immediate entrance to the mine the inclination is about 5°. The coal can be easily wrought and the mine well drained, in spite of its clay roof. The coal is of excellent quality, but like most of the brown coals of the west, crumbles on exposure to the atmosphere, as appears from the condition already of the large coal heaps in front of the mine.

So far as I have been able to ascertain, I am inclined to believe that the coal bed already alluded to is the lowest in the region and identical with the one so successfully worked at Carbon Station on the line of the Union Pacific Railroad ; but I do not think that it is the oldest coal bed in the tertiary series of the West.

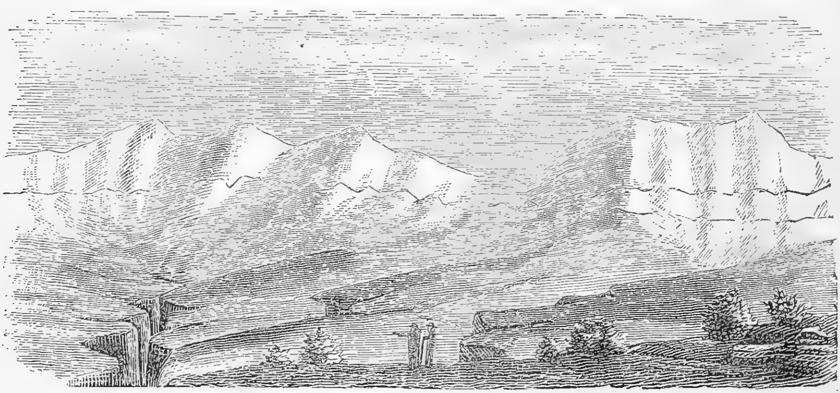
The valley of Rock creek is from three to five miles in width and evidently a valley of erosion. On the west side of it there is a ridge at least 500 feet high, composed of tertiary beds, which in some places incline 10° to 15°, but the general dip is not more than 5°.

On both sides of the stage road for ten miles west of Rock creek there is a large area covered with huge piles of rusty brown sandstone, mostly concretionary. In some localities a great many impressions of deciduous leaves were found. The tertiary beds extend to the mountains and form a large part of the foot hills. Here lofty wall-like exposures of sandstone make their appearance, giving a very rugged appearance to the country. As far as the eye could reach we saw peculiar looking pyramidal, conical and dome-shaped hills, from 300 to 500 feet high, composed of alternate layers of rusty yellow sandstone and greenish gray indurated sands, which are sometimes in the valleys of streams exposed for a thickness of 1000 or 1500 feet. These beds incline gently from the mountains, about north-east.

Since crossing the Big Laramie river exposures of the red beds have not been observed in the foot hills of the mountains. Usually they form a most conspicuous feature in the scenery. Their absence here is due either to the comparatively small erosive action, insufficient to wear away the cretaceous and tertiary beds; or to the fact that they are covered with a thick deposit of drift. The inclination of the beds are gentle and the ascent of the mountain side is as it were by steps; one series of foot hills rising slowly above another, until the snow capped ranges are reached. In this region all the hills, and even the gorges through which the little streams flow, are so covered with debris and the whole surface is so clothed with grass, that the rough points are smoothed down and the underlying rocks are difficult to see. Even Elk mountain, which must rise at least 1500 feet above the bed of Medicine Bow creek, is so smooth and so covered with grass, that the rocks are nowhere visible.

North of the road for 30 miles or more, the tertiary beds are on the contrary worn by atmospheric agencies into a great variety of rugged forms, so that the scenery recalls portions of the "Bad Lands" on the Upper Missouri composed of the same formations. Fig. 1 illustrates the character of the coal-bearing formation of the Upper Missouri, but is equally descriptive of the region under notice. The feature of greatest interest is that which affords evidence of comparatively recent glacial action, not merely in valleys of erosion, but in vast deposits of water-rolled rocks, everywhere visible. The mountain sides toward the plains are literally paved with rounded boulders, commonly of no great size; but the sides of the hills opposite the mountains, have scarcely any on them, and are in most cases covered with bushes or with grass. The bottoms of the streams are also covered with pebbles or boulders; and the nearer the mountains the larger and more numerous these rocks become.

FIG. 1.



The Medicine Bow creek, a fine mountain stream fringed with a considerable belt of cotton-wood, has a valley extending far into the mountains, with a gradual ascent. It is by far the most beautiful valley west of the Laramie river. Although covered thickly with boulders the soil is good, and the grass excellent. It has been for years a favorite pasture ground.

Elk mountain is a short range of spurs with its highest point fronting the creek; it resembles the short range, with abrupt front, east of the Little Laramie. The metamorphic rocks have been uplifted, while the unchanged rocks have remained quiet, or been let down at the foot of the mountain, without leaving that series of upheaved ridges which we find running along the base of most of the mountains. The range is about 10 miles long, forming what I have called an abrupt anticlinal; that is, on one side of the mountain the anticlinal is complete, the unchanged rocks inclining *from* the mountain in regular order of sequence; while on the mountain side the rocks are nearly vertical, and the sedimentary beds jut up against the base, their edges being entirely concealed. Against the north side of Elk mountain the cretaceous and some of the tertiary beds jut so abruptly that all the older rocks are concealed, while on the opposite side, the entire series, from the granite nucleus to the cretaceous formation, may be measured across their upturned edges.

Along the immediate base of the mountains there is a belt of country which in many instances might be called a monoclinal valley. It has been even more smoothed by erosion than any of the valleys of the streams, and always runs at right angles to them. Through this valley of erosion the old stage road and Western Union Telegraph line is located.

North of the road can be seen a series of upheaved ridges somewhat irregular in their continuity but gradually receding northward like sea waves. The first ridge is composed of a series of dark brown indurated clays and sands, with layers of more or less laminated rusty sandstone of fine texture, and tendency to concretionary forms, varying rapidly in thickness from 2 to 10 or 12 feet, dipping N. 20° W. from 5° to 10°, 20° west of north. In this ridge are quite extensive beds of lignite, one of which is about six feet thick separated into three parts by layers of clay. In the harder layers above and below are great quantities of indistinct vegetable impressions. The interval between the first main ridge and the second is about 1½ miles, and in that interval several lignite beds crop out with layers of light gray fine grained siliceous rock.

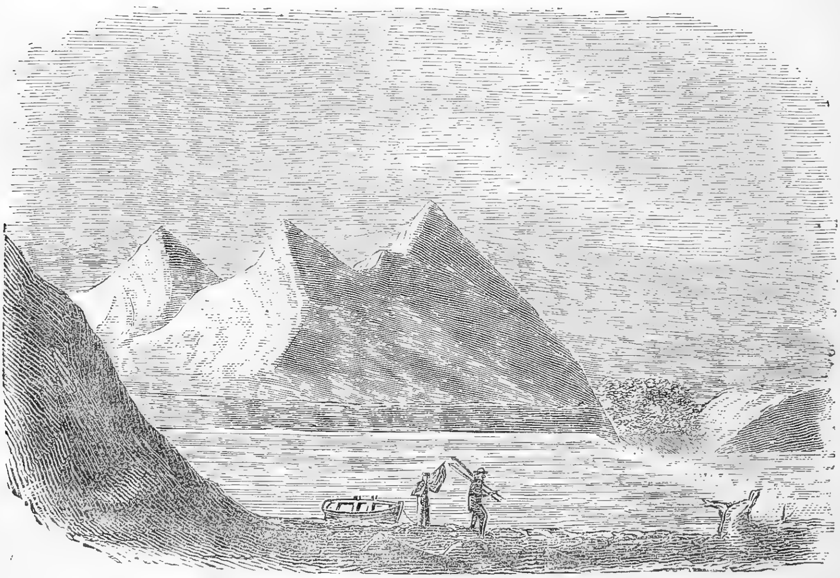
The second main ridge is composed of a variety of beds inclining 3° to 5°, the general color being brown, or light drab, while the harder layers are rusty sandstones. One bed, perhaps 50 feet thick, is of fine gray indurated sand with a greenish tinge. At the summit of this ridge were very distinct indications of the lignite bed at some period in the past. Several feet of rocks were baked to a brick red color, and fragments of completely fused rock lay scattered about. From the bed of the Medicine Bow to the summit of the second ridge I estimated that 1200 to 1500 feet of strata were exposed to view, and from the presence of lignite and deciduous leaves I regarded them all as belonging to the tertiary series. Some of the sandstones are made up of an aggregate of crystals of quartz and feldspar, showing that the materials were derived at least in part from the metamorphic rocks. Many of these sandstones disintegrate by exfoliation, or exquamation, and have the rusty spherical concretions scattered through them.

The main trend of these ridges is N. E. and S. W. The general appearance of the country is extremely desolate and cheerless; scarcely any vegetation but sage and grease-wood; with here and there a little lake, which from its alkaline character only adds to the dreariness of the scene.

Near the summit of the second ridge in the burnt rocks are quite abundant impressions of plants; and more especially lower down, about the middle of the ridges, there is a layer of the iron rocks about 2 feet in thickness largely composed of fragments of leaves.

A few miles west of Fort Halleck a very conspicuous hill, called Sheep mountain, is composed of carboniferous limestones, red beds; and is probably capped with lower cretaceous rocks. These beds incline 25°, but a very hard bed of sandstone capping the summit dips 35°. There appears to be an unusual thickness of triassic (?) rocks at this locality. The average dip of the strata is from 30° to 50°, varying between west and north.

FIG. 2.



From Medicine Bow river to Rattle Snake Pass, a distance of about 30 miles, the road extends through a monoclinal valley.* For nearly our

* Fig. 2 illustrates the character of the upheaved ridges which everywhere are seen upon the margins of the mountain ranges, extending in many cases for miles, like waves; and the geologist can walk across the upturned edges of all the formations from the granite to the most recent tertiary inclusive.

entire route the road seems to form the line of separation between the cretaceous and tertiary rocks, the former being well displayed on our left, jutting up against the mountain sides; the latter extending in wave like ridges into the distance on our right. As we approach Pass creek however about 5 miles to the east, the cretaceous beds reveal themselves clearly on the right side of the road, No. 5 attaining a great thickness; while, on the left, inclining from Sheep mountain Numbers 3 and 2 are very plainly shown in a series of irregular and rather low ridges. All along Elk mountain the red beds are visible but not conspicuous, and they do not give color to the debris at the foot of the hills. In this vicinity the tertiary beds must be at least 5000 feet thick, which, with an equal thickness of the cretaceous, makes in all at least 18,000 feet, a larger development than I know at any other point to the eastward. Indeed we shall be able to show that these formations continue to increase in thickness as we go west.

On the north side of Pass creek we have an uplift of rather fine grain yellow sandstone, which presents a front like a wall composed generally of vertical columns. On the summit are isolated piles of every form, the relics of erosion. The sandstone is about 200 feet in thickness and the ridge inclines northward at an angle of about 19°. The trend of all these ridges varies between north and west.

As we emerge from the hills through the Pass on the Pass creek, we strike a vast open plain, and the ridges of upheaval seem to pass off and die out en echelon in the plain, the ends making a gentle flexure from the west northward, so as to form one side or rim of the plain. There appears to be in these formations many alternate beds of brownish yellow sand and sandstones, the whole readily yielding to atmospheric influences, covering the hills as well as the valleys, with a great depth of fine sand, from which the long lines of harder sandstone project. These ridges of upheaval run at various distances from each other, from 100 to 1000 yards, with monoclinal valleys intervening.

The broad plain west of Elk mountain must be a region of depression; or a portion of the country left undisturbed while the surrounding parts were elevated. As far as the eye can reach this plain appears to be perfectly level; and no cuts to show the character of the underlying beds. A thick deposit of drift covers every thing. On its northern side the mountain ridges seem to trend about north-east and south-west, the southern end sloping gently down with the plain. The rusty calcareous sandstones which form the inner ridges facing the plain are undoubtedly cretaceous and incline 30° to 45°. These rusty sandstones here form a belt about 1½ miles in width, with intercalated layers of yellow arenaceous material covered with grass, only the harder layers projecting here and there above the surface. In one of these higher ridges of sandstone a Baculite (*B. ovatus*) was found. In another ridge was a seam about six inches in thickness composed entirely of a small oyster about the size, "though probably distinct from" *O. Congesta*. In the plain country, even far distant from the mountains, the rocks are more or less disturbed, but generally not exposing older beds than the cretaceous.

We find also that there is an irregular series of anticlinals and synclinals resembling somewhat, but on a gigantic scale, the furrows in a ploughed field. Not unfrequently we meet with a high synclinal ridge, formed of rocks inclining toward each other; and then following the same beds along and across the ridges we shall find them dipping away from each other making a synclinal valley.

I have given my observations along this route somewhat in detail from the fact that no accurate information concerning the geology of this region has ever been published; and because we have had no definite data for coloring a geological map. Our course was along the Overland Stage Road just at the base of the mountains, on the south side of the Laramie plains, from 5 to 20 miles south of the Union Pacific Railroad line; and by comparing my observations of the geology along the stage road with those along the line of the railroad it will be seen that there are many points of difference. As I have before remarked, the Laramie range of mountains forms one of the most complete and beautiful anticlinal systems in the West.

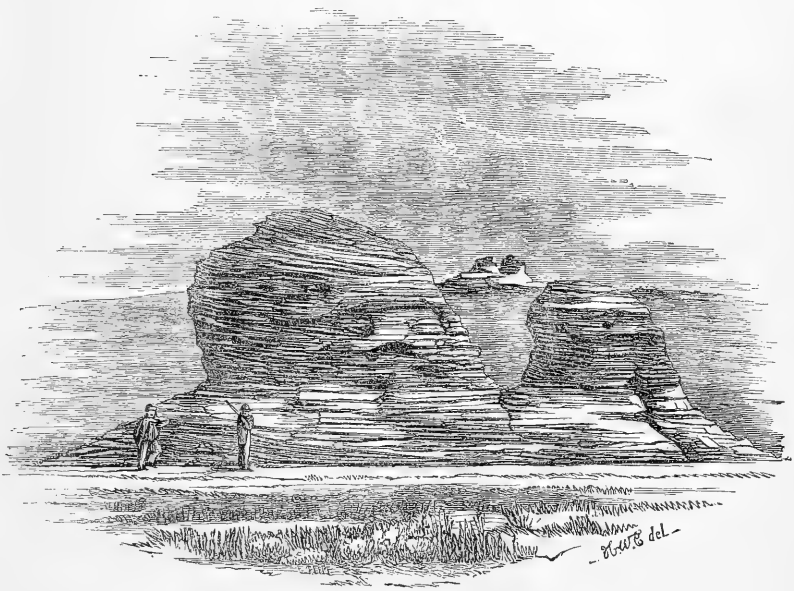
The Laramie plains, as the area enclosed by these mountains is called, exhibits a broad, undulating almost treeless, surface about 60 miles long from East to West, and 50 miles broad from North to South. From Fort Sanders along the stage route to Little Laramie river, the distance is about 18 miles. The surface is quite undulating, but all the slopes are moderate in their inclination. All the basis rocks belong to the cretaceous period. At the crossing of the Big Laramie may be seen a small thickness of the black clays of No. 2, and here and there are isolated hills which show the yellow chalky layers of No. 3. Some of the higher ridges which extend down into the plains from the foot of the mountains reveal here and there the rusty yellowish arenaceous marls of No. 5.

From Little Laramie Station to Cooper's creek the distance is 15 miles. Over this interval the cretaceous rocks prevail and belong mostly to the upper portion of that period. There are probably isolated patches of tertiary overlapping the cretaceous beds. One of these isolated areas of tertiary occurs about two miles north of Cooper's Creek Station on the west bank of the creek where an excellent coal bed has been opened nine feet thick. The coal is quite pure, compact, but rather light, and burns well. I do not think it will be continuous over a very large area, but it will yield a large amount of fuel before it is exhausted.

From this point westward nearly to Fort Bridger, and perhaps beyond, the tertiary beds may be said to prevail in the plain country. Rocks of older date with comparatively few exceptions are not seen except in close proximity to the mountains. In some instances the mountains abut abruptly on the plains, the tertiary or cretaceous beds jutting against the granite or igneous nucleus, and concealing for long distances all the older rocks. Again, intervening between the plain country and the principal mountain ranges are 50 to 100 miles of what may be called foot hills, or minor ranges of the mountains, in which are exhibited on a grand scale the entire series of unchanged rocks known to exist in this country.

In the mountains near the sources of the Little Laramie the red beds show themselves in very great thickness and give to the scenery peculiarly picturesque features.* Near Elk mountain the red beds appear again ; but in the interval they seem to be partially concealed either by drift or cretaceous and tertiary beds. It will be impossible to represent minute details of the geology of this country by colors except on a carefully prepared topographical map constructed on a much larger scale than any that we have. We are satisfied, however, whether the older formations are well shown or are concealed entirely, or in part, that they either do now or did once extend across the country with a nearly uniform thickness.

FIG. 3.



We will now return to Laramie City and examine the geological character of the country along the line of the Union Pacific Railroad westward. From Laramie City to Cooper's Lake Station, a distance of 25.6 miles, there is a good degree of uniformity in the character of the coun-

* The action of the atmosphere upon these brick red sandstones of the Triassic Age is beautifully shown in the wood cut, Fig. 3, taken from a photograph. These worn sandstones form a conspicuous feature in the scenery of the Laramie Plains.

try. On our right the Laramie range appears like a wall bending round to the north-west and west, and finally disappearing from view at Cooper's Creek Station. Near the crossing of the Big Laramie river we see on our right the red beds which are somewhat marked. We can follow them up to the foot of the mountains by their peculiar brick red color. Then come the cretaceous rocks, especially the upper members of the group, soon after crossing the Laramie river, and continue to a point about 5 miles east of Como Station, more than 60 miles west of Laramie City. There may be some few isolated patches of the tertiary beds. The principal rocks seem to belong to No. 5.

Carmichael's Cut east of Rock Creek is a locality quite well known. The strata cut through are mostly rather friable fine grained rusty gray sandstones, with bluish brown calcareous concretions of various sizes scattered through them, which when broken open reveal a great variety of shells—Baculites, Ammonites, Inoceramus, and many other species characteristic of No. 4 and 5, which undoubtedly blend throughout this region, and cannot be separated as distinct divisions of the system. No. 3 has not been observed along the immediate line of the railroad, but it is well showed in many localities in the Laramie plains.

From Laramie City to Cooper's Station the country as far as the eye can reach presents a cheerful appearance. The irregularities of the surface are smoothed down and a long stretch of level prairie is covered with grass, with here and there a grass covered ridge or rounded butte. The basis rocks are mostly indurated arenaceous clays or loose yellow sands which yield readily to atmospheric influences. There are many rounded arenaceous concretions, and sometimes a thin layer of laminated sandstone. There is a slight disturbance of the beds; and the ridges of upheaval seem to trend nearly east and west.

As we proceed westward from Cooper's Station we find the black clays of No. 2, and the appearance of the country becomes dreary and sterile in the extreme. They extend to a point about 5 miles east of Como. The waters are alkaline, and there is no timber along the creeks except stinted willows, and very little grass or vegetation of any kind; as far as the eye can reach nothing but black plastic clays.

Just before reaching Como we come to a very interesting quarry of sandstone from which the materials for the construction of the extensive railroad buildings at Laramie City and Cheyenne are obtained. The rock is a gray, rather friable, sandstone, and occurs in isolated patches resting on the shaly clays of No. 2, and are so filled with fragments of vegetable impressions, sometimes quite distinct deciduous leaves, that one is reminded of the tertiary sandstones. I am inclined to think however that it is a local deposition of sandstone in the cretaceous series. This point and the district about Como is extremely interesting to the geologist, and there are some curious problems yet to be solved.

At Como Station the railroad runs for some distance through a distinct anticlinal valley, the strata inclining away to each side. The south side of the road exhibits the most complete series of the beds. A high ridge is composed of jurassic beds mostly capped with the sandstones of No. 1, while as far as the eye can extend southward the low wave like ridges of No. 2 can be seen. Towards the southwest the anticlinal valley seems to close up, but north-eastward expands indefinately, and extends no doubt to the Laramie mountains. In the valley the red arenaceous beds are quite conspicuous.

These jurassic rocks are composed for the most part of alternate layers of loose sands and some harder beds of sandstones, but there are a few layers of sandstone and marl; and in these are great quantities of an *Ostrea*, *Pentacrinus*, *Asteriscus*, and *Belemnites densus*, all well known jurassic types.

These beds throughout the jurassic series are full of tidal ripples, mud markings and irregular laminæ of deposition, indications of a shallow water deposit. All the fossils are badly broken and worn as if they had been transported from a great distance and deposited in turbulent waters. About a mile west of the station the road cuts through the full series of jurassic beds with Nos. 1 and 2 of the cretaceous inclining north-west at an angle of 45° to 50°.

From a point about 10 miles east of Como to St. Mary's Station, for a distance of about 50 miles, the tertiary formation occupies the country with the sands, sandstones and clays peculiar to it and also numerous coal beds. The most marked development of the coal beds is at Carbon Station, about 80 miles west of Laramie Station. The rocks incline nearly south-east or south and east. Three entrances have been made to mine a bed 9 feet thick. The openings follow the dip and consequently descend. The mines are about 300 yards from the railroad; a side track has been laid to them. More than 1000 tons of coal have already been taken out, and the Union Pacific Railroad Company are ready to contract for any amount that can be supplied. The coal at Carbon is of the best quality of tertiary splint, very compact and pure. It is not as hard as anthracite, but the miners informed me that it was more difficult to work than the bituminous coals of Pennsylvania. It is used to a great extent on the locomotives, and the engineers speak in high terms of it. Over the coal is what the miners call slate, a somewhat earthy bed breaking into slabs showing woody fibre, and much of it looking like charred wood or soft charcoal. As we pass up in the section fragments of deciduous leaves are seen more distinctly, and finally the whole graduates into a dark drab clay. At the bottom of the coal are thousands of impressions of deciduous leaves, such as *Populus*, *Platanus*, *Tilea*, &c. Some of the layers of rock, 2 to 4 inches in thickness, are wholly composed of these leaves, in a good state of preservation, and so perfect that they could not have been transported any great distance.

The Union Pacific Railroad Company have placed their coal interests in charge of Mr. Thomas Wardell, an old English miner, who is constantly employed in prospecting and opening mines the whole length of the road. At Carbon he has erected six pretty cottages, as residences for the miners, and a number more are in process of building. At

Separation and Point of Rocks other villages will be built. All the apparatus for permanent and extended mining operations are being gradually introduced. Nearly all the wood now along the line of the road has to be transported from 10 to 40 miles, and in two years from the present time most of it within a reasonable distance of the road will have been consumed. The future success of this great thoroughfare is therefore wholly dependent on the supply of mineral fuel, and its importance cannot be too highly estimated.*

From St. Mary's to Rawlings Springs, a distance of about 30 miles, the railroad passes over rocks of cretaceous age. No coal beds need be sought for in the immediate vicinity of the road, although it is quite possible that on the north side of the road isolated patches of tertiary containing coal may be found. The railroad from a point about 8 miles east of Benton to Rawlings Springs, passes through one of the most beautiful anticlinal valleys I have seen in the West. On either side the rusty gray sands and sandstones dip away from the road at an angle of 10° to 15°. This anticlinal valley is most marked near Fort Steele at the crossing of the North Platte.

About 5 miles east of Fort Steele I made a careful examination of a railroad cut through a ridge of upheaval which inclined about south or a little east of south. We have, exposed here, commencing at the bottom :

1. Gray fine grained sandstone, rather massive and good for building purposes and easily worked, 80 feet thick—dip 25°.

2. A seam, 2 feet thick, of irregular black indurated slaty clay, with layers of gypsum all through it then 2 feet of aranaceous clay.

3. Ten feet of rusty gray compact sandstone.

4. Eight feet of clay and hard arenaceous layers, very dark in color, passing up into harder layers which split into thin laminæ, the surfaces of which are covered with bits of vegetable matter.

5. About 50 feet of rusty yellowish gray sandstone. All these sandstones contain bits of vegetable matter scattered through them.

6. 100 to 150 feet of steel-brown indurated clay with some iron concretions. The clay is mostly nodular in form.

7. A dark brown arenaceous mud rock, quite hard, 30 feet.

From bed 5 I obtained numerous species of marine shells, among them a species of *Ostrea* and *Inoceramus* in great numbers. The upper surfaces of the hard clay layers appeared as though crowded with impressions of sea-weeds or mud markings. In another railroad cutting about 4 miles

* Mr. J. P. Carcou, an assistant on the survey, made an analysis of a fair specimen of the coal from the Carbon mines with the following result:

Moisture at 100° C. 11.60.	
Volatile Combustible Matter,	27.68.
Fixed Carbon,	51.67.
Ash,	6.17.
Sulphur,	2.88.
Color of Ash, light grey.	
Specific gravity, 1.37.	
Weight, per cubic yard, 2212 lbs.	

east of Rawlings Springs I obtained the same *Inoceramus* and a large species of *Ammonite*. These fossils are important in establishing the age of these rocks.

At Rawlings' Springs are some very interesting geological features. At this locality the elevatory forces were exerted more powerfully than at any other point along the railroad from Laramie Station to Green river. The entire series of rocks are exposed here, from the syenites to the cretaceous inclusive. The railroad passes through an anticlinal opening. To the south of the road are variegated gray, brown and reddish siliceous rocks dipping 5° to 10° S. W. A very hard bluish limestone resting upon them I have no doubt is carboniferous, although I was unable to find any fossils in this region. North of the road ridges of upheaval stretch away toward the north-west and attain a height of 1200 to 1500 feet above the road. On careful examination the red syenite may be found exposed in a number of places, and gives us the opportunity of studying the relation which the unchanged rocks sustain to the metamorphic. The syenite beds dip 70° about S. E., the unchanged beds resting upon them in nearly a horizontal position. The layers immediately on the syenite are a beautiful pudding stone of rounded quartz pebbles and feldspar, and above it layers of fine siliceous rock with thin intercalations of clay, the whole having the position and appearance of Potsdam sandstone. I am inclined to believe that we have here lower silurian representatives. In all cases these rocks repose on the upturned edges of the syenite; sometimes nearly horizontal; again inclining 3° to 10°. In one or two places these lower silurian (?) beds are lifted a thousand feet or more into the air, still maintaining a nearly horizontal posture. On the mountain sides the beds are broken off so as to incline 50°, 60°, up to nearly 90°.

These siliceous rocks, covered with ripple marks, &c., afford excellent building stone, and are much used by the railroad company. They reach a thickness of 500 to 800 feet. Upon them rests the blue limestone, 30 to 40 feet thick; then variegated sandstones; and the red beds in the distance.

From the tops of these ridges one can see numbers of both synclinal and monoclinal valleys. There is one monoclinal valley, 3 to 5 miles wide, which stretches far into the north-west, a smooth and level grassy prairie. All these ridges have suffered great erosion, and the silurian (?) beds are planed and grooved even to a greater extent than the more recent beds. Everywhere the evidences of erosion during the drift period are on a gigantic scale.

A fine sulphur spring from under the bed of blue limestone gives name to the station. The water is clear and possesses excellent medicinal properties.

About 4 miles west of Rawlings' Springs the tertiary beds begin to overlap, but in the distance on either side are lofty ridges of cretaceous and perhaps still older rocks. The ridge, 15 miles south of Separation, at least 1000 feet high, is certainly formed of lower cretaceous and probably also of that great thickness of sandstones and clays which hold a position between the transition No. 1, and the brick red beds.

Near Separation, about 10 miles west of Rawlings' Springs, a coal bed 11 feet thick has been opened, probably the same as the one opened at Carbon, and near Rock and Cooper creek. The dip is nearly west about 10°. The opening being at the summit of the hill, all the coal will have to be drawn up a slope, and the difficulties of drainage will be greatly increased. The coal is of excellent quality. Above and below the coal is the usual drab indurated clay. Below the clay is a bed of gray ferruginous sandstone.

On the summits of the hills in the vicinity are layers of fine grained siliceous rocks with arenaceous concretions, some of them containing impressions of deciduous leaves.

The tertiary beds lie in ridges running across the country. The beds are uplifted in every direction. A more desolate region I have not seen in the West. Nothing seems to grow but sage bushes, and in some of the valleys they grow very large. All over the surface of the hills and in the plains are great quantities of water-worn pebbles. Many of these valleys were scooped out by an amount of waters far in excess of any known at the present day in this region. Some of the widest and deepest do not now contain any running stream.

The layers of fine grained sandstone on the hills in this vicinity contain more or less impressions of leaves, like *Populus* and *Platanus*, in a good state of preservation.

West of Separation the dip of the tertiary beds diminishes. Before reaching Creston, about 13 miles west of Separation, they lie nearly horizontal, and all the surrounding country presents more the appearance of a plain. At that station the Union Pacific Railroad Company have a well 100 feet or more deep, at a depth of 83 feet in which was struck an 8 foot coal bed, with 4 feet of excellent coal and 4 feet of coaly shale. The coal was of about the same quality as that near Separation, probably from the same bed. If so, coal at a depth of about 80 feet must underlie an area of at least 100 square miles. In this well beds of bluish arenaceous clay were passed through first, then black clay with carbonaceous matter throughout. Just over the coal was fine bluish indurated clay with very distinct impressions of leaves, among which the most abundant were *Populus* and *Platanus*. The railroad cuts and the valleys themselves show very distinctly the character of the intermediate softer beds. The erosion has been so great in this country, and all hills and cañons are so covered with debris that it is almost impossible to obtain a clear idea of the color and composition of the intermediate softer beds. The harder sandstones, &c., project from the surface and are accessible to the eye without much excavation. Marine and fresh-water tertiary formations occupy the whole country along the line of the railroad to Quaking Asp Summit, west of Fort Bridger, and possibly over to Salt lake to a greater or less extent.

From Creston to Bitter Creek Station, a distance of 45 miles, the beds are mostly fresh water and hold a nearly horizontal position. West of Bitter creek we get again upon marine tertiaries dipping 3° to 6° nearly east. We have therefore between Rawling's Springs and Green river a sort of synclinal basin, the marine tertiary dipping west about 10° on the east side, and the same marine beds inclining east 3° to 6° on the west side; while at Table Rock, Red Desert, and Washakie, a considerable thickness of purely fresh water beds are filled with shells of the genera *Paludina*, *Unio*, *Melania*, &c.

Table rock is a square butte lifting itself about 400 feet above the level of the road, composed of the beds of a sandstone which in many instances is little more than an aggregation of fresh water shells.

After leaving Bitter Creek Station the hills approach nearer to the road and show the characteristic features of the marine tertiary again. Seams of coal appear in many places, while yellow arenaceous marls, light gray sand with indurated clay beds and more or less thick layers of sandstone occur. The dip varies from 3° to 6° east or nearly east.

At Black Bute Station on Bitter creek, about 15 miles west of Bitter Creek Station there is a heavy bed of yellow ferruginous sandstone, irregular in its thickness and in part concretionary, and full of rusty concretions of sandstones of every size from an inch to several feet in diameter, mostly spherical, and when broken revealing large cavities filled with oxide of iron loam. This sandstone, 150 to 200 feet in thickness, forms nearly vertical bluffs, and is worn by atmospheric agencies into the most fantastic shapes. Above it are sands, clays, sandstones of every texture and coal beds, one of which, near the summit of the hills, has been burned, baking and melting the superincumbent beds. I found in several layers the greatest abundance of deciduous leaves, and among them a fine Palm leaf, probably the same species which occurs in the coal beds on the Upper Missouri, named by Dr. Newbury *Campbelli*. There is also a thin seam near one of the coal seams made up of a small species of *Ostrea*.

The railroad passes down the Bitter creek valley which has been run through the tertiary beds, and on each side high walls can be seen inclining at low angles. As we pass down the valley toward Green river, the inclination brings to view lower and lower beds. These are all plainly marine tertiaries, while an abundance of impressions of plants are found everywhere. No strictly fresh water shells occur, but seams of *Ostrea* of various species. There are also extensive beds of hard tabular rocks which would make the best of flagging stones. On the surface are excellent illustrations of wave ripple marks, and at one locality tracks of a singular character; one looking as if it had been made by a soliped. It resembles the tracks of mules on the soft bottom ground. Others seem attributable to some huge bird; another to some four-toed Pachyderm. I obtained specimens and careful drawings of these tracks.

In the field report some detailed sections of these tertiary beds will be given. Yet I am convinced that local sections are not very important. The character is so changeable that two sections taken ten miles apart would not be identical, and in some cases not even very similar. The more recent the age of formations the less persistent seem to be their lithological characters over extended areas.

Although the coal beds seem to be abundant everywhere along the line of the road in the lower tertiary deposits, they have been wrought as yet in few localities. Near Point of Rocks Station, about 45 miles east of Green river, one of the best coal mines I have yet seen in the West has been opened, and Mr. W. Snyder, the able Superintendent of the Union Pacific Railroad, has ordered a side track to be laid to it about a quarter of a mile long. Five coal beds have been opened in a vertical height of 80 feet. The lowest is about 100 feet above the bed of the creek. They are respectively 5, 1, 4, 3 and 6½ feet thick. The five foot bed is the most valuable, and as the strata are nearly horizontal it can be worked with ease and free of water. The hard, compact coal is pitched down the sides of the hill more than a hundred feet without being broken by the fall. It is purer and heavier than any coal I have yet seen west of the Laramie mountains. The other beds already opened will yield moderately good coal. Several other beds are in these hills which have not yet been examined. Near the summit of the hills, above the coal beds, there is a seam six inches thick composed entirely of oyster shells, about the size of the common edible oyster, but of a distinct and probably undescribed species.

Another bed of coal has been opened about 28 miles west of the Point of Rocks, at Rock Spring. It is about 4 feet thick, with a bed of sandstone at the bottom and a slaty clay roof. It cannot be worked to advantage.

Scattered all through the coal-bearing strata are seams and concretions of brown iron ore in abundance, sometimes persistent over extensive areas, and varying from 4 to 12 inches in thickness. The ore occurs mostly however in a nodular form, and much of it can be made of economical value when there is a demand for it. There are also numerous Chalybeate and Sulphur springs with excellent medicinal properties.

Near Rock Springs fresh water beds again incline nearly west 6° to 10°, but apparently different from those between Creston and Bitter creek.

The beds exposed at this point are made up of drab clays, sometimes a little sandy, with heavy beds of gray and rusty yellow easily disintegrating sandstones. There are also in the clay beds quite thick beds of coal which have ignited spontaneously and baked the superincumbent layers, in many cases melting the rock. There is very little vegetation on these hills, only now and then a dwarf cedar.

Near the summit of the hills there is a thin layer of limestone composed of an aggregate of small *melanias.*

From Rock Spring to Bryan the rocks present a peculiar appearance, occurring mostly in thin laminæ or layers like slate. There are 300 to 500 feet of these drab gray laminated shales, and above them, capping the hills about Green river, are from 300 to 500 feet of rusty yellow shales, which are weathered into castellated forms.

Near the junction of Bitter creek and Green river there is a bed of very singular bituminous earth which has excited much attention. It has been used as a fuel and burned so readily in stoves, that some people valued it more than true coal; but it is not now much used. An analysis shows that it is an inferior fuel.* The bed is usually about 4 feet thick, but sometimes only 2 or 2½. It is often parted by several thin seams of shale. These Green river shales or slates as they might be called, must contain some calcareous matter, although not very fossiliferous. Possibly a more careful study will reveal a greater variety of animal and vegetable forms.

In the same cuts between Green river and Bryan, a distance of about 13 miles, great quantities of fossil fishes occur in a kind of chalky slate. Quite perfect impressions are formed upon the surfaces of the slates, presenting the appearance of having been preserved in quiet waters. Indeed all the Green river rocks may be said to possess a soft chalky character. At Bryan some fine specimens of fish were obtained from a well about 60 feet below the surface.

On the distant hills of this locality are layers of a chalky limestone which would make excellent lime and is now used as a building stone. It has the appearance of oolite, and in fact is made up of an extinct undetermined species of *Cypris*. About 7 miles west of Bryan we have:

4. Yellowish chalky laminated beds, very thinly divided.

3. Thin layers of gray chalky limestone filled with fresh water shells like *Corbula*.

2. Rusty indurated sandstone, somewhat shaly.

1. Gray shale.

Many of the layers in bed No. 3 are made up almost entirely of a small bivalve shell.

About 2 miles above Green River Station the river cuts through a great thickness of fine sand and gravel showing, on the slope and bottoms a vast deposit of drift. Much of the shale in this region has a greenish tinge, and the river in passing over them seems to have taken up some of the green coloring matter, so that the water has a peculiar green color and hence the name.

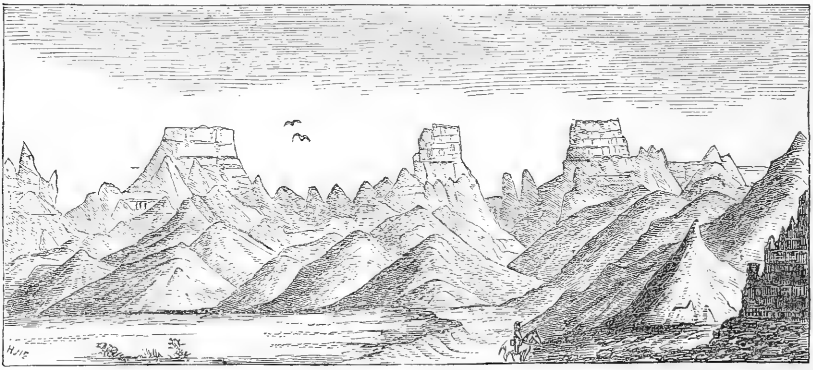
From Bryan to a point about 10 miles west of Fort Bridger the entire surface of the country is covered with buttes of every shape, cones,

* Mr. Carson's analysis of a specimen of this bituminous earth gives the following constituents:

Silicic acid,	18.58.
Sulphuric acid,	3.88.
Sesquioxide of Alumina,	8.14.
Sesquioxide of Iron,	2.19.
Lime,	14.11.
Magnesia.	7.11.
Carbonic acid,	17.40.
Water,	2.90.
Volatile Matter,	22.25.
Fixed Carbon,	3.73.
	100,29.

pyramids, and long ridge-like hills which show a vast amount of erosion. Indeed the portion about Church Butes is precisely like the Manvaises-terres or Bad Lands of White river.*

FIG. 4.



In a cut along the railroad nearly opposite to Church Butes there is a bed formed of clay filled with small kidney shaped masses of fine bluish clay, the whole filled with beautiful specimens of *Unios*, *Paludinas* and other fresh water shells. There are also in the same cut layers of greenish clay much indurated, flesh colored concretionary and rusty drab sandstone.

About 6 miles west of Carter's Station a cut in the road reveals a tough plastic dark gray clay, and at the top of the cut a bed of flinty concretions filled with small seams of chalcedony. The whole country is paved with small water worn pebbles, mostly of opaque flint and some of them exceeding 4 or 5 inches in diameter. Over a belt about 10 miles wide from east to west and of unknown length from north to south, there are the greatest quantities of moss agates. I am inclined to the opinion that they originated in thin irregular seams in this recent tertiary formation, probably somewhere south of Church Butes. The origin of all this drift is evidently local and it is most probable that the transporting power had its origin in the Utah mountains. These tertiary beds are all nearly horizontal, inclining not more than 1° to 3°.

At South Bend Station there is a layer of silicious limestone filled with small *Melanias*, which are entirely changed into chalcedony. Some *Unios* also occur. The bed below it is composed of ashen gray shale a little arenaceous; then comes a silico-calcareous layer. Above the shell seam

* The geologist can compare the following illustration of the "Bad Lands" of White river, Dakota, with Fig. 4, which is engraved from a photograph taken from nature, of Church Butes. The peculiar features of the weathered hills in this region bear a striking resemblance to those on White river.

is a great thickness of shale, capped with a kind of conglomerate made up of rounded pebbles and concretions, with here and there a *Unio*. In the south and east, 75 miles distant, we can see a range of snowy mountains, Minetah; and the intermediate country is covered with rugged tertiary bluffs. To the north, 100 to 150 miles away, the Wind River range is visible, and this interval is also occupied by the same rugged hills.

At Church Butes a remarkable undescribed species of turtle was found projecting from the hill sides.

The beds of this basin near Church Butes and Fort Bridger incline to the eastward, but are nearly horizontal, and seem to jut up against the mountain sides with very little inclination. The style in which they have weathered or suffered erosion, their position in relation to the older formations, and the general appearance of the surface, suggest their identity with the White River formations. But they are more arenaceous. I am inclined to the opinion that while they are independent basins they were synchronous.

The western rim of this recent fresh water basin is well defined at Quaking Asp ridge. Everywhere here the examples of erosion are displayed on a tremendous scale, and the rounded water worn boulders almost pave the ground. The west sides of the hills are quite abrupt, and are covered with the worn rocks; while the eastern sides slope gently down in long ridges; showing the direction from which the forces have acted as well as their local character; that they originated somewhere in the direction of the mountains, and by scooping out the valleys, strewed the surface with rocks.

Near Fort Bridger, and west to Quaking Asp Summit, there are in the recent tertiary formations several beds of the reddish grit which give its peculiar variegated character to much of the surface in this part of the West. In the cuts of the railroad are shown numerous beds of brick red and purplish clays and sands. The inclination of the beds just on the western margin of the basin is 3° to 5°. There are 100 to 150 feet of reddish indurated clays, slightly arenaceous, with some light brands, and one or two layers of gray sandstone; above this, 100 feet or more of light gray arenaceous material, with some hard layers of sandstone; then irregular harder layers of sandstone, sometimes concretionary, projecting from the sodded hills, and many of the peculiar features of the scenery are due to their existence.

After passing Quaking Asp Summit westward we come into a region underlaid by a distinct series of formations of older date than those at Fort Bridger, and in many cases nearly or quite vertical. The same dip is again to the westward.

About 20 miles west of Fort Bridger there is a fine soda spring yielding the most delicious water. Judging from a deposit near the spring of what appears to be limestone, the water must hold lime as well as iron, &c., in solution. Probably it will be a place of resort at no distant day.

On Bear river there are several outcroppings of coal. The principal one by the side of the railroad near the station is nearly vertical, enclosed between beds of drab clay, and separated into two members by a clay parting of from 8 to 10 feet thick. There is probably an aggregate of from 12 to 15 feet of good coal. The dip is towards the northwest 60° to 80°. On the upper side, above the drab clay, there is a bed of rather soft gray sandstone 50 to 100 feet thick. Below, are beds of rusty sandstone, clay, and indurated arenaceous clay, yellowish, drab, reddish and gray.

In a railroad cutting, about a mile east of the coal mine, are 25 to 50 feet of drab indurated clay, covered with 150 to 200 feet of ferruginous and gray sandstone dipping north-west. The lowest beds shown here look like cretaceous clays of No. 2; and in some of their slaty layers are an abundance of fish scales, a species of small oyster and a shell like an *Inoceramus*. These black plastic clays, are undoubtedly cretaceous and lie below the coal. The strata enclosing the coal are evidently marine, for all the organic forms thus far discovered seem to belong to marine types. There is also an oil spring in Bear River valley in which parties are sinking a shaft. The whole country exhibits abundant signs of drift action, and the hills as well as the valleys are paved with worn rocks. Between Bear and Sulphur creeks, there is a fine plateau 40 to 50 feet high, covered with sage—*Artemesia tufida*, and as smooth as a table. The soil in the bottoms of the streams is most fertile; if irrigated, vegetables of all kinds grow well, and there is abundance of water for that purpose.

On the right side of Bear river, 10 miles below the station is, Medicine Bute, which must be 800 to 1000 feet high above the bed of the creek. It is undoubtedly composed for the most part of the strata of the coal series, which I am inclined to regard as of older tertiary age, although the evidence is as yet conflicting.

Passing westward from Bear Creek Station, over beds nearly horizontal or inclining at a small angle, we suddenly come to an upthrust of rocks, called the Needles, dipping east or south-east 25° to 35° or 40°. This is a more remarkable exhibition of massive conglomerate than any I have ever seen further east. The rocks project their summits in the shape of sharp pointed peaks to a height from 300 to 500 feet above the road. Some of the worn masses which compose the conglomerate are an aggregation of worn pebbles, proving that a portion of the materials were derived from some still older conglomerate. Sometimes there is a thin local seam of coarse sand containing only a few pebbles, but the whole mass, from 500 to 1000 feet thick, is in the main a coarse conglomerate made up of water worn rocks varying in size from the smallest pebble to boulders a foot in diameter. The pebbles are mostly flint, mixed with a few of sandstone; rocks of modern data being comparative rare. This seems to be a local outburst of the conglomerate through a vast thickness of variegated sands and clays which inclines westward 40° to 60°. The trend is a little west of north. These "needle rocks" are near Yellow Creek Station, and the ridge of upheaval extends down from the Minetah range. In the vicinity of the mountain ranges such local dips are common, and keep to no regular direction; but far distant from the source of power the ridges are comparatively regular.

From the hills about a mile west of Yellow Creek Station we have the first and most extended view of the country I have ever seen in the West. We can examine objects with considerable distinctness on a clear day for a radius of 50 to 100 miles in every direction, over a most rugged surface, with high ridges and deep gorges, the strata showing red, yellow, gray, and in fact every variety of color. Other beds are composed of quite light colored sandstone.

From Fort Bridger westward one of the most interesting phenomena is the favorable change that takes place in the vegetation of the surface. Broad plains and hill slopes covered thickly with grass, with comparatively little sage, is now the rule. Patches of quaking asp appear here and there and along the streams are fringes of cotton wood.

About 3 miles west of the Needles there is an upheaved ridge carrying a bed of white limestone, with streaks of chalcedony in it resembling those of the White River tertiary limestones, and dipping nearly east at an angle of 20°. After leaving this point the rocks, again nearly horizontal, have for the most part a prevailing reddish tinge, with alternations of reddish indurated clays, and gray and reddish sandstones. The harder layers form quite abrupt bluffs 150 to 200 feet high all along the streams or valleys. In a tunnel at the head of Echo cañon, where the beds have been excavated by the Union Pacific Railroad Company, the base is a red indurated clay, slightly arenaceous, with bands of hard sandstone of a greenish tinge; above this, a red grit, much indurated, but becoming less so as we approach the summit. At Echo Station there are high bluffs of the red grits, with gray sandstones; but the prevailing color of all the rocks in Echo cañon from source to mouth is reddish or dark purple. The excavations for the grading of the railroad are extensive in this region and give a clear idea of the succession of the beds; but there is a great uniformity in the composition of the rocks. The sandstones are gray or yellow, and always yielding readily to the weather, wearing into all sorts of fantastic shapes, full of holes and caves, projecting points and pillars. The hills are covered with a considerable amount of loose material, worn rocks, &c. The valleys are also covered with a heavy superficial deposit.

From Bear creek to Echo Kanyon Station, 20 miles, most of the way is over the red grit beds. The railroad runs directly down the Echo valley from its source to its junction with the Weber valley. Its scenery is wonderful from its general ruggedness; the water is excellent; the grass is good and all the valleys are susceptible of cultivation. Timber, though scarce everywhere, is more abundant than in localities farther to the east.

Passing down Echo Kanyon from Hanging Rock Station to the mouth of Echo valley, bluffs of massive sandstone rise upon the right to a height of from 400 to 1000 feet, colored gray and yellow, yellowish purple and brick red, and containing some conglomerate.

A mile below Hanging Rock a drift into the bank 20 feet beneath a bed of conglomerate, discovered six inches of carbonaceous clay between two beds of ash colored, somewhat sandy, indurated clay, each about 6 feet thick. Below the coaly layer there are 2 inches of a material, which an analysis shows to be composed of Water 2.62, Volatile Matter 73.92, Sesquioxide 1.41, Lime 0.87, Magnesia trace, Sulphuric acid 0.37, Phosphoric acid a trace, Silica 59.14—99.80.

From the mouth of Echo up the valley the rocks seem to form a sort of gentle anticlinal for about 10 miles and then the inclination is reversed. The general dip however is 5° to 15°, nearly north-west; but for 6 miles below and 3 miles above Hanging rock it is increased to 25° and even to 35°.

This formation, which differs somewhat lithologically from any with which I am acquainted, must have an aggregate thickness of at least 3000 feet. The conglomerate portion must be at least 1500 feet in thickness. It includes beds of coal, and shows a few fossils, which are all either impressions of deciduous trees or marine shells.

Near Coalville, a little town in the valley of Weber river, 5 miles above the mouth of Echo creek, coal outcrops several times. At Spriggs' opening the dip is 20° or 30° east; and the coal bed about 15 feet thick; capped with gray sandstone, much of it charged with pebbles. I was informed that in other places this pebbly sandstone rests directly on the coal bed. A few hundred feet from Spriggs' opening, a shaft to strike the same bed has been sunk 79 feet deep, through 12 feet of gravel and sand, into black clay growing harder downward, and holding numerous specimens of a species of *Inoceramus*, *Ostrea*, and *Ammonites*, showing that the black clays are certainly of cretaceous age. If these beds do actually lie above the coal as the dip would indicate, then this formation of doubtful age, extending from Quaking Asp Summit to Salt lake, must be cretaceous, and some of the finest coal beds in the West are in rocks of that age.*

The Weber river flows directly west and the rocks incline in a sort of half circle between north and south. Several beds of massive sandstone cap the high hills, and between them are layers of clay with a reddish tinge. I was informed that there were in this section 6 or 7 beds of coal varying in thickness from 18 inches to 15 feet.

Passing down the Weber valley the dip would carry down the Coalville coal beds, in a distance of 5 miles, that is, at Echo City, to a depth of from 1200 to 1500 feet beneath the surface. So that the coal area that can ever be made available for economical purposes in this region must be very limited.

An interesting feature along the Weber river is its terraces. Near Echo City there is a rather narrow bottom near the river; then an abrupt ascent of 30 feet; then a level plain or bottom of 200 to 400 yards; then a gentle ascent to the rock bluffs. The summit of the first bluff at Echo is 500 feet high; it then slopes back to the plains beyond.

Passing down the Weber valley, about a mile below Echo Station, the beds begin to dip 25° N. E. The whole valley is filled with rounded

[* Confirming the published opinions of Dr. Le Conte and Dr. Newberry.—Editor.]

boulders, some of them 3 to 4 feet in diameter. The Weber river throughout the greater part of its course seems to plough through a monoclinal valley; but just before reaching the entrance of Lost creek it seems to pass along a local synclinal valley. A long ridge of conglomerate extends down from the direction of the Wasatch mountains, nearly north-east and south-west, inclining nearly north-east 5° to 10°. At this point, the Weber, instead of continuing in the synclinal valley, cuts through the ridge, isolating a portion about half a mile in length and forming a huge chasm, or gorge, which is called here the Devil's Gate. After passing through this ridge, the Weber receives Lost creek, and makes an abrupt bend to the southward; and here are exposed an immense thickness of the older rocks in a nearly vertical position. These rocks extend down the Weber river four miles or more, when the beds abruptly change from the nearly vertical position to a nearly horizontal one.

Commencing near the "Narrows," or the mouth of Lost creek, we have a considerable thickness of the jurassic limestones and marls, dipping 70° or 80° north-east, of a bluish ash color, very hard and brittle, cleaving into thin layers, and fracturing in every direction, so that the sides of the hills are covered to a great depth with its debris. Then comes a series of mud shales, with ripple marks, some layers of very white sandstone, and a thick bed of hard red sandstone, destined to take the highest rank among the building stone of Utah. It can be easily wrought into fine forms for culverts, fronts for buildings, caps and sills, &c. Then comes a vast thickness of gray, and dark gray, more or less cherty, limestones, which are probably carboniferous; and below these again a very hard silicious rock, oftentimes massive, which I referred to the Potsdam period, portions of which are filled with holes at right angles to the layers, very similar to much of the Potsdam east of the Mississippi pierced by *Scolithus linearis.* In this quartzose group there is a bed of shaly limestone, 6 to 10 feet thick. A few indistinct molluscs, were observed in the limestones and the mud shales.

The distance from the mouth of Lost creek to the end of the nearly vertical series of rocks is about three miles. So that we have here a thickness of strata not much less than two miles from the top of the Jurassic downwards so as probably to include the Silurian.

At the mouth of Lost creek, there is a remarkable example of non-conformity in hills of different ages. The reddish conglomerate rests directly upon the upturned edges of the vertical beds described above, and it is an important question what has become of all the intermediate beds, containing the coal, which are so conspicuous about 5 miles above Echo city.

Descending the Weber from the "Narrows" we find some of the most remarkable rugged scenery in the west. The walls are very noticeable, and are formed of two beds of limestone, projecting from the sides of the valley, at right angles, from between which 10 or 12 feet of loose material has been washed out. Near the tunnels the rocks on the left side of the Weber dip about 10°, nearly north, while on the other side the strata incline in the opposite direction 3° to 5°, as if the valley was anticlinal.

Then again the valley would appear to be monoclinal, the strata on the right side of the river inclining 20° south, and on the opposite side, though presenting a nearly vertical front, inclining south also. A little farther on down the valley, and on the right side of the river, come beds of red sandstone ; below these again gray sandstone, with a reddish tinge, the red sandstone dipping east 12° ; while on the opposite side of the river, the hills are open, rounded and grass covered.

The cherty crinoidal limestone extends to Morgan city and generally disappears. The red sandstones are seen among the foot hills.

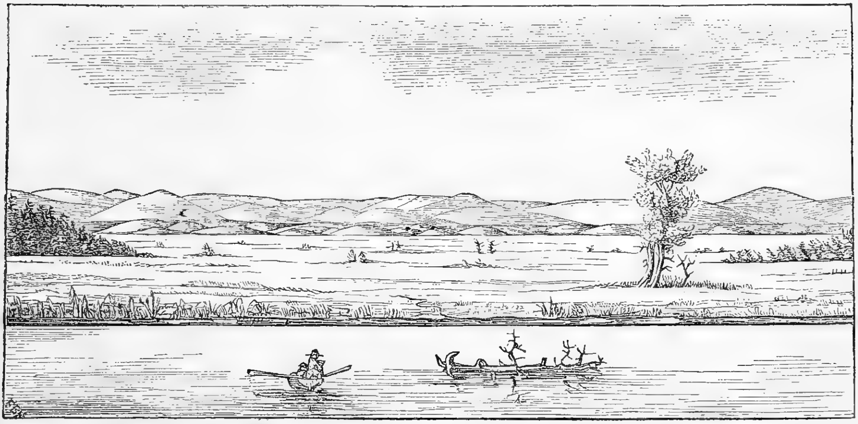
At Morgan city, we come out of the principal cañon of the Weber, into a broad open bottom, filled with little villages and farm houses. The soil is of great fertility. The hills on either side are smoothed off and covered thickly with loose material and vegetation. The high vertical exposures all disappear. The Wasatch range seems to trend nearly north and south ; even the foot hills of this range are so smoothed off and covered with drift and then with grass, that the underlying rocks are not to be seen. The industry shown by the Mormons in this valley is worthy of all praise. The little streams are made use of to irrigate the rich bottom lands, which produce abundantly, and the houses look neat and comfortable. Fruit cannot be raised to any extent in the Weber valley. The varieties of trees are confined mostly to the bitter-cotton-wood, although from Echo city down, we meet with a small dwarf, oak-box, elder, striped maple, and choke-cherry.

Just below the little village of Enterprise, I saw in the hills rocks composed of an aggregate of quartz pebbles, the whole mass looking like the Potsdam. Still farther down, we come to feldspathic rocks, indicating that the dip of the gneissic beds of the Wasatch range is westward. The Wasatch range is composed of gneiss so far as the rocks can be seen along the Weber. The rocks are beautifully banded everywhere. There are also coarse aggregations of quartz and feldspar with large masses of tourmaline ; and all through the gneiss are seams of feldspar and quartz of various thicknesses.

The evidence is quite clear that from Morgan city to the entrance of the Wasatch Kanyon stretched a lake, the waters of which must have filled up the valley, rounded off the hills and covered the sides of the mountains with loose debris. Along the sides of the Kanyon of the Wasatch, $4\frac{1}{2}$ miles long, are thick deposits of loose sand interspersed with water worn boulders in many places. These deposits have been cut through in making excavations by the railroad, and the lines of current deposition are curiously well marked. About half way through the kanyon, there is a sudden bend in the Weber river, by which a small portion of one of gneissic ridges is cut off. Opposite this ox-bow, a kanyon descends the mountain side, down which a vast quantity of loose material has been swept, filling the channel of the river with local drift, and probably driving the current through the gneissic ridges. The Weber river, if its channel were straightened, would run through this deposit of drift, which is about 30 feet thick; instead of which, it makes a bend and cuts its way through a massive gneissic ridge.

Extensive deposits of whitish, fine blue and rusty yellow sandstones, hard enough for building purposes, with flesh colored marls, probably of pliocene age, and resembling very closely in many respects the more recent tertiary beds along the Platte, occur in this valley. These recent beds dip east or south-east. We thus learn that some of the later movements in the elevation of these mountain ranges have been of comparatively modern date. Terraces continue to show themselves the entire length of the Weber river, and they are probably synchronous with those which surround the basin of Salt Lake valley.*

Fig. 5.



After emerging from the Wasatch Kanyon of the Weber valley, we pursued a southerly course along the base of the Wasatch range to Salt Lake city. For 20 miles or more, all the unchanged rocks have been worn away from the flanks of the mountains or completely concealed by debris. All over the gentle slopes at the foot of the mountains are strewn masses of rocks; all gneissic and evidently from the central parts of the mountains. Terraces distinctly surround this basin everywhere. There is one large one, with two or three smaller ones, on the sides of the mountains, and from the lowest one downwards, the surface slopes gently to the lake. I was informed that the lake had risen 9 feet vertically since 1868, and of course the water has aggressed upon the land to a great distance. I have heard no explanation of this phenomenon. All the lakes in the west are said to be rising more or less.

* This illustration from a sketch by Mr. F. W. Meek of the terraces along the Missouri river between Council Bluffs and Sioux City, will apply equally well to Helena or Salt Lake valley; and they are doubtless synchronous in age. In the sketch, the distant high hills are composed of yellow marl or "loess," the terraces the same, and the bottom of rich vegetable mould.

The carboniferous limestones begin to make their appearance along the flanks of the mountains about 10 miles north of Salt Lake city, and continue to a great or less extent all around the rim of the basin.

On the flanks of the mountains, east of the city, are the red beds (jurassic?); probably a careful study would reveal jurassic, cretaceous, and possibly even tertiary beds. President Young has long since offered a large reward to any one who would discover workable beds of coal within a reasonable distance of the city, and a thorough search has been made for them, but thus far without success. A bed of coaly clay only has been found near the city in the mountains. All the coal used in the valley is transported in wagons from Coalville, on the Weber. The best of red sandstone for building purposes is brought from red sandstone cañon, just east of the town. I am inclined to believe that it is carboniferous. The beautiful gray granite which is used in the construction of the Mormon temple is brought from Cottonwood valley in the Wasatch mountains. It is composed of white feldspar, quartz and black mica.

The surface of Salt Lake valley has been rendered fruitful by the industry of the Mormons. Like the greater portion of the west, it was originally a vast sage plain. Now by irrigation all kinds of cereals and roots grow luxuriantly, and there are no better apples, peaches, plums, grapes, &c., raised in America. It may eventually become a vine growing region.

Following the stage road eastward, 16 miles from Salt Lake city to the Brewery at the mouth of Parley's Kanyon, we reach the foot of the mountain, over sand beds which are probably of post-pliocene age. Here a little stream cuts through the sand beds, exposing a vertical bluff 200 feet high, composed of some fine sand, horizontally stratified and overlaid with a great thickness of water worn pebble conglomerate. There are indications all along the flanks of the mountains, that nearly or quite all the formations already recognised as far west as this point are here represented. At the entrance of the kanyon, the carboniferous limestones dip north-east 70° to 80°; over them lie the purple and red sandstones and rusty yellow layers; and under them reddish shales. Beneath these shales an immense thickness of dark gray silicious rock stands nearly vertical. All this vast thickness of older rocks, in appearance semi-metamorphosed, are undoubtedly the counterparts of the series described in the Weber valley just below the entrance of Lost creek.

The road passes up a monoclinal valley between the ridges of silurian (?) rock, having a brittle fracture, and the monoclinal slopes are covered with debris. No gneissic rocks are noticeable along this road.

Before reaching the summits, in fact soon after we begin the ascent, we come to the conglomerates and sandstones which accompanied us down the Echo and Weber valleys. Near the summit all the hills are rounded by erosion and grassed over, and water-worn boulders are scattered about here and there, so that the underlying rocks are partially concealed. Just beyond the summit we arrive at a broad open exposure in the valley of the stream called Parley's Point, half a mile wide, and about 7000 feet above sea level. Settlements are numerous all along the road; but while there is very good grazing, few of the cereals will grow.

All the rocks on the eastern slope incline at a greater or less angle apparently towards the east. Just as we enter Silver Creek valley, we come to numerous upthrusts of partially changed sandstones and conglomerates, the first indications that we get along our route of the neighborhood of igneous rocks. Some of the masses of rock which go to make up the conglomerate are of great size, very compact and of a steel gray color, and are enclosed in a gray siliceous paste; but whether large or small, all are angular. The formation looks much like that near South Boulder creek, near Denver.

Passing down the valley of Silver creek, we soon emerge into the valley of the Weber. We come to the hills enclosing the coal which dip down the valley at angles of from 20° to 50°, and of course the belt along which the coal beds are exposed is very narrow. Five or six beds as I have before said, varying in thickness from a few to 15 feet, are reported. I heard also that about 4 miles from Mr. Sprigg's opening, a bed of fossil oysters had been seen above the coal. That these coal strata are of marine or estuary character I have no doubt; but the limited time given me for their study prevented me from securing such positive evidence as is desirable; and as this formation occupies a vast area west of Fort Bridger, it seems all the more important to fix its geological position. That it is not older than the cretaceous we know by the occurrence of leaves of deciduous trees, and the black plastic clays of No. 2, holding quantities of fragments of fish-remains.

I will now recapitulate briefly the principal geological formations along the line of the Union Pacific Railroad from Omaha to Salt Lake city.

The Upper Coal Measure Limestones are seen at Omaha, near the water's edge, and quarried all along the Platte nearly to the Elk Horn river.

The Lower Cretaceous rusty sandstones of No. 1, overlap the Upper Carboniferous limestones about four miles above the mouth of the Platte, and extend to the mouth of the Loup Fork; but the yellow marl deposit or lœss, conceals for the most part the underlying rocks. A fine yellowish sand, of the same age, or a little less recent, overlaps the cretaceous near Columbus.

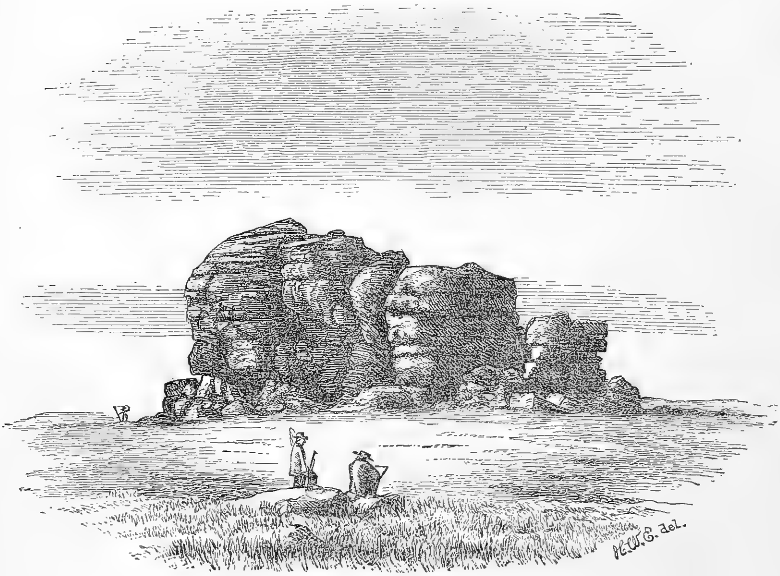
The chalky limestones of No. 3, with the characteristic *Inoceramus problematicus*, here and there crop out, and some obscure exposures have been detected in the Pawnee Reservation, 15 or 20 miles up the Loup Fork.

This fine yellowish sand soon gives place to the Pliocene beds of the Platte, Loup Fork and Niobrara rivers, indurated marls, sands, or sandstones, which continue on as far as the margin of the Laramie range of mountains, 530 miles west of Omaha, that is, for nearly 430 miles along the line of the railroad. In the grand anticlinal of the Laramie range, which I have already described, they sometimes repose with a slight discordance on the older rocks; sometimes, as near the Laramie peak, they rest directly on the syenites, and entirely conceal, for a distance of 40 or

50 miles, all the unchanged rocks of older date ; but a careful study of the eastern flank, from Red Butes to Long's Peak, will reveal all the formations that are known to exist in this part of the west, inclining from the sides of the granitic nucleus at various angles.

The railroad then for 40 miles passes over and cuts through a great variety of Syenites ; some compact, beautiful building stones, almost equal to the Scotch lyenites, but the greater part ferruginous and easily disintegrating on exposure.*

Fig 6.



On the west side of the Laramie range, we pass across the upturned edges of the counterparts of the various formations seen on the eastern slope. From Laramie city to Salt Lake, formations of different ages continually appear and disappear. The Cretaceous formations occupy the country for 60 miles from Laramie city nearly to lake Como.

Genuine Jurassic beds, with characteristic fossils, are here exposed for a short distance, in an anticlinal valley, along which the railroad passes. *Belemnites densus* are in great numbers.

Cretaceous beds mostly No. 2, appear again west of Como.

Miocene coal beds overlay the cretaceous, just before reaching Carbon

* These syenites weather into most beautiful forms resembling gigantic ruins, so that they have sometimes deserved their common appellation, of broken down temples, castles, &c. The sketch, (Fig. 5,) shows well the peculiar features which these piles of rocks assume through atmospheric influences. It is engraved from a photograph of a scene on the Laramie range, taken by Mr. Carbutt, photographer, of Chicago, Illinois.

Station, 80 miles west of Laramie. At Carbon where they are exposed to view, impressions of fossil leaves occur in the greatest abundance. The species are few and nearly all of them identical with those described by Dr. Newbury, from the miocene tertiary beds of the Upper Missouri. Some strata consist almost entirely of leaves, in a fair state of preservation, as if they had not been subjected to a great deal of drifting prior to deposition. Indeed, the trees themselves must have grown near the spot, to shed their leaves in such great abundance, just as we find leaves accumulated now in muddy bottoms. Dr. Newbury has identified from this locality, *Populus Cuneata, Populus Nebrascensis, Platanus Haydeni* and an undescribed species of *Cornus*. The Wyoming Coal Company's shaft sunk at this station to reach the coal, has descended nearly 60 feet through a considerable thickness of bluish-black arenaceous clay, in rather thick layers, upon the surface of which are great quantities of *Populus* and *Platanus*. Very nearly the same species are described throughout a great thickness of these tertiary beds, and the evidence seems to be pretty clear that the vegetation was nearly uniform throughout the period of the deposition of the coal strata.

The Cretaceous beds are again exposed in a sort of anticlinal valley, about 10 miles east of the N. Platte crossing. But a few miles on either side of the railroad tertiary beds are seen.

At Rawling's Springs, all the formations from the syenites to the cretaceous, are thrown up over a restricted area ; 2 miles farther west, the tertiary beds again overlay. At Separation, 26 miles west of Benton Station, a bed of excellent coal has been opened by the railroad company, in the rocks over which *Platanus Haydeni* and *Cornus acuminata*, (N,) with other undetermined species of plants occur. This forms the eastern rim of a basin which extends about 110 miles to the westward.

Soon after leaving Separation, the strata becomes nearly horizontal, and are of fresh water instead of estuary origin. Beyond Bitter Creek Station, estuary beds reappear dipping east. At Washakie, Red Desert and Table Rock occur thick beds made up of an aggregate of fresh water shells, of the genera *Unio, Paludina, Limnea, Melania*, &c., At Black Butes and Point of Rocks, a great abundance of impressions of deciduous leaves are found. At Black Bute Station, about 850 miles west of Omaha, I found in the coal strata *Sabal Campbelli*, N, *Rhamnus elegans, Cornus acuminata, Quercus aceroides, Tilia antiqua*, with some undescribed species.

At Point of Rocks, an important coal station, about 14 miles farther west, I found *Platanus Haydeni, P. Nebrascensis, Cornus acuminata*, and *Magnolia tenerafolia*. In the vicinity of Elk mountain, along the overland stage road, in beds which I regarded as belonging to the older tertiary, and holding a position near the junction of the tertiary and cretaceous, and nearly or quite on a parallel with the lower tertiary beds near Denver, Colorado, I found *Platinus Haydeni, Quercus aceroides, Magnolia tenerafolia*; with fragments of *Cornus* and *Rhamnus*.

Near Green River the eastern rim of what appears to be another tertiary basin commences, the beds having a gentle dip to the westward. Between

Green River crossing and Bryan Station, fine specimens of fossil fishes occur in rocks which resemble the Solenhofen slates. West of Bryan, fresh water shells of the genera *Corbicula*, *Limnea*, *Physa*, *Paludina*, *Melania*, and *Unio* occur in the greatest quantities. This basin extends to Quaking Asp ridge, 22 miles west of Fort Bridger.

We then come to a series of variegated beds, whose dominant color is red or reddish, of estuary or marine origin, with coal beds from 6 to 15 feet thick. These extend far westward to the Wasatch mountains, possibly farther. The evidence inclines one to regard them of cretaceous age, but they may be older tertiary.

In Weber valley there is an immense thickness of the older sedimentary rocks from the jurassic inclusive to the silurian inclusive, the thickness of which I estimated at from 5,000 to 10,000 feet.

The Wasatch range is composed of metamorphic rocks, mostly gneisic, which are well shown in the valley of Weber river for the distance of 4 miles.

The Union Pacific Railroad from Omaha to Salt Lake valley, a distance of nearly 1200 miles, really pass through metamorphic rocks but twice; first in crossing the Laramie range, a distance of 20 or 30 miles, and in the Weber valley through the Wasatch range, 4 miles. At Rawling's Springs, the syenites are seen on the north side of the road for a little distance, but not immediately along it.

It will thus be seen that over the vast region known as the Rocky Mountain district proper, the area that can be colored on a geological map as occupied by igneous or metamorphic rocks is comparatively small, while the more modern formations as tertiary and cretaceous, are met with everywhere even up to the summits of the loftiest ranges and sometimes covering them.

NOTE. The illustration, Plate 1, Fig. 2, Pulpit Rock, shows the high nearly vertical bluffs of conglomerate, at the entrance of Echo creek into the Weber river, Utah Territory. I am inclined to regard these rocks as older tertiary, from the fact that they lie along the coal beds of this region, but they may be cretaceous.

Twin Peaks, No. 1, Plate 1, form a part of a mountain range, enclosing Salt Lake valley. The terrace system is well shown, as described in the preceding paper.

ON THE GEOLOGICAL AGE AND EQUIVALENTS OF THE MARSHALL GROUP.

By Prof. A. Winchell.

Contents.

I. Existence of Controversy.

Every person conversant with the history of American geological science is aware of the controversy which has long existed in reference to the age and equivalents of the strata lying between the Corniferous limestones and the limestones of the Lower Carboniferous system. Geologists of the highest ability—both American and European—have participated in the discussions; and western geologists, almost without exception, have been constrained to commit themselves, for specific reasons, to definite, though often diverse, views in reference to the geology of the zone in question. As additional facts have been successively brought to light, some important progress has been made in the settlement of controverted points; and the great body of western geologists seem to have united with considerable unanimity in a judgment upon the main issues. Very persistent opposition is manifested, however, in certain quarters, to the verdict which is already shadowed forth ; and there are probably few whose convictions have been satisfactorily and finally settled by a comprehensive comparison of the facts which have been collected. I think, therefore, it may be useful, in the present state of opinion, to bring forward a review of the data upon which the controversy has proceeded, and to furnish the grounds of the convictions which for some years past have been strengthening in my own mind. In doing this, I hope I shall be actuated by a spirit of candor, and sentiments of profound respect for the distinguished names arrayed against my position. I seek only the truthful determination of the question; and I would not raise my voice in a discussion where so many worthier ones have been heard, did I not recall to mind that the merest child, or the humblest peasant may stumble upon phenomena which the philosopher had long sought in vain, and which may serve as the solvent of chronic and distressing doubts.

II. History of Discovery and Opinion.

So far as I have observed, the first distinct allusion by any geological writer to the zone of rocks under consideration, is embraced in an elaborate description of the topography and geology of the "bituminous coal deposits of the valley of the Ohio, and of the accompanying rock strata" by that distinguished pioneer of western geology, Dr. S. P. Hildreth.[1]

In the section which he has given of the "Ferruginous deposits,"[2] it would appear that the lower beds, 500 feet in thickness, extend into the series afterwards designated the "Waverly series" by the Ohio geologists. Dr. Hildreth styles them the "Great Lias Rock," and afterwards an "Argillaceous sandstone rock, very fine grained," &c. Dr. S. G. Morton appends to this paper descriptions and figures (mostly too imperfect for identification) of several species of included fossils.

In 1838, Mr. C. Briggs,[3] assistant upon the geological survey of Ohio, bestowed the name "Waverly Sandstone Series" upon the lower portion of the succession of shales, sandstones, and shaly sandstones, interposed between the so-called Black Slate and the great Carboniferous Conglomerate. The series took its name from the village of Waverly in the southern part of the State in Pike county, since some of the most beautiful building stones afforded by the series had been quarried at that place. The Ohio geologists, however, in other and subsequent publications, generally referred to this assemblage of strata under the designation of "Fine Grained Sandstone Series."[4] The lower limits of the series, as defined, were distinctly marked by the horizon of the Black Shale ; but the upper limits were not stated with precision. It does not appear however that the series was originally supposed to reach upwards to the Conglomerate ;[5]

[1] Amer. Jour. Science and Arts, vol. 29, p. 1, and Plates 1 to xxxvi.

[2] Ib. p. 133; also 136.

[3] First Ann. Rep., Ohio, p. 79.

[4] See for instance "Report of Special Committee to report on the best method of obtaining a complete geological survey," 1836, p. 13, where the expression seems to have been first employed; Whittlesey, Second Ann. Report, 1838, p. 56; J. W. Foster, Ib. p. 76; Briggs, Ib. pp. 122, 130.

[5] Whittlesey, 2d Ann. Rep., p. 56.

though the Ohio geologists appear eventually to have given the term "Fine Grained Sandstone Series" that extension of meaning; and Col. Whittlesey, Prof. Hall, Dr. Newberry and others, have since treated the term "Waverly series" as synonymous. The Ohio geologists abstained, on principle, from expressing any opinion on the subject of the American or foreign equivalents of these rocks.

During the same year, Mr. J. W. Foster[6] made a report in which he described the Fine Grained Sandstone of Licking and Franklin counties, as a continuation of the Waverly series of Briggs, and expresses the opinion that it is "a member of the mountain limestone formation." I direct particular attention to this early judgment. It must be noted, however, that the older Cliff Limestone was also at that time regarded as belonging to the mountain limestone series. Both Foster and Briggs speak of the paucity of organic remains in the lower portion of the series, and their abundance in the upper portion.

The public geological survey of Michigan was inaugurated at about the same time as that of Ohio. The earliest mention of sandstones in that State, occupying a position in the zone under consideration, is found in Dr. Houghton's report for 1838.[7] Under the head of the "Upper Sandstone of the Peninsula," he notices those rocks which I have designated[8] the "Woodville Sandstone" above the coal; the "Parma Sandstone" beneath it, and those portions of the "Marshall group" which outcrop in the southern counties. The outcrop of the last named sandstones in the vicinity of Pt aux Barques, east of Saginaw bay, is treated by Dr. Houghton in connection with the Lake Superior Sandstone under the head of "Lower Sandstone or Graywacke group" (p. 9).

In the report of the following year, the Marshall sandstones are again stated by Dr. Houghton to belong to "the great carboniferous group of rocks."[9]

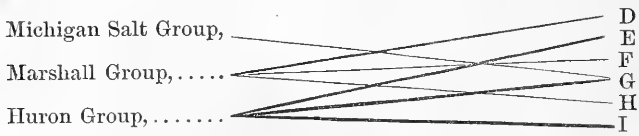
The first attempt at a systematic account of these strata was made in 1840 by Bela Hubbard,[10] assistant on the geological survey. Mr. Hubbard correctly apprehended their position as beneath the coal producing strata, and alluded to the richness of the lower beds in organic remains. *The deeper and more argillaceous strata were never, in southern Michigan, associated as in Ohio, with the newer and more arenaceous beds.* The entire series of argillaceous strata, including the black shale of the state, which is very inconspicuous in the southern counties, were described by Hubbard as the "Kidney Iron Formation." This was regarded as the bottom of the Carboniferous system. The northern outcrop of these groups were reported upon in 1841.[11] In his attempt to assign them to their proper stratigraphical position, Mr. Hubbard fell into singular errors, and introduced into the most elaborate account of the lower peninsula which was destined to be published for twenty years, a confusion of facts which rendered the geology of Michigan an enigma to every one who attempted to

[6] Second Ann. Rep. Geol., Ohio, p. 103.
[7] First Ann. Rep. Geol. Mich., p. 3.
[8] First Bienn. Rep. Mich., 1861.
[9] Mich. Geol. Rep., 1839, p. 28.
[10] Mich. Geol. Rep., 1840, p. 87.
[11] Mich. Geol. Rep., 1841, p. 114.

parallelize the rocks with those of surrounding States.[12] The following is Mr. Hubbard's tabular statement of the succession of groups embraced in the lower peninsula,

A. Erratic Block group or Diluviums,
B. Tertiary Clays,
C. Coal measures,
D. Sub-carboniferous Sandstones,
E. Clay and Kidney Iron formation,
F. Sandstones of Pt aux Barques,
G. Argillaceous slates and flags of Lake Huron,
H. Soft, light-colored Sandstones,
I. Black, aluminous slate,
K. Lime rocks of Lake Erie.[13]

In this table, as we now know, the groups marked D, F, and H, are but different outcrops of the Marshall group; and those marked E, G, and I, but different outcrops of the Kidney Iron or Huron group. Following Dr. Houghton in the report of 1838, Mr. Hubbard regarded the Pt aux Barques sandstones and conglomerates as occupying a position beneath the Kidney Iron formation of the southern portion of the state, and consequently failed to identify the underlying shales. In the next place, Mr. Hubbard identified with the Pt aux Barques shales, the shales of the "Michigan Salt group," struck in the salt wells at Grand Rapids, although these latter actually occupy a position above the Marshall sandstones. When, therefore, these sandstones and the underlying Huron shales were struck in the boring of the salt wells, they were supposed to constitute the third couplet of similar strata, and are set down as groups H and I, in the above table.[14] This confusion is illustrated by the following diagram:



The Pt aux Barques sandstone were rightly recognized by Hubbard as the equivalent of the characteristic portion of the Waverly sandstone series in Ohio; and it is singular that they were not observed to be equally identifiable with the sandstones of Hillsdale county in the southern part of the state. The upper conglomeratic portion of the Pt aux Barques sandstones was erroneously synchronized with the Carboniferous conglomerate, which though reposing on the Waverly of Ohio, is separated from the equivalent Marshall in Michigan, by the Carboniferous limestone and the Michigan Salt group. The Black Shale was also recognized as

[12] In his attempt, in 1843, to parallelize the strata of Michigan with those of other states, Prof. Hall assigned the Pt aux Barques series to the zone of the Waverly Series and the Portage and Chemung; but he seems not to have known how to dispose of the rocks denominated by Houghton and Hubbard the "Upper Sandstone of the Peninsula." Rep. Geol., 4th Dist. N. J., p. 519.

[13] See also Report, p. 136.

[14] Report, p. 133.

agreeing "in general character *and position*" with "the Black Shale stratum of Ohio and Indiana." [15]

In 1841, when Professor Hall was closing up his labors upon the geology of Western New York, he undertook an extended tour through the western states for the purpose of ascertaining to what extent the formations recognized in New York could be traced in other regions. The general results of this tour were announced in 1842.[16] At this time, he was led to regard the Waverly series (embracing everything between the Black Shale and the Conglomerate), as a prolongation of the Chemung and Portage groups of New York. The thick bedded sandstones at Newburg and Waverly were identified with the Portage sandstones, while the shaly sandstones and flags near Cleveland were regarded as representing the Gardeau shales and flagstones. From Newburg to Cuyahoga Falls, and also at Akron, he identified the shales and sandstones of the Chemung group.

Passing down the Ohio into Indiana, Prof. Hall again identified strata corresponding to the Portage, and doubtfully to the Chemung; while above these, and beneath the carboniferous limestone, was a series of arenaceous strata becoming interstratified above with beds of mountain limestone, and, on the whole, exhibiting affinities with the Carboniferous system. Nevertheless he inclined to regard them as "sub-carboniferous" (used in the sense of *subter-carboniferous,*) remarking that "a limit should be fixed between what is to be strictly referred to the Carboniferous period, and older deposits." [17] The Black Shale of Ohio and Indiana was regarded by Professor Hall as the equivalent of the Marcellus Shale of New York "being the only representation of that rock, the Hamilton group and the Genesee slate" (Ib. 280).

During the same year, Mr. Conrad [18] read a paper before the Academy of Natural Sciences of Philadelphia, in which he embraced brief descriptions of three fossils from the Marshall sandstone of Moscow, Michigan, which he referred to the Carboniferous system. Mr. Vanuxem's Report on the Geology of the Third District of New York, also appeared this year.

In 1847 the distinguished European geologist, de Verneuil, gave the world the results of an extended and critical investigation of the parallel-

[15] It is interesting to note this early identification of the now styled Marshall sandstones with the characteristic portion of the Waverly sandstone series; and the Black Shale of Michigan with the Black Shale of Ohio and Indiana; as these opinions were expressed by Hubbard anterior to the first elaborate attempts by Hall and de Verneuil to trace the parallelism of formation in the different states. Dr. Houghton had, indeed, previously recognized the correspondence of the "Black Shale" with certain formations in western New York, as described in the annual reports of that State; though there is room to doubt whether he made the identification preferably with the Marcellus or the Genesee Shale. Under the great natural difficuities attending the exploration of the "wilderness of Michigan," then just emerging from a territorial condition, and the equally great embarrassments resulting from the undisturbed condition of the strata, it is indeed remarkable that the early geologists of the state succeeded in establishing so many conclusions which have stood the test of nearly a third of a century.

[16] Amer. Jour. Sci. and Arts, xlii p. 51; Jour. Bost. Soc. Nat. Hist. v. p. 1, and more fully in Trans. Assoc. Amer. Geol., p. 267. See also Geol. Rep., Fourth Dist. N. Y., p. 229.

[17] Trans. Assoc. Am. Geol., p. 281.

[18] Jour. Acad. N. S., Phil., vol. viii, p. 249 and 269.

ism existing between American and European paleozoic formations.[19] This paper was translated and somewhat condensed by Professor Hall for publication in America.[20]

Professor Hall's translation is accompanied by criticisms and additions.[21] One of the results of de Verneuil's studies was to lower the base of the Devonian system from the bottom of the Portage group where it had been placed by Conrad, to the bottom of the Oriskany sandstone, and to fix the summit above the Catskill group. He recognized the prolongation of the Portage and Chemung groups into Ohio, but did not detect them in Indiana, Kentucky, and Tennessee; though Prof. Hall in his notes upon the paper, was inclined to recognize them in Indiana above his and Owen's "sub-carboniferous." The upper, or fossiliferous portion of the Waverly series was regarded by de Verneuil as falling within the limits of the carboniferous system. The Black Slate of the West was identified with the Genesee Shale of New York. These conclusions are fortified by extended paleontological comparisons.

Professor Hall in his commentary upon this elaborate paper, seems to oscillate between two opinions. He insists at one time upon the Silurian relationships of the Hamilton, Portage and Chemung, and the broad lithological and paleontological gap intervening between the Chemung and the Catskill,[22] intimating that there is the place to draw the systemic lines; while at another time he asserts that the Chemung is more intimately "related to the Carboniferous sandstones of the West than the Hamilton group of New York"[23]—that "there is no well defined line of separation between the Chemung rocks of New York, and the sandstones of Ohio and Indiana, which contain carboniferous fossils"—and that "the error of American geologists who have attempted to compare our formations with those of Europe, has been, in this instance, that of regarding the great Carboniferous limestone as forming the basis of that system, including all the strata below it in Devonian and Silurian."[24]

In 1848 Mr. Murray, of the geological survey of Canada, made an examination of black bituminous shales on the south-east shore of Lake Huron at Kettle Pt., and described them[25] under the head of "Hamilton group," remarking that they contained *Lingula*, but "neither of the two species represented by Mr. Hall as belonging to the Genesee slate." Mr. Murray adds that "no trace of the sandstones [of the Portage and Chemung groups] . . . has yet been met with in western Canada."

19 "Sur le parallélisme des dépots paléozoïques de l'Amerique Septentrionale avec ceux de l' Europe; suivie d' un tableau des éspèces fossiles communes aux deux continents, avec l' indication des étages où elles se rencontrent, et terminée par un examen critique de chaque de ces éspèces." Bulletin de la Soc. Geol. de France, 2me Ser. Tome, iv, p. 646.

20 Am. Jour. Sci. and Arts, [2] vol. v. pp. 176 and 359 and vol. vii. pp. 45 and 218.

21 See further critical remarks by Sharpe, "On the Paleozoic Rocks of N. A.," in Quar. Jour. Geol. Soc. Lond., Aug. 1848, and a paper by Mr. Elle de Beaumont, entitled "Note sur les systémes de Montagnes les plus anciens de l' Europe."

22 Amer. Jour. Sci., [2] v. 367, Note; vii, 46, Note 3 and p. 231. He had previously pointed out the break below the Catskill. Pal. N. Y., vol. 1, introd. p. xvi.

23 Amer. Jour. Sci., [2] vii, p. 46, Note (a,)

24 Amer. Jour. Sci, [2] vii, 45, Note.

25 Report of Progress, 1848-9, p. 24.

In 1850 Professor Hall resumed the discussion of the parallelism of eastern and western formations, and the parallelism of the whole with the standard systems of Europe.[26]

In this celebrated discussion, Professor Hall states that "the shales and sandstones of the Catskill mountains, . . . have no representatives at the West. Succeeding the Black Shale, however, there is a group of shales and sandstones which, from the fossils they contain, are regarded as belonging to the Carboniferous period."[27] And again, "the green shales and sandstones of Ohio and Indiana, which succeed this Black Shale, have been recognized as carboniferous by their fossils, though there is still some doubt whether the lower part may not represent the Chemung group of New York."[28] He still insists on the carboniferous aspect of the rocks from the Marcellus to the Catskill, and cites, after de Verneuil, the *Goniatites rotatorius* and *Goniatites princeps* as proving the carboniferous age of the "Rockford bed" which he regards as embraced in the Marcellus shale.[29]

About the same date, Mr. Murray[30] reported new observations on the Black Shales of Canada West, in the region more recently famous for its production of petroleum. These he still regarded as embraced in the Hamilton Group, and probably continuous with those previously examined at Kettle Point. He remarks that the "bituminous springs [of Enniskillen] probably owe their origin" to this formation.

In 1851, Mr. Christy[31] read a paper before the American Association at its Cincinnati meeting, in which he announced that the Rockford Goniatite limestone is centrally located in the Black Slate of Indiana, and according to Verneuil embraces the carboniferous fossils *Goniatites rotatorius* and *G. princeps*, and *Cyclolobus*. Mr. Christy specifies several localities at which the limestone and the slate may be seen in juxtaposition, and accounts for Dr. D. D. Owen's error in pronouncing the limestone a portion of the Cliff limestone. Mr. Christy states that the Goniatite limestone has about 28 feet of black shale below it, and about 30 feet of black shale above it. The latter is succeeded by "about 350 to 400 feet of soft shale with an occasional stratum of limestone and some beds of sandstone, including fossils."[32]

At the same meeting Col. Whittlesey[33] read a paper "On the equivalency of the rocks of north-eastern Ohio, and the Portage, Chemung, and Hamilton rocks of New York." Col. Whittlesey's extended and accurate observations in the state, enabled him to furnish valuable sections of the Ohio strata, to which I shall have occasion again to refer. Following Professor Hall in his paper published in 1842, he places the Ohio rocks, from the Cliff limestone to the Conglomerate, in the zone of the New York Upper Devonian.

In 1852 Dr. D. D. Owen[34] published a geological map of the North-west,

[26] Foster and Whitney's Rep. Min. Land District, L. Sup., vol. 11., chap. xviii, p. 285.
[27] Ib. p. 292.
[28] Ib. p. 307.
[29] Ib. p. 309.
[30] Rep. Progress Geol. Sur. Can., 1850-51, p. 29,
[31] Proc. Amer. Assoc., vol. v., p. 76.
[32] Ib. p. 80.
[33] Ib. p. 207.
[34] Geol. Rep. Wis. Iowa, and Minn.

in which he colored as Carboniferous, all those regions in Missouri and Iowa underlaid by rocks intervening between the Carboniferous limestone and the Black Slate. Dr. Owen embraced in the Mountain limestone series, the yellow sandstone at the base of the exposure at Burlington, Iowa, and from the associated oölitic bed he describes and recognizes *Producta Cora*, *Spirifera striata* and *Cryroceras Burlingtonense* (Ib. p. 95).

Professor Swallow[35] in his Missouri Report, published in 1855, recognizes the Chemung group, and establishes three divisions called respectively, in descending order, the "Chouteau limestone," the "Vermicular sandstone and shales," and the "Lithographic limestone." Professor Swallow in referring to differences of opinion about the age of these rocks, says: "Many of our fossils are either identical with, or very similar to those of the Chemung group of New York. Among these are a species of those remarkable forms of the New York reports called *Fucoides caudagalli?* and *Filicites gracilis;* also *Avicula subduplicata* and *Nucula bellatula.* Mr. F. B. Meek[36] in his appendix, enumerates 55 species of fossils from these rocks, of which 19 are described by Dr. B. F. Shumard as new species; 13 are identified with European carboniferous species, while one only, *Avicula duplicata* (Hall,) is identified with species from the Chemung of New York, and two—*Spirifera mucronata?* and *Nucula bellatula,* are identified with Hamilton species. Such determinations would seem to afford but slender support to Professor Swallow's decision, to range these rocks on the horizon of the Chemung.

During the same year Mr. Marcou[37] reproduced in Europe the geological chart of the United States, which he had first published in America[38] in 1853. In this chart he colors as underlaid by the Mountain Limestone, the entire area in Michigan which we now know to be occupied by the Marshall and Huron groups. The area of the Waverly series is colored as Devonian. This chart was again reproduced in 1858[39] with alterations, at which time, Mr. Marcou seems to have regarded the area of the Marshall group in Michigan as also of Devonian age.

Norwood and Pratten[40] in 1855, in describing *Chonetes Fischeri* from the yellow sandstones at Burlington, Iowa, refer them to the "base of the Mountain Limestone."

The "Knobstone" formation of Kentucky was ranged by D. D. Owen[41] in 1856, as "sub-carboniferous"; while the "Black Singula Shale," as he styles it, was regarded as Devonian.

Professor Safford[42] in the same year advanced the opinion that the Black Shale of Tennessee ought to be regarded as Carboniferous.

In Mr. Murray's[43] Canadian report for the year 1855, he decides to transfer the Black Shale of Canada West to the "Portage and Chemung

[35] Rep. Geol. Surv. Mo. I., p. 101. [36] Ib. II, p. 218.
[37] "Geol. Karte d. Verein- Staaten," in Peterm. Mittheilungen, p. 149.
[38] Geol. Map of U. S., with explanatory text.
[39] Geology of North America, with Maps and Plates, Zurich.
[40] Jour. Acad. Nat. Sci., [2] vol. iii, p. 25. [41] Geol. Rep. Ky., vol. I. p. 89.
[42] Geol. Reconnoissance Tenn., p. 153. [43] Rep. Geol. Surv. Can., 1853 6, p. 129.

group;" assigning as his motive the fact that "Professor Hall, on seeing the section at Kettle Pt., expressed it as his opinion that the rocks were the lowest measures of the Portage and Chemung group," and the fact that "a nearly complete section of the Hamilton group" had been discovered on "some of the tributaries of the River Sable (south)."

The ferruginous shales of the Marshall group of Michigan were again pronounced Carboniferous in 1858, by Dr. R. P. Stevens,[44] who described from Battle Creek three species of *Leda* and one species each of *Nucula* and *Chonetes*. These are spoken of as occurring in "association with an *Orthoceras*, *Nautilus*, and *Bellerophon Urei*, which is evidently carboniferous."

In the same year, Professor Hall[45] published his Report on the geology of Eastern Iowa, in which he embraced the first separate account which I have observed of the yellow sandstones which outcrop on the banks of the Mississippi at Burlington and other localities. He speaks confidently of their equivalency to the Chemung rocks of New York, and points out a bed of green shale at the base, which he thinks might represent the Portage group. He does not fail to recognize, however, the imperceptible graduation of these sandstones into the overlying Burlington limestone, and expresses the opinion that the Chemung group of Missouri, as organized by Professor Swallow, "will probably be found to include a portion of the Hamilton group."[46] Professor Hall describes eleven species of fossils from these strata, but makes no identifications with fossils from the typical Chemung of New York. Mr. C. A. White's "sections" of the rocks at Burlington, in the appendix to this report, possess very great interest, as embodying the results of exact observations.

In September, 1860, Messrs. Meek and Worthen[47] published descriptions of five new species of fossils from the Rockford limestone. In the same month, Mr. C. A. White[48] published "Observations on the Geology and Paleontology of Burlington, Iowa, and its vicinity;" embracing descriptions of seven new species from the yellow sandstones, and elaborate discussions establishing the intimate relations existing between the yellow sandstones and the overlying Burlington limestone.

During 1859-60-1, a geological survey of the lower peninsula of Michigan was in progress under my direction. The first public announcement of the determinations made upon this survey was in the form of a lecture delivered at the University by myself to an audience consisting mainly of a delegation from the Chicago Academy of Sciences, who were then on an excursion to the University of Michigan. This lecture was reported in full and published in the Chicago Tribune in December, 1860. A summary of the results of the survey was also published in the Detroit Tribune, December 11th, 1860, and briefly in the Detroit Advertiser of January 26, 1861. Advance sheets of my official report were sent off August 18th, 1861, and noticed in the American Journal of Science and Arts in September, 1861.

[44] Amer. Jour. Sci. [2] xxv., 262.
[45] Geology of Iowa, 1, p. 88.
[46] Ib. p. 91.
[47] Proc. Acad. Nat. Sci. Phil., September, 1860, p. 447.
[48] Jour. Boston Soc. Nat. Hist., vol. vii, p. 209.

In the several documents to which I have just referred, I stated distinctly that I regarded the Marshall sandstones of Michigan as the equivalents of the Fine grained sandstone series of Ohio, and the Black Shale of Michigan as equivalent to the Black Shale of Ohio and Indiana. I also stated as a matter of stratigraphical demonstration, that these black shales are seen in Thunder bay of Lake Huron and in Grand Traverse bay of Lake Michigan to rest *above* the well characterized Hamilton limestones. I had at first considered these black shales as the equivalent of the Genesee Shale of New York,[49] but in deference to the judgment of Professor Hall, personally expressed, I united them with my overlying Hudson group, which was organized to receive a series of bluish and greenish argillaceous strata beneath the Marshall sandstones, and supposed by me to correspond to the Portage group of New York.[50] I was not aware at that time, that Mr. Murray had had an almost identical experience,[51] as I have already stated.

In 1860, Professor Swallow[52] published descriptions of 19 species of fossils from the Chouteau and Lithographic limestones of Missouri; and in the same year, Mr. Lyon[53] published a section of the rocks of Kentucky, in which he ranges the "Knobstone formation" under "sub-carboniferous," and inclines to place the Black Slate in the same position.

Early in 1861, Professor Hall[54] published "Notes and Observations upon the Fossils of the Goniatite Limestone in the Marcellus Shale of the Hamilton group in the eastern and central parts of the State of New York, and those of the Goniatite beds of Rockford, Indiana, with some analagous forms from the Hamilton group proper." In this paper Professor Hall returns with strong assurance to his original opinion enunciated in 1842, that the Black Shale of the West is the equivalent of the Marcellus of New York, and that the ferruginous sandstones of Ohio and Indiana, are the equivalents of the Portage and Chemung. He describes as new 18 species from the Rockford beds including those recognized as *Goniatites rotatorius*,[55] and *Goniatites princeps* by Verneuil, and two species previously described by Meek and Worthen. He, however, fails to identify a single species from the Rockford limestone with any species occurring in the Marcellus Shale or other Devonian rocks of New York.

The same number of Silliman's Journal which contained the announcement of my official report, contained also a paper by Messrs. Meek and Worthen[56] on the "Age of the Goniatite Limestone at Rockford, Indiana, and its relations to the Black Slate of the Western States, and to some of the succeeding rocks above the latter." These authors deny that any portion of the Black Slate is found above the Goniatite limestone, as had been asserted by Christy, and announced that it lies entirely below. The limestone they identify with the Chouteau limestone of Missouri, founding the opinion on an identification of at least six out of 23 or 24 Rockford species, and a close resemblance amongst most of the others. They argue

[49] Mich. Geol. Rep., 1861, p. 78.

[50] Ib. pp. 79 and 139.

[51] In alluding to this fact in my report, I inadvertently attributed this experience to Mr. Billings; Report, p. 79.

[52] Trans. St. Louis Acad. Sci., 1, 635.

[53] Trans. St. Louis Acad. Sci., 1, 620.

[54] xiii. Report New York Regents App., p. 95.

[55] This is described as G. Ixion, in a note, p. 125.

[56] Amer. Jour. Sci.. [2] xxxiii., 167.

with a degree of paleontological acuteness which cannot be gainsayed, that both the Rockford beds, and the three members of the Chemung group of Missouri as interpreted by Professor Swallow, present characteristics which forbid their introduction into the Devonian system. They affirm the judgment of de Verneuil, that the Black Slate of the West is the equivalent of the Genesee Shale of New York. In an appended note they propose to adopt the name Kinderhook group for the rocks in Illinois lying between the Black Shale and the Mountain Limestone.

Some time in 1862, Professor Hall[57] published a "supplementary note" to his paper on the Rockford limestone, in which he states that having identified the Rockford *Goniatites Hyas* among fossils from the Waverly sandstone of Licking county, Ohio,[58] he is led to "conclude that the position assigned to the Goniatite beds of Rockford may be erroneous, and that the true position is higher in the series, or more nearly in a parallel with the Chemung group."

During the year 1862 large additions were made to our exact knowledge of the species of fossils embraced in the series of rocks immediately underlying the Mountain Limestone. In February, Messrs. White and Whitfield[59] published a paper entitled "Observations upon the rocks of the Mississippi valley, which have been referred to the Chemung group of New York, together with descriptions of new species of fossils from the same horizon at Burlington, Iowa." This paper embraces descriptions of 31 new species. The authors in their introductory remarks, synchronize the yellow sandstones of Burlington, with the Chemung of New York, though admitting the strong paleontological contrast, and their striking affinity with the Burlington limestone and higher carboniferous rocks. This opinion is founded upon the identification of several Iowa and Missouri fossils with species from the Waverly series of Ohio, which is assumed to be in physical continuity with the Chemung of Western New York, as originally alleged by Professor Hall.

In April, Mr. White[60] published further descriptions of new species from the same horizon at Burlington, Iowa; Hamburg, Illinois; and Hannibal and Clarkesville, Mo.; and in the same month Professor Swallow[61] published descriptions of two new species from the Chouteau limestone of Missouri.

In May I published[62] a paper "On the rocks lying between the Carboniferous Limestone of the Lower Peninsula of Michigan, and the limestones of the Hamilton Group, with descriptions of some Cephalopods, supposed to be new to science." Of the species enumerated, 24 were from the Marshall group, and one from the Huron. In this paper the Black Shale

[57] Fifteenth Report New York Regents, App., p. 81.

[58] Having myself examined the fossils, I do not consider it identified with G. Ixion, Meek and Worthen (=G. Hyas, Hall,) but with G. Marshallensis, Winchell, which differs from G. Lyoni by constant technical characters, having an additional accessory lobe and saddle, and having the dorsal lobe broader and relatively longer. A transverse section of G. Lyoni, is broadest near the umbilicus, while a section of G. Marshallensis is regularly oval. Professor Hall's inference, however, remains unchallenged.

[59] Proc. Boston Soc. Nat. Hist. vol. viii, p. 289.

[60] Proc. Boston Soc. Nat. Hist., vol. ix, p. 8.

[61] Trans. St. Louis Acad. Sci., vol. 2, p. 81.

[62] Amer Jour Sci, [2,] xxxiii., 352.

of Michigan and Canada West, were again identified and ranged within the limits of the Huron group, next above the Hamilton.

In September[63] I continued the enumeration of Michigan species from the Marshall and Huron groups, giving 63 from the former, and 17 from the latter. Of the Marshall species, 5 were identified with fossils previously described from Rockford. Of the Huron species, 6 were identified more or less doubtfully with species from the Hamilton group of New York.

In November, Col. Jewett[64] and Professor Hall[65] both made publication of the results of late observations upon the rocks in Eastern New York, which had been embraced within the limits of the Catskill group upon the geological map of the state. Col. Jewett declared the opinion as the result of his examinations, that the Catskill group did not exist within the limits of the state; while Professor Hall admitted that the upper limit of the Chemung rocks must be carried in the Catskill mountains, "to an elevation of at least 2,000 feet above tide-water." He stated that it now becomes necessary to restrict the term *Catskill group* to the beds above [the Chemung of Delaware county, hitherto regarded as Catskill,] or to those formerly known as X and XI of the Pennsylvania Survey." He closes by remarking that "in tracing the Chemung group westward, there are many indications that it may require to be restricted in its designation," and that "the Waverly sandstone group of the Ohio reports, at one time regarded by [himself] as entirely equivalent to the Portage and Chemung groups, may, in its upper members, constitute a distinct group, though we do not yet know any line of demarkation between them."

In 1862, Professor R. Owen[66] in his Report on the geology of Indiana, ranges the shales and sandstones underneath the Mountain Limestone in a group designated after D. D. Owen, "sub-carboniferous," regarding them as at the base of the Carboniferous system, and the equivalent of at least some portion of the Waverly series of Ohio. The Black Slate he identifies with the Genesee Shale.

In January, 1863,[67] after having read Col. Jewett's announcement of the unreal character of the Catskill group, and Professor Hall's admission that this group must, at least, be very materially reduced in thickness, I gave utterance to convictions which had for some time been maturing, that not only were the Waverly rocks of the West of Carboniferous age, but that also the Chemung of New York, which Hall, White, Whitfield, Swallow, and others had persisted in identifying with these, must also be regarded as Carboniferous. I furnished a synopsis of the paleontological evidences that the Chemung, Waverly, Marshall, Rockford and Burling-

[63] Proc. Acad. Nat. Sci. Phil., September, 1862, p. 405. In the Sixteenth Report of the New York Regents Professor Hall has given figures of the internal structure of Centronella Julia, described in this paper, from drawings furnished by myself. He however, refers the species to Cryptonella—an error which he has since recognized. (Notice of vol. iv. of the Paleontology of New York, p. 21.)

[64] Fifteenth Report Regents New York, p. 198, and Amer. Jour. Sci., [2,] xxxiv, 418.

[65] Canadian Naturalist and Geol., vol. vii, p. 377.

[66] Indiana Geol. Rep., 1862, pp. 92, 108, &c.

[67] Amer. Jour. Sci., [2] xxxv, 61. In this paper, an editorial alteration makes me say "Old Red Sandstone of New York," when I wrote "Old Red Sandstone of Scotland."

ton beds were synchronous, and that all should be ranged within the Carboniferous system.[68]

In January, 1863,[69] I published a series of "descriptions of fossils from the yellow sandstones lying beneath the Burlington limestone, at Burlington, Iowa." The number of new species described in this paper was 59, and the number of old species there first identified from the yellow sandstones was 10—raising the total number of species thus far known from those strata from 66 to 135. The Carboniferous facies of this assemblage of organic remains was again insisted upon.[70]

Sir William Logan[71] in the Geology of Canada, published in 1863 or 1864, refers the Black Shale of Canada West to the Genesee, but states that Professor Hall embraces the Genesee in the Portage. This is what I had done in 1860.

In November, 1863, a pamphlet appeared from Professor Hall[72] containing descriptious of 17 species of crinoidea obtained from the Waverly sandstone series at Richfield, Ohio. While admitting that this assemblage of crinoids presents affinities with Carboniferous types, he asserts that the affinities are quite as strong with types from the recognized Chemung and even the Hamilton of New York. *Forbesiocrinus lobatus* is actually identified with a Hamilton species, while *F. communis*, though intimately related to forms from the Keokuk limestone, has also been found in the Chemung. He regards *Scaphiocrinus Ægina* as closely related also to *Poteriocrinus diffusus* of the Hamilton group. He concludes: "Left to the evidence afforded alone by the collection, and the means of comparison at present possessed, I should infer that the geological position of these species is between the Hamilton group and the lower Carboniferous beds; while the occurrence of a single species identical with a species in the middle of the Chemung group will ally them more nearly with the fauna of the Hamilton group than with that of the Carboniferous period."

The age of the Ohio sandstones was again touched upon by Professor Hall[73] in 1864, who thought that the study of the fossil plants of the Chemung tended to confirm opinions previously entertained as to the Carboniferous affinities of these rocks and those in Ohio, which he had

[68] The identifications with Chemung fossils had been reported by others; as at that time I had not personally examined Chemung specimens. I had identified one Avicula from Professor Hall's figure and description.

[69] Proc. Acad. Nat. Sci. Phila., Jan., 1863, p. 2.

[70] The genus *Syringothyris* established in this paper, though not accepted by Professor Hall, (Proc. Amer. Phil. Soc. May, 1866, p. 250) has been shown to be valid by the examinations of some of the highest authority in America and England. (See Meek: Proc. Acad. Nat. Sci., Dec., 1865, and——: Carpenter: Annals and Mag. Nat. Hist., July, 1867, p. 68, where the genus is partially illustrated-Davidson; Geolog. Mag., July, 1867, who gives a fully illustrated description of the genus—partly from drawings furnished by myself.) Dr. Carpenter now refers to this genus a part of *Spirifer cuspidatus* from Millicent Ireland (as first suggested by Mr. Meek;) *S. Hannibalensis* Swallow, *S. Capax*, Hall, *Syntrielasma hemiplicatus*, Meek and Worthen—also probably a portion of *Spirifer distans* of Belgium.

[71] Geology of Canada, 1863, p. 387

[72] Pamphlet; reprinted in xvii. Rep. N. Y. Reg., 1865, p. 50.

[73] xvi. Rep. N. York Regents, pp. 92 and 107. Note.

regarded as contemporaneous. In a note he remarks that the Catskill rocks of Eastern New York must probably be restricted to "the coarse conglomerate of the upper part of the Catskills," which corresponds to the outliers occurring on the summits of the higher hills in Western New York, and to a continuous formation beyond the limits of the State in Pennsylvania.

In July, 1865, I presented[74] a continuation of the results of my researches in the paleontology of the rocks under consideration, embracing descriptions and notices of fossils from the States of Michigan, Ohio, Indiana, Illinois, Iowa and Missouri, in all which I had made personal explorations. The number of species noticed in this paper is 94, of which 36 were therein first described. This paper presents a shadowing forth of conclusions which I feel constrained to think, demand the candid consideration of paleontologists. To this time I had been impressed with the expectation that the Chemung rocks of New York would eventually be synchronized with the Waverly series of Ohio upon paleontological grounds. It had generally been supposed that the Chemung strata embraced from three to six species which could be identified with western species from the horizon of the Waverly sandstone; and that on the completion of the study of these rocks by the paleontologist of New York, further identifications would be effected. At the suggestion of Professor Hall, I spent several days with him in February and March 1865, in making direct comparisons between the types of the Chemung group of New York and a collection of fossils supposed to belong to the same horizon, from the Western States. The western fossils brought under comparison numbered about 175 species. To the great surprise of both of us, we were unable to identify a single species with Chemung types. All the reputed identifications had to be abandoned. This is a conclusion in which Professor Hall united with myself.

Not satisfied to be completely frustrated in my attempt to determine the New York equivalent of our western sandstones, I turned my attention to an examination of the facts in connexion with strata occupying a position in Western New York above the typical Chemung strata. Professor Hall[75] had described a conglomerate in Western New York as terminating the Chemung series, and had remarked that it contained Chemung fossils; though it does not appear that any critical and final examination had been made upon this point. The Catskill group had been restricted at the east to certain conglomerates capping the Catskill mountains, and at the west to detached outliers of sandstone becoming also at times conglomeritic.[76] In addition to these he had described a conglomerate which he identified with the Carboniferous of Pennsylvania and Ohio[77]. It does not appear that any two of these conglomerates had been

[74] Proc. Acad. Nat. Sci. Phil., July, 1865, p. 109. The materials for this investigation, besides my own collections in different States, embraced Col. Whittlesey's Ohio collection and numerous residual *investiganda* of the White collection of the University, from Iowa, Missouri and Illinois.

[75] Geol. Rep. 10th Dist. N. Y., p. 252 and elsewhere.

[76] Canadian Naturalist, vii. p. 380.

[77] Rep. Geol. 10 Dist. N. Y., p, 284.

seen in juxtaposition,[78] and I am not aware of the evidence upon which they had been pronounced stratigraphically consecutive.

Through the kindness of Professor Hall I was permitted to examine the original specimens of fossils from the so-called Chemung and Carboniferous conglomerates. The fossils of the latter had been collected from a single locality, about four miles north of Panama in Chatauque county, and did not number in all more than half a dozen species, of which three had been described in the New York Report.[79] Of these, four were found, to the surprise of both of us, to be identical with species from the horizon of the Waverly series of the West.

Nor was this all. On comparing specimens of the so-called Chemung conglomerate with these, I remarked not only a great lithological similarity but a striking general resemblance of the fossils, and an actual identity of two species with species which had been identified in the Carboniferous conglomerate. My conclusions, so far as any could be reached, were announced in the following words :

"In the light of these identifications, and in the absence of all identifications between the western species and those of the Chemung, as well as between the species of this (so-called Chemung) conglomerate and those of the Chemung, it might not seem unreasonable to doubt its affinities with recognized Chemung rocks, and to suspect its continuity with the supposed 'Carboniferous conglomerate,' until observation shall have demonstrated that its stratigraphical position is really below that formation. And further, since we must probably abandon the attempt to coördinate the Chemung of New York with the fossiliferous portions of the sandstones and shales of the West lying between the 'Black Slate' and the Coal Conglomerate, it seems not unlikely that we may yet be able to prove the conglomerate of Western New York to be the attenuated and littoral prolongation of those western sandstones and shales—at least of the superior and fossiliferous portions of them ; so that the latter would stand as a hitherto unrecognized group of strata lying at the very base of the Carboniferous system ; while the Chemung rocks of New York fall within the Devonian system, toward which the writer is now inclined to think that their paleontological affinities attract them."

"It yet remains to determine by observations in the field, whether the so-called 'Carboniferous conglomerate' of Western New York is really the equivalent of the Coal conglomerate of Ohio ; and whether any actual junction of superposition can be discovered in Western Pennsylvania or Eastern Ohio between the Chemung rocks in their westward prolongation and the fine grained sandstones and gritstones of the Western States."

In December, 1865, Messrs. Meek and Worthen[80] described three additional species from Ohio and Illinois ; and Mr. Meek[81] took up a discussion which involved the characters and validity of the Genus *Syringothyris* from the yellow sandstones of Iowa.

In 1866 I published[82] the results of a geological and economical survey

[78] Hall—Rep. Geol. 10 Dist. N. Y., p. 292.
[79] Geol. 10 Dist. N. Y., p. 291.
[80] Proc. Acad. Nat. Sci. Phil., Dec., 1865, p. 245.
[81] Proc. Acad. Nat. Sci. Phila., Dec., 1865, p 275.
[82] The Grand Traverse Region, p. 51.

of the Grand Traverse Region in the lower peninsula of Michigan, among which I alluded to the ratification of my previous opinions that the Black Shale of the West is the equivalent of the Genesee Shale. I announced here, for the first time that this shale had afforded me two characteristic New York fossils from near the mouth of Bear Creek in Canada West—*Leiorhynchus multicosta* and *Discina Lodensis*.[83]

In this report I repeated my correction that the "green shales" above the Genesee Shale in Michigan correspond to some portion—perhaps the Cashaqua Shale—of the Portage group of New York, while the higher bluish, argillaceous shales might answer to the Chemung.

In June of the same year, having occasion to make a survey and report,[84] in conjunction with Dr. Newberry, upon portions of Knox and Coshocton counties in Ohio, I cited several Waverly sandstone species as extending upward into the Coal Measures, and suggested that the Ohio equivalent of the Portage and the Chemung might be the series of the "Chocolate Shales and Flags," whose existence beneath the fossiliferous sandstones of Ohio had been demonstrated by borings. The deepest of these borings indicated the existence of 1060 feet of shales and sandstones between the base of the False Coal Measures and the top of the Genesee Shale. Of this distance 534 feet were occupied by the so-called "chocolate shales and flags."

In July of the same year Messrs. Meek and Worthen[85] described two additional species, of which one was from Richfield, Summit county, Ohio, and the other from Rockford, Indiana.

During the same year (1866) appeared the first volume of the final Report on the geology of Illinois, in which Mr. Worthen,[86] speaking of the Kinderhook group, locates it at the base of the Carboniferous system, insists upon the carboniferous affinities of its fauna, and expresses the opinion that no rocks exist in Illinois or Indiana which can be referred to the Chemung group of New York.

Before the close of the year the second volume of this Report appeared, in which the paleontology of the Kinderhook group is described by Messrs. Meek, Worthen, and Newberry,[87] the facts of which seemed fully to sustain the previous opinions of those geologists in reference to the age of the group.

During the same year (1866) Professor Hall[88] also made advance publication of some views which were to be embodied in his fourth volume of the Paleontology of New York. In this paper he insisted with great earnestness upon the probable Chemung age of the Waverly series and its western equivalents, explaining the contrast of the eastern and western faunas on geographical and hydrographical considerations.

83 Mr. J. P. Lesley has somewhere attributed the discovery of these fossils to Professor Hall. It is true that I had exhibited them to Professor Hall and obtained his acquiescence in my identification, but he did not intimate that he previously observed them west of New York. Indeed, in his latest known opinion these Canadian shales had been referred to the Portage group. (Geology of Canada, 1863, p. 387.

84 Prospectus of the Neff Petroleum Co., p. 7.

85 Proc. Acad. Nat. Sci. Phil., July, 1866, p. 251.

86 Geol. Survey Ill., I, p. 108.

87 Geol. Surv. Ill. II, Paleont. pp. 62, 77, 80, 145.

88 Trans. Amer. Philosophical Soc., 1866, p. 246; in advance of Vol. IV, Paleont. of N. Y.

In 1867, at the meeting of the National Academy at Hartford, Professor Hall reiterated the same views with considerable amplification. Professor Agassiz, who was present, gave them his earnest endorsement, pronouncing them the natural and philosophical conclusions of a geologist who had devoted 30 years to the study of the data upon which the conclusions rested. His remarks in reference to geologists who felt themselves constrained to entertain divergent opinions were at least emphatic, if they were not complimentary.

Finally in August, 1868, Dr. T. S. Hunt read a paper before the Chicago meeting of the American Association[89] in which he makes note of the occurrence, in the extreme western part of the province, of some gray and more or less blackish shales overlying the Genesee Shale proper, which he ranges in the horizon of the Portage group. It will be noticed in the sequel of this paper that I have made a similar disposition of similar strata in Michigan, Ohio, Indiana, Kentucky, and Missouri.

Such is a sketch of the history of opinion in reference to the rocks under consideration.[90]

III. Present State of our Stratigraphical Knowledge.

In the State of New York the strata above the Genesee Shale have been arranged by Professor Hall[91] as follows :—

Carboniferous Conglomerate :—Coarse silicious conglomerate and diagonally laminated sandstone.

Catskill Group :—Conglomerate of the Catskill mountains. Along Genesee river, a calcareous sandstone, sometimes highly ferruginous, approaching iron ore.

Chemung Group :—Conglomeritic at top in Western New York. Greenish gray sandstones with occasional fossiliferous bands.

Portage Group :—A, In Eastern New York.

1. Shales and shaly sandstones and flagstones 100 feet.
2. Red shale and shaly sandstone 400 to 500 feet.
3. Greenish and gray shales and shaly sandstones.
4. Darker shales to Hamilton Group.

[89] Published in Amer. Jour. Sci. and Arts [2] XLVI. p. 355. In this paper Dr. Hunt takes occasion to state that "Professor Winchell, for some reason, doubts the existence of the Portage formation in Ontario." As Dr. Hunt makes no reference to any published doubts entertained by me on this subject, I am at a loss to know the source of his mis-information. I have heretofore always identified with the Portage (or Portage and Chemung) the series of argillaceous strata extending from the Genesee Shale to the Marshall sandstones, (See the various references already made in this paper.) If these strata exist in Ontario I should pronounce them Portage. I have already described them upon the Michigan borders of Ontario, and it is to be presumed that they extend across the boundary. As Dr. Hunt states, these Portage shales are physically a continuation of the Genesee shale proper, and by ranging them all in my Huron group, I did in 1861, what Dr. Hunt has done in in 1866 and 1868.

[90] I have made no note of the elaborate and able researches of Dr. Dawson upon the fossil vegetation of rocks lying in and near the zone under consideration. Dr. Dawson's papers—together with some minor papers, also passed over—will be referred to in an Appendix.

[91] Final Rep. IV Dist. N. Y.; Canadian Naturalist and Geologist, vol. vii., p. 377; xvi. Report Regents N. Y., p. 107. Note.

B, In Western New York.

1. *Portage Sandstone*, thick bedded.
2. *Gardeau Shales and Flagstones*—green and black—slaty and sandy shales with thin layers of sandstone.
3. *Cashaqua Shale*—soft, argillaceous, green, crumbling to a tenaceous clay.

In Ontario, although Professor Hall and Sir William Logan have assigned at least a portion of the black shales to the horizon of the Portage Group, I have not been able to distinguish any of them from the Genesee shale proper containing *Leiorhynchus multicosta* and *Discina Lodensis.* As overlying shales of the age of the Portage Group however exist in Michigan close to the national boundary, I have always presumed that they extend across it. This opinion Dr. Hunt has very recently confirmed.

In Michigan I have been able to make out a complete determination of the strata as follows:[92]

Parma Conglomerate:—a whitish or rusty, often conglomeritic and obliquely laminated sandstone with vegetable remains. 105 feet.

Carboniferous Limestone:—irregularly bedded, often cherty or ferruginous, and much shattered *in situ*—becoming arenaceous below. 70 feet.

Michigan Salt Group:—consisting of aluminous and gypseous shales, thin gray flags, bands of limestone and thick beds of gypsum. 200 feet.

Marshall Group:—consisting of:—

Napoleon Sandstone, pale buff, often conglomeritic, obliquely laminated, thick bedded. 123 feet.

Marshall Sandstone, reddish, yellowish, olive, obliquely laminated, highly ferruginous—the iron often under a rudely concentric, concretionary arrangement. In places calcareous. Highly fossiliferous. 160 feet.

Huron Gritstones, bluish or greenish gray, fine grained, regularly bedded. 15 feet.

Huron Group, consisting of:—

Argillaceous shales and flagstones—the latter less prominent in the southern part of the State. 500 feet.

Green arenaceous shales, especially in Grand Traverse Bay. 25 feet.

Black bituminous shale (Genesee shale). 25 feet.

Hamilton Group. [The calcareous member of this group is conspicuous in Michigan.]

In the State of Ohio the succession of strata seems to be nearly as follows:[93]

Conglomerate, buffish, obliquely laminated, more or less pebbly, often with rudely concentric spheroids of iron ore. Sometimes underlaid by "False Coal Measures."

[92] Mich. Geol. Rep., 1861, p. 138; Amer. Jour. Sci. [2] xxxiii., 352; The Grand Traverse Region, p. 49.

[93] Foster Geol. Rep. Ohio, p. 77; Briggs—Ib., p. 79; Whittlesey—Proc. Amer. Assoc. v. p. 76; Winchell—Mich. Geol. Rep., 1861, p. 78, also, Prospectus, Neff Petroleum Co., p. 7.

Gritstone series, consisting of flaggy shales, ferruginous, somewhat thick-bedded sandstones with iron-stone partings, often with interstratified blackish or bluish shales. Followed downward by shales of a bluish, brownish or reddish color, 100 to 150 feet.

Waverly series:—Bluish or greenish gray, fine-grained and evenly bedded, often fossiliferous sandstones and flags, with interstratified brownish shales. 200 feet. [In Knox county the Gritstone and Waverly series are together 517 feet.]

Chocolate shales, argillaceous, chocolate colored, bluish and blackish. 250 to 300 feet. [In Knox county this series is 450 feet.]

Black Shale, 100 to 150 feet. [This is an abnormal thickness of the Black Shale in the West, and it is probable the upper portion belongs with the Chocolate series.]

In the State of Indiana the series seems to be constituted as follows:[94]

Carboniferous Conglomerate.

St. Louis Limestone, freely represented.

Warsaw Limestone.

Keokuk Group, consisting of:—

Gray limestone and calcareous shales (Floyd county) 50 feet. Wanting in Northern Indiana.

Brown shales with geodes and nodules of hornstone.

Knob formation or gritstones, micaceous, ferruginous, friable, with intercalated limestones in the upper part. 150 feet or more.

Rockford Limestone, with Goniatites, &c.; represented by a thin bedded sandstone in Northern Indiana. Wanting in Western Indiana.

Black Shale.

In the State of Illinois we have the following succession of strata.[95]

Burlington Limestone.

Kinderhook Group, consisting of "gritstones, sandy and argillaceous shales, with thin beds of fine-grained and oölitic limestone." 100 to 200 ft.

Black shale. "Dark blue, green, or chocolate colored shales, passing locally into a black bituminous shale." [Presents in Southern and Western Illinois, rather the characters of the Huron shales of Michigan. May it not constitute, with the lower portion of the Kinderhook group, a representation of the Portage and Chemung of New York?]

In Iowa (at Burlington) the series of strata is the following:[96]

No. 8. Upper Burlington Limestone. 20 feet.

No. 7. Lower Burlington Limestone. 30 to 50 feet.

No. 6. Oölitic Limestone, with fossils. 2 feet.

No. 5. Yellowish Sandstone with abundant casts of Brachiopods. 4 to 6 feet.

No. 4. Limestone, with Brachiopods. 9 feet.

No. 3. Oölitic Limestone. 3 in.

[94] Hall—Trans. Assoc. Amer. Geol. p. 280; Meek and Worthen—Amer. Jour. Sci. [2] xxxii., 167; Worthen—Ill. Geol. Report, vol. i., p. 116; Christy—Proc. Amer. Assoc., v., p. 76.

[95] Worthen—Geol. Surv. Ill., I., p. 108; III., p. 115.

[96] Hall—Iowa Geol. Rep., I., 90; White—Ib., Append.

No. 2. Bluish-brown Limestone with corals. 8 in.
No. 1. Yellowish Sandstone, passing downward into a bluish indurated clay. Fossils rare. 68 feet and more.

In Missouri we are furnished with the following series of rocks:[97]
Encrinital Limestone, regarded as equivalent to the Burlington Limestone.
Chouteau Limestone. 10 to 70 feet.
Limestone, brownish-gray, earthy, silico-magnesian, in thick beds. 40 to 50 feet.
Limestone, blue or drab, compact, thin and irregularly bedded.
Vermicular Sandstone and shales. 30 to 100 feet.
Sandstone, buff or yellowish-brown, fine-grained, argillo-calcareous. Sometimes becomes an impure magnesian limestone.
Shale or fire-clay, blue or brown, argillaceous, in regular, thin strata.
Lithographic Limestone, light drab to light buff and blue, pure, fine, compact, even-textured, silicious. 60 to 70 feet.
At bottom is a blue shale 30 to 40 feet thick.

In Kentucky, according to my own observations, we have at Knob Lick and Pine Knob, four miles south of Danville, the following section:
Sandstone, yellowish, from top of Knob down. 150 feet.
Shale, blue, arenaceous, with bands of iron ore and ferruginous sandstones, forming the phenomenon known as "Knob Lick." 80 feet. [Resembles shales of Huron Group.]
Black Shale, only moderately bituminous. 40 feet.
Silicious and Geodiferous Beds, containing *Cystiphyllum Americanum*, *Phillipsastræa gigas*, *Heliophyllum Halli*, *Fistulipora Canadensis* and other Hamilton fossils.[98]
Hydraulic Limestone, blue, arenaceous, very thick bedded, with fragments of fossils. 12 feet.
Nashville Group.

In Tennessee the Black Shale rests directly upon the Nashville group, and is overlaid by about 150 feet of the "Silicious Group," in the very lowest beds of which I have recognized *Producta semireticulata*, *Orthis Michelini*, *Spirifera Logani*, and an undescribed *Zaphrentis*, which, with the *Spirifera*, is regarded as characteristic of the Keokuk Limestone.[99] Above the Silicious group we have 394 feet of cherty limestone, mainly referable to the St. Louis division,[100] since it contains *Lithostrotion Canadense*, *Producta semireticulata*, *Streptorhynchus umbraculum*, *Spirifera Keokuk* Var, *S. perinflata?* The presence of *Rhynchonella Verneuiliana* indicates that the Warsaw limestone may also be represented in the lower portion of this formation. Next above we have 603 feet of limestone abundantly

97 Swallow—Neo. Geolo. Report, I., 101 and Tab. 15, p. 99; Meek and Worthen—Amer. Jour. Sci. 2] xxxii., 171.
98 D. D. Owen speaks of no Devonian in this part of Kentucky except the Black Shale. He, however, speaks of Upper Silurian rocks; these I have not seen.
99 These fossils were collected in Hickman and Maury counties, and kindly furnished me by Prof. Safford.
100 In its physical characters this cherty limestone is a continuation of the Silicious Group, and Prof. Safford informs me that he so treats it in his forthcoming Report.

stocked with the crinoids of the Kaskaskia division of the Mountain limestone, embracing *Pentremites Godoni, pyriformis, symmetricus* and *globosus* and *Agassizocrinus gibbosus.* This section is from the eastern border of the basin of Tennessee along the road from Nashville to Sparta and the summit of the Cumberland Table Land at Bon Air.

A black bituminous shale exists in considerable force in Carrol county and other parts of Arkansas, immediately superimposed by lower carboniferous limestones; but Dr. D. D. Owen expresses a doubt whether it answers to the Devonian Shale of Ohio; and he also doubts the existence of rocks in Arkansas corresponding to the Knob formation.[101]

In attempting to trace the parallelism of these formations on purely structural and lithological grounds, it may be remarked, in the first place, that the identity of the Black Shale cannot now be mistaken. It is a matter of no surprise that it should at any time have been referred to the horizon of the Marcellus Shale, as long as stratigraphical observations were confined to Ohio and Indiana. Its stratigraphical position above the Hamilton group is now, however, demonstrated by actual superposition in Grand Traverse Bay of Lake Michigan, Thunder Bay of Lake Huron, at various points in the peninsula of Ontario, and on the borders of the "Knob region" below Danville in Kentucky. Its position immediately below the arenaceous and argillaceous beds which are the subject of discussion in this paper, is demonstrated by the order of superposition at Pt aux Barques of Lake Huron, at sundry points in Branch, Kalamazoo and Allegan counties, Michigan, and at various places in northern and central Ohio. When at Rockford, Indiana, I had the opportunity to make my observations under favorable circumstances. The milldam had been broken away by a freshet, and the exposure of Black Shale three-fourths of a mile above was such as to indicate clearly by the dip, that this rock passes under the Goniatite limestone. My observations in this vicinity enabled me to determine the following succession of strata.

Goniatite Bed—seen below the dam and at Wilson's creek.

Semi-indurated clay.

Limestone, fine, compact but shattered, bluish, rusted in the vicinity of the fractures. Contains the Brachiopods and Radiates described from Rockford.

Black Shale.

It is further possible, as first suggested by Messrs. Meek and Worthen, that the blue shale at the base of the Lithographic Limestone in Missouri should be co-ordinated with the Black Shale. I think, however, there are reasons for considering the Genesee Shale unrepresented in Missouri.

It is proper to remark that the so-called Black Shale or "pyroschist"[102]

[101] Geology Reconnois. Ark. I, pp. 87, &c., and 135.

[102] Dr. T. S. Hunt proposes this Anglicised Græcism of the "Brandschiefer" of the Germans, (Amer. Jour. Sci. [2] xxxvi., 159,) since, as he asserts, this shale contains no free bitumen. In this, however, he is certainly mistaken, as I have seen it oozing from the cliffs in Grand Traverse Bay; and I am informed that the odor has sometimes attracted the attention of travelers. It appears, furthermore, that the intimate mingling of comminuted organic matters with argillaceous materials creates the most favorable conditions for the spontaneous evolution of hydrocarbonaceous products from the rocks.

varies very materially in the percentage of bituminous and carbonaceous matters at different localities; and the thickness of the dark bituminous beds is also extremely variable. In Michigan and Tennessee the bituminous beds are comparatively thin, but in the former State there is a vast mass of non-bituminous or slightly bituminous shales immediately overlying the lower portions, which pass by insensible gradations into the typical black shale. These, according to Hunt, occur also in Ontario. Proceeding from structural data alone, I united this entire series of shales in one formation which I styled the Huron group; and I am even now strongly inclined to associate this shale with the strata above rather than with those below. Should it be thought these facts tend to point out the equivalency of the Black Shale proper with the dark shales existing in the lower part of the Portage group of New York, it may be stated that the existence of *Lingula spatulata* in great abundance in the Black Shale of Ohio and Kentucky and the presence of *Discina Lodensis* and *Leiorhynchus multicosta* in the Black Shale of Ontario will effectually narrow the determination to the Genesee Shale of New York.[103]

In the next place, the Carboniferous Conglomerate marks a superior horizon which cannot ordinarily be mistaken. The Parma Conglomerate of Michigan, as I have heretofore indicated,[104] occupies the same stratigraphical position. The conglomerate of Western New York identified by the New York geologists with the Coal Conglomerate of Ohio, presents undoubtedly a lithological affinity. The same is true, however, of the conglomerate represented as terminating the Chemung series, and also of the conglomeratic portions of the Catskill group. I am not informed of the lithological or structural grounds upon which these three similar conglomerates (each locally varying to similar sandstones) have been ranged in an order of sequence. As they are nowhere seen in immediate superposition, it is at least supposable that they are but local occurrences of one and the same formation. If thus identifiable, the question still remains to be determined whether the formation lies in the horizon of the Chemung, in that of the Catskill or that of the Coal Conglomerate. The only evidence at present in our possession bearing upon the determination of this question is paleontological. This evidence, as I have already intimated, tends to unite the so-called Chemung and Carboniferous conglomerates and range them in a zone below the Coal Conglomerate of Ohio. This subject will be resumed in the paleontological part of this paper.

In the third place, it may be remarked that we are now in possession of the means of determining the parallelism of the western strata between

[103] I desire to remark, in passing, that the Marcellus shale of New York is probably represented in Little Traverse Bay by the highly bituminous and earthy limestone near the base of the Hamilton group. The same is seen at Thunder Bay Island, Lake Huron, and in the oil wells of Enniskillen, Ontario. This shale seems therefore, like the Genesee shale, to constitute only an appendage to another formation.

[104] Michigan Geol. Rep., 1861, pp. 114, 138. So far as I know this was the first instance in which a geological designation was bestowed upon this formation. The Canadian geologists in the Report of 1863, apply the name "Bonaventure formation" to a series of arenaceous strata "belonging to the base of the Carboniferous series." (p. 404.) In the Atlas to accompany this Report, published in 1866, the Bonaventure formation is put down as the equivalent of the Coal Conglomerate of the United States.

the Carboniferous Conglomerate and the summit of the arenaceous series which has been locally designated Waverly, Marshall, Kinderhook, &c. The Carboniferous limestone of Michigan has been shown [105] on paleontological grounds to possess affinities with the median stages of the Carboniferous Limestone series of the Mississippi valley. The Michigan Salt Group has at length yielded some beds of fossiliferous flags, from which, as might have been anticipated, it is shown to stand in close relation with the same series. The Knobstones of Indiana and Kentucky, always ranged by geologists within the limits of the Carboniferous system, possesses strong lithological affinities with the Waverly series, and withal occupy the same relative position between recognized Carboniferous limestones and the Black Shale. But paleontological evidence compels us to elevate them into the zone of the Mountain Limestone which, at every point of contact, is shown to lie above the Ohio psammitic series. Indeed, it appears from observations made by others and by myself, that the Knobstone formation of Indiana and Kentucky, with the associated shales and limestones, is substantially restricted to the horizon of the Keokuk division of the Mississippi Limestone series, or "Mississippi group."[106]

The Silicious group of Tennessee is only a southward prolongation of the same under changed petrogenetic conditions; though in that State, the silicious characteristics also invade the horizon of the Warsaw and St. Louis Limestones—as may be seen along the valley of the Calfkiller river, and on the first bench of the ascent to the Cumberland Table Land.

We come now to the series of strata, the determinations of whose equivalencies has presented the most serious difficulties. The Gritstones and Waverly sandstones of Ohio offer marked petrographic affinities with the arenaceous strata of the Chemung and Portage groups of New York; and it is doubtful whether on purely lithological and structural grounds we should ever be able to distinguish them. The same may be said however, and has been said, of the Knobstones of Indiana; and the same is also measurably true of a comparison between the Chemung and Catskill strata, or the Catskill and Millstone Grit, or the Waverly and Millstone Grit. There seems to be, moreover, a connection of continuity between the psammites of Ohio and the Chemung flags of Chatauque county. A similar petrographic resemblance is apparent between the Marshall rocks of Michigan in the northern and southern outcrops, and the Waverly of Ohio. Furthermore, no little resemblance can be traced between these sandstones and the yellow sandstones beneath the Carboniferous limestone of Iowa. The Rockford limestone and the calcareous strata of the same zone in Illinois and Missouri present considerable contrast, but they approximate, on the other hand, certain calcareous beds in the Waverly series of Summit county, Ohio, and the Marshall series of Calhoun county, Michigan. Moreover, these calcareous strata are intimately associated in Illinois and Missouri, with arenaceous strata which everywhere recall the aspect of the arenaceous strata of other States. In respect to stratigraphi-

[105] Mich. Geol. Rep. 1861, p. 103.

[106] I propose the use of this term as a geographical designation for the Carboniferous Limestones of the United States which are so largely developed in the valley of the Mississippi river.

cal position, we find all these formations lying beneath the Mississippi limestones and above the Genesee shale.

The synchronism of the Waverly and Gritstone series of Ohio, with the Portage and Chemung of New York, has not only long been asserted—at least at invervals—by Professor Hall, but has been generally assented to by others, who have had occasion to consider the subject, or have felt disposed to defer to competent authority. The controversy which has existed has been rather in reference to the systemic position of the two, as the citations which I have already made from the history of the controversy sufficiently indicate. The Waverly series has generally been regarded of late years, as extending down to the Black Shale; and the denial of the parallelism of this series with the Chemung and Portage has appeared to leave no space for the existence of the latter groups in Ohio. There is, as Professor Hall has frequently asserted, an improbability that a group more than a thousand feet thick in western New York, should have completely thinned out before reaching the meridian of Cleveland or the peninsula of Michigan. There are some facts in my possession, however, bearing upon this subject, which I have never yet had the opportunity to bring into prominent notice.

In my Report on the lower peninsula of Michigan I described a series of argillaceous strata[107] underneath the Marshall sandstones, and extending to the Hamilton limestones. The Genesee Shale constitutes the lower portion of this group—being structurally a portion of it. In my Report I assign but 210 feet of thickness to this group, as this was all that I had actually measured at outcrops; but borings subsequently executed in various parts of the State, show that the group actually possesses a thickness of 500 to 600 feet.[108] This mass occupies the place of the Portage and Chemung strata. In the southern portion of the State it is quite purely argillaceous, passing vertically at intervals into micaceous arenaceous shales, or even calcareo-arenaceous flags; but in its northern outcrops, we find compact flagstones frequently intercalated in the series, giving it a physical approximation to the New York strata, whose stratigraphical position it usurps. Moreover, in Grand Traverse Bay, we discover, not far above the Genesee Shale, a mass of green arenaceous shales which apparently answer to the Cashaqua Shale of the Portage group.

We have in this series all that is requisite to answer the demands of the Portage and Chemung groups. The thickness is, indeed, considerably reduced; but it must be remembered that all the other New York groups traced into Michigan exhibit even a greater attenuation than this parallel would imply.[109]

[107] I embraced in this group 14 feet of gritstones, which I subsequently removed, on studying their paleontology. (Amer. Jour. Sci. [2] xxxiii., 352.

[108] I have several times published these later determinations, but Dr. Hunt continues to quote from my Report of 1861, (Amer. Jour. Sci. and Arts, xlvi., 357,) having evidently overlooked my later announcement. (See, for instance, "The Grand Traverse Region," (1866) p. 52.)

[109] Dr. Hunt thinks the Salina Strata will yet be found to attain a greater thickness in Michigan than that assigned to them in my Report of 1861, (Amer. Jour. Sci. and Arts, xlvi., p. 359.) The facts announced by him would certainly justify such an expectation; but I embrace the opportunity to state that though bored through in several places since the date of my Report, the thickness has not been found materially greater than stated in 1861.

Let us now inquire whether in Ohio, which lies contiguous to Michigan, anything can be discovered which answers to the Huron group. The lower portion of the series super-imposed upon the Black Slate of Ohio, has generally been passed by with the remark that it appears to be unfossiliferous, or that it *may* belong to a different epoch from the fossiliferous sandstones above. I think, however, the thickness of these subter-psammitic strata has not been generally suspected. As in Michigan, so in Ohio, we are indebted to the enterprise stimulated by the late petroleum-industry, for the disclosure of the full extent of the argillaceous and flaggy deposites immediately above the Black Shale. We are now assured of the existence of a vast series of shales in Ohio which correspond both in position and in lithological characters to the Huron group of Michigan. In Knox county they attain a measured thickness of 450 feet. Here, again, we discover ample scope of strata to answer the demands of the New York Portage and Chemung, without bringing in the Waverly and Gritstone series above.

In Kentucky also, at "Knob-lick," south of Danville, and at other points, we discover a series of argillaceous strata not less than 80 feet thick, reposing upon the Black Shale, and presenting again all the physical characters of the Huron group. As these shales are surmounted by Knobstones of Keokuk age, we have no stratigraphical determination whether they should be synchronized with the Huron group, or the Marshall, or the lower part of the Mississippi group. I think it will be admitted, however, that some presumption exists that they lie in the horizon of the Huron Shales.

In Iowa it seems not unlikely that the base of the yellow sandstone series, with its bluish, slightly micaceous sandstones, comes into the same zone; while the blue shales, 80 feet thick, beneath the Lithographic limestone in some parts of Missouri, may probably be more correctly synchronized with the argillaceous shales of the Huron group than with the black or Genesee section of that group. I would suggest also that the Illinois shales, somewhat doubtfully referred by Prof. Worthen to the horizon of the Genesee shale, may lie rather in the horizon of the Huron shales of Michigan.

It appears from the foregoing statements that we are by no means compelled to resort to the Waverly and Marshall series to discover the western representatives of the Portage and Chemung of New York. If the apparent continuity of the eastern and western formations should appear to compel such identification, let it be remembered that the Knobstones stand in the same apparent relation to the Waverly that the Waverly does to the Chemung, and yet we yield to the weight of paleontological evidence in denying their equivalency. If, moreover, it appears that the Chemung and Portage have become finer and more argillaceous in their westward extension, it will be remembered that the Waverly strata also, when traced into Indiana, Illinois, and Missouri, have assumed a finer constitution, and have received moreover that accession of calcareous constituents which we always expect to characterize formations remoter from the ancient continental shores.[110] During the periods which followed the Genesee epoch, the time was approaching when the agitations of the terrestrial crust should culminate in the spread of thousands of square miles of coarse *débris* over the bottom of the continental lagoon of North America; the materials of the great Carboniferous Conglomerate. In the progress of the gathering convulsion, the movement of the waters had attained such a degree of violence during the period of the Portage and Chemung as to give rise to the formation of flags and sandstones within the limits of the State of New York, while yet the quieter waters which rested over Michigan and Ohio were precipitating only the materials of shales , and the regions further west were as destitute of mechanical sediments as of the organic *débris* which give origin to limestones. In the following or Marshall period, the disturbance of the terrestrial crust had attained such a limit as to give distribution to the Catskill and so-called Chemung and Carboniferous Conglomerates of New York, while in Ohio and Michigan, it attained only such a degree of energy as had been witnessed in New York during the preceding period, and resulted in the sandstones and shales of the Waverly and Marshall series. Still further West the quiet conditions of limestone-making continued to prevail. In the Knobstone epoch following this, the agitation had extended still further West. While 3,000 feet of mechanical sediments were accumulating in Pennsylvania, the conditions of sandstone accumulation had traveled towards the centre of the American lagoon as far as Indiana, Kentucky and Tennessee, while even yet, the state of quiet was sufficient in Illinois and west of the Mississippi to permit the existence of limestone making animals. The grand agitations of the Millstone grit epoch followed, with the still later oscillations of the surface which conditioned the phenomenon of the Coal epoch, terminated by the tremendous convulsions which gave birth to the mountain barriers of the Atlantic border. But none of these events were felt in the far West. Deep seas and limestone-forming operations—as Prof. Hall has well shown[111] continued to characterize the history of the interior of the continent while the coal marshes of Ohio and Pennsylvania were heaved and tossed in the titanic pastimes of geological forces.

This sketch of the succession of geological events shows that the parallelism which I have traced is in strict harmony with the method of later Paleontological Time ; and instead of suggesting abrupt disappearances and incongruous synchronisms, is the only marshalling of the American strata which keeps perfect time with the grand march of geological events.

[110] There is *a priori* evidence against the continuity of the Chemung and Waverly. Arenaceous sediments, from the circumstances and conditions of their origin, must be limited in extent, at least in one direction. We should therefore *expect* the Chemung to grow finer and to lose its physical identity in its western prolongation; and, if a sandstone recurs at the West, the immediate *presumption* arises that it is a phenomenon of changed continental conditions, characterizing another geological period. Compare Hall: Foster and Whitney's Rep. II, p. 287.

[111] Report on the Geol. and Pal. Mex. Boundary Surv. p. 124; Iowa Geol. Rep. p. 137—141.

Stated Meeting, March 19, 1869.

Present, ten members.

JOHN C. CRESSON, Vice-President, in the Chair.

Letters accepting membership were received from C. L. Rütimeyer, dated Basel, February, 18th, and from J. Prestwich, dated Shoreham, near Seven-oaks, England, March 2, 1869.

A letter of envoy was received from the Meteorological Office of the Royal Society at London, dated Dec. 24, 1868.

Donations for the Library were received from the Meteorological Office of the Royal Society of London, from M. Chevalier, Membre de la Commission de l'Exposition Internationale de 1867 at Paris, from the London Board of Trade, from the Boston Natural History Society, from the American Antiquarian Society at Worcester, from the Editors of the American Journal of Arts and Sciences at New Haven, from Prof. Cook, State Geologist of New Jersey, at Newark, from Mr. Henry C. Carey, Mr. Pliny E. Chase, and the College of Pharmacy, at Philadelphia, and from the Smithsonian Institute, at Washington.

Commodore John Marston presented, for the cabinet, four fragments of painted pottery, dug up by him, early in the year 1861, from the soil of the Island of Sacrifices, near Vera Cruz, Mexico.

The principal piece is 5 inches long by 2 inches wide, a sort of doll, with a fillet over the head, and a painted white plain ribbon-like collar round the neck, from which seems to have depended six painted white and red tags, four on the breast, and one behind each shoulder. The fillet over the forehead is painted in alternate red and white sections. The skin of the forehead and nose, the region around the mouth, the lower parts of the ears, and the half-seen eyeballs, are painted the same dead white ; the rest of the doll has been painted a deep red, much of which has worn off. Two banded bent arms can be traced down the sides and upon the breasts, ending in two white spots for hands. An attempt has been made to signify the left arm by a slight relief. The head has the Astec monument look, there being nothing but backhead and forehead. The eyes are half closed, and the upper teeth exposed by the drawing back of the upper lip. This gives the impression that it was intended to represent a corpse or mummy. Two small holes show that the cylinder is hollow ; but they do not communicate.

One of the other three pieces is a whistle, made of a human head without neck, the aperture slanting up over the forehead. The cheeks are hugely swollen, and the mouth set to represent the act of blowing. The nose is colossal, and the whole thing full of that peculiar humor of Mexican art, which is so strikingly exhibited in the set of masks (?) which the Society has in its Poinsett Cabinet.

The other two fragments are very imperfect, and seem to have been pipe-stands, ornamented, the one with a bird's head, and the other with something like a calf's.

Judge Cadwalader read, by appointment, an obituary notice of Mr. Bancker, which was followed by remarks by Mr. E. K. Price, describing the consequences of the policy inaugurated by Mr. Bancker, as President of the Franklin Insurance Company, of holding a large number of small mortgages. To the encouragements and facilities which this policy affords mechanics and builders with small capital, and, therefore, to Mr. Bancker, the City of Philadelphia has been largely indebted for its rapid extension.

Dr. Emerson communicated a description of an ingenious and important improvement in Whitney's Cotton Gin (1793), made by Mr. R. R. Gwathmey, of Kentucky (1867), and already adopted by planters in the Southwestern States.

Whitney's gin requires the cotton to be picked by hand from the boll, before it can be ginned. Gwathmey's machine, by simply reversing the motion of the saws, rejects the hulls unbroken, and thereby increases the working capacity of a field hand fourfold, that is, from the old rate of five bales of (400 lbs.) per month to twenty.

Pending nominations Nos. 622 to 626 were read.

The Chairman of the Special Committee on the Letting or Selling of the Hall reported that the Committee desired the advice of the Society respecting price. In view of the small attendance of members, on motion, this subject was made the order of business for the next meeting, notice to be sent to all the members.

On motion of Prof. Trego, the subject of the Rittenhouse Clock was referred to the Curators, with power to act, reporting their action to the Society.

And the Society was adjourned.

OBITUARY NOTICE OF MR. BANCKER BY JUDGE CADWALADER.

Charles Nicoll Bancker, one of our oldest members, died on 16th February last, aged 91 years. The Society's request that I would prepare their memorial of him is fulfilled with a mournful pleasure. But my domestic connection with him was so close that the duty cannot be performed without a feeling of some embarrassment. The spontaneous tendency to the language of eulogium will be restrained.

I will not here speak of him in his religious or social relations. My remarks will be limited to subjects which may concern more directly his relations to our Society.

We may thus consider the career of Mr. Bancker as a merchant on an extended scale, as a practical and scientific insurer, and as a man of general scientific information.

New York, the city of his birth, was, in the days of his youth, a place of secondary importance. He removed, in his boyhood, to Philadelphia, then the commercial, political, and literary metropolis, where he entered the counting house of John Guest, one of the largest importers from England, and was thoroughly educated for the pursuit of commerce. Before he had completed his twenty-first year, he became, through his abilities, energy, and assiduous efficiency, the partner of Mr. Guest, who changed his residence to England, leaving their vast concerns here in the sole charge of his young associate. This was Mr. Bancker's responsible relation for many years, including the latter part of the first war, and a great part of the second war, of the French revolution. In each of these eventful periods, the commercial navigation of the world was, in a great measure, carried on under the flag of the United States. The opposing belligerents asserted that the cargoes, professedly of neutral ownership, in vessels thus navigated, were of more than twenty times the greatest value that could be honestly owned by neutrals. The retaliatory maritime hostilities of the opposing belligerents against professed neutrals were chiefly directed against the United States. Cruisers and privateers captured our vessels and those of avowed enemies almost indiscriminately. Such were the causes of the maritime war of the United States with France in 1799, and of their general war with England in 1812.

I believe that Mr. Bancker's house in trade owned no vessels, and neither imported nor exported merchandize for the account of others. The immense business in which they were engaged for their own account required the purchase of millions of sterling bills. This important part of their business was conducted so regularly and carefully that not a penny was ever lost from the failure of parties to such paper. The fact is remarkable, and the reason is interesting. It was not that parties to the paper did not fail. Many failures of course occurred. Of perhaps five sets of Exchange, three, or even four, through capture, might not reach their destination. But there was no loss, for the reason that Mr. Bancker's house took no bills which they did not, on sufficient grounds, believe to have been drawn upon shipments, or intended shipments, of adequate value. His house were mere buyers in the exchange market. They did not themselves take, or directly control, any security except the personal responsibility of the drawers of the bills. But this was not the security on which they relied. Believing that the business in which every bill had been drawn was legitimate, they had no doubt that the bill would be accepted abroad, upon the credit of shipments which had been, or would be *fully insured* against capture.

Capricious vacillation marked the belligerent conduct of the British Government in the occasional suspension and renewal of ill judged retaliatory measures affecting neutrals. A sudden commercial crisis, from one of the most ill-timed of these vacillations, caused, in 1810, an unprecedented depression of the values of a large stock of British imports in the United States. The heaviest losers were Guest and Bancker. The partnership was dissolved. He retired from it, without retaining any property, but was not indebted to any one.

During the interval which preceded the war of 1812, he visited England on business of Stephen Girard, then the wealthiest merchant of the United States, with results of extraordinary profit for Mr. Girard, and of corresponding advantage to himself. He soon resumed commercial business on his own account, and continued it variously for several years. At one time, he dealt largely in cotton, including the product of the remotest parts of our country in which it was grown. His practical experience in almost all subjects of internal and external trade, was of the most extended range.

He was not engaged in commerce after 1826. It then became necessary for him to seek other employment; and his attention was turned to insurance.

The science of insurance—for it *is* a science—cannot be sufficiently taught by professors of law, nor fully understood by mere merchants, nor very deeply fathomed by mere mathematicians. Insurance, we may be told, is a substitute for capital, and should enable men without capital to engage securely, on borrowed means, in enterprises otherwise unduly hazardous; and, therefore, that where insurance has been made, and the premium paid, anything which may tend to prevent fair indemnification against loss, ought in law to be deemed a breach of contract, and must in ethics be a subterfuge and fraud. On the other hand, we may be told that the contract is one of indemnity against a risk of which the subject is always beyond the insurer's reach or control, and is at the exclusive charge and disposal of the insured; that the insurer is therefore entitled always to expect a rigid application of the purest principles of ethics for the protection of his interests, and that no public interest would be promoted by excusing a careless disregard of his rights. Each proposition, when correctly understood, may, with certain applications, be true. But neither proposition is of much practical use. In the absence of fraud, persons insured do not ordinarily forfeit their insurances through any mere carelessness of themselves or their agents. But *no prudent insurer will take a risk where any interest of the insured would be promoted by carelessness of the subject* of the risk. Insurance, it has again been often said, is an *aleatory* contract, that is to say, a bargain upon a chance, like a throw of dice. An insurer's tables of risks may, in a certain sense, resemble those which might be made for the use of a professional gamester on a grand scale. But beyond this, there is properly no analogy to gaming. Insurance, in its general results, is, in fact, though not in form, a contract of mutual benefit; and the benefit is not, in any proper sense, *uncertain* upon either side. The values of life insurances can thus be calculated with approximate certainty, because, however uncertain may be the continuance of an individual life, the *average* duration of human life, is known from experience, and is almost invariable. Then, as to marine insurances, it has been often said with truth, and, in our own city, has been practically tested in more cases than one, that a merchant employing a great many ships, or shipping a great many cargoes, may prudently calculate for himself whether he would more probably lose by insuring than derive benefit; in other words, whether the premiums to be paid would probably exceed the maritime losses to be incurred.

Fire Insurance, under this head, is not an exception. Where the risks are sufficiently numerous, at points detached from one another, and of small amounts, or where large risks are divided among several insurers, the rates of premium are safely adjustable to a standard of uniformity. The more the insurances are with due caution multiplied, and the source of profit increased, the greater is the safety of the insurer. These are truisms, whatever may be the complexities of their safe application. I will not add any general remarks concerning the reservation and investment of accruing income to meet losses.

It is a misfortune of the present age, and an especial evil in this country, that men do not scruple to engage in responsible business, without any apprenticeship, or other preparatory training. An insurer without experience would be not less unfit for the business than a landsman for navigation. In Mr. Bancker's time, interests of importance were not thus trusted in untried hands. His youthful experience of marine insurance had been acquired when it was principally the business of underwriters not incorporated. It had been regulated by them on the sound basis of self interest. The insurance of his own shipments may have been instructive to him, but had probably been less so than his necessary constant observation, during the wars of the French revolution, of the transactions of other merchants, whose bills he purchased when the safety of his remittances depended upon the insurances of millions in value of shipments afloat, whose dangers have been mentioned under a former head. He had afterwards been, for some years, the agent, in this country, of one of the largest associations of English insurers; and had been a director of a life insurance company in this city. Fire insurance was the branch of the business in which he proposed specially to engage. To the preparatory study and observation of the peculiarities of insurance of this kind, he devoted more than two years until 1829, when, through his influence, the Franklin Fire Insurance Company was incorporated. He conducted this Company's business for almost forty years.

At his death, the Company, with an entire capital of $400,000, had paid five-and-a-half millions of losses, and the claims unsettled were less than $24,000. The annual income was $360,000, or 90 per cent. on the capital. The yearly dividends for ten years had been 32 per cent.; and the assets were more than $2,600,000,—the accrued surplus being about $1,100,000. Nothing had ever been lost upon an investment; nor was there an existing investment of doubtful security. This complete success of the Company was due entirely to his administration of its affairs.

The attainment of such success, or of much greater seeming success, would not have been surprising, or even extraordinary, if there had, in the meantime, been a corresponding hazard of proportional heavy losses. But such hazard had not been incurred. At the outset, serious difficulties were indeed encountered in promoting the extension of the new Company's business without assuming an undue proportion of extra-hazardous risks. Of risks of small amount in Philadelphia, most of the less hazardous were taken by two or three mutual insurance Companies of long established standing, which made no dividends. Competition for such risks, at full premiums, could not be expected until a corresponding surplus fund, in addition to the capital, should have been accumulated. The division of large risks among several insurers was then difficult, if not impossible, because fire insurers, and fire insurance agencies, were few, and fire insurance brokers fewer. Upon manufacturing establishments and the contents, insurances might readily have been effected. But there could be no standard of premiums on such risks uniformly proportional to the actual hazard, because, independently of the combustibility of the subjects, and of general reasons which under a legislative policy of artificial protection affect such risks, the constantly recurring changes in the protective legislation of the United States made the inducements to care of such subjects by the parties insured peculiarly variable. These early difficulties were for a time partly overcome by the obvious and ordinary, though often unsatisfactory expedient of establishing agencies at points more or less distant. The difficulties were completely overcome through the adoption of a very simple plan to multiply insurances upon small risks near home.

The plan was to lend on first mortgages of newly constructed dwelling houses of moderate dimensions, in Philadelphia and the suburbs, enough money to pay the cost of the ground and the premium of a perpetual insurance on the buildings, with sometimes the addition of a small portion of the cost of their construction. The insurances were, of course, made by the Company's own policies. The two-fold purpose of a proper insurance, and a safe investment, was thus effected in every such case.

There was nothing novel in such transactions of combined investment and insurance. The novelty in this Company's transaction of such business was, that they were the first insurers who made it *systematic* instead of *occasional.* Every builder of limited means became aware that he could, with certainty, on making such an insurance with this Company, obtain the accommodation of such a loan upon mortgage, and that the time of credit, however limited in form, would, in fact, be indefinite, if the interest were punctually paid. The Çompany's business of this kind increased until such mortgage investments, I believe, 1100 or 1200 in number, of an average amount of less than $2,000, constituted four-fifths of the assets.

I have described this method of investment in order to introduce the statement of a wonderful truth. It is that, although this Company has paid, as I have said, five and a half millions for losses by fire, these losses have all, with one or two insignificant exceptions, occurred on property *not mortgaged* to the Company. The exceptions have been within a year or two, and of an amount so small as to be quite inappreciable. Thus, it may be said that these insurances and investments have actually been made *without any loss.* The Company, for several years past, might have annually divided more than 20 per cent. on their capital, though during the whole of this time, not a single new insurance had been effected. I do not mean that it would in that case, have been prudent for insurers to have done so. But the fact attests the safety of the business of an insurer who while extending it to the utmost fair limit, adheres to the cardinal maxim, already mentioned, of *never insuring where the interest of the insured might be promoted by carelessness* of the subject of insurance.

But who may be the cautious and energetic insurer capable of combining constant adherence to this maxim with a continual increase of business? Without answering the general question, let us consider Mr. Bancker's peculiar capacity for executing the two-fold function.

His perception was most acute, clear and comprehensive, his intellectual energy the most active, his decision was always prompt, and his purpose firm. I have already shown that the range of his practical experience was almost universal. Let me add here that no extent or magnitude of his operations ever prevented his vigilant, particular, and accurate attention to the minutest details of any and every business in which he was concerned for himself or others. This minute attention to the details of his duty was continued until the closing hour of his life.

As a man of general scientific tastes and attainments, he was known within these walls, and extensively beyond them. The general results of existing knowledge were, in the concrete, well understood by him; and he pursued experimental and analytical investigation sufficiently to enable him to understand the causes and modes of improvement, and to keep pace with its progress. His mind was thus amply stored with true knowledge. He was a constant, it might be said, universal reader. To the day of his death, he read as a student, not, according to the ordinary habit of old age, as a critic or a censor. His own extensive library contained, in theology, in metaphysics, in history, belles lettres, natural philosophy, and every other department of useful knowledge, or polite accomplishment, all the literature of his varied and unremitting study. New books in every department, read by him, and on his parlor table upon their first publication, were, in due season, transferred to their proper shelves. His philosophical apparatus, constantly renewed from all parts of the world, was the collection of his long lifetime, and, like his library, was arranged according to the most improved plan. Possibly this apparatus may now, in some part, be antiquated. But I am informed that in certain departments, every modern improvement has been supplied, and that, under some heads, for example the polarization of light, the means and appliances for illustrative experiment are complete and unsurpassed.

He took pleasure in promoting and assisting the pursuit of useful knowledge by others. Such a man may, through such benevolence, contribute more to the diffusion of scientific information than those who justly obtain the praise of useful discoverers. Public lecturers on natural philosophy and on experimental chemistry, had always the free use of his apparatus. They frequently availed themselves of the privilege. I heard, in my childhood, public acknowledgments of his liberality in this respect; and they were, after the lapse of half a century, renewed in the hearing, perhaps, of others now present.

If I have described him rightly, it will be understood that he may have been eminently capable of comparing the results of investigations by other persons in different branches of art and science. This made his conversation often useful and instructive to practical men. Fallacious pretensions to originality of invention he detected at once, by intuition, as it were. He discerned, with as quick a glance, latent merit which was ultimately to succeed, not only in the practical, but likewise in the fine arts.

Stated Meeting, April 2, 1869.

Present, twenty-two members.

JOHN C. CRESSON, Vice-President, in the Chair.

A letter accepting membership was received from S. Nillson, dated Lund, Sweden, 3d Marz, 1869.

A letter was received from Mr. J. Whiteaves, Curator of the Museum of the Natural History Society at Montreal, dated March 29, 1869, acknowledging the receipt of Transactions and Proceedings, and offering a set of the Canadian Naturalist in exchange.

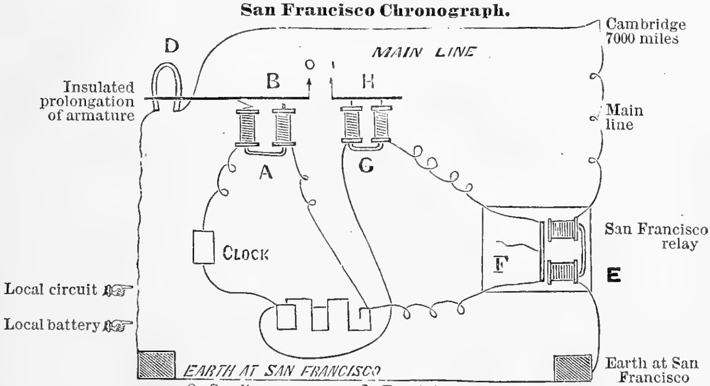
A letter from the London Antiquarian Society, acknowledged the receipt of Proceedings, A. P. S., No. 80.

Donations for the Library were received from the London Geological Society, Essex Institute, Peabody Academy at Salem, New Bedford Library, George E. Ellis of Cambridge, New Jersey Historical Society, Franklin Institute, Academy of Natural Sciences, Philadelphia, and the Protestant Episcopal Church Hospital.

The decease of Dr. Robley Dunglison on the 1st inst., aged 71, at Philadelphia, was announced by Mr. Peale, and on motion of Mr. Fraley, Dr. Pancoast was appointed to prepare an obituary notice of the deceased.

Professor Trego communicated an extract from a letter from Mr. Davidson of the Coast Survey, to Mr. D. B. Smith of Germantown, detailing the method employed to obtain the recent determination of Longitude and the velocity of the electric current between Cambridge and San Francisco.

San Francisco Chronograph.



O. Sending pen. I. Receiving pen.

San Francisco, *March* 1*st*, 1869.

I give you the first written news not only of our telegraph longitude success, but of the success of my plan for determining the *time of transmission of clock signals from my clock to Cambridge and back*, over 7,000 miles of wire, through 13 repeaters and a multitude of relays. Through the liberality of the Western Union Telegraph Company, I had two trans-continental lines placed at my use, and last night I succeeded beautifully. My circuit was as follows. My clock breaks the local circuit every second, depriving the helix A of its electricity, and the magnet of its magnetism. This relieves the armature B, which is drawn away by a spring, and the pen C makes its record on the revolving cylinders of the chronograph. At the same instant the main current to Cambridge and back is broken by the insulated prolongation of the armature at D, and the break transmitted to Cambridge and back, through 7,000 miles of wire, to my relay E, which relieves the armature F, and the local circuit is broken ; the helix G deprived of its electricity and the magnet of its magnetism, relieving the armature H, which is drawn away by a spring, and the pen I makes the record on the revolving cylinders of the chronograph. These two pens are on the same horizontal line. Our experiments show that it took 0.87 of a second to traverse the above circuit. I also made experiments through to Buffalo, Chicago, Omaha, Cheyenne, Salt Lake, and Virginia, and back. All successful. As this experiment was not contemplated by the programme of the longitude experiments, I have the satisfaction of seeing my ingenuity successfully proved.

Prof. Kirkwood communicated through Mr. Chase a discussion of the periodicity of the Sun's spots.

Mr. Chase made a communication of certain curious relationships of astronomical elements.

Mr. Dubois presented through Dr. Harris a specimen and analysis of silver ore.

Mr. Dubois offers the following recent notes from the Assay Office, U. S. Mint:

By far the largest single piece of silver ever brought to the Mint, was a cake or test-bottom, deposited on the 16th March, by Mr. Christian, President of the Brown Silver Mining Company, of Colorado. Its weight was 4,343 ounces troy, equal to 290 lbs. avoird. nearly. There was a small proportion of gold, and the net Mint value was 5,720 dollars, silver coin. This was stated to have been extracted from twenty tons of galena in the gangue ; making about 286 dollars to the ton.

In the Report of the British Commission on International Coinage, lately published, we find an extract from the "Journal des Debats," of Nov. 13th, 1866, stating that the German assayers had found the average fineness of French gold coins of that year to be 898 thousandths, "and a fraction." It adds that this is an unworthy source of gain to Government, whose ambition it should be to have the coins *correct.*

The "Moniteur" of Nov. 20th (official organ), replies, that this is as near to standard as can be expected from the defects of practical operation ; and that it is the duty of Government to prevent these "ill-founded criticisms."

Our own assays for many years, have proved a deficiency in the French coins, averaging about one thousandth.

The apology of the "Moniteur" has no just foundation. Both at this Mint, and at San Francisco, the gold coins are kept close to the mark, scarcely varying the tenth of a thousandth; as is proved by annual assays, and by foreign reports. British coinage is equally exact.

This fact affords an argument against the project of International Coinage. If we work to 900, and France to 899 or less, and both pass alike, the difference is against us.

We have a letter from a gentleman of South Carolina, an extract from which may lead to philosophical reflections, and therefore be in place:

"Our State, poor as it is, is full of coin. Planters will have nothing to do with securities. They can't spend money on negroes—they have land enough—and so they get gold, and bury it. I know of more than one who has over 30,000 dollars in gold, and of one who has 80,000 dollars.

"Even the 5 cent nickel is hoarded to an enormous extent. We have sent great quantities into the interior, but in travelling in the country you will never meet with them. I am told they are regarded as of full silver value."

Herewith is shown to the Society, a specimen of silver ore from the White Pine Region of Nevada, which is now drawing so much attention. This new mining district is in Lander county, in the mountain range, east of the Reese River district.

This specimen is from the "Black Spider Mine," and is a silicious gangue containing sulphides of copper and antimony, with rich seams of chloride of silver. It came marked "$10,000 per ton," and Mr. Eckfeldt's assay found it to contain half that proportion; or as we prefer to say in such cases, $2.50 per pound; inasmuch as such ores are not found by the ton; and it is desirable to avoid the grandiloquence which favors deception.

Mr. P. W. Sheafer communicated through the Secretary some boring records from the Anthracite Basins.

The Committee on the disposal of the Hall reported, and on motion of Dr. Le Conte, the subject was postponed.

The Publication Committee requested instructions as to the disposal of ninety pages of new matter, with several wood cuts and two more plates inserted by Prof. Cope in the memoir now going through the press, explaining that the original estimate of cost would probably cover the expense of the new matter. On motion of Dr. Le Conte the subject was referred to the original Committee.

Pending nominations, Nos. 622 to 626 were read.

And the Society was adjourned.

ON THE PERIODICITY OF THE SOLAR SPOTS.

BY DANIEL KIRKWOOD.

§ *I.—The Results of Observation.*

(1.) The most ancient observations of sun-spots, of which we have any record, are those of the Chinese in the year 321, A. D. The first notice of their detection by Europeans is found in the annals of the Frankish kings. A black spot, according to Adelmus, was seen on the sun's disk, March 17th, 807, and continued visible 8 days. Similar phenomena were again observed from the 28th of May to the 26th of August, A. D. 840. The year 1096 was also signalised by the appearance of spots so large as to be visible to the naked eye. The next date, in chronological order, is that of 1161, when a spot was seen by Averroës. Finally, on the 7th, 8th, and 16th of December, 1590, "a great blacke spot on the sunne," apparently "about the bignesse of a shilling," was observed at sea by those on board the ship "Richard of Arundell."* The foregoing are, we believe, the only undoubted instances in which these phenomena were observed previous to the invention of the telescope.

(2.) From 1610 to 1750 the sun was frequently observed through instruments of various optical power, and the sparseness, or even the entire absence of spots, during considerable intervals of time, as well as their great number and magnitude at other epochs, were noticed by different astronomers. From the latter date till the close of the first quarter of the present century the solar observations were more frequent and regular; still, no idea of the prevalence of *law* in the varying numbers and magnitudes of these mysterious objects had been even conjectured. We come now, however, to a most interesting and remarkable epoch in the history of solar physics.

(3.) *The* 11–*Year Period of Schwabe.*—In 1826, Hofrath Schwabe, of Dessau, commenced a series of sun-spot observations, which have been continued without interruption to the present time (1869). On each clear day he notes the number of visible groups, giving to each a special designation, to guard against counting it twice in a single rotation of the sun. In the first year, 1826, 118 spots were observed; the number was considerably greater in 1827; and in 1828 it had increased to 225. During the next five years there was a gradual *decrease;* the minimum being reached in 1833. The results of 43 years' observations are presented at one view in the following table:

* For authorities see Humboldt's Cosmos, Vol. IV., and Chambers' Descrip. Astronomy, p. 21.

TABLE I.

Schwabe's Observations of Solar Spots.

Year.	*Days of Obs.*	*Days of no Spots.*	*New Groups.*	*Max. and Min. according to Wolf.*
1826	277	22	118	
1827	273	2	161	
1828	282	0	225	Max. (1829.5)
1829	244	0	199	
1830	217	1	190	
1831	239	3	149	
1832	270	49	84	
1833	247	139	33	Min. (1833.8)
1834	273	120	51	
1835	244	18	173	
1836	200	0	272	
1837	168	0	333	Max. (1837.2)
1838	202	0	282	
1839	205	0	162	
1840	263	3	152	
1841	283	15	102	
1842	307	64	68	
1843	312	149	34	
1844	321	111	52	Min. (1844.0)
1845	332	29	114	
1846	314	1	157	
1847	276	0	257	
1848	278	0	330	Max. (1848.6)
1849	285	0	238	
1850	308	2	186	
1851	308	0	151	
1852	337	2	125	
1853	299	3	91	
1854	334	65	67	
1855	313	146	79	
1856	321	193	34	Min. (1856.2)
1857	324	52	98	
1858	335	0	188	
1859	343	0	205	
1860	332	0	211	Max. (1860.5)
1861	322	0	204	
1862	317	3	160	
1863	330	2	124	
1864	325	4	130	
1865	307	25	93	
1866	349	76	45	
1867	312	195	25	Min. (1867.0)
1868				

(4.) This table presents a very marked periodicity; the interval between two consecutive maxima or minima, being, according to Schwabe, about 10 years. Soon after the announcement of this interesting discovery Dr. Lamont, of Munich, detected a corresponding decennial period in the variation of the magnetic needle; the epochs of maxima and minima in the latter coinciding with those in the former. These results have also been confirmed by other observers in places quite remote from each other; so that the decennial *magnetic* cycle may be regarded as well established. The equality of this period with that of the solar spots naturally suggested the hypothesis of their intimate relationship. Such a causal connection may be difficult of explanation: the fact, however, is placed beyond doubt by the researches of Wolf and Sabine.* The former, besides carefully observing the sun-spots since

* These magnetic variations, which will not be discussed in the present paper, are mentioned to give completeness of view to the phenomena under consideration. It is also worthy of remark that the Aurora Borealis is believed to exhibit a corresponding periodicity.

1847, has discussed all accessible recorded observations, both solar and magnetic, bearing on the subject. He has thus ascertained a number of epochs of maxima and minima anterior to those observed by Schwabe,—from all of which he has determined the period of the spots to be 11.11 years. He undertakes to show, moreover, that this period coincides more exactly with that of the magnetic variation than the 10–year cycle of Lamont.

(5.) *The* 56–*Year Period.*—Besides Schwabe's period of 11 years, Wolf finds a larger cycle of 55 years, in which the solar activity passes through a series of changes. It is not, however, so distinctly marked as the cycle of Schwabe. Its last maximum was about 1837, and that preceding, about 1780. The *relative* number of spots in different years, from 1749 to 1826, when Schwabe commenced his systematic observations, are given (according to Wolf) in Table II.

TABLE II.

SOLAR SPOTS, FROM 1749 TO 1825.

Year.	*Rel. no. of Spots.*	*Max.*	*Min.*	*Year.*	*Rel. no. of Spots.*	*Max.*	*Min.*
1749	63.8			1788	90.6	1788.5	
1750	68.2	1750.0		1789	85.4(?)		
1751	40.9			1790	75.2		
1752	33.2			4791	46.1		
1753	23.1(?)			1792	52.7(?)		
1754	73.8			1793	20.7(?)		
1755	6.0		1755.7	1794	23.9		
1756	8.8			1795	16.5		
1757	30.4			1796	9.4		
1758	38.3(?)			1797	5.6		
1759	48.6(?)			1798	2.8		1798.5
1760	48.9			1799	5.9		
1761	75.0	1761.5		1800	16.1		
1762	50.6			1801	30.9(?)		
1763	37.4			1802	38.3(?)		
1764	34.5			1803	50.0(?)		
1765	23.0			1804	70.0(?)	1804.0	
1766	17.5(?)		1766.5	1805	50.0(?)		
1767	33.6			1806	30.0(?)		
1768	52.2			1807	10.0(?)		
1769	85.7			1808	2.2		
1770	79.4	1770.0		1809	0.8		
1771	73.2			1810	0.0		1810.5
1772	49.2			1811	0.9		
1773	39.8			1812	5.4		
1774	47.6(?)			1813	73.7		
1775	27.5		1775.8	1814	20.0(?)		
1776	35.2(?)			1815	35.0(?)		
1777	63.0			1816	45.5	1816.8	
1778	94.8			1817	43.5		
1779	99.2	1779.5		1818	34.1		
1780	72.6(?)			1819	22.5		
1781	67.7			1820	8.9		
1782	33.2(?)			1821	4.3		
1783	22.5(?)			1822	2.9		
1784	4.4(?)		1784.8	1823	1.3		1823.2
1785	18.3			1824	6.7		
1786	60.8			1825	17.4		
1787	92.8						

(6.) *The* 233–*Day Period.*—Prof. Wolf, after carefully discussing his own and Schwabe's observations, claims to have discovered two or three minor periods of solar activity. "By projecting all the results in a continuous curve, he finds in it a series of small undulations succeeding each other at an average interval of 7.65 months,"* or 233 days.

(7.) *The 27-Day Period.*—The same astronomer thinks he has detected a short period of variation corresponding to the sun's time of rotation with respect to the earth, or about 27 days.

(8.) *The* 584-*Day Period.*—De La Rue, Stewart and Lœwy, have found a period varying between 18 and 20 months; the mean being about 584 days.† Other periods of maxima and minima will probably be detected; but those we have enumerated are perhaps the only ones sufficiently well established to justify any attempt at explanation.

§ *II.—Discussion of the Phenomena.*

(9.) That the solar spots are produced in some way by the planetary disturbance of the photosphere, is now generally admitted. As yet, however, the manner in which this influence is exerted, can be little more than matter of conjecture. If the action is analogous to that of the moon on the earth, the relative disturbing power of the different members of the system will be as follows:

TABLE III.

Relative Influence of the Planets on the Sun's Surface.

Name.	*Mass.*		*In Aph.*	*At M. Dist.*	*In Perih.*
Mercury	$\frac{1}{4865751}$	(Encke)	63	111	219
	$\frac{1}{3000000}$	(Leverrier)	102	180	355
Venus	$\frac{1}{401211}$		203	207	211
Earth	$\frac{1}{314760}$		95	100	105
Mars	$\frac{1}{2994790}$		2	3	4
Jupiter	$\frac{1}{1047}$		194	214	236
Saturn	$\frac{1}{3496}$		8	10	12
Uranus	$\frac{1}{24899}$		0	0	0
Neptune	$\frac{1}{18780}$		0	0	0

This table is derived from the formula

$$\delta = \frac{m}{a^3},$$

where δ represents the disturbing power of a planet, m, its mass, and a, its distance.

(10.) The connection between the number of sun-spots and the positions of the planets was noticed by Wolf as long since as 1858. In the *Comptes Rendus*, for January, 1859, he published a formula in which the number of sun-spots was made to depend on the different configurations of Venus, the Earth, Jupiter and Saturn. In the learned and interesting memoir—previously referred to—of De La Rue, Stewart and Lœwy, the causal connection between the positions of Venus and Jupiter and the behaviour of sun-spots seems to be clearly established. Professor Wil-

* Sir John Herschel, Quart. Jour. Sci., Vol. I., p. 228, April, 1864.

† Am. Journ. of Sci. and Arts, for March, 1867.

liam A. Norton, of Yale College, in his "Treatise on Astronomy," pp. 434—436, presents a brief but valuable discussion of the same subject. An inspection, however, of Table III., shows that writers generally have given undue weight to Saturn's influence. Again, although Mercury's action at aphelion is but feeble, and even at his mean distance, less than that of Venus or Jupiter, his perturbing power at *perihelion* is the greatest of all planets—a fact which certainly demands consideration in any theory which refers the origin of solar spots to planetary agency. In short, after giving the subject much study and attention, I deem it impossible, with the numbers given in table III., *and without the introduction of any modifying cause,* to establish a general correspondence between the different sun-spot periods and those of regularly recurring planetary configurations.

(11.) But the hypothesis that a particular portion of the sun's surface is more favorable to spot formation—or, in other words, more susceptible to planetary influence—than others, will, it is believed, obviate all difficulty. Is there, then, any independent probability of the truth of this hypothesis? It is well known that the formation of spots occurs chiefly between particular parallels of *latitude,* and that the numbers are greater in the northern than in the southern hemisphere. It seems, therefore, at least not improbable that a like difference may exist in regard to *longitude.* "Sömmering directs attention to the fact, that there are certain meridian belts on the sun's disk, in which he had never observed a solar-spot for many years together."* Buys-Ballot, of Utrecht, has found, from an elaborate discussion of a great number of meteorological observations, that there is a short period of variation in the amount of solar heat received by our planet; the period from maximum to maximum coinciding, at least approximately, with that of the sun's rotation with respect to the earth. Sir William Herschel also believed that one side of the sun, on account of some peculiarity in its physical constitution, was less adapted to radiate light and heat than the other.

(12.) On the hypothesis which we have ventured to suggest, the sun-spot period would be equal to the interval between two conjunctions of the disturbing planets on the heliographic meridian (designated by M) of that part of the surface most susceptible to their influence. It would depend, therefore, on the ratio of the sun's period of rotation to the interval between two consecutive conjunctions of such planets. Or, as Mercury's influence is extremely variable, a maximum would be produced by this planet's perihelion passage, when the most susceptible part of the sun's surface had the same, or nearly the same, heliocentric longitude. In order, then, to test this hypothesis, we must first inquire what is the most probable period of the sun's rotation?

(13.) On account of the *proper* motion of the solar spots, the time of the sun's rotation as determined by their *apparent* motion across the disk, varies from about 25 to 29 days. The *proper* motion of the spots

* Humboldt's Cosmos, Vol. IV., p. 378.

has recently been discussed with great labor and ability by Professor Spöerer, of Anclam, and Mr. Carrington, of England, who have shown conclusively that the rapidity of movement varies regularly with the latitude. The equatorial portions have the greatest angular velocity; in other words, the proper motion of the spots is in a direction contrary to that of the sun's rotation. The formula by which the astronomers named express the law for the dependence of the sun's apparent period of rotation on the latitude are as follows:

According to Carrington, $\xi = 865' - 165' \sin \frac{7}{4} l$ . . . . (1)

" " Spöerer, $\xi = 16.^\circ 8475 - 3^\circ.3812 \sin (41^\circ 13' + l,)$. (2)

where ξ is the arc described in a solar day. The true time of rotation is supposed to be that indicated by an equatorial spot; and on this assumption, (1) gives

$P = 24.^d 9711 = 24^d\ 23^h\ 18^m\ 23^s$ . . . . (3)

or, (2) gives

$P = 24.^d 62447 = 24^d\ 14^h\ 59^m\ 0^s$ . . . . (4)

The true value is probably between the results here given.

(14.) But will this modifying element in the theory of planetary action afford a satisfactory explanation of the periodic recurrence of maxima and minima of solar spots? Let us consider.

(*a.*) *The* 11–*Year Cycle.*—The anomalistic period of Mercury is $87.^d 9702$, and

$87.^d 9702 \times 46 = 4046.^d 6292 = 11.^y 077 = T_1$ . . . . . (5)

This is very nearly equal to Wolf's value of the cycle, and agrees at least equally well with recorded facts.* Again,

$\frac{T_1}{163} = 24.^d 82594 = 24^d\ 19^h\ 49^m\ 21^s$ . . . . . . (6)

which is nearly a mean between Spöerer's and Carrington's values of the sun's period of rotation. With this, therefore, as the time of the sun's axial revolution, we have 46 times the period of Mercury—equal to 163 times that of the sun's rotation. The recurrence of maxima at mean intervals of 11.077 years would thus be accounted for.† Again, the epochs at which sun-spots were seen before the invention of the telescope may be presumed, with much probability, to have been nearly co-incident with the maxima epochs of Schwabe's cycle. Now, it is a remarkable

* The following astronomical cycles are also nearly equal to this period of variation:

1. 18 periods of Venus=$11.074y$.	4. $17t_1 = 11.030y$
2. 35 syn. per. of Mer.=11.104	5. $28t_2 = 11.082$
3. 1 period of Jupiter.=11.860	6. $45t_3 = 11.063$,

where t_1=the syn. per. of Venus with respect to Jupiter; t_2=syn. per. of Mercury with respect to Venus; and t_3=that of Mercury with respect to Jupiter.

† It is not probable that Mercury is on the meridian M precisely at the epoch of perihelion passage. It is only necessary to suppose this coincidence to occur when the planet is *near* the perihelion point. Even at the distance of 20° the diminution of the disturbing power would be extremely small.

fact that all of those dates given in Art. (1), except perhaps the last, harmonise with the value which we have adopted for Schwabe's period of variation. Thus,

From	321, A.D.	to 1860,	we have	139	periods of	11.072+	years each.
"	321	to 807	"	44	"	11.045	"
"	807.22	to 840.5	"	3	"	11.093	"
"	840.5	to 1096	"	23	"	11.109	"
"	1096	to 1161	"	6	"	10.833	"
"	1161	to 1590.9	"	39	"	11.024	"
"	1590.9	to 1750.0	"	14	"	11.367(?)	"
"	1750.0	to 1829.0	"	7	"	11.286	"
"	1829.0	to 1860.5	"	3	"	10.500	"

The variability of the period will be hereafter considered.

(*b.*) *Wolf's Cycle of* 56–57 *Years.*—The synodic revolution of Mercury is $115^d 87748$, and

$$115.^d 87748 \times 177 = 20510.^d 31396 = 56.^y 15324 = T_2 \quad . \quad . \qquad (7)$$

In this period the line of conjunction of Mercury and the earth advances 56.15324 revolutions. Now,

$$\frac{T_2}{826.15324} = 24.^d 82628 = 24^d \ 19^h \ 49^m \ 50^s \quad . \quad . \quad . \quad . \qquad (8)$$

This value of the sun's period of rotation differs from that in (6) by only 29 seconds. Adopting it, therefore, we find that Mercury and the earth will be in conjunction on the same heliographic meridian at regularly recurring epochs of 56 years and 56 days.

(*c.*) *The* 233–*Day Period.*—The mean interval between the consecutive conjunctions of Venus and Jupiter is $236^d 992$. The close agreement of these periods, leaves little room to doubt that the latter is the true period of spot variation.

(*d.*) *The* 27–*Day Period.*—This is at once satisfactorily accounted for on the hypothesis prepared in Art (11).

(*e.*) *The* 584–*Day Period.*—The identity of this period with that of the synodic revolution of Venus has already been indicated by De La Rue, Stewart and Lœwy.

(15.) It would be easy to point out theoretically other periods of variation, which an exact discussion of observations would probably confirm. It will be obvious, however, that the actual phenomena must be exceedingly complicated. The great eccentricity of Mercury's orbit; the ever-varying configurations of the disturbing planets; the probably unequal susceptibility of different parts of the sun's surface to their influence; combined, perhaps, with other causes, but imperfectly understood, must render the complete discussion of the phenomena both operose and difficult. The subject, in short, presents a new and interesting department of the theory of perturbations.

(16.) A careful inspection of tables I. and II. will indicate that Schwabe's cycle is liable to considerable variation, both in duration and intensity. The epochs of greatest disturbance were 1837 and 1848, when the number of spots was about 50 per cent. greater than in 1828 and 1860.

The observations of recent years seem to render it probable, moreover, that the epoch of extraordinary activity is passing away. The number of new groups in 1867 was less than in any other year since the commencement of Schwabe's observations; while the whole number counted during the 11 years from 1857 to 1867 inclusive, as compared with that of the 11 years immediately preceding, was as 1483 to 1715.

(17.) *The Great Irregularity of the* 11–*Year Cycle from* 1828 *to* 1860.—Mercury was in perihelion about 1838.277, and this was probably the maximum epoch *depending on Mercury alone.* But the *observed* epoch of greatest disturbance was about 1837.2. Let us, then, inquire whether any configuration of the disturbing planets will account for this marked deviation from regularity.

Mercury and Venus had the same mean longitude (343°) near the 1st of April, 1837, or, about 1837.247*, when Mercury was at less than its mean distance from the sun. If this conjunction occurred on, or very near, the solar meridian M, an extraordinary disturbance of the photosphere would evidently result. Now, the interval from 1837.247 to 1838.277 was $376.^{d}2075$, during which time the sun would have performed 15 *entire* rotations; also the arc between longitude 343° and 75°, (that of Mercury's perihelion,) is 92°. The daily motion of Mercury, moreover, when nearest the sun is about 5°. If, then, the conjunction of 1837.247 occurred over the solar meridian M, and if we represent by t the number of days from 1838.277 till Mercury was on the same solar meridian, we shall have, taking the sun's period of rotation as adopted in (6)

$$\frac{376.2075 + t}{15 + \dfrac{92 \times 5t}{360}} = 24.826 \qquad (9)$$

whence $t = 3.^{d}8 +$, and $5° \times t = 19° +$ . . . . . . (10)

Hence the longitude of Mercury when on the solar meridian M in 1838, and at other recent maximum epochs, was 94°, or 19° from the perihelion. Again, the interval between two consecutive conjunctions of Mercury and Venus is $144^{d}.5651$, and

$$144.^{d}5651 \times 28 = 4047.^{d}8228,$$

exceeding the period of 163 solar rotations by $1.^{d}19$. It is easy to see, therefore, that when the mean longitudes of the planets were the same (about 348°) in 1848.328, the ecliptical longitude of the solar meridian M was 12° in advance, and that the disturbing effect would consequently be diminished, although still sufficient to fix the maximum in 1848 instead of 1849. In like manner the further decrease of solar activity in 1859—60, as well as the observed increase from 1828 to 1837, is readily accounted for.

(18.) Mercury and the earth had the same mean longitude, 0°, ± about 1837.726.

Mercury and Venus, " " 343° ± " 1837.247.

* This is not the precise epoch of conjunction; we may adopt it, however, without material error. It may be remarked that a great disturbance of the photosphere would also be produced by the passage of the planets *successively* over the meridian M, shortly *before* the time of actual conjunction.

The interval between these epochs was 174.^{d}95. Hence if these conjunctions occurred on the solar meridian M, the sun, during the interval, must have performed 7.047 revolutions. Now,

$$\frac{174.^{d}95}{7.047} = 24.^{d}826,$$

the same value of the sun's period of rotation as was found in (6). The harmony of these results affords a striking confirmation of the proposed hypothesis.

(19.) We have given a very imperfect discussion of the spot-cycles due to the disturbing effect of Mercury, Venus, and the earth. These results must be materially modified by Jupiter, whose disturbing influence has not yet been considered. It is not too much to hope that by means of a more exact analysis, in which the action of each of the planets, Mercury, Venus, the earth, and Jupiter shall be taken into account, the condition of the sun's surface may be predicted with as much certainty as the ebbing and flowing of the tides at any particular locality on the surface of our planet.

(20.) An easy calculation will show that the greatest tide produced in the sun's photosphere by any single planet must be less than an inch in height. The actual disturbance, therefore, is certainly much greater than might reasonably have been expected from a cause apparently so insignificant. It is conceivable, however, that the physical constitution of the fluids forming the luminous surface may be such that a very slight impulse may be sufficient to create a rupture, and thus occasion the phenomena observed.

(21.) The foregoing discussion justifies, we think, the following conclusions :

1. A connection between the behaviour of sun-spots and the configurations of certain planets has been placed beyond reasonable doubt.

2. The theory, however, of spot formation by planetary influence is encumbered with anomalies and even inconsistencies, unless we admit the co-operation of a modifying cause.

3. The hypothesis that a particular part of the solar surface is more susceptible than others to planetary disturbance is rendered probable by the observations of different astronomers.

4. The 11-year cycle of spot-variation is mainly dependent on the influence of Mercury.

5. The marked irregularity of this period from 1822 to 1867, is in a great measure due to the disturbing action of Venus.

6. Wolf's 56-year cycle is determined by the joint action of Mercury and the earth. And,

Finally, *the hypothesis proposed accounts, as we have seen, for all the well defined cycles of spot-variations.*

Bloomington, Indiana, *March* 15*th*, 1869.

COSMICAL RELATIONS OF LIGHT TO GRAVITY.

By Pliny Earle Chase.

Prof. Kirkwood's very interesting presentation of the evidence which indicates special lines of disturbance on the Sun's surface, furnishes a new analogy to guide the researches of investigators. The well known dependence of one class of magnetic fluctuations on the position of ocean meridians, strengthens his hypothesis of similar meridians beneath the solar photosphere* which may possibly be detected by spectroscopic observations, while the coincidence of luminous, magnetic, and gravitating lines encourages renewed efforts to trace out the fundamental harmonies of our planetary system.

Wheatstone's experiments have been generally regarded as proving that the velocity of electricity is greater than that of light. But the outbreak of the solar spot recorded by Sir John Herschel, and the simultaneous agitation of the magnetic needles at Kew and elsewhere, render it probable that electrical action is sometimes, if not always, transmitted with precisely the same velocity as light. May it not be that the induction between the successive coils of a wire, however widely they may be separated, produces a spark before the electric current has traversed the whole extent of the wire? Or, if the wire were transparent, is there any reason for supposing that it would transmit a wave of light less rapidly than one of electricity?

The analogies to which attention has been called by numerous observers, between phenomena which are dependent upon various forms of force, may be supplemented by relations, no less curious and interesting, of light to cosmical gravitation, some of which are shown in the following equations. They appear to open a new field for inquiry, in which analysts may, perhaps, find profitable employment.

Let the sun and planets be denoted by the following subscript figures. ☉$_1$; ☿$_2$; ♀$_3$; ⊕$_4$; ♂$_5$; inner asteroid$_6$; mean asteroid$_7$; superior asteroid$_8$; ♃$_9$; ♄$_{10}$; ♅$_{11}$; ♆$_{12}$.

Let h be the modulus of solar light, on the hypothesis that the luminiferous æther is an indefinitely elastic, material medium, and that, therefore, $h = \frac{u^2}{2g_1}$, u denoting the velocity of light.

V = velocity, and T = time of theoretical planetary revolution at the surface of the sun, or of a planet.

v_n = velocity, and t_n = time, of axial rotation of n

r = radius

m = mass

d = mean distance from sun

γ = centre of gyration = $\sqrt{\frac{2}{5}}$

* See also Henshall on ♂ of ☿, ♀, and ♃ with same face of sun. *Cosmos*, xvii., Nov. 1860. p. 573.

e = 1 + orbital excentricity

i = *effective* inertia of votation = moment of inertia divided by time of revolution = $m \sqrt{d}$ Then

1. $t_1 = \frac{2h}{u} = \left(\frac{2h}{g_1}\right)^{\frac{1}{2}} \therefore g_1 t_1 = u$, and $v = 2g_1 \frac{\pi r_1}{u} = \frac{1}{4} \cdot \frac{2g_1}{u} \cdot \frac{surface}{r}$

2. $\frac{d_7}{r_1} = \left(\frac{h}{r_1}\right)^{\frac{1}{2}} = \frac{i}{m}$ of æther

3. $\frac{d_{12}}{d_2} = \left(\frac{h}{r_1}\right)^{\frac{1}{3}}$

4. $d_4 = \frac{d_7}{\pi}$

5. $\frac{d_4}{\pi r_1} = \left(\frac{m_1}{m_4}\right)^{\frac{1}{3}}$

6. $d_2 = \left(\frac{\gamma}{e_4}\right)^2 d_4$

7. $d_3 - \frac{3\gamma}{e_4} d_2$

8. $d_5 = 2\,(d_4 - \gamma d_2)$

9. $\frac{d_9}{r_1} = \frac{m_1 \times e_9}{m_9}$

10. $d_{10} = \frac{d_{12}}{\pi}$

11. $\sqrt{2}\, d_6 = d_7$

12. $\gamma\, d_8 = d_6$

13. $\frac{d_{12} \times d_{11}}{d_4 \times r_1} = \left(\frac{m_1}{m_4}\right)^{\frac{1}{2}}$

14. $d_i\,(_{2 \cdot 3 \cdot 4 \cdot 5 \cdot}) = 2\gamma\, d_2$

15. $\frac{V_1}{v_1} = \frac{d_4}{r_1}$

16. $\frac{V_4}{v_4} = \frac{d_9 \times e_9}{r_4} \times \pi$

The motion of the air in the earth's annual revolution and daily rotation, is slightly undulatory, but hardly perceptibly differing from a regular ellipse. Its motions are controlled, mainly by solar, and subordinately by terrestrial force, the former giving a motion of 63.8, and a moment of inertia of 543,000,000 times the latter. According to Marriotte's law, the specific gravity of the atmosphere should be determined by the conjoined pressure of solar and terrestrial gravity. The liquid and solid portions of the earth, however, are not subject to Marriotte's Law.

In any fluid which is simultaneously affected by two attracting masses, e. g: by the earth and the sun, it would seem that two systems of waves should be generated, moving with velocities v, v^1 such that $v = \sqrt{2\,gh}$ $v^1 = \sqrt{2\,g^1 h^1}$

But if the fluid is on the earth's surface, $h = h^1$, while at the centres of force, $g : g^1 :: m : m^1$.

In the orbital motion the pressure of solar force is nearly constant, but terrestrial gravity tends to maintain the atmosphere at a uniform level, or in a constant volume. Now the kinetic energy under constant pressure : that under constant volume : : 1.421 : 1, or very nearly : : $\sqrt{2} : 1$.

M. Trèves found that the number of oscillations in a tuning fork was increased $\frac{1}{817}$ by magnetizing the fork. Farther experiments are desirable to determine whether his result may be accepted as a general one, but it may be temporarily regarded as curiously coincident with our hypothetical case, in which

17. $v : v^1 : : \sqrt{2m} : \sqrt{m^1}$
$817 : 1 : : \sqrt{2m_1} : \sqrt{m_4}$

18. $\sqrt{2m_1} : \sqrt{m_4}$: : sp. gr. water : sp. gr. air (at mean temperature)

19. $\left(2m_1\right)^{\frac{1}{4}} : \left(m_4\right)^{\frac{1}{4}} : g_1 : g_4$

20. $2\, g_4\, t_4 \times \frac{g_4}{g_1} = V_4$

21. The inertia of the air which is retarded by the thermal and tidal "brakes" appears to be overcome and the wave-equilibrium restored, after g_4 has acted for a sufficient time to give V_4.

22. $d_4 = \left(\frac{\text{yearly}}{\text{daily}}\text{ barometric range}\right)^2$ at St. Helena $\times\, g_4\, t_4{}^2$

23. $2\sqrt{2m_1} \times (e_4)^2 : \sqrt{m_4} : : g_4 : g_1 \times \left(\frac{r_1}{d_4}\right)^2$

24. Mean vel. of sound = mean vel. of air.

25. If $\frac{d_9}{r_1}$ be divided in proportion to the i of the several planets, Jupiter's proportion will be $\frac{8}{13}$ of 1125.84 = 692.83, and 692.83 $\times\, V_1 = u$.

It may be desirable to modify some of these equations by considerations connected with centrifugal force. The closeness of the principal analogies may be illustrated by a few examples, in which I assume the following values as a basis of comparison : $\lambda \frac{g_1}{g_4} = 1.449662$; $\lambda\, r_1 = 5.630334$.·. $\lambda\, h =$ 11.302517 ;—and Newcomb's estimates, $\frac{m_1}{m_4} = 326,800$; $d_4 = 92,380,000$; $u = 185,600$.

	Spörer.	Faye.	Carrington.	Kirkwood.	Theory.	Mean.
1. $t_1 =$	24.62447 dy.	25.07472 dy.	24.9711 dy.	24.82594 dy	25.0297 dy.	24.9052 dy.
.·. $u =$	188,697 m.	185,267 m.	186,035 m.	187.123 m.	185,600 m.	186,528 m.

		Theoretical.	Assumed.
3.	$\frac{d_{12}}{d_2} = \frac{30.070552}{\cdot 3870984}$	.·. $\frac{h}{r_1} = 468,770$	465,604.
4.	$\frac{d_7}{r_1} = 682.3516$	.·. $\frac{d_7}{d_4} = 3.1416$	3.153.

5. $\frac{d_4}{\pi r_4} = 68.88 \quad \therefore \frac{m_1}{m_4} = 326,800 \qquad [327,280]$*

10. $\frac{d_{12}}{d_{10}} = \frac{30.070552}{9.5388} \quad \therefore \frac{d_{12}}{d_{10}} = 3,1416 \qquad 3,1524.$

15. $\frac{d_4}{r_1} = 216.395 \quad \therefore \frac{V_1}{v_1} = 216,395 \qquad 218,142.$

17. $\frac{v}{v^1} = 817 \quad \therefore \frac{m_1}{m_4} = 333,750 \qquad 326,800.$

18. Mean s. g. $\frac{\text{water}}{\text{air}} = 807.45$† $\therefore \frac{m_1}{m_4}$ $325,380 \qquad 326,800.$

19. $(2 \times 326,800)^{\frac{1}{4}} = 28.\dot{4}\dot{3} \quad \therefore \frac{g_1}{g_4} = 28.\dot{4}\dot{3} \qquad 28.162.$

20. $2g_4\, t_4 \times \frac{g_4}{g_1} = 18.7$ m. $\therefore V_4 = 18.7 \qquad 18.4.$

21. $2g_4 \times 50\frac{1}{4} \times 60 = 18.376$ m. $\therefore V_4 = 18.376 \qquad 18.4.$

22. $\left(\frac{.135}{.067}\right)^2 \times g_4\, t_4{}^2 = 92,361,900$ m. $\therefore d_4 = 92,361,900 \qquad 92,380,000.$

24. $\frac{\cos. 43^\circ \times 2\pi r_4}{t_4} = 1112.97$ ft. $\therefore$ vel. $= 1112.97 \qquad 1118.09$‡

25. $692.83\ V_1 = 187,750$ m. $\therefore u = 187,750 \qquad 185,600.$

26. The earth's proportion would be .000862 of 1125.84 = .97, and

$$.97 \times \frac{V_1}{v_1} = \frac{4\pi}{3} \times \frac{\text{mass of sun}}{\text{mass of planets}}$$

27. $.97 \times 2\, g_4\, T_4 = u.$

The following estimates of the sun's mass and distance, and the velocity of light, are derived from the foregoing equations :

	From magnetic acceleration.	From sp. gravity of air.	From length of day.	From atmospheric inertia.	From annual barom'ic range.	From inertia of Jupiter.	From mean estimate of $g_1 t^1$
Sun's mass	333,750	325,380	341,560	325.520	326,610	338,490	321,940
Sun's distance	93,033,200	92,246,000	93,886,300	92,260,000	92,361,900	93,450,000	91,920,000
Vel. of light	186,910	185,330	188,630	185,360	185,560	187,750	184,670

The study of gaseous molecular motions may, perhaps, be aided by the analogies of luminous vibrations. The equation $u = g_1\, t_1$ seems to be an important one. A solitary planet or particle would acquire the velocity of revolution in a circular orbit in $\frac{1}{6}$ of the time of *revolution*, but the particles of the hypothetical elastic fluid to which the luminous vibrations are attributed, under the combined pressure of g_1 and of their own adja-

* As the value assumed for r_1 was derived from this equation, the theoretical and assumed results of course correspond exactly. The bracketed number corresponds to the ordinary value $\frac{d_4}{r_1} = 216.4$. The estimates vary from 214.9 to 217.5.

† According to Johnston's Physical Atlas, the average of the air and ocean temperatures on the parallels of 45° latitude, is 53°.69 F. The specific gravity of air at that temperature is 1 ÷ 807.45.

‡ The retardations of the atmospheric tides at St. Helena, at 0^h, 6^h, 12^h, and 18^h respectively, are 59^m, 85^m, 26^m and 31^m, the mean retardation being $50\frac{1}{4}^m$ [*See Trans. A. P. S.*, vol. 13, p. 128.]

§ Mean of polar (32°) and equatorial (82°) = 57°. Isothermal of 57° = latitude 43°.

cent particles, do not acquire the oscillatory velocity of light until g_1 has acted for $\frac{1}{2}$ the time of *rotation*. Does this indicate successive vibrations in the directions of three co-ordinate axes? And does the tidal action of the planets contribute to the disturbance from which the vibrations originate? The sun-spot theory, and equations 25, 26, and 27, favor such a hypothesis. The proportionality indicated by (1,)

$$u : v_1 : : g_1 \, t_1^2 : 2 \, \pi \, r_1$$

becomes significant, if we consider that any equatorial particle must move through the distance $2 \, \pi \, r_1$ before it returns to the same relative position, and that during the entire series of disturbances, through which it passes in the interval, g_1 is exerting an energy, the resultant of which is equivalent to a fall of $g_1 \, t_1^2$.

BORING RECORDS FROM THE ANTHRACITE BASIN.

By Mr. P. W. Sheafer.

Record of Lower Boring. Nassau Shaft. One mile north of Scranton.

From Surface below R. Road.	8′ 3″		
Rock,	3′ 0″		11′ 3″
Coal,			1′ 0″
Rock,	1′ 2″		
Sandy Gravel,	4′ 7″		
Slate,	6″		
Rock,	1′ 2″		
Slate,	20′ 3″		
Sand Stone,	8′ 4″		
Light Slate,	4′ 6″		
Dark Slate,	4″		39′ 10″
Coal,			2′ 6″
Dark Slate,	7′ 4″		
Hard Rock,	6″		
Dark Slate,	2′ 1″		9′ 11″
Coal,		3′ 0″	
Slate,		3″	
Coal,		1′ 0″	4′ 3″
Slate,	2′ 1″		
Slate, (hard bands,)	1′ 11″		
Hard Rock,	3′ 6″		
Slate, (hard bands,)	20′ 8″		
Dark Hard Rock,	7′ 1″		
Dark Slate,	10′ 6″		44′ 9″
Coal, pure,		8′ 4″	
Coal, bony,		3″	
Coal, good,		6″	
Coal, bony,		6″	
Coal, good,		11″	10′ 6″
Hard Rock,	1′ 4″		
			128′ 7″

The above is from the journal kept by Wm. Barryman, reported to Mr. P. W. Sheafer, Eng. Mines, Pottsville, in 1857. Rocks dip gently South.

Record of Upper Boring. Nassau Coal Company. One mile north of Scranton, Pa.

From surface,	13′ 00″		
Rock,	12′ 7″		26′ 27″
Coal mixed with Slate,			2′ 0″
Light Rock,	21′ 3″		
Dark Sand,	6″		
Hard Rock,	14′ 1″		35′ 10″
Coal,			1′ 00″
Slate, dark soft,	1′ 0″		
Slate, dark,	1′ 4″		
Rock, light,	12′ 4″		
Slate, dark,	4′ 0″		18′ 6″
Coal,		9″	
Black Slate,		2′ 0″	
Coal (with Slate,)		9″	
Coal, pure,		5′ 6″	9′ 0″
Slate, dark, hard,	10′ 0″		
Rock,	9′ 9″		
Slate,	11′ 0″		30′ 9″
Coal,			1′ 9″
Slate, (hard bands,)	5′ 3″		
Rock,	1′ 0″		
Slate, (hard bands,)	6′ 8″		12′ 11″
Coal,			2′ 8″
Slate, dark hard,	12′ 9″		
Rock, light,	5′ 3″		
Slate, (hard bands,)	3′ 0″		
Rock, hard,	1′ 3″		
Slate bands,	4′ 3″		
Slate and hard bands,	18′ 10″		
Slate, dark,	8′ 7″		
Rock, hard,	3′ 0″		
Rock, light,	9′ 6″		
Slate, dark,	9″		66′ 4″
Coal, pure,			8′ 0″
Slate, dark,	5′ 6″		
Slate, hard, light,	1′ 1″		
Rock, hard,	8″		
Rock, hard, light,	17′ 3″		
Slate, dark,	1′ 0″		25′ 6″
Coal,			3′ 6″
Slate, dark,	1′ 0″		
Slate, light,	6′ 5″		7′ 5″

Coal,		1′ 6″	
Slate, light,		3″	
Coal,		1′ 0″	2′ 9″
Slate, black,	6′ 11″		
Slate, (hard bands,)	8′ 7″		
Slate, dark,	2′ 5″		
Rock, light,	5′ 1″		
Slate, dark,	8′ 8″		
Slate, light,	8′ 6″		
Rock, light,	1′ 0″		
Slate, black,	3′ 11″		
Rock, hard,	7″		
Slate, black,	1′ 8″		47′ 4″
Coal,			10′ 8″
Slate,	6″		
Rock, hard,	10″	(measured on rods)	309′ 3½

NOTE. Journal kept by Mr. Berryman, and reported to Mr. P. W. Sheafer, in 1857.

Swartz Boring above Dunmore, about N. 78° ¾E. (7,000 feet) from the corners, in Dunmore, near Scranton. By Mr. Stevenson, Jan. 6, 1857, to P. W. Sheafer.

Earth from Surface down,	2′ 0″	
Sand Rock, hard, coarse,	28′ 0″	
Sand Rock, yellow,	18′ 0″	49′ 0″
Coal,		5′ 0″
Sand Rock and Slates,	28′ 0″	
Blue Rock, hard,	11′ 0″	
Slate,	3′ 6″	42′ 6″
Coal,		4′ 2″
Slate,	3′ 6″	
Sand Rock,	19′ 0″	
Blue Rock, hard,	35′ 0″	
Slate,	5′ 0″	62′ 6″
Coal,		4′ 6″
Slate,	21′ 0″	
Blue Rock, hard	2′ 0″	190′ 8″

National Anthracite Company's Cross Section.

Top Rock.				
Slate,	8″			
Bony Coal,	2′ 0″			
Top Bench of worked Coal,			5′ 6″	
Middle Bench of Coal,			10″	11′ 10″
Bottom Bench of Coal,	1′ 6″	to	2′ 0″	
Bony Coal, rough,	2′ 0″			
Slate,	19′ 0″			

Tolerably Good Top Slate,			
Top Bench of good Coal,		4′ 10″	6′ 1½″
Slate,	6″		
Bottom Bench of Rough Coal,		9½″	

The above is a section of the two beds of Coal in the Lackawanna Coal Basin, 1½ miles west from Scranton, furnished by the boss miner to P. W. Sheafer, March 11, 1857. Opened by two drifts on the South bank of the Lackawanna, where the Coal dips about 5° West.

These Coal were known as the 9 and 11 foot beds.

Stated Meeting, April 16, 1869.

Present, seventeen members.

Dr. George B. Wood, President, in the Chair.

A letter accepting membership was received from J. C. Mill, dated Blackheath Park, March 22, 1869.

Letters acknowledging the receipt of diplomas of membership were received from John Tyndall, dated London, March 20th, and from H. A. Newton, dated Yale College, March 2d, 1869.

Donations for the Library were received from the Royal Academy and Observatory at Turin, the Geological Society and M. Bossange at Paris, the R. Astronomical Society and Mr. Quaritch at London, the Royal Society at Edinburgh, the Portland Society of Natural History, the Rev. J. B. Perry, the Essex Institute and Cambridge Museum, the editors of the Journal of Medical Sciences, Dr. Isaac Lea, J. B. Lippincott & Co., and the Fairmount Park Commissioners of Philadelphia.

Professor Spencer F. Baird, of Washington, was appointed to prepare an obituary notice of the late member, John Cassin, of Philadelphia.

The Committee to which was referred additions to the Memoir of Professor Cope, reported in favor of publication.

Professor Cresson introduced the subject of the brilliant Aurora Borealis of the preceding evening, which Dr. Emerson, Mr. Price, and Mr. Chase described as seen by them.

Mr. Lesley said that it was so brilliant and roseate at Washington, D. C., that the fire engines were taken out; that it did not invade the southern half of the heavens to any extent; but that he observed a brightly illuminated feather, 30° or 40° in length from east to west, float slowly west-north-westward, some little distance south of the zenith, gradually expanding its dimensions but scarcely changing its form, during half an hour. Its head or eastern point was, when first seen, say 40° east of the meridian, and at the end of half an hour, quite that distance west of the meridian. It was evidently an electrified cirrus cloud, and could no doubt have been watched until it sank to the horizon, but for the fact that it passed lengthwise directly under the moon, then about four days old, and very bright. Castor and Pollux shone brightly through it, as it passed beneath them. At one time an auroral feather shot from its northern edge and streamed along westward, nearly parallel with its northern edge, continuing brilliant about twenty seconds. Soon after, an electric spot glowed suddenly in its centre for about the same length of time. With these exceptions, it appeared steadily and uniformly illuminated. Mr. Lesley compared it with the triple curtain aurora which he saw July 23d, 1862, on the banks of the Gulf of St. Lawrence, and described in the Proceedings of the Society, Vol. IX, page 60.

Dr. Emerson called the attention of the Society to the Robbins' process for preserving wood from mould and decay by the injection of the vapors of coal tar. Professor Cresson explained the difference between this and other processes for attaining the same end; especially one now in use in Philadelphia, in which the spontaneous inflammability of wood injected with high volatile hydrocarbons is guarded against by a subsequent injection of the surface with silicates.

Nominations Nos. 622 and 626 were read and spoken to. At the request of the recommenders, nomination No. 626, after being discussed, was postponed, for the purpose of affording an opportunity for associating with it other names mentioned in the discussion. Nos. 622 to 625 were then balloted for.

The Rittenhouse Clock. The curators were authorized to have it put in complete order, although it is no longer fit to use for astronomical purposes.

The following named persons were declared duly elected members of the Society:

D. G. Brinton, M. D., of Philadelphia.

A. D. White, President Cornell University, Ithaca, N. Y.

J. H. C. Coffin, U. S. N., Supt. Naut. Almanac, Washington, D. C.

Joseph Wharton, of Philadelphia.

And the Society was adjourned.

Stated Meeting, May 7, 1869.

Present, nine members.

John C. Cresson, Vice-President, in the Chair.

Dr. Brinton was introduced to the presiding officer, and took his seat.

Letters accepting membership were received from J. H. C. Coffin, dated Nautical Almanac Office, Washington, April 21, 1869; D. G. Brinton, dated 1001 North Sixth street, Philadelphia, April 19, 1869; A. Carlier, dated 6 rue de Milan, Paris, Avril 19, 1869, and D. White, dated Cornell University, Ithaca, N. Y., May 1.

Donations for the Library were received from the Royal Academies and Societies at St. Petersburg, Berlin, Copenhagen, Göttingen, Munich, and Dublin; the Societies of Science at Offenbach, Frankfort, Bordeaux, Manchester and Leeds; the Geological Societies at Vienna, and Geographical Societies at London and Paris, the Zoological Botanical Society at Vienna, the London Astronomical, Chemical, Meteorological and Asiatic Societies, the Boston Natural Historical Society and Wool Manufacturers Association, the American Pharmaceutical Society, Academy of Natural Sciences, Franklin Institute, House of Refuge, Deaf and Dumb Institute, Dr. C. D. Meigs, the United States Sanitary Commission, the Congressional Library, and Mr. T. B. Brooks, Civil Engineer at Negaunee, Michigan.

Dr. Hayden presented, for publication in the Transactions, an Appendix to his report of the Geology on the Yellow and Missouri Rivers, under the superintendence of Captain Raynolds, said Appendix consisting of a sub-report on the Carices of the Expedition made by the late Dr. Dewey. On motion, the Memoir (with its five plates) was referred to a Committee consisting of Mr. Durand, Mr. James, and Dr. Ruschenberger.

Mr. Rothwell, Engineer of Mines, exhibited through the Secretary a published copy of his new map of the eastern end of the first Anthracite Coal Basin, with cross sections, showing the excessive plication of the synclinal. (See Plate 2, fig. 2.)

Mr. Chase communicated by permission of Mr. Pierce, Director of the U. S. Coast Survey, the more recent results of his investigations into the rain gauge curves.

The observations which were examined, and the method of treatment, were described in my discussion of the tidal rain-fall of Philadelphia, (*ante*, vol. x., pp. 523-7).

The frequent tendency to triple maxima and minima, which I have attributed to lunar influence on the daily barometric spheroid,—the establishments, both of temperature, and of position with reference to great bodies of water,—the different relations of precipitation to atmospheric pressure at different seasons of the year,—the influence of the moon and of each of the principal planets on temperature, winds, cloudiness, and both frequency and amount of rain-fall,—the probability that the influences upon temperatnre are due to the induced aerial currents and not to radiation, (a South wind raising, and a North wind depressing the thermometer),—the secular variation, which appears to depend principally upon the combined action of the Moon and Jupiter,—are all clearly indicated by the normal curves.

Most of the curves show a great similarity at the opposite equinoxes, and a great contrast at the opposite solstices, both at Greenwich and at Philadelphia. But in the total rain-fall at different solar hours, the equinoctial and solstitial contrast is modified by a synchronous divergence at the two stations, the Philadelphia curves differing greatly at the equinoxes and being nearly alike at the solstices. This peculiarity may be owing to the fact that the prevailing winds at Greenwich are from the ocean, while those at Philadelphia are from the land, so that an atmosphere saturated with moisture is normal at the former station, abnormal at the latter.

The planetary curves are so strongly marked that it seems impossible to account for them by any action analogous to the Moon's differential attraction. They may perhaps be satisfactorily explained by the moment of inertia, and the constantly and often rapidly varying distance of the centre of gravity of the earth and disturbing planet.

Dr. Brinton communicated the information which he had obtained respecting the valuable Arawak MSS. Grammar and

Vocabulary by Shultz, in the library of this Society, and the desirableness of publishing a discussion of their relations to other MSS. existing in Europe. It appears that the language which Columbus reported to be common to all the larger islands of the W. Indies was neither Carib, nor Maya, but genuine Arawak, scarcely differing from that now spoken between the Amazon and Orinoco, not more than Chaucer's English from the English of to-day. It is an added proof that the whole fauna (man included) of the islands outside the Gulf Stream came from the Spanish Main, the movement being in the opposite direction to that of the fauna of N. America which terminated its course in Florida.

A letter and enclosed testimonial note of the proceedings of the Michaux Legacy were read, from M. Carlier, announcing the final settlement of the legacy at Paris and in Pontoise; and on motion of Mr. Chase, these documents were referred to the Committee on the Michaux Legacy with instructions to prepare the needful papers, and procure the signature of the President of this Society, and to remit funds for the expenses incurred; and they are hereby authorized to draw upon the Treasurer of the Society for the necessary amount.

A communication from the Janitor was referred to the Committee on the Hall. And the Society was adjourned.

Stated Meeting, May 21, 1869.

Present, seventeen members.

Mr. Fraley, Vice-President, in the Chair.

Mr. Wharton was introduced to the presiding officer, and took his seat.

A letter returning thanks for election to membership, was received from the President of the United States, dated Executive Mansion, April 24, 1869.

A letter acknowledging the receipt of a set of the Society's

Proceedings, Vol. I to X., was received from the London Meteorological Office, May 9th, 1869, and from the R. Academy at Lisbon, acknowledging receipt of No. 77.

Donations for the Library were reported from the Berlin Academy, Dr. Jarvis, Mr. Haven, Dr. Le Conte, Prof. Coffin, the New York Canal Commissioners, Buffalo Young Men's Association, Cincinnati Observatory, and California Academy of Sciences.

The Committee on Dr. Dewey's Carices, &c., reported, recommending its publication in the Transactions, which was so ordered.

A communication and letter was received for the Magellanic Premium, read by title and regularly referred to the Board of Officers.

Dr. Horn presented for publication in the Transactions a paper entitled Revision of the Tenebrionidæ of America north of Mexico, by Geo. H. Horn, M. D., which was referred to Dr. Le Conte, Dr. Leidy and Dr. Bridges.

Mr. Lesley exhibited a photo-lithograph of a section across the Alleghany mountains, to illustrate the proportionate plication of the earth's surface to its radius. See Plate 2, Fig. 1.

Dr. Hayden's Geological Map of the Upper Missouri was exhibited, together with many sketches and photographs of scenery and structure. It was afterwards resolved, that the Secretaries be instructed to address a letter to Gen'l A. A. Humphreys, Chief Engineer U S. A., expressing the desire of the A. P. S. to have the results of the Geological explorations made in the Territories of the U. S. by Dr. Newberry, Hayden and others, while employed by the Government, made speedily available for present use by publication at the expense of the Government, or in such other manner as may be thought expedient.

The Committee to which was referred the publication of the Choltec MS. recommended its publication in the Proceedings, under the supervision of Dr. Brinton, which was so ordered, and on motion of Mr. Price, the Secretaries were authorized to print additional copies, according to their best judgment.

And the Society was adjourned.

Stated Meeting, June 18, 1869.

Present, ten members.

Mr. Fraley, Vice-President, in the Chair.

A letter accepting membership was received from Professor Rolliston, University Oxford, England. May 29.

Letters of invoice were received from the Imperial Geog. Society of Russia, May 15; U. S. Nav. Obs. May 19th; Cincinnati Obs. May; and A. M. Mayer, of Bethlehem, May 26.

Letters of acknowledgment were received from the Imperial Geographical Society of Russia. The Cincinnati Observatory requested the completion of its imperfect set of the Proceedings.

The Meteorological Office reported its change of address to No. 116 Victoria street, London, S. W.

Donations for the Library were received from the Paris Geographical Society and School of Mines, the London Astronomical Society, Prof. Rolliston, of Oxford, the Bath Society, W. T. Blanford, the Boston N. H. Society, the Rhode Island Society for En. Dom. Industry, Franklin Institute, College of Pharmacy, Medical News, Philadelphia University, West Penn Academy, Prof. Mayer, Prof. Ennis, Provost C. J. Stille, the U. S. Sanitory Commission, Naval Observatory, Census Bureau, R. W. Rossiter, Wilmington Institute, and St. Louis Public School Commissioners.

Mr. Cope made a communication concerning a discovery of certain fossil remains found in New Jersey, the structure of which indicated a connection between the bird and reptile classes, and described the peculiarities of construction presented by the fossil referred to. He also exhibited fossil remains of the Plesiosaurus and Mososaurus orders or types, and described their relation to other genera of similar type.

The fossil which Prof. Cope exhibited was the almost perfect cranium of a Mosasauroid reptile, the Clidastes propython. He explained various peculiarities of its structure, as the moveable articulation of certain of the mandibular pieces on each other, the suspension of the os-quadratum at the extremity of a cylinder composed of the opisthotic, &c., and other peculiarities. He also explained, from specimens, the characters of a large new Plesiosauroid from Kansas, discovered by Wm. E. Webb, of Topeka, which possessed deeply biconcave vertebrae, and anchylosed veural arches, with the zygapophyses directed after the manner usual among vertebrates. The former was thus shown to belong to the true Sauropterygia, and not to the Streptosauria, of which Elasmosarus was type. Several distal caudals were anchylosed, without chevron bones, and of depressed form, while proximal caudals had anchylosed diapophyses and distinct chevron bones. The form was regarded as new, and called Polycotylus latipinnis, from the great relative stoutness of the paddle.

He also gave an account of the discovery, by Dr. Samuel Lockwood, of Keyport, of a fragment of a large Dinasaur, in the clay which underlies immediately the clay marls below the lower green sand bed in Monmouth County, N. J. The piece was the extremities of the tibia and fibula, with astragalo-calcaneum anchylosed to the former, in length about sixteen inches; distal width fourteen. The confluence of the first series of tarsal bones with each other, and with the tibia, he regarded as a most interesting peculiarity, and one only met with elsewhere in the reptile Compsognathus and in birds. He therefore referred the animal to the order Symphypoda, near to Compsognathus Wagn. The extremity of the fibula was free from, and received into a cavity of the astragalo-calcaneum, and demonstrated what the speaker had already asserted, that the fibula of Ignanodon and Hadrosaurus had been inverted by their describers. The medullary cavity was filled with open cancellous tissue. The species, which was one half larger than the type specimen of Hadrosaurus foulkii, he named Ornithotarsus immanis.

Dr. H. C. Wood spoke of his investigations with regard to the Fresh Water Algæ of Eastern North America.

Pending nominations, Nos. 628 to 638, new nominations, Nos. 638 to 640, were read.

Dr. H. Allen offered and read a paper "On Human Osteology, containing the heads of divisions of a more extended communication, which he proposes to present at a future time.

The following observations have been instituted with the object of testing the value of the following propositions:

I.

That a true conception of the skeleton can be only secured by studying embryology and osteology conjointly.

For inasmuch as the skeleton is the frame-work adapted to protect internal organs, and to afford attachments to ligaments and muscles, and since the osseous particles (centres of ossification, either free or combined) are the results of forces acting in obedience to the necessities of organs to be protected and of trunks to be moved, it follows that bones can be best studied when understanding the requirements calling them into existence.

II.

That the "centre of ossification" is the osteological unit.

For since "the bones" are associations of centres of ossification having little or no determinate value, it is rational to prefer these centres as the primal forms, before the more or less arbitrary ones, the results of their combination.

III.

That the causes of variation of the forms of "bones" within the limits of health are to be found in the muscles placed in association with them.

Since the idea of a limb is progression, the bones stand up as fulcra and levers to the power, we find the degree of power holds a direct ratio to the strength of lever and amount of weight. Hence, bones of limbs correspond in point of strength and size to the muscles associated with them. Habit is thus seen to be indirectly the chief cause of the variation of ossific forms.

IV.

That the causes of localization of diseased action are best determined by the application of the foregoing propositions.

(1.) A number of centres of ossification coalescing to protect a given viscus, the resultant form may preserve, throughout life, a physiological as well as a mechanical unity. Example: The centres composing the brain case. When, however, the centres of ossification in the bones of limbs unite, while losing their identity in form they maintain a peculiar independence of action throughout life. Example: The centre composing the femur and tibia.

(2.) The evidences of retrograde activity (atrophy) are most marked along the lines of progressive activity (growth.)

(3.) Activity of development is accompanied with vascularity. Increased vascularity is an exciting cause to morbid action. Therefore it follows that diseased action may be often found in association with an incomplete genetic process.

(4.) Since muscles control the normal shapes of bones during harmonious action, their inharmonious action may prove a cause of deformity.

(5.) Continual excitation of points of connection of muscles with bones may prove an exciting cause to disease within such areas.

The Society was then adjourned.

FIG. I. SECTION OF 150 MILES ACROSS THE APPALACHIAN BELT IN PENSYLVANIA

DRAWN TO THE SAME SCALE VERTICAL AND HORIZONTAL.

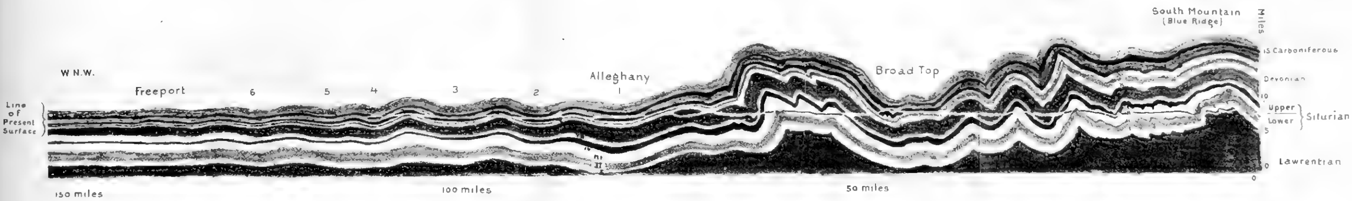
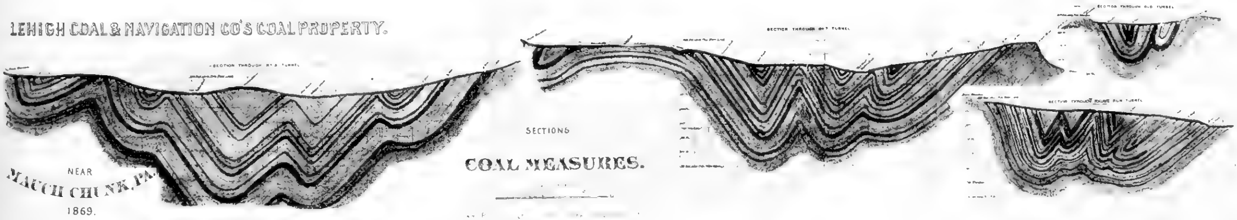


FIG. 2



PRODROMUS OF A STUDY OF THE FRESH WATER ALGAE OF EASTERN NORTH AMERICA.

By Horatio C. Wood, Jr.,

Professor of Botany in the University of Pennsylvania.

For several years all the leisure, my more strictly professional duties allow me, has been devoted to the study of the Alga-fauna of our inland waters, and I had intended delaying publication until ready to offer to the scientific world an elaborate memoir upon the subject. The field is however so constantly enlarging, that the day of final preparation seems rather to recede than draw near. This and the hope of stirring up other laborers, have induced me to print now a very brief abstract of the results that have so far rewarded my efforts. In enumerating and describing the species herein contained, I shall follow the classification and arrangement adopted by Rabenhorst in his "Flora Europœa Algarum." It should, however, be plainly understood that I do not do this, as endorsing the method of the German Professor, but simply because I do not feel prepared at present to discuss the natural arrangement of this group, and desire to leave the whole subject for a future Memoir.

The desire of enlisting the assistance various of observers, as already mentioned, has been one of the motives that have prompted me to publish at this time. I am already greatly indebted to several botanists for aid, amongst whom I may mention Dr. J. S. Billings, U. S. A., Professor H. W. Ravenel, and Mr. William Canby, and am thereby emboldened to ask for more. If there are any persons engaged in the study of these plants, I will be most happy to exchange specimens with them, either fresh or mounted for the microscope; and when occasion may arise, will most freely give all the credit due them for species new to America or Science. If there are others willing to help me, I will do all in my power to aid them in return by labelling specimens, giving information as to books, &c., or make such other returns as circumstances will permit. Any one who is thus willing had better address me by letter, when I will forward to him preservative fluid, with some directions.

A certain amount of experience and knowledge of the subject greatly facilitates the collection of these plants, but scarcely so much as in other departments of cryptogamic botany. Most of the species of fresh water algae are so small that the most experienced algologist does not know how great the reward of the day's toil may be until he places his booty on the object glass of his compound microscope. In order to aid any one who is desirous of collecting and studying these low forms, it seems to me not amiss to make here a few remarks upon the where and the when to look, and the how to preserve after they are found.

There are three or four distinct classes of localities, in each of which a distinct set of forms may be looked for. Stagnant ditches and pools; springs, rivulets, large rivers, and other bodies of pure water; dripping rocks in ravines, &c.; trunks of old trees, boards, branches and twigs of living trees and other aerial localities.

In regard to the first of these—*stagnant waters*—in these the most conspicuous forms are oscillatoriæ and zygnemaceæ. The oscillatoriæ may almost always be recognized at once, by their forming dense, slimy strata, floating or attached, generally with very fine rays extending from the mass like a long, delicate fringe. The stratum is rarely of a bright green color, but is mostly dark; dull greenish, blackish, purplish, blue, &c. The oscillatoriæ are equally valuable as specimens at all times and seasons, as their fruit is not known, and the characters defining the species do not depend upon sexual organs. The zygnemas are the bright green, evidently filamentous, slimy masses, which float on ditches or lie entangled amongst the water plants, sticks, twigs, &c., in them. They are only of scientific value when in fruit, as it is only at such times that they can be determined. Excepting in the case of one or two very large forms, it is impossible to tell with the naked eye with certainty whether a zygnema is in fruit or not; but there are one or two practical points, the remembrance of which will very greatly enhance the probable yield of an afternoon's search. In the first place, the fruiting season is in the spring and early summer. The latter part of March, May and June are the months when the collector will be best repaid for looking for this family. Again, when these plants are fruiting they lose their bright green color and become dingy, often yellowish and very dirty looking—just such specimens as the tyro would pass by. The fine, bright, green, handsome masses of these algae are rarely worth carrying home. After all, however, much must be left to chance; the best way is to gather small quantities from numerous localities, keeping them separate until they can be examined.

Adhering to the various larger ditch plants, to floating matters, twigs and stones, &c., will often be found filamentous algae, which make fine filmy fringes around the stems, or on the edges of the leaves; or perchance one may meet with rivulariæ or nostocs, &c., forming little green or brownish balls, or indefinite protuberances attached to small stems and leaves. These forms are, however, to be looked for especially later in the season. Whenever seen, they should be secured.

In the latter part of summer, there is often a brownish gelatinous scum to be seen floating on ditches. Portions of this should be preserved, as it frequently contains interesting nostocs and other plants.

In regard to large *rivers*, the time of year in which I have been most successful in such localities, is the latter summer months. *Springs* and small bodies of clear water may be searched with a fair hope of reward at any time of the year when they are not actually frozen up. I have found some exceedingly beautiful and rare algae in such places as early as March, and in open seasons they may be collected even earlier than this. The desmids are most abundant in the spring, and possibly most beautiful then. They, however, rarely conjugate at that time, and the most valuable specimens are therefore to be obtained later—during the summer and fall months; at least, so it is said; and the little experience I have had with this family seems to confirm it. *Rivulets* should be watched especially in early spring, and during the summer months.

From the time when the weather first grows cool in the fall, on until the cold weather has fairly set in, and the reign of ice and snow commences, is the period during which the algae hunter should search carefully all wet, *dripping rocks*, for specimens. Amongst the dew bearing stems of wet mosses—in dark, damp crevices, and little grottoes beneath shelving rocks—here, at this season, is the algae harvest to be reaped. Nostocs, palmellas, conjugating desmids, sirosiphons, various unicellular algae, then flourish in such localities. My experience has been, that late in the fall, ravines, railroad cuttings, rocky river-banks, &c., reward time and labor better than any other localities.

The vaucherias, which grow frequently in wet ground, as well as submerged, fruit in the early spring and summer in this latitude, and are therefore to be collected at such times, since they are only worth preserving when in fruit.

In regard to algae which grow on trees, I have found but a single species, and do not think they are at all abundant in this latitude. Farther south, if one may judge by Professor Ravenel's collections, they are the most abundant forms.

As to the preservation of the algae—most of the submerged species are ruined by drying. Studies of them should always, when practicable, be made whilst fresh. Circumstances, however, will often prevent this, and I have found that they may be preserved for a certain period, say three or four months, without very much change, in a strong solution of acetate of alumina. If this is not to be had, I would recommend a trial of a preservative liquid, made of glycerine, carbolic acid (creasote of the shops), and water. This mixture might be made by dissolving half an ounce of pure carbolic acid (a little more of the impure), in three fluidounces of glycerine, and adding a full pint of pure water.

Almost all species of algae which are firm and semi-cartilaginous, or almost woody in consistency, are best preserved by simply drying them, and keeping them in the ordinary manner for small plants. When studied, fragments of them should be soaked in water.

The only satisfactory way that algae can be finally prepared for the cabinet is by mounting them whole, or in portions, according to size, for the microscope. Of the best methods of doing this, this is hardly the place to speak; but a word as to the way of cleaning them will perhaps not be out of place. Many of them, especially the larger filamentous one, may be washed by holding them fast upon an ordinary microscope slide, with a bent needle or a pair of forceps, and allowing water to flow or slop over them freely, whilst they are rubbed with a stiffish camels hair pencil or brush. In other cases, the best plan is to put a mass of the specimens in a bottle half full of water, and shake the whole violently; draw off the water from the plants in some way, and repeat the process with fresh additions of water, until the plants are well scoured. At first sight, this process would seem exceedingly rough, and liable to spoil the specimens, but I have never seen bad results from it, at least, when practised with judgment. The water seems so to envelope and protect the little plants that they are not injured.

After all, in many instances it appears impossible to clean these algae without utterly ruining and destroying them—the dirt often seeming to be almost an integrant portion of them; so that he who despises and rejects mounted specimens, simply because they are dirty and unsightly, will often reject that which, scientifically speaking, is most valuable and attractive.

In concluding this introduction, it is perhaps pardonable to state, that there are in my possession elaborate descriptions and drawings (from nature) of nearly all the plants mentioned in this paper, and that of the species mentioned, all but a dozen or two are new to science or new to this continent.

CLASS PHYCOCHROMOPHYCEAE.

ORD. CYSTIPHORAE.

FAM. CHROOCOCCACEAE.

GEN. CHROOCOCCUS.

C. REFRACTUS. *Sp. Nov.*

C. cellulis in familias solidas arcte consociatis, plerumque subquadratis, saepius triangularibus, rare multiangulis; familiis saepius lobatis; cytiodermate tenui, vix visibile, achroo; cytioplasmate subiliter granulato, subfusco vel subluteo, valde refrangente.

C. Cells closely associated together into solid families, mostly subquadrate, very often triangular, rarely multiangular; families often lobed; cytioderm thin, scarcely perceptible, transparent; cytioplasm finely granular, brownish or yellowish, highly refractive.

Diam. cell. $\frac{1}{6000}''$ $\frac{1}{3000}''$, rare in cellulis singulis $\frac{1}{2000}''$; famil. $\frac{1}{1500}''$ $\frac{1}{170}''$.

Hab. In rupibus irroratis prope Philadelphia.

C. MULTICOLORATUS. *Sp. Nov.*

C. in strato mucoso inter algas varias sparsus; cellulis singulis sphaericis, vel 2–4 (rare 8) aut angulis aut semisphaericis aut abnormibus in familias oblongas consociatis; cytiodermate crasso, hyalino, haud lamelloso; tegumentis plerumque nullis, interdum subnullis; cytioplasmate plerumque homogeneo, interdum subiliter granulato, vel luteo-viride vel caeruleo-viride vel luteo vel subnigro, vel brunneo, vel saturate aurantiaco, saepe ostro tincto.

Diam. cell., sing. sine tegm., $\frac{7}{9000}''$ cum teg. $\frac{2}{1500}''$; cell. in famil. sing. $\frac{2}{4500}''$—$\frac{4}{4500}''$. Fam. long. $\frac{7}{4500}''$—$\frac{10}{4500}''$; lat. $\frac{6}{4500}''$—$\frac{7}{4500}''$.

C. Occurring scattered in a mucous stratum with other algae; cells spherical and single, or else angular semisphaerical or irregular and associated together in oblong families of from 2–4 (rarely 8); inner coat thick, hyaline, not lamellate; outer coat generally wanting, sometimes indistinctly present; endochrome mostly homogeneous, sometimes minutely granular, either a yellowish green or bluish green, or yellowish, or brown, or blackish, sometimes tinged with bright lake.

Hab. In rupibus humidis prope Philadelphia.

GEN. GLOEOCAPSA.

G. SPARSA. *Sp. Nov.*

G. in strato mucoso sociis algis variis sparsa ; cellulis sphaericis, vel oblongis vel ovatis, 2–8 in familias consociatis ; familiis subglobosis vel subovatis, interdum numeroso-aggregatis ; tegumentis internis aureo-fuscis, firmis, rarissime coloris expertibus, homogeneis, vel lamellosis ; tegumentis externis achromaticis, rare subachromaticis, plerumque vix visibilibus; cytioplasmate homogeneo.

Diam. max. cell. oblong. sine tegum. long., $\frac{1}{3000}''$; lat., $\frac{1}{7500}''$; cell. glob., sine tegum., $\frac{1}{5000}''$; cum tegum., $\frac{1}{1875}''$; fam., $\frac{1}{750}''$.

G. scattered in a mucous stratum composed of various algae ; cells spherical, or oblong, or ovate, associated together in families of from 2-8 ; families subglobose or subovate, sometimes aggregated together in large numbers ; inner tegument yellowish brown, firm, rarely colorless, homogeneous or lamellate ; external tegument achromatic, rarely sub-achromatic, generally scarcely visible.

GEN. MERISMOPEDIA.

M. CONVOLUTA. *Bréb.*

Hab. Prope Philadelphia.

Remarks.—I have only a slide of specimens, which were given me by my friend Dr. J. Gibbons Hunt. Our American form seems to be too close to the European species to be separated from it, although in no case is the frond in any wise plicate or convolute, and the cells are somewhat smaller (long diameter, $\frac{1}{6000}''$).

M. NOVA. *Sp. Nov.*

M. thallo membranaceo, distincte limitato, cellulis numerosissimis composito ; cellulis ovalibus, arcte approximatis, 16 in familias consociatis, dilute caeruleo-viridibus, interdum medio constrictis; thalli marginibus rectis, integris.

Thallus membranaceous, distinctly limited, composed of very numerous cells ; cells oval, closely approximated, consociate in families of 16, light bluish green, sometimes constricted in the middle ; margin of the thallus straight and entire.

Diam. cell. ad. $\frac{1}{4000}''$.

Hab. In flumine Schuylkill, prope Philadelphia.

FAM. OSCILLARIACEAE.

GEN. OSCILLATORIA.

O. NIGRA. *Vauch.*

In stagnis prope Philadelphia.

Remarks.—Our American form does not quite equal the measurements given by Rabenhorst. I have never measured it over $\frac{1}{3400}''$ in diameter.

O. LIMOSA. (*Roth.*) *Agh.*

Hab. In stagnis prope Philadelphia.

Remarks.—The dissepiments are never granulate, at least that I have seen. Otherwise our American forms agree in all respects with the descriptions of the European.

O. NEGLECTA. *Sp. Nov.*

O. trichomatibus modice brevibus, aut dilute purpuraceo-plumbeis aut plumbeo-cinereis, plerumque rectis, aut stratum mucosum atro-purpureum haud distincte radiante formantibus, aut in strato gelatinoso haud radiante subplumbeo dispersis et cum algis aliis intermixtis, rare oscillantibus sed lente sese moventibus; articulis diametro fere 4 plo brevioribus; dissepimentis plerumque haud granulosis, rare indistincte granulosis; apiculo obtuse rotundato, interdum breve nonnihil attenuato.

Filaments rather short, of a dilute purplish lead color, or leaden gray, generally straight, either forming a mucous, blackish purple stratum without marked rays, or diffused with other algae in a gelatinous mass, rarely oscillating but gliding; articles about four times shorter than broad; joints for the most part not granulate, rarely indistinctly granulate; ends obtusely rounded, occasionally shortly somewhat attenuate.

Diam. $\frac{1}{1500}''$=.0066.

Hab. In stagnis prope Philadelphia.

O. IMPERATOR. *Sp. Nov.*

O. in strato mucoso, plerumque natante, olivaceo-atro, longe radiante; trichomatibus rectis aut subrectis, tranquillis, dilute viridibus vel saturate olivaceis, haud oscillantibus, sed ambulantibus; apiculis nonnihil attenuatis, late rotundatis vel subtruncatis, curvatis; articulis diametro 5–12 plo brevioribus, ad genicula indistincte contractis; cytioplasmate homogeneo, olivaceo-viride; vaginis firmis, ad genicula distincte transverse striatis,

O. Occurring in an olive-black mucous stratum, mostly swimming and with long rays; filaments straight or straightish, light green or deep olive, tranquil, not oscillating, but moving with a gliding motion; ends somewhat attenuate, broadly rounded or subtruncate, curved; articles 5-12 times shorter than broad, slightly contracted at the joints; cytioplasm homogeneous, olive green; sheaths firm, distinctly transversely grooved at the joints.

Diam. .002.″

GEN. LYNGBYA.

L. BICOLOR. *Sp. Nov.*

L. trichomatibus simplicibus in cæspites nigro-virides dense intricatis, varie curvatis, plerumque inarticulatis, interdum breve articulatis et ad genicula contractis; cytiodermate dilute caeruleo-viride, plerumque copiose granulato, saepe interrupto; cellulis perdurantibus cylindricis, saepe elongatis, saturate brunneis, sparsissimis; vaginis firmis, achrois, in trichomata matura modice crassis.

L. with the filaments closely interwoven into a blackish green mat; filaments variously curved, simple, mostly inarticulate, sometimes shortly articulate with the joints contracted; endochrome light bluish green, mostly very granulate, often interrupted; heterocysts cylindrical, often elongate, deep brown, very few; sheaths firm, transparent, in old filaments moderately thick.

Diam. $\frac{1}{1700}''$.

Hab. In flumine Schuylkill prope Philadelphia.

FAM. NOSTOCHACEAE.

GEN. NOSTOC.

N. CALCICOLA. *Ag.*

Hab. In rupibus prope Catoosa Springs, Georgia.—Prof. Ravenel.

Remarks.—The heterocysts in the American plant are both intermixed and terminal, otherwise the description of the European form is well answered. The region of country in which the specimen was collected is a limestone one. I am unable to say more positively whether the rocks on which it was growing were limestone or not.

GEN. SPHAEROZYGA.

S. POLYSPERMA. *Rabenhorst.*

In stagnis prope Camden, New Jersey.

S. SUBRIGIDA. *Sp. Nov.*

S. natans; trichomatibus singulis, rectis aut subrectis, minimis, dilute viridibus; articulis cylindricis aut subglobosis, distinctis; sporis cylindricis, in medio gradatim nonnihil constrictis, singulis aut duplicis, sine cellulis perdurantibus inter se; cellulis perdurantibus brevecylindricis, singulis, distinctis.

S. Floating; filaments single, straight or straightish, very small, light green; articles cylindrical or subglobose, distinct; spores single or double, in the middle gradually a little constricted, not having a heterocyst between them; heterocysts shortly cylindrical, single, distinct.

Diam. cell. veg. trans. $\frac{1}{6000}''=.00016$; spor. transv. $\frac{1}{4300}''-\frac{1}{4500}''=$ $.00023''-.00022''$; long. $\frac{1}{1500}''=.00066''$; cell. perd. transv. $\frac{1}{4500}''=.00022$.

Hab. In stagnis prope Philadelphia.

GEN. CYLINDROSPERMUM.

C. FLEXUOSUM. (*Ag.*) *Rabenh.*

Hab. In humo irrorato prope Philadelphia.

C. MINUTUM. *Sp. Nov.*

C. trichomatibus dilute aerugineis, plerumque flexuoso-curvatis et intricatis, interdum subrectis; articulis cylindricis, ad genicula plus minus constrictis, homogeneis vel granulatis; cellulis perdurantibus terminalibus, hirsutis, globosis; sporis ellipticis, diametro 2-3 plo longioribus, subtilissime granulatis.

Filaments light aeruginous green, generally curved and intricate, sometimes straightish; articles cylindrical, more or less constricted at the joints, homogeneous or granulate; heterocysts terminal, hirsute, globose; spores elliptical, 2-3 times longer than broad, very minutely granulate.

Diam. Artic. $\frac{1}{9000}''$; spor. long. $\frac{1}{1630}''$; transv. $\frac{1}{4000}''$.

Hab. In stagnis prope Philadelphia.

GEN. ANABAENA.

A. GELATINOSA. *Sp. Nov.*

A. thallo mucoso gelatinoso, indefinite expanso, dilutissime brunneo, nonnihil pellucido; trichomatibus haud vaginatis, leviter flexuoso-curvatis, nonnihil distantibus, haud intricatis, aut dilute aureis aut dilute caeruleo-viridibus; articulis globosis, homogeneis; cellulis perdurantibus articulorum diametro fere aequalibus, globosis, vel rare oblongis; sporis terminalibus, singulis, globosis, (fusco-brunneis?)

Thallus gelatinous, mucous, indefinitely expanded, somewhat pellucid, with a brownish tinge; filaments not vaginate, somewhat curved, rather distant, not intricate, either a light golden yellow or light bluish green; joints globose, homogeneous; heterocysts about equal to the filament in diameter, globose or rarely oblong; spores terminal, globose.

Hab. Prope Philadelphia.

GEN. NOSTOCHOPSIS. *Gen. Nov.*

Trichomata ramosa cum cellulis perdurantibus aut in latere sessilibus aut in ramulorum brevissimorum apicibus dispositis. Vaginae nullae. Thallus definitus.

Thallus definite; filament branched; heterocysts sessile upon the sides of the filaments or raised upon the apices of short branches; sheaths none.

Remarks.—The curious plant upon which this genus is founded has the habit of a nostoc. The outer portion of the frond is condensed so as to give the appearance of a periderm; there is, however, no true periderm. The consistence of the thallus is that of a firm gelatinous mass. The trichomata or filaments radiate from the inner part of the frond towards the outer surface, but many of them take their origin in the outer portions of the thallus. In most places they are distinctly articulated, and indeed often seem to be composed of globular cells, resembling the filaments of a nostoc; on the other hand in certain portions they are not at all articulated. No sheaths are anywhere visible. The heterocysts are strangely enough never placed in the continuity of the filaments. Sometimes they are sessile immediately upon the latter, sometimes they are raised upon very short branches. They are globose with rather thick walls. No spores were discovered. It seems to me best for the present to class this curious plant with the nostochaceae, although I am not altogether satisfied as to its affinities.

N. LOBATUS. *Sp. Nov.*

N. thallo vivide viride aut luteo-viride, cavo, enormiter lobato, natante, modice magno, firmo, gelatinoso; trichomatibus plerumque longis, flexuosis, dilute viridibus, plerumque articulatis, partim inarticulatis, cylindricis aut sub-moniliformibus, sparse granulatis.

Diam. trichom; cell. perdur.

Remarks.—I found this plant floating upon the Schuylkill river just above Manayunk. The hollow frond was buoyed up by a bubble of gas contained within it. It was an irregular, flattened, somewhat globose mass, of a bright green color and about $\frac{1}{2}$ an inch in diameter. It seems very probable that in its earlier condition, it was a solid attached frond. The long slender filaments are often very tortuous, but run a pretty direct general course towards the outer surface.

FAM. RIVULARIEAE.

GEN. GLOIOTRICHA.

G. INCRUSTATA. *Sp. Nov.*

G. globosa vel subovalis, firma, solida, ad pisi minimi magnitudinem, dilute viridis, crystallophora; trichomatibus rectis aut leviter curvatis, in pilum productis, viridibus aut flavescentibus, saepe infra laete viridibus sed supra flavescentibus, haud ordinatim articulatis; articulis inferioribus in trichomatibus maturis brevibus, plerumque compressis; pilo apicale recto aut leviter curvato, plerumque indistincte articulato, saepe interrupto; vaginis amplis, achrois, saccatis, interdum valde constrictis; sporis cylindricis, saepe curvatis, diametro ad 9 plo longioribus; cellulis perdurantibus sphaericis.

Diam. trichom. cum vag. $\frac{7}{7500}''-\frac{9}{7500}''$ sporis max. $\frac{3}{7500}''-\frac{4}{7500}''$; cell. perd. $\frac{7}{15000}''$.

Frond globose or suboval, firm, solid about the size of a very small pea, light green, crystal bearing; filaments straight or slightly curved, produced into long hairs, green or yellowish, sometimes bright green in their proximal portions but yellowish above, not regularly articulate; lower articles in the mature filament short, and generally compressed; apical hair—like portion straight or slightly curved, mostly indistinctly articulate, frequently interrupted; sheath ample, transparent, saccate, sometimes strongly constricted; spores cylindrical, frequently curved, about 9 times as long as broad.

Hab. Schuylkill river, plantas aquaticas adhaerens.

GEN. RIVULARIA.

R. CARTILAGINEA. *Sp. Nov.*

R. subglobosa, parva, cartilaginea, saturate brunnea vel sub-atra, solitaria in plantis aquaticis :—trichomatibus maturis sterilibus rectis aut subrectis, cylindricis, elongatis, haud articulatis ; cytioplasmate saepe interrupto ; vaginis arctis et distinctis ; cellulis perdurantibus globosis, diametro subaequalibus :—trichomatibus fertilibus rectis aut sub-rectis, supra spora cellulis 8-9 instructis ; sporis elongatis, rectis, cylindricis ; vaginis nonnihil crassis, arctis :—trichomatibus immaturis, breve articulatis ; vaginis subamplis.

Frond subglobose, small, cartilaginous, deep brown or blackish, solitary upon aquatic plants : mature sterile filaments, cylindrical, elongated, not articulated, their cytioplasm frequently interrupted, their sheaths close and distinct, their heterocysts globose and about equal to them in diameter ; fertile filaments straight or nearly so, above the spores furnished with 8 or 9 cells ; spores elongate, straight, cylindrical ; sheaths rather thick, close ; immature filaments shortly articulate, their sheaths rather large.

Diam. trich. cum vag. $\frac{1}{2000}''$; spor. $\frac{1}{3000}''$.

Hab. In palude, Northern Michigan.

GEN. DASYACTIS.

D. MOLLIS. *Sp. Nov.*

D. parva, ad magnitudinem pisi minimi, enormiter subglobosa, mollis, gelatinosa, dilute viridis, haud distincte zonata ; trichomatibus plerumque subrectis, partim distincte, partim indistincte articulatis ; vaginis, in trichomatibus maturis haud visibilibus, in trichomatibus juvenibus supra subamplis ; cellulis perdurantibus sub-globosis, globosis, vel ellipticis, diametro duplo majoribus, plerumque singulis sed interdum bi vel triseriatis.

Frond small, about the size of a small pea, irregularly subglobose, soft, gelatinous, light green, not distinctly zoned ; filaments generally straightish, partly distinctly, partly indistinctly articulate ; sheaths in the mature filament not perceptible ; in the young filaments rather large in the upper portion ; heterocysts subglobose or globose or elliptic, twice as large as the filament, generally single but sometimes bi or tri-seriate.

Diam. trich. $\frac{1}{6000}''$–$\frac{1}{4500}''$; cell. perd. $\frac{1}{1800}''$.

Hab. In palude plantas aquaticas adhaerens, Northern Michigan.

GEN. MASTIGONEMA.

M. ELONGATUM. *Sp. Nov.*

M. initio subglobosum, postea saepe nonnihil fusinum, nigro-viride, lubricum, firme ; trichomatibus aerugineis, valde elongatis, flagelliformibus, interdum inarticulatis sed saepius breve articulatis, interdum ad genicula valde constrictis ; apice interdum truncato sed plerumque in pilo, longo, achroo, flexuoso, producto ; vaginis achrois, arctis, saepe apice truncatis ; cellulis perdurantibus globosis vel subglobosis.

Thallus at first subglobose, afterwards frequently fusiform, blackish green, slippery, firm; filaments aeruginous, very elongate, sometimes not articulated, but more generally shortly articulated, sometimes strongly contracted at the joints; apices sometimes truncate but generally produced into a long, flexuous, translucent hair; sheath transparent, close, frequently truncate at the apex; heterocysts globose or subglobose.

Diam. $\frac{2}{7500}''$=.00026.''

Hab. In aquario meo.

GEN. MASTIGOTHRIX.

M. FIBROSA. *Sp. Nov.*

M. trichomatibus dilute caeruleo-viridibus vel olivaceis vel subaerugineis, infra haud articulatis, supra saepe breve articulatis; apice in trichomatibus maturis in setam hyalinam, distincte articulatam, longam, producto; vaginis achrois, in filamentis immaturis, distale distinctis, latis, hyalinis, infra modice crassis, arctis—in trichomatibus maturis infra arctis, et indistinctis, supra in fibetillis dissolutis, in apice, absentibus; cellulis perdurantibus globosis interdum geminis.

Filament either light bluish green or olivaceous or subaeruginous, below not articulate, its upper portion often shortly articulate; apex produced in the mature filament into a hyaline seta, which is long and distinctly articulate; sheath transparent—in the immature filament, distally distinct, broad, hyaline, but proximally close and rather thick—in the mature filament below close and rather indistinct, and superiorly dissolved in fibrillae so as to be entirely wanting at the apex; heterocysts globose, sometimes in pairs.

Diam. trichom. $\frac{1}{2250}''$; cell. perdur. $\frac{7}{18000}''$—$\frac{4}{18000}''$.

Hab. In strato mucoso cum algis variis, in rupibus irroratis prope Philadelphia.

FAM. SCYTONEMEACEAE.

GEN. SCYTONEMA.

S. CATARACTA. *Sp. Nov.*

S. rupicola, caespitosum, fusco-atrum, longe et late expansum; trichomatibus flexuosis, flexilibus, fere 0.25'' longibus, vage pseudoramosissimis, superficie laeve; pseudoramis elongatis, singulis, rarissime geminis, liberis, interdum fuscis, saepius hyalinis, apice plerumque truncato, rare nonnihil attenuato, saepe barbato, haud rubello; trichomatibus internis aerugineis, tenuissimis, plerumque distincte articulatis; articulis diametro plerumque brevioribus, sed interdum longioribus, saepe sejunctis, saepe subglobosis; vaginis crassis et firmis; cellulis perdurantibus et basilaribus et interjectis, singulis, rarissime geminis.

Diam. trich. c. vag. plerumque .00045''; max. .0011''; sine vag. max. .00013.''

S. Forming on rocks an extended turf-like stratum of a brownish black color; filaments flexuous, flexible, almost 0.25″ long, irregularly branched, their surface smooth; branches elongate, single, rarely in pairs, free, sometimes fuscous, frequently hyaline, their apices generally truncate, rarely somewhat attenuate, frequently provided with enlargements, never reddish; cytioplasm aeruginous, very thin, generally distinctly articulate; articles mostly shorter than broad, but sometimes longer, frequently disjoined, often subglobose; sheaths thick and firm; heterocysts both basal and interjected, single, extremely rarely geminate.

Hab. In flumine Niagara prope cataractam.

S. CORTEX. *Sp. Nov.*

S. minutissimum, stratum tenue submembraneum formante; trichomatibus sparse pseudoramulosis, pseudoramulisque repentibus et plus minus concretis, viridibus aut dilute fuscis, varie curvatis, haud rigidis; cytioplasmate viride, articulato, rare distincte granuloso; articulis diametro longioribus aut brevioribus; vaginis arctis, nonnihil tenuibus, achrois, plerumque coloris expertibus, sed interdum dilute fuscis; cellulis perdurantibus et singulis et geminis, et basalibus et interjectis, globosis vel subglobosis.

S. Very minute, forming a thin, submembranaceous stratum; filaments sparsely branched, together with the branches, creeping and more or less concreted together by their sides, green or light brown, variously curved, not rigid; cytioplasm (internal filament) articulate, rarely distinctly granulate; joints longer or shorter than broad; sheaths close, rather thin, transparent, generally colorless but sometimes light brown; heterocysts globular or subglobular, single or in pairs, basal or otherwise.

Diam. trich. cum vag. $\frac{2}{7500}''$–$\frac{3}{7500}''$.

Hab. South Carolina in ramis (Platanus occidentalis). Prof. Ravenel.

S. RAVENELLII.* *Sp. Nov.*

S. lignicola, breve caespitosum, viride-nigrum; trichomatibus plerumque repentibus, vel fusco-olivaceis vel aureo-fuscis, modice pseudoramosis; ramis ascendentibus, rigidis, flexuosis rare pseudoramulosis, vel fusco-olivaceis vel aureo-fuscis, rarissime cum apicibus subachrois; trichomatibus internis coloris expertibus, granulosis, saepe vagina erumpentibus, plerumque articulatis; articulis diametro longioribus aut brevioribus; vaginis arctis, crassibus, fusco-olivaceis vel aureo-fuscis, plerumque supra truncatis et apertis, superficie nonnunquam irregulare; cellulis perdurantibus subquadratis, singulis, interjectis.

S. Forming little, shortly turfy spots, on bark, of a greenish color; filaments mostly creeping, either brownish olive or yellowish brown, moderately branched; branches ascending, rigid, flexuous, very rarely provided with secondary branchlets, either brownish olive or yellowish

* It affords me great pleasure to dedicate this species to Prof. H. W. Ravenel as an acknowledgment, not so much of the aid rendered in my studies of our fresh water algae, as of his great services to science in some of her kindred branches.

brown, rarely subtransparent at the apex; cytioplasm colorless, granular, often extending out beyond the sheaths, generally articulate; joints longer or shorter than broad; sheaths close, thick, brownish olive or yellowish brown, for the most part truncate at their ends and open, their surface sometimes irregular; heterocysts subquadrate, single, interstitial.

Diam. trich. cum vag. $\frac{9}{7500}''-\frac{6}{7500}''$; ram. c. v. $\frac{4}{7500}''-\frac{6}{7500}''$.

Hab. South Carolina, in ramis Celtis. Prof. H. W. Ravenel.

GEN. SYMPHOSIPHON.

S. CORIACEA. *Sp. Nov.*

S. in strato ad 2 lineam crasso, coriaceo, nonnihil spongioso disposita; trichomatibus pseudoramulisque flexuosis, dense intricatis, arcte concretis; trichomatibus internis rarissime haud articulatis sed plerumque breve et distincte articulatis, plerumque pallescentibus, interdum dilutissime aerugineis, saepe interruptis; articulis granulosis, interdum sejunctis, diametro subaequalibus ad fere duplo longioribus; vaginis crassissimis, distincte lamellosis, achrois et coloris expertibus, stratis externis saepe intumescentibus, superficie corrugata, hirta; cellulis perdurantibus nullis?

S. Forming a leathery and spongy, tough stratum of about 2 lines in thickness and of a light slate color. Filaments and branches flexuous densely intricate, closely concreted; internal filament very rarely not articulated, in most cases very distinctly jointed, generally nearly colorless, sometimes with a faint aeruginous tint, often interrupted; articles granular, sometimes disjoined, from about equal to twice the length of their diameter; sheaths very thick, transparent and colorless, very distinctly lamellated, external lamella often swollen, their surface corrugate and variously rough and ragged; heterocysts none.?

Diam. trich. c. vag. max. $\frac{10}{12000}''=.00083$; sin. vag. max. $\frac{3}{12000}''=.00025$.

Remarks.—I have examined a great number of filaments and have nowhere seen anything like a heterocyst. The specimens examined had been preserved in solution of acetate of alumina, but I do not think the salt had changed materially their color.

Hab. Texas. Prof. Ravenel.

GEN. TOLYPOTHRIX.

T. DISTORTA. (*Müller.*) *Ktz.* *Var.?*

In aquario. Dr. Fricke.

Remarks.—The specimens which have been identified as T. distorta, agree well with the descriptions of that species, except in the fact that the heterocysts are often 4-seriate and that they are rather parallelogrammatic than subglobose, as well as in the circumstance that the sheaths are close. I do not think the differences are sufficient to distinguish species.

FAM. SIROSIPHONEACEAE.

GEN. SIROSIPHON.

S. PULVINATUS. *Breb.*

Hab. In rupibus irroratis prope Philadelphia.

S. GUTTULA. *Sp. Nov.*

S. in maculis subnigris, parvis, tenuibus, plerumque rotundatis, interdum enormibus, dispositum; trichomatibus arcte intertextis, ramossissimis, rigidis, inaequalibus, subcylindricis, nonnihil contortis; ramulis abbreviatis vel nonnihil elongatis, apice obtuse rotundatis; ramulorum et trichomatum cellulis tri-multiseriatis, plerumque pachydermaticis, ferrugineo-fuscis, enormiter globosis, homogeneis; cellulis apicalibus interdum breve cylindricis, haud articulatis; vaginis sat amplis, luteo-brunneis vel dilute ferrugineo-brunneis.

Arranged in small, thin black spots, which are generally round, but sometimes irregular: filaments closely interwoven, very much branched, rigid, unequal, subcylindrical, somewhat contorted; branches abbreviate or somewhat elongate, apex obtusely rounded; cells of the trichoma and branches 3 to many seriate, mostly with thick coats, ferruginous-fuscous, irregularly globose, homogeneous; apical cells sometimes shortly cylindrical, not articulate, sheaths ample, yellowish brown.

Diam. max. trich. cum vag. $\frac{1}{750}''$=.0013.

Hab. South Carolina, ad Taxodium distichon corticem. Prof. Ravenel.

S. ACERVATUS. *Sp. Nov.*

S. in guttulis minutissimis, subcrustaceis, nigris, in strato subcontinuo saepe aggregatis; trichomatibus parvis et brevibus, rigidis, admodum inaequalibus, prostratis, tuberculis, arcte et dense ramossissimis, viridibus aut aureis aut brunneis; ramulis brevibus, plerumque haud ramulosis, erectis aut ascendentibus, saepe abbreviatis, papilliformibus, obtusis, saepe lateraliter connatis; cellularum serie in trichomatibus multiplici in ramulis plerumque simplici; cellulis subglobosis vel subangularibus, viridibus, haud distincte granulosis, in ramulorum apice saepe breve cylindricis et interdum obsolete articulatis; vaginis aureis, nonnihil hyalinis.

Arranged in drops, which are very minute, subcrustaceous, black, and frequently aggregate into a subcontinuous stratum; filaments small and short, prostrate, rigid, somewhat unequal, tuberculate, densely and closely branched, green or golden or brown; branches short, for the most part not branched, erect or ascending, frequently abbreviate, papiliform, obtuse; series of cell multiple in trichoma, mostly simple in the branches; cells subglobose or subangular, green, not distinctly granulate, in the apices of the branches frequently shortly cylindrical and sometimes obsoletely articulate; sheaths golden, somewhat hyaline.

Hab. South Carolina, ad corticem (Ilex opaca). Prof. H. W. Ravenel.

Diam. trich. cum. vag. max. $\frac{1}{500}$ Ram. $\frac{3}{7500}$ - $\frac{4}{7500}$

Remarks.—This species is closely allied to S. coraloides, but I think is distinct from it.

S. LIGNICOLA. *Sp. Nov.*

S. strato expanso, tomentoso, atro; trichomatibus ramossissimis, arcte intertextis; ramulis abbreviatis vel elongatis, subrectis aut varie curvatis, apicibus obtuse rotundatis vel subacuminatis; trichomatum et ramulorum cellulis uni vel biseriatis, plerumque pachydermaticis, dilute vel saturate aerugineis, enormibus, plerumque homogeneis; cellulis terminalibus elongatis, cylindricis, saepius nonnihil oscillatorium modo articulatis, granulosis; vaginis sat amplis, haud achrois, vel luteo-brunneis vel fuscentibus vel ferrugineis.

Occurring in an expanded, tomentose, black stratum; filaments very much branched, closely interwoven, branches abbreviate or elongate, nearly straight or variously curved, their apices obtusely rounded or subacuminate; cells 1-2 seriate, mostly thick walled, light or deep aeruginous, irregular, mostly homogeneous; terminal cells elongate, cylindrical, frequently articulate somewhat like an oscillatoria, granulate; sheaths somewhat ample, not transparent, light brown, fuscous or ferruginous.

Diam. trich. cum vag. max. $\frac{1}{1500}''$=.00066''.

Hab. South Carolina; in lignis fabrefactis. Prof. H. W. Ravenel.

S. NEGLECTUS. *Sp. Nov.*

S. immersus; trichomatibus subsolitariis, longis usque ad lineas quatuor, cylindricis, ramossissimis; ramulis singulis; cytioplasmate interdum aerugineo, plerumque aureo-brunneo; cellulis uniseriatis rarissime biseriatis, subglobosis, interdum sejunctis sed plerumque arcte connectis et moniliformibus, modo confluentibus, haud distincte pachydermaticis; cellulis terminalibus elongato-cylindricis, saepe nonnihil oscilatorium modo articulatis; cellulis interstitialibus nullis; vaginis achrois, interdum brunneis, plerumque coloris expertibus.

S. immersed, subsolitary, attaining a length of 4 lines, cylindrical, very much branched; branches single; cytioplasm aeruginous, mostly yellowish brown; cells uniseriate, very rarely biseriate, subglobose, sometimes separate but more frequently closely united and moniliform; terminal cell an elongated cylinder, often articulate somewhat like an oscillatoria; interstitial cells wanting; sheaths transparent, sometimes brown, mostly colorless.

Remarks.—This species is perhaps too close to S. crameri, but appears to differ from it very markedly in habit and place of growth.

Diam. trich. cum. vag. $\frac{1}{570}$ = .0017; sine. vag. $\frac{1}{1000}''$

Hab. In stagnis prope Camden, New Jersey.

S. PELLUCIDULUS. *Sp Nov.*

S. immersus; trichomatibus ramossissimis, solitariis vel subsolitariis; ramis plerumque unilateralibus, ramulosis; ramulorum apicibus late rotundatis, haud attenuatis; cellulis in seriebus simplicibus dispositis, in trichomatibus nonnihil rotundatis, in ramulis saepe angularibus, plerumque compressis, diametro aequalibus—4 plo brevioribus, terminalibus cylindricis, obscure articulatis; cellulis interstitialibus nullis; vaginis arctis, hyalinis, haud lamellosis; cytioplasmate aerugineo vel brunneo, minute granulato.

S. immersed; filaments very much branched, solitary or subsolitary; branches mostly unilateral, branched; apices of the branches not attenuate, broadly rounded; cells disposed in a simple series, in the trichoma somewhat rounded, in the branches frequently angular, mostly compressed, equal to 4 times shorter than the diameter; terminal cell cylindrical, obscurely articulate; interstitial cells none; sheath close, hyaline, not lamellate; cytioplasm aeruginous or brown, minutely granulate.

Diam. trich. cum vag. $\frac{8}{7500}''$=.00106″; sine vag. .0008″.

Hab. In stagnis, prope Hibernia Florida. Mr. Wm. Canby.

S. SCYTENEMATOIDES. *Sp. Nov.*

S. strato submembranaceo, nigro-viride, saepe interrupto, cum superficie inaequale; trichomatibus saepe arcte intricatis, flexuosis aut varie curvatis, haud rigidis, plerumque vix ramosis; cellulis uniseriatis, interdum interruptis, arctis, irregulare quadrangulis, diametro subaequalibus aut 1-3 plo brevioribus, haud distincte granulatis, caeruleo-viridibus; vaginis amplis, haud distincte lamellosis, superficie enormiter corrugatis et hirtis, achrois, plerumque coloris expertibus interdum dilute brunneis.

S. In a submembranaceous, blackish green, frequently interrupted stratum, with an uneven surface; filaments often closely intricate, flexuous or variously curved, not rigid, mostly sparsely branched; cells uniseriate, sometimes interrupted, close, irregularly quadrangular, about equal in length to their diameter, or about 1-3 times shorter, not distinctly granulate, bluish green; sheaths ample, not distinctly lamellate, their surface rough and corrugate, transparent, mostly colorless, sometimes light brown.

Diam. sine. vag. max. $\frac{5}{7500}''$=.00066″; cum vag. max. $\frac{10}{7500}''$=.0013″.

CLASS CHLOROPHYLLOPHYCEAE.

FAM. PALMELLACEAE.

GEN. PALMELLA.

P. JESENII. *Sp. Nov.*

P. thallo indefinite expanso, initio dilute aut laete viride, molle, pellucidulo; aetate provecta firmo, tuberculoso, saturate olivaceo-viride; cellulis globosis vel ellipticis,—in thalli aetate immaturo, plerumque singulis aut geminis, saepe distantibus,—in aetate provecta saepe in familias connexis, plerumque confertis; tegumentis in thalli aetate immaturo plerumque diffluentibus, aetate provecta plerumque distinctis.

Thallus indefinitely expanded, in the beginning soft and pellucid, afterwards firm, tubercular, deep olive green: cells globose or elliptical; in the immature thallus, single or geminate, frequently scattered; in the mature thallus often closely conjoined into families, mostly crowded; in the young thallus the teguments of the cells are mostly diffluent, afterwards distinct.

Diam. cell. glob. max. $\frac{1}{3500}''$=.00028; cell. oblong. long. max. $\frac{1}{2500}''$ =.0004.

GEN. TETRASPORA.

T. LUBRICA. (*Roth*) *Ag.*

In aquis limpidis prope Philadelphia.

GEN. RHAPHIDIUM.

R. POLYMORPHUM. *Fresen.*

Hab. Prope Philadelphia.

FAM. PROTOCOCCACEAE.

GEN. SCENESDESMUS.

S. ACUTUS. *Meyen.*

Hab. Prope Philadelphia.

S. POLYMORPHUS. *Sp. Nov.*

S. cellulis fusiformibus, aut ovalibus aut ellipticis aut globosis, singulis aut 2-8 conjunctis, plerumque utroque polo aculeo unico, interdum aculeis duobus, instructis: apicibus obtusis, acutis, vel acutissimis; aculeis gracillimis, rectis, modice elongatis, inclinatis.

S. cells fusiform, or oval, or elliptic, or globose, single or 2-7 conjoined, furnished in most cases with a single spine, sometimes 2, at each end; ends obtuse, acute or very acute; spines exceedingly slender and acute, straight, moderately long, inclined.

Diam. $\frac{1}{2500}''-\frac{1}{7500}''$; plerumque $\frac{1}{4000}''$.

Hab. In aquis quietis prope Camden, New Jersey.

GEN. HYDRODICTYION.

H. UTRICULATUM. *Roth.*

Hab. In stagnis prope Philadelphia.

GEN. PEDIASTRUM.

B. BORYANUM. (*Turpin.*) *Mengh.*

Hab. In stagnis prope Philadelphia.

FAM. DESMIDIEAE.*

GEN. PALMOGLOEA.

P. CLEPSYDRA. *Wood.*

P. saxicola et bryophila, in gelatina achroa interdum dilute viride nidulans; cellulis cylindricis, cum polis obtuse truncato-rotundatis, diametro 2-3 plo longioribus; lamina chlorophyllacea axili, plerumque indistincte, saepe nulla; plasmate dilute viride; nucleo plerumque distincto; zygosporis subfuscis aut subglobosis aut enormiter in clepsydræ forma; membrana externa enormiter excavata et sulcata.

P. living on rocks and mosses, swimming in a transparent, sometimes light green jelly; cells obtusely truncated, rounded at the ends, 2-3 times longer than broad; chlorophyll lamina axillary, mostly indistinct, often wanting; endochrome light green; nucleus generally distinct; zygospore subfuscous, either subglobose or of an irregular form, somewhat resembling that of an hour-glass; external coat irregularly excavated and sulcate.

Diam. $\frac{13}{7500}''$.

Hab. In rupibus et in muscis irroratis ad Chelten Hills, prope Philadelphia.

GEN. CLOSTERIUM.

C. EHRENBERGII. *Menegh.*

Hab. Prope Philadelphia.

C. DIANAE. *Ehrb.*

Hab. Prope Philadelphia.

C. LUNULA.

Hab. Prope Philadelphia.

C. ROSTRATUM. *Ehrb.*

Hab. Prope Philadelphia,

C. SETACEUM. *Ehrb.*

Hab. Prope Philadelphia.

C. LINEATUM. *Ehrb.*

Hab. Prope Philadelphia.

C. LEIBLEINII. *Ktz.*

Hab. Prope Philadelphia.

C. PARVULUM. *Naeg.*

Hab. Prope Philadelphia.

C. ACEROSUM. (Schrank.) *Ehrb.*

Hab. Prope Philadelphia.

* I have paid so little attention to the Desmids that I intended at first to omit the family, but afterwards thought best to mention the few I have identified.

GEN. TETMEMORUS.

T. GRANULATUS. (*Bréb.*) *Ralfs.*

Hab. Prope Philadelphia.

GEN. PLEUROTAENIUM.

P. TRABECULA. (*Ehrb.*) *Naeg.*

Hab. Prope Philadelphia.

GEN. SPIROTAENIA.

S. BRYOPHILA. (*Bréb.*) *Rabenhorst.*

Hab. Prope Philadelphia.

GEN. MICRASTERIAS.

M. TRUNCATA. (*Corda.*) *Brib.*

Hab. Prope Philadelphia.

M. JENNERI. *Ralfs.*

GEN. STAURASTRUM.

S. PUNCTUALATUM. *Bréb.*

Hab. Prope Philadelphia.

GEN. DIDYMOPRIUM.

DR. GREVILII. *Ktz.*

Hab. Prope Philadelphia.

GEN. COSMARIUM.

C. CUCUMIS.

Hab. Prope Philadelphia.

C. BOTRYTIS. (*Bory.*) *Menegh.*

Hab. Prope Philadelphia.

FAM. ZYGNEMACEAE.

Remarks.—In this family I only enumerate such species as I have found in fruit, since there can be no certain identification of sterile plants. My list I am well satisfied, however, by no means completely represents the fauna of the neighborhood of Philadelphia.

GEN. RHYNCONEMA.

R. ELONGATA, *Sp. Nov.*

R. articulis vegetativis diametro 7-20 plo longioribus; articulis sporiferis multo brevioribus, valde tumidis; cytiodermate utroque fine protense et replicato; fascia unica, laxissime spirali; anfractibus plerumque 7; sporis ellipticis, diametro 1-2½ plo longioribus.

Sterile joints 7-20 times longer than broad; fertile joints much shorter, greatly swollen; cell wall at each end produced or folded in; chlorophyll filament 1, spiral lax; turns mostly 7; spores elliptical, 2-2½ times longer than broad.

Diam. Spor. $\frac{8}{7500}$ = .00106. Artic. vegetat. $\frac{4}{7500}$ .0005.

Hab. In aquis limpidis prope Philadelphia.

R. PULCHELLA. *Sp. Nov.*

R. articulis sterilibus diametro 2-3 plo longioribus; sporiferis nonnihil tumidis; fascia unica; anfractibus 3-4; sporis ellipticis, diametro fere duplo longioribus; cytiodermate utroque fine protense et replicato.

Sterile joints 2-3 times longer than broad; fertile joints somewhat swollen; chlorophyll band one; turns of spiral 3-4; spores elliptical, almost twice as long as broad; cell wall at each end produced or folded in.

Diam. Artic. Steril. $\frac{4}{7500}$ – $\frac{9}{7500}$ = .00033 – .0013. Spar. $\frac{9}{7500}$ – $\frac{10}{7500}$ = .0012 .00133.

Hab. In stagnis prope Philadelphia.

GEN. SPIROGYRA.

S. WEBERI. *Ktz.*

Remarks.—The American form agrees pretty well with the European, but is however, larger, its cells also a attain a greater proportionate length, and their chlorophyll bands have more turns. The lower limits of the American form are, however, so overlapped by the upper limits of the European, that it seems to me they must be considered identical.

Hab. In stagnis prope Philadelphia.

S. DUBIA. *Ktz.*

Remarks.—I have never seen the sporangial cell swollen in American specimens, in other respects the agreement is complete.

Hab. In stagnis prope Philadelphia.

S. QUININA. (*Ag*) *Ktz.*

Hab. In stagnis prope Philadelphia.

S. RIVULARIS. (Hassall), *Rabenhorst.*

Hab. In rivulis prope Hibernia, Florida. Mr. Wm. Canby.

S. LONGATA. (*Vauch*), *Ktz.*

Hab. In stagnis prope Philadelphia.

S. INSIGNIS. (*Hassall*), *Ktz.*

Hab. In stagnis prope Philadelphia.

S. PROTECTA. *Sp. Nov.*

S. saturate viridis, lubrica; articulis sterilibus diametro 6 plo longioribus; sporiferis vix tumidis; cytiodermate in cellulæ utroque fine protense et replicato; fascia unica; anfractibus 6; sporis oblongis vel ellipticis: membrano crassissimo.

S. Deep green, slippery; sterile joints 6 times longer than broad; fertile cells scarcely swollen; cell wall folded in at the ends; chlorophyll band single; turns 6; spores oblong or elliptical, spore wall very thick.

Diam. Art. steril. $\frac{11}{7500}''$=.00146; spor. lat. $\frac{10}{7500}''-\frac{12}{7500}''$=.00133–.0016 long. $\frac{25}{7500}$=0033.

S. CRASSA. *Ktz.*

Hab. In stagnis prope Philadelphia.

S. DILUTA. *Sp. Nov.*

S. articulis sterilibus diametro subæqualibus ad duplo longioribus; fructiferis haud tumidis; fasciis spiralibus 5, angustissimis, laxis, valde nodosis; anfractibus plerumque $\frac{1}{2}$, interdum 1; zygosporis sparsis, late ellipticis vel ovatis aut globosis; cytiodermate modice teuue, in utroque fine nec protenso nec replicato.

S. Sterile joints about as long as broad to twice longer, fertile cells not swollen; chlorophyll bands 5, exceedingly narrow, lax, strongly nodose; turns mostly $\frac{1}{2}$, sometimes 1; zygospores few, broadly elliptical, ovate or globose; cell wall moderately thin, not infolded at the ends.

Diam. Artic. steril. $\frac{23}{7500}''$=.003''.

Hab. In stagnis prope Philadelphia.

S. PARVISPORA. *Sp. Nov.*

S. articulis sterilibus diametro 2-4 plo longioribus; fructiferis haud tumidis, diametro 1-2$\frac{1}{2}$ plo longioribus; fasciis spiralibus 4, angustis, nodosis, anfractibus pluribus; zygosporis parvissimis, ellipticis, diametro 1$\frac{1}{4}$-2 plo longioribus; cytiodermate utroque fine nec protenso, nec replicato.

Sterile joints 2-4 times longer than broad; fertile not tumid, 1-2$\frac{1}{2}$ times longer than broad; chlorophyll bands 4, narrow, nodose; turns many; zygospores very small, elliptical, 1$\frac{1}{4}$-2 times longer than broad; cell wall not infolded at the end.

Diam. Art. Steril $\frac{23}{7500}''$=.003 spor. diam. transv. $\frac{15}{7500}''-\frac{17}{7500}''$=.002–0023; long $\frac{21}{7500}''-\frac{30}{7500}''$=

Hab. In stagnis, Hibernia, Florida. Mr. Wm. Canby.

GEN. ZYGNEMA.

Z. INSIGNIS. (*Hassall*), *Ktz.*

Hab. In stagnis prope Philadelphia.

GEN. SIROGONIUM.

S. RETROVERSUM. *Sp. Nov.*

S. articulis sterilibus diametro 7-15 plo longioribus; fasciis spiralibus 1, rare 2, latis, granulatis; anfractibus 1-9; articulis fertilibus valde tumidis, retroversis, copulatione genuflexa et sine tubo connexivo; cytiodermate nonnihil crasso, utroque fine protenso vel replicato; sporis ellipticis.

Sterile joints 7-15 times longer than broad; chloroplyll band 1, rarely 2, broad, granulate; turns 1-9; fertile article very tumid, retroverted;

union of cells without connecting tubes, genuflexuous; cytioderm somewhat thick, infolded at the ends; spores elliptical.

Diam. cell. steril. $\frac{9}{7500}''$=.0012.

GEN. MESOCARPUS.

M. SCALARIS. *Hassal.*

Hab. In stagnis prope Philadelphia.

ORD. SIPHOPHYCEAE.

FAM. HYDROGASTREÆ.

GEN. HYDROGASTRUM.

H. GRANULATUM. (*Linn*). *Disv.*

Hab. In stagnis exsiccatis, Delaware. Dr. I. F. Billings.

FAM. VAUCHERIACEÆ.

GEN. VAUCHERIA.

V. GEMINATA. (*Vauch*). *De C.*

Hab. In stagnis prope Philadelphia.

V. POLYMORPHA. *Sp. Nov.*

V. in cæspites dense intricata; thallo capillari, tenui; antheridia corniculata ex ramuli lateralis apice formatis; ramulis fertilibus interdum et oogoniis et antheridiis instructis, interdum antheridiis solum; oogoniis plerumque geminis, interdum singulis, globosis vel ovatis, sæpe brevirostratis, plerumque distincte pedunculatis sed rarius sessilibus; oosporis enormiter subglobosis vel ovatis; sporodermate achroo e stratis duobus composito.

Cæspitose; thallus hair like, thin; antheridia corniculate, formed of the apex of lateral branches; fertile branches sometimes furnished both with oogonia and antheridia, sometimes with antheridia alone; oogonia sometimes single but mostly in pairs, occasionally shortly rostrate, generally distinctly pedunculate but sometimes sessile; oospores irregularly subglobose or ovate, surrounded by a transparent double spore coat.

Hab. In aquis prope "Buffalo Bayou," Louisiana. Prof. H. W. Ravenel.

V. SERICEA. *Lyngb.*

Hab. In stagnis et humis irroratis prope Philadelphia.

V. AVERSA. *Hassal.*

Remarks.—I have found this species in the neighborhood of Philadelphia, if indeed it be a species. Prof. Rabenhorst thinks it probably merely a form of the preceeding and all the specimens I have seen appeared to run into it.

ORD. NEMATOPHYCEAE.

FAM. ULVACEAE.

GEN. SCHIZOMERIS.

S. LEIBLEINII. *Ktz.?*

See Proc. Biolog. and Microsc. Department, Ac. Nat. Sc. 1868, p. 12.

FAM. OEDOGONIACEAE.

O. MIRABILE. *Sp. Nov.*

O. gynandrum, rare setigerum; articulis diametro 2-8 plo longioribus; oogoniis plerumque singulis, rare geminis, nonnihil ovatis, infra latis sed supra contractis et medio tumidis; poris lateralibus duobus supra medium positis; oosporis aut late ovalibus aut subglobosis; sporodermate haud signato; antheridiis plerumque bicellularibus, interdum tricellularibus, plerumque in filo vegetativo infra oogonium aut in oögonio insidentibus; spermatozoideis singulis et geminis.

O. gynandrous, rarely setigerous; articles 2-8 times longer than broad; oosporangia mostly single, rarely geminate, subovate, in the lower portion broad, in the middle swollen, in upper part contracted; the 2 lateral pores situated above the middle; oospore subglobose or broadly ovate; it coats without markings; antheridia generally bicellular, sometimes tricellular, numerous, placed generally upon the female filament either upon or below the oosporangia.

Diam. Artic. veget. $\frac{3}{7500}''-\frac{13}{7500}''$=.0004–0017. Spor. $\frac{18}{7500}''-\frac{20}{7500}''$=.0024'' –0027''.

H. ab. In rivulis quietis prope Philadelphia.

O. HUNTII. *Wood.* (*American Naturalist.*)

Hab. In aquario meo.

O. INEQUALE. *Sp. Nov.*

O. dioicum; cellula basali biloba; plantis femines quam plantis masculis permulto majoribus; oogoniis enormiter globosis vel subovoideis, poro laterale supra medium posito instructis; oosporis forma eadem, sed paulo minoribus.

O. dioecious, basal cell bilobate; feminine plant very much larger than the male plant; oosporangium irregularly globose or subovoidal, opening by a lateral pore above the middle; resting spores of the same form as the sporangium but a little smaller.

Hab. In stagnis prope Philadelphia.

O. MULTISPORUM. *Sp. Nov.*

O. gynandrum; oogoniis singulis, vel binis vel ternis continuis, globosis; pore laterale distale instructis; oosporis globosis, oogonii lumen replentibus; antheridiis plerumque pluribus planta feminea insidentibus, cellula inferiore multo majore.

O. gynandrous: oosporangia single or bi or triseriate, globose, about the same size as the sporangial cavity; antheridia bi or tricellular, curved, with the lower cell much the largest, generally adhering in considerable numbers to all parts of the female plant.

Hab. In stagnis prope Philadelphia.

GENUS BULBOCHAETE.

B. CANBYII. *Sp. Nov.*

B. permagna ad .035″ longa, sparse ramosa; articulis sterilibus diametro 2-8 plo longioribus: oogoniis lateralibus vel in ramulorum apicem positis, transverse enormiter ovalibus; oosporis, transverse enormiter ovalibus, plerumque nonnihil triangularibus, oogonii lumen replentibus; sporodermate crasso, haud costato, enormiter punctato; antheridiis bicellularibus.

B. very large, attaining a length or more than one-third an inch, sparsely branched; sterile joints 2 to 8 times longer than broad; oosporangia lateral or placed upon the ends of branches, irregularly transversely oval; oospores of a similar shape often a little triangular, filling the cavity of the sporangium; spore coat thick, not costate but irregularly punctate.

Diam. cell. steril. $\frac{5}{7500}''-\frac{8}{6500}''$=.00066–001. Spor. transv. $\frac{17}{7500}''$=.00226.

Hab. In aquis quietis prope Hibernia, Florida, Mr. William Canby.

Remarks.—It affords me great pleasure to dedicate this very handsome species to Mr. William Canby, as an acknowledgment of favors received, and as a testimony of respect and high personal regard for him as a man, and as being among the foremost students of American phanerogamic botany.

B. DUMOSA. *Sp. Nov.*

B. articulis diametro 1½-2 plo longioribus; oogoniis plerumque in ramorum brevissimorum apicibus positis sed interdum lateralibus, plerumque setam terminalem gerentibus; oosporis enormiter ovalibus aut ovatis, nonnihil indistincte longitudinaliter oblique subarcte striatis; antheridiis bicellularibus, stipite instructis, cellula basale medio tumida, supra saepe contracta.

Joints 1½–2 times longer than broad: oosporangia generally placed upon the ends of short branches but sometimes lateral, mostly carrying a terminal seta; resting spores irregularly oval or ovate, somewhat indistinctly obliquely longitudinally and rather closely striate; antheridia bicellular, furnished with a little stipe, their basal cell tumid in the middle, frequently contracted above.

Hab. In aquario meo.

B. IGNOTA. *Sp. Nov.*

B. sparse ramosa, elongata; articulis diametro max. ($\frac{1}{1500}''$=.0066) 1½–2½ plo longioribus; oogoniis interdum lateralibus et sessibilius, interdum inter ramulorum cellulas vegetativas positis, dissepimento nullo; oosporis ovalibus, longitudinaliter nonnihil oblique et distante costatis, sporodermate nonnihil crasso; antheridiis 3-4 cellularibus, stipitatis.

B. sparsely branched, elongate with the joints $1\frac{1}{2}$–$2\frac{1}{2}$ times longer than broad ($\frac{1}{1500}''$=.0066); oosporangia sometimes lateral and sessile, sometimes placed upon the apex of a branch, sometimes situated in the length of the branches between their cells; the empty cell which supports them without dissepiment; oospores oval, filling closely the cavity of the spore case, longitudinally somewhat obliquely and distantly costate; spore coat rather thick; antheridia 3–4 celled, scarcely stipate.

Hab. In aquis quietis prope Philadelphia.

FAM. CHAETOPHORACEAE.

GEN. CHAETOPHORA.

C. PISIFORMIS (*Roth*) *Ag.*

Hab. In stagnis plantas, &c., adhaereus prope Philadelphia.

GEN. DRAPARNALDIA.

D. PLUMOSA. (*Vauch.*) *Ag.*

Hab. In aquis quietis prope Philadelphia.

D. GLOMERATA. (*Vauch.*) *Ag.*

Hab. In rivulis et stagnis et aquis limpidis quietis prope Philadelphia.

D. BILLINGSII. *Sp. Nov.*

D. valde gelatinosa; filis et ramis primariis achrois ad $\frac{30}{7500}''$ crassis, sparsissime ramosis, articulis diametro 2-6 plo longioribus, saepe medio valde tumidis; fasciis chlorophyllis dilute viridibus, saepe nullis aut subnullis; ramulorum fasciculis distantibus, late ovalibus vel late triangularibus, alternantibus vel oppositis vel triplo verticellatis, sparse ramosis, patentissimis; ramulis cum pila longissima robusta terminale; oosporis globosis, moniliforme conjunctis; sporodermate crasso.

Frond very gelatinous, filament and primary branches attaining a diameter of $\frac{1}{250}''$, very sparsely branched, their articles 2-6 times longer than broad, often very much swollen in the middle; chrorophyll band light green, frequently almost or entirely wanting; fascicles of branches distant, broadly oval or triangular, alternate, opposite or in whorls of three, very open; ultimate branchlets terminating in a long, robust, hyaline hair; resting spores globose, with thick walls, arranged in long moniliform sometimes branched filaments.

Remarks.—I dedicate this very beautiful species to Dr. J. S. Billings, U. S. A., to whom I am under the greatest obligations for aid in the prosecution of this research, and whom I have ever found to unite the greatest scientific liberality to a strong enthusiasm for and able prosecution of the study of these lower vegetable forms.

Hab. In aquis limpidis quietis prope Philadelphia.

GEN. APHANOCHAETE.

A. REPENS. *A. Braun.*

Hab. In algiis confervaceis prope Philadelphia.

CLASS RHODOPHYCEAE.

FAM. PORPHYRACEAE.

GEN. PORPHYRIDIUM.

P. CRUENTUM. (*Ag*) *Naeg.*

Remarks.—A small piece of bone was sent me by my friend, Dr. Billings, on which were a few specks of this little organism. The bone had been picked up on Governor's Island, New York Harbor, and it is very possible that it was a fresh arrival from Europe. I have never met with traces of the species elsewhere.

P. MAGNIFICUM. *Sp. Nov.*

P. cellulis globosis vel subglobosis, rare nonnihil polygonis; cytioplasmate purpureo, granulato; cytiodermate crasso, haud lamelloso.

Cells globose or subglobose, rarely somewhat polygonal; endochrome purple, granulate; cell wall thick, not laminate.

Dram. Cell cum. tegum. $\frac{8}{24000}$–$\frac{13}{24000}$. Tegum. $\frac{1}{30000}$–$\frac{1}{16000}$.

Hab. In terra humida, Texas. Prof. Ravenel.

FAM. CHANTRANSIACEAE.

GEN. CHANTRANSIA.

C. EXPANSA. *Sp. Nov.*

C. caespitosa, in lapide stratum saturate violaceo-purpureum lubricum, indefinite expansum formans; filis purpureis, modice ramosis, fere 2 lineas longis et ramis plerumque strictis et rectis, saepe elongatis; ramulis fertilibus brevibus, ascendentibus; articulis diametro 3-8 plo longioribus, extremis obtusis; polysporis in ramellis lateralibus racemosim et confertim cumulatis, ovalibus vel nonnihil obovatis.

Caespitose, forming a dark purple, slippery, indefinite stratum on stones; filaments purple, moderately branched, almost 2 lines long, together with the branches strict and straight, often elongate; infertile branches sometimes very few, sometimes very numerous; fertile branches short, ascending; joints 3-8 times as long as their diameter, the final articles obtusely rounded: polyspores racemose, crowded on the fertile branches, oval or somewhat ovate.

Diam. Fil. $\frac{1}{2500}''=.0004''$, Spor. transv. $\frac{1}{3650}''=.00027$ long. $\frac{1}{2500}= .0004''$

Remarks.—I formerly referred this species very doubtfully to C. violacea Ktz., but am now convinced that it is distinct. Its size, mode of growth, and habit all are very different from those of that species.

Hab. In rivulis prope Philadelphia.

Whilst the above has been going through the press I have found floating on a "brick pond" the following new nostochaceous plant.

ANABAENA GIGANTEA. *Sp. Nov.*

A. thallo nullo, trichomatibus singulis et numeroso-consociatis, natantibus, rectis, in aetate juveni spiraliter convolutis; articulis plerumque subglobosis, arcte connexis, granulosis; cellulis perdurantibus interjectis, articulis vegetativis subaequalibus utroque polo punctiforme incrassatis, subsphaericis; sporis subsphaericis.

Thallus wanting; filaments occurring floating singly on water or in great numbers, straight, but in the young state often spirally convolnte; articles mostly subglobose, closely connected, granular, heterocysts subsphaerical, interstitial, a very little larger than the vegetative cells, thickened at each end in a punctiform manner; spore subsphaerical.

Diam. Artic vegetat. max $\frac{11}{24000}$=——— . Heterocysts $\frac{1}{2000}$=.0005. Spor. at. $\frac{11}{12000}$=———Long. $\frac{1}{1000}$=.001.

Remarks.—With the above anabaena was a Caelosphaerium, which appears to be the *C. dubium Grun.* In no instance, however, was the frond of nearly so great size as the European form is said to attain to.

I have also recently identified the following plants, new to this continent.

GEN. CLADOPHORA.

C. BRACHYSTELECHA. *Rabenh.*

Hab. In aquis prope Philadelphia.

C. FRACTA. *Dillw.*

Hab. In flumine Schuylkill.

Stated Meeting, July 16, 1869.

Present, eight members.

Mr. FRALEY, Vice-President, in the Chair.

A letter accepting membership was received from John Phillips, dated Oxford, England, June 12, 1869.

A photograph for the Album was received from J. H. C. Coffin, of the National Observatory, Washington, D. C.

Letters of invoice and acknowledgment were received from the Royal Library at Munich, the Royal Academies at Pesth and Brussels, and from Mr. S. A. Green, Librarian of the Massachusetts Historical Society.

A letter was received from Gen. Humphreys, in reply to the communication of the Secretaries respecting the publication of geological surveys in the West.

Donations for the Library were received from the Royal Societies and Academies of Tasmania, Hungary, Prussia, Bavaria and Belgium, the Societies at Moscow, Görlitz, Bremen, Penzance and Liverpool, the Observatories at Munich, Brussels, Washington and Cincinnati, the Geological Societies at Berlin and London, the Geographical Societies at Paris and London, M. Barrande, M. Zantedeschi, the Astronomical and Meteorological Societies at London, the Boston Public Library, Massachusetts Historical Society, Peabody Museum and Harvard College, the Franklin Institute, the Peabody Institute, the Bureau of Refugees and War Office at Washington, and the Wisconsin Historical Society. A large number of Educational volumes and pamphlets were received in exchange from the Massachusetts Historical Society.

The report of the Committee on Dr. Horn's paper was read and accepted, and the paper referred to the Publication Committee, with instructions to publish in the Transactions.

The death of Dr. C. D. Meigs, at his residence in Media, Pa., June 28, in the 78th year of his age, was announced by Dr. Rushenberger, and on motion the President of the Society was requested to nominate a member to prepare an obituary notice of the deceased.

Prof. Cope exhibited drawings of the fossil remains of a large Cretaceous Mosasauroid. He offered also for the acceptance of the Society six 8vo lithographic plates already prepared on stone to illustrate two papers of fossils found in Virginian caves. On motion the plates were accepted, and the Secretataries directed to have the requisite number of impressions taken to illustrate the two papers, for the next number of the Proceedings.

On motion the balloting for nominations 626—637 was postponed until October, on account of the small number of members present.

Pending nominations 638, 639, 640 were read, and the Society was adjourned.

SEVENTH CONTRIBUTION TO THE HERPETOLOGY OF TROPICAL AMERICA.

By Edward D. Cope.

[*Read before the American Philosophical Society, July 16, 1869.*]

Hydromedusa tectifera, *Cope, sp. nov.*

Char. The anterior portion of the carapace depressed and prolonged; the first vertebral scutum nearly twice as long as wide; the nuchal scutum narrow transverse, twice as wide as the first vertebral; four times as wide as long. Light brown, with slightly radiating or transverse darker brown spots on the costal plates. Below bright yellow.

Description. Carapace more elevated at the anterior vertebral bone than above the pelvis, then descending steeply, and prolonged roof-like to the nuchal margin. Posteriorly rather abruptly decurved to opposite the lowest plane of the sternum, and considerably below the strongly recurved points of the posterior lobe of the same. Two posterior vertebrals and each posterior costal with a projection at the posterior part. Margin a little elevated and turned out above the hinder limbs. The sides descend steeply, and the superior plane is broad outside of the scapulæ. Lateral marginals not prominent, being a ridge directed rather upwards, which is bounded above by a strong groove. Fine median marginals not united to disc throughout, but by costal processes. The first three marginal bones very much wider than long, the second nearly twice as wide. The nuchal marginal very large, as long as wide. Three marginal bones of the bridge with an undulate ridge along their upper margin, the third with the ridge running diagonally across it, descending behind.

Two last pairs of costal bones united on the median line. Last vertebral scutum of an urceolate form, much narrower at its point of contact with the penultimate. The latter the narrowest of the series. Penultimate marginal scutum extending nearly to the middle of the last vertebral. Second marginal scutum much longer than wide, the first, twice as long as wide. First costal longer than wide.

Sternum without fontanelle or intersternal elements, the anterior lobe both longer and wider than the posterior. The gular scuta small, the humeral and femoral each considerably wider than the pectoral. No axillary or inguinal plates, bridge short; claws strong. Posterior lobes with a deep rounded emargination.

Measurements.

	In.	Lin.
Length carapace (over arch)	11	4
Depth	3	1
Length sternum	8	4
Total width below	6	2
Length bridge	1	8
" femur (straight)	2	4
" tibia	2	5
" foot		23

Upper surface of limbs dark brown.

Habitat. This turtle occurs in some of the tributaries of the Parana or Uraguay rivers, either in the Argentine Confederation or the Banda Oriental, but in which, I do not know. My information is derived from W. W. Morgan, M. D., of Philadelphia, who resided many years in Monte Video, where he obtained the specimen from a collector.

This species differs from those already known, in the greater extension forwards and laterally of the anterior margin of the carapace. In consequence the forms of the vertebral, nuchal, and marginal plates are exaggerated in form, the first in length, the last two in width.

Chelopus rubidus, *Cope.*

If this genus be regarded as co-extensive with the *Geoclemmys* of Dr. Gray, it embraces with the present addition, fourteen species.

Carapace oval, moderately elevated and with obtuse median keel; margin entire not recurved. Vertebral plates broader than long, with concave posterior sutures, except the anterior, in which the length is somewhat in excess. Its lateral margins are parallel and the anterior angle is produced, curtailing the small nuchal. Scuta concentrically grooved, visible, though obsolete in the old individual. Plastron rather plane, deeply emarginate behind; very openly in front. Inguinal and axillary scales very small. Areolæ of the scuta a little above and behind their centres.

Claws short, toes much united on all the limbs. Soles and palms with large scales. Forearm with six cross-rows of large scales in front, and two longitudinal rows on the outer side. A cross series of three across the carpus behind. Posterior foot club-shaped. Testudo-like, the heel with three cross rows of shields of 1, 3, 2 respectively, the posterior of the last two very large, double the next smallest. Rest of the hind limb small scaled.

Head broad plane above, muzzle and loreal region vertical. Beak obtusely hooked, not emarginate; alveolar faces without grooves or ridges.

Ground color of body yellow, the limbs and throat shaded and spotted with red, which is margined with black. The neck above and laterally is marked with numerous black rings and lines; below with the gular region it is closely black dotted. Tail very short, even in the males, yellow, with fine black longitudinal lines above. Limbs with black and pink dots. A chevron shaped red band extends from the orbits round the canthus nostralis and muzzle, and another wider and with narrow black margin between the orbits, with the apex forwards. Two similar bands extend from the orbits posteriorly to the obscure tympanum, and two are concentricably arranged on the occiput, the apex of the anterior being separated as a large red spot. In the male the colors are deeper and brighter. Carapace yellowish brown, each costal scutum with a horizontally oval black-edged yellow spot in its area, surrounded by yellow annuli. The young shows shows that there are two such concentric annuli. Marginals with alternating longitudinal yellow and black lines above, brown below. In the young, the vertebrals have a marginal yellow anuulus, and median oval ring with yellow and black variations.

Below, deep brown, the plastron broadly yellow all round. In the young the yellow extends over the whole plastron; in the very old the brown is very narrow medially.

Measurements, (No. 265.)

Greatest length plastron	Cm. .1525
Width medially (Total)	" .1123
Greatest length carapace	" .16
Greatest elevation carapace	" .064
Hind limb from knee	" .0538
Fore " elbow	" .041
Head and neck above	" .07
Width head (Temporal)	" .024
From orbit to end muzzle	" .0082

Habitat. Tuchitan Tehuantepec, Mexico, discovered by Prof. Francis Sumichrast. Four specimens, Nos. 264–5–6–7.

This handsome land tortoise appears to approach sufficiently near the C. callicephalus, Gray (Proc. Zool. Soc., London, 1863, 254), of unknown habitat, to render a comparison proper. That species according to Gray, has a posteriorly truncate plastron, and a notched beak. The vertebral scuta are as long as broad, the second and third longer. The chin, throat, and upper parts of the neck are spotless. We owe this species to our active correspondent, F. Sumichrast, who since the days of Natterer, has not been equalled in the thoroughness and extent of his zoological researches in Tropical America.

CONIOPHANES PICEIVITTIS, *Cope.*

Scales in twenty-five longitudinal series, vertex and muzzle in one plane; upper part of rostral plate prominent, not produced between the internasals. Latter less than half prefrontals. Prefrontals longer than wide, decurved to the subquadrate loreal. Postnasal higher than prenasal. Preoculars one or two, postoculars two, superior larger. Superciliaries narrow. Frontal rather wide, with long posterior angle, and parallel lateral outlines which are little shorter than the anterior. Occipitals elongate, scarcely emarginate behind. Superior labials eight, fourth and fifth entering orbit. Sixth higher than long; seventh largest. Temporals 1–2. Postgeneials shorter than pregeneials. Inferior labials ten. Gastrosteges 158 two anals; urosteges, 90. Total length, .542 m.; of tail, .063 m.; from muzzle to canthus oris, .014 m.; interorbital width, .0048 m.

The ground color above and below is white, which is immaculate below, except on the throat and chin, where it is black dusted. Above three broad black bands extend from the end of the muzzle to the end of the tail. The inferior commences on the middle of the third row, and occupies three and two half rows of scales; a row and one-half intervenes between this and a median dorsal band which covers six and one or two half rows. The ground color on the head is an irregular line from the muzzle along each canthus and beyond orbit, and the upper labial plates; these are thickly dusted with black, the anterior spotted on the edge.

From Chihuitan, Tehuantepec, Western Mexico. F. Sumichrast, Coll. in Mus. Smithsonian, No. 248.

SYMPHIMUS LEUCOSTOMUS, *Cope, sp. et gen. nov.*

Char. gen. Dentition isodont; cephalic plates normal except that the internasals are confluent with the nasal, and the latter with each other and with the loreal. Preorbitals one. Rostral shield not prominent; scales smooth, equal, uniporous; anal bifid. General form elongate.

This genus differs from Chilomeniscus, to which its technical characters are similar, about as much as any colubrine serpent does from a burrowing calamarian. Its form is nearly that of Cyclophis, and it should perhaps be placed nearest to it in the system. Steindachner's *Bergenia mexicana** should, it appears to me, be referred to Chilomeniscus Cope, of which it is the fourth species.

Char. specif. The head narrow, not very distinct, the muzzle acuminate, but obtuse at the extremity. The scales in fifteen longitudinal series. The form is cylindric and elongate. The tail of medium length as in Cyclophis. Rostral plate high as wide, scarcely visible from above, not prominent. Side shield of the muzzle pierced by the nostril and extending to the preocular; latter long as high, not reaching the frontal. Postoculars one on one side, two on the other. Superior labials seven, third and fourth bounding orbit, all longer than high except the fifth; temporals 1–2 large, the anterior bounding the fifth and sixth labials. The median sutures of the rostronasal and prefrontal plates of equal length. Frontal longer than wide, with concave sides; superciliaries wide, occipitals elongate, common suture nearly as long as prefrontals and frontals together, truncate behind. Inferior labials eight, fifth largest—narrow; pregeneials a little longer than postgeneials. The eye is rather small. Urosteges, 111, gastrosteges.

Color olive gray above, a dorsal band of light brown extending over three rows of scales to the origin of the tail; the skin of its median region being yellow. Throat, chin and superior labials light yellow, a black line above the superior labials from the second posteriorly. The brown of the upper regions descends to the lower row of scales at about the twelfth transverse row; two or three lower rows are pale edged. Belly dirty white. The dorsal band is posteriorly ill defined, and extends a little beyond the vent; tail brown.

	In.	Lin.
Total length, No. 240	31	5.5
Length tail	10	9
Length rictus, No. 227		6.8
Interorbital width		2.8
Width muzzle		1.8
Width orbit		1.4
Length tail	7	0

No. 240. From Chihuitan, from the same.

No. 227. From the collections of the Smithsonian Institution from the province of Oaxaca, Mexico, made by Francis Sumichrast.

* Reised. Oester. Freg. Novara Reptilia, 92 fig.

LEPTODIRA MYSTACINA, *Cope.*

Scales in nineteen longitudinal series. Body very slightly compressed, head distinct, an elongate oval. Superior labials seven, the second in contact with the upper and lower preoculars, third and fourth with orbit, and fifth with occipital excluding the temporal. Fourth, fifth, and sixth higher than long ; temporals 1-1-2. Oculars 2–2, inferior small in both sets. Internasals long as wide, prefrontals longer than wide. Frontal longer than wide, with parallel sides, considerably in contact with superior ocular. Occipitals oval, scarcely emarginate behind. Postgeneials longer than than pregeneials. Gastrosteges 187, anal 1–1, urosteges 70.

The ground color is a dirty white, and is uniform below. Above it, marked by very broad cross-bands, which extend to the gastrosteges and are twice as wide as the intervals of ground. There are thirteen to the vent ; on the posterior half of the body they divide on the vertebral line, and alternate ; one is thus continuous with two of an opposite side, leaving the ground in lateral squares. Head above, including occipitals, a lighter speckled brown above, leaving a white collar. A black band from eye to angle of mouth, and a second from below the eye to mouth, parallel to the above, encloses with it a light band ; a black band from eye to nostril ; lips in front black spotted. Total length 16.25 inches ; of mouth 7 lines ; of tail 4.25.

Habitat. The western region of Mexico, near the Isthmus of Tehuantepec, two specimens (251–261) sent to the Smithsonian Institution by Francis Sumichrast. This serpent approaches very near the L. pacifica Cope in details, but differs totally in coloration. The structural differences are the following :

L. mystacina.	*L. pacifica.*
Head elongate oval ;	Head short wide.
Preocular reaching frontal ;	Preocular not reaching.
Prefrontals longer than wide ;	P. f. wider than long.
Fifth labial to occipital ;	Fifth labial not to occipital.

TRIMORPHODON, *Cope.*

Proceed. Acad. Nat. Sci., Phila., 1861, 297.

This peculiar genus, hitherto not found outside of the Mexican, Central-American and Sonoran districts, is well illustrated by the collections received by the Smithsonian Institution. Two species have been hitherto known, and I now add three others, as follows :

I. Scales in 21–3 *Rows.*

Seven (six) superior labials ; three loreals ; head black in front with a white T shaped mark ; back with uniform black rhombs.

T. TAU.

Eight superior labials ; head broad, short ; three loreals ; head dark-brown, with light cross-bar on muzzle and between eyes, and V on occiput ; body with broad brown annuli ; tail one-fifth the total.

T. UPSILON.

Nine superior labials; head long, swollen behind; two loreals; head with a lyre-shaped pattern, back with irregular rhombs, with pale centres; tail one-sixth the length. T. LYROPHANES.

Nine superior labials; head long; two loreals; head with chevron bands; body with irregular pale centred rhombs.

T. BISCUTATUS.

Scales in 27 Rows.

Nine superior labials, three loreals; head elongate; two dark cross-bands and two chevrons on head; back with very irregular rhombs, with pale centres; tail one-sixth. T. MAJOR.

TRIMORPHODON TAU, *Cope.*

Scales in twenty-three series. Muzzle projecting considerably beyond the mouth. Rostral plate somewhat produced behind; internasals, about one-fourth size of prefrontals, which are long as wide. Frontal with straight lateral margins, which are longer than anterior. Occipital not longer than frontal, regularly rounded behind. Nostril in middle of nasal. Three loreals, three post and three preoculars. Temporals, 2–3–4. Superior labials six, the fifth probably composed of two plates fused, as it is twice as long as deep, on both sides. The fourth and fifth enter the orbit, the third is cut down by the lower loreal and preocular. Inferior labials, eleven. Body strongly compressed. Total length 0m. 236; of tail, .035 m.

Above gray, with twenty-three jet-black rhombs, which extend to the gastrosteges by their lateral angles. Tail with ten rhombs; all everywhere unspotted with paler. Sides of belly black spotted. Head gray with a black mask above as far as the middle of the occipitals, but with two lateral ear-shaped prolongations on the same; a pale T-shaped mark extends transversely between orbits, and longitudinally to end of muzzle.

One specimen, No. 236, from F. Sumichrast, from the western part of the Isthmus of Tehuantepec, Mexico.

TRIMOPHORDON UPSILON, *Cope.*

Internasals broader than long, prefrontal broad as long, frontal with parallel outline not reached by the preocular. Oculars 3-3. Nasals distinct, loreals three, forming an L. Temporals 3-3-3. Fourth and fifth labials in contact with orbits. Twelve inferior labials. Scales in 2-3 series. Body with twenty-four brown annuli, which are broken into irregular spots on the belly, and are broader than long on the vertebral line. On all but the anterior third the length, a vertical brown bar stands between these on the sides. Chin and lips white, superior plates brown spotted above. Loreal region spotted. Temporal and occipital region brown with a pale Y on the occipital common suture. Total length 0.34 m. Tail .052 m.; head to aictus .011 m.

One specimen in Mus. Smithsonian from I. I. Major, from Guadalaxara, West Mexico.

TRIMORPHODON MAJOR, *Cope.*

This large species has a head of lanceolate form; the body is compressed and the tail slender. The large number of series of scales characterizes it most distinctly. Gastrosteges 258, anal 1-1, urosteges 88. The preocular does not reach the frontal; temporals 3-4-5. There is a broad brown band across the muzzle and chevron, ceasing between the eyes, whose limbs are lost above the rictus ovis. A second chevron behind this is closed by a spot connecting the limbs behind. The dorsal rhombs extend to the gastrosteges, and are manifestly formed by the union of four spots, two vertebral, and one on each side; they enclose three spots of the ground in a cross-row.

Two specimens from near Tehuantepec from Francis Sumichrast.

TELEOLEPIS STRIATICEPS, *Cope, sp. et gen. nov.*

Character genericus. Dentition diacranterian. Cephalic shields normal; two nasals, the nostril in the anterior one; the loreal region with a deep longitudinal groove. Scales equal, smooth, biporous; anal shield entire. Tail short, body slender; head wide, very distinct.

Disregarding the scale pores, this form might be regarded as a near ally of Xenodon, or perhaps of Opheomorphus, for it has the head of the first and the body of the last. The importance of Reinhardt's scale pores I have often had occasion to observe, and I believe their absence or single or double existence to be as important indices of natural groups as any other structural feature. In general, Reinhardt's tables show that subterranean and aquatic Colubrine serpents do not possess these pores, while the more highly developed and typical forms of a more aerial life possess them double; the Coronelline forms of an intermediate character, possess single pores, though frequently none, and rarely two.

Teleolepis agrees with Alsophis in many technical characters, except in having a single anal shield, but the latter differs especially in its excessively elongate tail. A close approach appears to be made by Zamenis, but here the anal plate is double also. Bothrophthalmus Schleg. a Lycodont, presents the peculiar loreal groove.

Character specificus. The body is rather compressed, the urosteges not angulate. The scales are in nineteen longitudinal series, and are rather wide on the dorsal region The length of the tail enters the total 5.66 times. The head is broad and flat, and the neck narrow. The rostral plate is flat, and slightly visible from above. The internasals are little shorter than the prefrontals, but not so wide. Both nasals are visible from above, but not the loreal; the preocular reaches the frontal. The latter is as long as the occipitals and rather narrow, with concave borders. Each occipital is as broad as the middle suture; the superciliaries large. The eyes are large and with round pupil.

Nasals about equal; the loreal with a curved supero-posterior margin, which invades the single preocular; postoculars three, the superior in contact with occipital only, the inferior the largest, joining only the fifth and sixth superior labials. The temporals are very small and number 2-3-4. Superior labials eight, fourth and fifth entering orbit; sixth quite elongate, last two each longer than high. Inferior labials nine; geneials equal, not elongate. Gastrosteges 189, urosteges 70. Total length of a young animal 0m 30; of tail 0m 03.5.

Color above light brown, with a dorsal series of transverse quadrate deep brown spots extending from nape to middle of tail; they extend over seven and two half rows of scales, and are restricted by a light yellow line, which extends on each side the back. The spots are yellow-edged anteriorly and posteriorly. The sides are marked with two rows of alternating pale brown blotches, of which the superior is opposite the dorsal series. There is a triangular dark edged yellow spot on the extremity of each gastrostege; belly closely brown punctate. A blackish band extends from the rostral plate to the side of the neck, and three similar bands with pale middles extend on the top of the head to the nape. Lips and chin yellow, brown blotched.

This species was found by Geo. Sceva, of the Thayer Expedition to Brazil, and is No. 909, Mus. Comparative Zoology, Cambridge, Mass.

Lygophis lachrymans, *Cope*.

This species repeats the generic characters of Lygophis in the diacranterian dentition, lack of scale pores, tail of medium length and normal scutellation.

Scales in seventeen series, obtuse. Muzzle short, rostral shield not as high as wide, not prominent. Internasals broader than long; frontal broad, shorter than occipitals, with a right angle behind. Superior labials eight, fourth and fifth only in orbit, sixth only higher than long. Loreal longer than high; oculars 1–2, the anterior not reaching frontal; temporals 1–2. Inferior labials large, nine; pregeneials shorter than postgeneials. Gastrosteges 173; anals 1–1; urosteges 78.

Color above, chestnut brown; ends of gastrosteges and first three and a half rows of scales blackish, yellowish margined above from side of neck to end of tail. On the anterior half the body is divided by a yellowish band on the first and second rows of scales. Below and labials bright yellow, the anterior superior labials brown margined. A deep brown band from eye across sixth labial, another across seventh, and a black spot on side of neck. Head above brown. *Habitat*, unknown.

This species is remotely like Coniophanes fissidens. It differs from Rhadinaea taeniolata Jan. (*Enicognathus*) in the broader frontal, and the lip bands as well as uniform back.

Alsophis rijgersmaei, *Cope*.

Six specimens of this species serve to represent its characters. In three the scales are in 23 series, in one in 21. The loreal plate is longer than high, and with a straight superior suture, except on one side of one individual, where it is angulated above as in A. antillensis. The muzzle projects considerably beyond the mouth, but the rostral plate is not prolonged on its upper surface. Superior labials eight, third, fourth, and fifth in orbit; these with the sixth are the only labials higher than long. Temporals 1–2 the anterior in contact with inferior of the two postoculars only. One preocular occasionally divided and not reaching frontal.

Nasals different in size, the anterior much smaller and not more elevated than the loreal. Muzzle very narrow, internasals longer than broad, vertical elongate and contracted by the concave superciliary sutures, its anterior suture one-half its length, which equals the common occipital suture. Occipitals emarginate behind. Gastrosteges 201, 201, 204, 210; anal $\frac{1}{1}$; urosteges 100, 122, 108, 100. Length 37.25 inches, of which the tail measures 3.25 inches.

Color, dark slate brown above, with a number of blackish cross-bands behind the head, which are sometimes quite indistinct and sometimes separated by paler bands. A broad brown band from the nostril through the eye which expands and is lost on the temporal region, though its lower boundary is continued as a line on the side of the neck. The scales on the median dorsal line have a white border. Belly, the posterior half black, anterior yellowish, gray spotted. Upper labial region orange, brown spotted; gular region grayish brown and orange mingled. Frontal and occipital plates dark medially. This species is in general appearance much like the A. sanctaecrucis, but it has the loreal plate of the A. angulifer, and several more series of scales than either. The frontal shield is of a narrower form than in either A. sanctaecrucis or A. antillensis.

Habitat. So far as yet known, this distinct species is confined to the small island of St. Martins, in the Spanish West Indies, which has an area of only about thirty square miles. Six specimens were sent to the Academy Natural Sciences by Dr. R. E. Van Rijgersma of that island. I dedicate the species to him in recognition of his labors in endeavoring to lay a basis for the complete zoology of that island.

XENODON ISOLEPIS, *Cope.*

Eight superior labials, fourth and fifth entering orbit, sixth the largest, exceeding the seventh. Anal shield bifid. Scales of the body in nineteen series quincuncially arranged of equal size and form, one pitted. General arrangement that of a Coluber; the body is also as in that type entirely cylindric. Oculars 1–2; loreal little higher than long; postnasal highest; rostral not prominent. Temporals 1–2. Frontal longer than wide, longer than occipital.

Gastrosteges 156; urosteges 55.

Color uniform leaden above, flanks greenish, below dirty white. Posterior tooth rather short. This species is nearest in technical characters to the X. neovidii Gth. but differs entirely in color, and the equal size and form and quincuncial arrangement of the scales. The sixth upper labial is according to Gunther's figure (Ann. Mag. Nat. Hist., 1863, V. C.,) much smaller than the seventh; here the latter is distinctly smaller than the former.

From Pebas Equador on the upper Amazon. Received from Professor James Orton, of Vassar College, New York. A collection recently received from that gentleman from the same locality embraced the following species, all of which are in the Museum of the Academy Natural Sciences, presented through the liberality of Prof. Orton.

Testudinata.

Chelys matamata.

Ophidia.

Typhlops reticulatus, L.
Tortrix scytale, L.
Rhabdosoma microrhynchum, Cope.
Leptodira annulata, L.
Oxyrhopus clelia, L.
Xenodon isolepis, Cope.
Herpetodryas carinatus, L.
Himantodes.
Leptognathus catesbyi, D. B.
Elaps lemniscatus, Linn.
Elaps imperator, Cope, (*E. batesii,* Gthr.)
Elaps scutiventris, Cope.
Bothrops bilineatus (27 series of scales only.)

Lacertilia.

Amphisbaena alba, L.
Amphisbaena fuliginosa, Schreb.
Amiva surinamensis, Gray.
Thecadactylus rapicauda, Houtt.
Anolis viridiaeneus, Peters.

Batrachia.

Pithecopus tarsius, Cope. Specimens with head and body five inches in length.

Pithecopus tomopternus, Cope.

Hyla marmorata, Daud.

Hyla leucophyllata, Beireis. A curious variety with a round or discord blackish spot on the vertex, brown lateral band from end of muzzle, and whole under surfaces a bright salmon color. Another variety apparently has been named *Hyla triangulum by* Günther, P. Z. S. Lond., 1868.

Scytopis allenii, Cope.

Bufo naricus, Spix.

Bufo margaritiferus, Merr.

Pipa surinamensis, L.

ELAPS SCUTIVENTRIS, *Cope.*

Form slender, tail short, thick. Oculars 1–2; superior posterior with its inferior suture continuous with that of the occipital. Superior labials seven, third and fourth in orbit, all except the first higher than long, none reaching occipital. Temporals 1–1. Superciliaries broad as long; prefontals and internasals of equal length, the former much the wider. Rostral broader than high, not prominent. Symphyseal largely in contact with pregeneials. Scales in fifteen series. Gastroteges 274; anal divided; urosteges 15.

Above black, except a broad yellow head-band, which extends from the posterior margin of the prefontals to that of the occipitals. Tail with one or two crossings above. Below black, with large transversely oval yellow spots, which extend to the third row of scales, and include three or four gastrosteges at intervals of the same width. Length, 17.5 inches, tail, 7 inches.

From Pebas on the Amazon in Equador. From Prof. Orton.

This species appears to be nearest the E. narducci of Jan.

TRIGONOCEPHALUS (Bothrops) ARBOREUS, *Cope.*

Scales in thirty-five longitudinal series, all carinate except the inferior. Eight superior labials which diminish in size posteriorly, bounded above behind posterior line of orbit by seven small scales, which are not distinguishable from those of the temple. Second labial forming anterior boundary of fossa; two rows scales between fourth and orbit. Inferior labials eleven. Three scales on the canthus above, the anterior two large, forming with a pair on top of the muzzle a shielded space of six plates. Superciliaries large, separated by nine rows. Gastrosteges 201, urosteges 64 pairs. The body is much compressed, and the coiled tail with slightly expanded prehensile extremity, appropriately to arboreal life.

Color, greenish yellow, the first series of scales yellow, ends of the gastrosteges with a green line. Dorsal region with faint brownish yellow spots often paired; many scales black edged. Labial scales of both jaws black edged; a black band with yellow interruptions from eye to angle of mouth.

This handsome and venomous tree serpent was discovered by Dr. Otho Wucherer, near to Bahia, Brazil. It is a near ally of the B. bilineatus of Nieuwied, but that animal has 27-9 rows of scales, and the top of the muzzle is scaled, (as given by Schlegel in the atlas of his Physionomie des Serpens), and the color is slightly different.

TRIGONOCEPHALUS (Bothrops) PUBESCENS, *Cope.*

Scales in twenty-three rows, all including the inferior, keeled. Eight superior labials, the fourth longest, and separated from the orbit by three rows of scales. Second not extending to the front of the maxillary pit. Posterior labials quadrate shorter. Seven rows of scales between superciliaries; two on canthus rostralis above, besides the edge of the preocular. The anterior quite large, flat, the second separated by five rows scales. Maxillary, palatine and pterygoid, mandibular and laryngeal margins with the fang sheaths, silky pubescent, forming short longitudinal fringes. Color, brown, with blackish brown spots on each side from vertebral line to fourth row of scales. The spots are rounded and pale edged and alternating. They are divided by a longitudinal line of the ground near their middle. There are in their intervals above, round pale edged brown spots. A brown band from eye to angle of mouth, pale edged below; a similar band across head *in front of superciliaries;* two divergent brown spots behind the same plates, and two divergent brown bands behind these, all yellow edged. Sides of face and throat thickly brown dusted. Belly closely brown spotted; widest spots near end of gastrosteges. Gastrosteges 182, urosteges 25.

One specimen of this serpent was brought by the Thayer expedition from the Rio Grande do Sul, Brazil. It is nearest the B. nieuwiedii, Spix, but may be distinguished by the extraordinary character of the silky fringes in the mouth as well as by the entirely different coloration. In the latter respect it is rather more like B. diporus.

CNEMIDOPHORUS GRANDENSIS, *Cope, sp. nov.*

Char. Ten series of abdominal plates; brachium plated; two frontoparietals. Green with 2–3 white longitudinal lines on each side, a row of brown spots between the two superior and above the more dorsal of the latter.

Description. The nostril is anterior to the naso-frenal suture. Infralabials four, separated from labials behind by one series flat scales (not granules), mesoptychium entire, with 3–4 rows plates, some small ones on the margin, except at middle. Supranasals in contact; also the prefrontals. Frontal single, much angulate in front. Supraorbitals four, not separated from frontals and frontoparetals by granules. Two pairs wedge shaped parietals, interparietal parallelogrammic as large as one pair. Scutellation minute, caudal scales strongly keeled. Brachials and antibrachials continuous, latter in two rows only; former continuous with postbrachials, the two forming together five rows, all smooth. Nine femoral pores. Anals continuous with abdominals, composed of one large median plate, margined laterally and behind by six plates, the two posterior marginals.

Coloration.—The inferior lateral pale line is interrupted aud not well marked; sides pale green, between and above the superior lateral lines, brown; median dorsal line bright green. Nineteen brown spots between nape and rump above upper line, those below rather fewer. Femur with two pale streaks behind, tibia and fore-arm spotted in front. Belly and throat uniform yellow.

Habitat. The Rio Grande, Brazil, brought by Capt. George Harrington, and presented to the Essex Institute, Salem, Mass., (No. 388,) Museum Academy Natural Sciences, Philadelphia.

This species only resembles the C. murinus, D. B., and the C. heterolepis, Tschudi in the increased number of its abdominal shields. In C. murinus the brachium is altogether granular, while the C. heterolepis differs in having but one frontoparietal plate, and only two parietals, with frontoparietal smaller than either. It is from Peru.

On account of the united frontoparietal shields I refer C. hyperythrus, Cope as type, and C. heterolepis, Tschudi, as second species of a genus different from the present, under the name of VERTICARIA.

Measurements of C. grandensis.*

Total length..........	0m 19.2	Fore limb.............	0m 02
" to vent..........	0m 06.5	Hind "	0m 036
" to collar........	0m 01.9	" foot.............	0m 2

AMEIVA ANALIFERA, *Cope, sp. nov.*

Of the group of A. plei, *i. e.*, with twelve ventral series of scales, no

* In the legal measure of the United States the metre and decimal fractions.

heel spurs, and one frontal plate. The tibial shields in three rows, the outer much larger, and outer toe longer than inner. It differs from that species in having the prebrachial shield small, and in three sub-equal longitudinal rows, graduating into the large prebachials regularly, in having ten or eight regular marginal anal plates, the median pairs not abruptly larger, and in not having a series of black spots on the sides. The teeth are from the nostril posteriorly 9 canine like, and seven or eight obutuse molars, two or three posterior usually with a lateral cusp. Two median plates in front of the anals. Gular scales in a transverse band of about nine rows, larger; relatively larger also than in A. plei, also the latter has several rows of scales between the labials and infralabials; the A. analifera but one row.

Greenish yellow below, brownish olive above, with blackish cross-shades on the nape in St. Martin's specimens. Sides, groin and tail above white spotted; some white spots in rows across the rump.

	In.	Lin.
Total length (two inches of tail reproduced)	13	
End muzzle to vent	4	6
Hind limb	3	1.5
Foot	1	6
Fore limb	1	8
Head including membr. tympani	1	1.5

Several specimens in Museum Academy from the island of St. Martins, West Indies, presented by Dr. R. E. Van Rijgersma, correspondent of the Academy at that place; also one specimen from the adjacent island of St. Bartholomews, from Dr. A. H. Goës of that island. The following species were included in the collection of Dr. Rijgersma.

IGUANA NUDICOLLIS, Cuv. This species occurs also in the Swan Islands off the coast of Honduras; Museum Columbia College, New York.

ANOLIS GINGIVINUS, Cope, P. A. N. S., Philadelphia, 1864, 170.

AMIVA ANALIFERA, Cope, supra.

MABUIA AENEA, Lacep.

ALSOPHIS RIJGERSMAEI, Cope, supra.

HYLODES MARTINICENSIS, Dum. Bibr.

SCELOPORUS SINIFERUS, *Cope.*

Twenty-four transverse series of scales between interscapular region and rump. Seven longitudinal series at the latter point, ten at the former. Lateral scales large, nearly equalling the ventral, which are considerably smaller than the dorsal. All well keeled and mucronate, except the ventral, which are smooth and without mucro or emargination, except a few spinous series in front of the vent. Gular scales entire. Palms and soles strongly keeled; tail slender, its scales strongly keeled like those of the back. Male with three, female with six femoral pores. No granular space in front of shoulder, and no longitudinal folds in the same region, but a short vertical fold in which the skin is so deeply inverted as to form a deep pocket extending more than half way to the tympanum, and with some subdividing folds. No auricular scales different from the temporal; all strongly keeled.

Two pairs of supranasals, two pairs frontonasals separated by a small internasal. Frontal divided transversely and longitudinally; frontoparietals small. Parietals small, transversely divided; interparietal large, broader than long. Supraorbitals four on each side, preceded by three scales, and bounded inwardly and outwardly by much smaller scales. None striate; those on muzzle weakly one keeled.

	In.	Lin.
Total length	6	8.2
Length to vent	2	1.4
" to axilla		10.2
" to canthus oris		5.3
" hind limb	1	8.4
" " foot		10.1
" fore limb		10.6
Width head		4.8

This species is comparable to S. oligoporus, Cope, in the large scales and few femoral pores, but differs much in the division of the frontal plate, large interparietal and cervical pocket. It is considerably smaller and of different coloration.

Numerous specimens in Smithsonian collections from Francis Sumichrast, from the Pacific side of the Isthmus Tehuantepec.

LIYLA RUGULOSA, *Cope, sp. nov.* Cystignathidarum.

Prefrontal bones in close union with each other and the fronto-parietals. Vomerine teeth present; auditory apparatus well developed. Manubrium cartilaginous, xiphisternum emarginate. Toes webbed; dilatations well developed, supported by T-shaped phalanges. Abdomen nearly smooth.

This genus is very near to Hylodes,* differing almost entirely in the webbed toes. Keferstein, who has just described this genus (Archiv. f. Naturgesch, 1868, 926), in consequence of his adhesion to the system of Günther, has attained to a very confused idea of its affinities.

Character Specificus.—Head broad, body short; heel extends to end of muzzle. Vomerine teeth in two approximated fasciculi, much behind the posterior line of the nares. Choanae half the size of the ostia pharyngea. Tongue oval, one-fourth free, openly emarginate behind. Tympanum nearly as large as orbit. Skin thin, with sundry rugosites on the sides of the dorsal region. Muzzle acuminate, not projecting; nostrils nearly terminal. Canthus rostralis well marked, lores slightly concave; front a little convex. Tarsal fold slight, metatarsal tubercle one inner. Solar web to the middle of the first (proximal) phalange on the first and fifth digits; to the base of the same on the others. Third

* Lithodytes rhodopis, Cope, Pr. A. N. Sci., Phil., 1866, 323 is *Hylodes sallœi*, Gthr. P. Z. S. Lond., 1868.

digit very elongate. Anterior toes free; lengths 2-4-1-3. A weak discoid abdominal dermal fold. Abdomen very obscurely areolate, medially nearly smooth.

Color blackish-brown above, sometimes with pale vertebral streak. Femora not marked behind; above with three oval brown areas enclosed by light lines. A black band between orbits. A dark band from orbit to nostril, and thence to lip; two similar bands from orbit to lip. Below unspotted white, except gular region, which is brown.

Length head and body	0m. .037
" " to posterior line tympanum	.014
Width " at canthus oris	.0145
Orbit to end muzzle	.0049
Length fore limb	.0215
" " foot	.0105
" hind foot minus tarsus	.0185
" " limb	.064

Habitat. Two specimens of this new form were sent to the Smithsonian Institution by Dr. Francis Sumichrast from the Pacific region of the isthmus of Tehuantepec, Mexico.

The collection sent from this locality embraced the following thirty-six species.

CROCODILIA.

Crocodilus americanus, Seba; various large specimens, which display the most remarkable variations in the number and position of the osseous scuta. They exhibit from two to four nuchal scuta, and from two to five cervical. In several specimens scuta of the external dorsal series meet on the median line, excluding the inner pair entirely.

TESTUDINATA.

Chelopus rubidus, Cope Supra.

LACERTILIA.

Heloderma horridum, Wiegmann.

Cnemidophorus, sp.

Uta bicarinata, *Phymatolepis bicarnatus* Duméril.

Sceloporus siniferus, Cope.

Sceloporus variabilis, Wiegmann.

Cyclura (*Ctenosaura*) quinquecarinata, *Enyaliosaurus quin.* Gray. Catalogue of Sauria in Brit. Mus. This region is the undoubted home of this hitherto rare species, as Sumichrast finds it in abundance. Gray was unable to assign its habitat.

Cyclura (*Ctenosaura*) acanthura, Wiegm.

Iguana rhinolopha, Saur. Probably only a variety of I. tuberculata.

Oligosoma gemmingeri, Cope.

Phyllodactytus tuberculatus, Wiegmann.

OPHIDIA.

Stenostoma.

Ogmius varians. *Oxyrhina varians* Jan. This genus is strongly glyphodont like Stenorhina. Prof. Jan considered it is isodont. His name *Oxyrhina* has been used variously before, on which account I propose the name above given. For a synopsis of genera allied to Ogmius. See Silliman's Journ. Sci. Arts, 1864, 457.

Stenorhina ventralis, D. B. A form with series of dots on the scales, confirming the identity of the lined var. freminvillei with the species.

Ophibolus polyzonus, Cope.

Coniophanes piceivittis, Cope.

Conophis vitattus, Peters.

Tomodon nasutus, Cope.

Oxyrhopus clelia, Linn.

Leptodira mystacina, Cope.

Leptodira annulata, Linn.

Trimorphodon biscutatus, D. B (Dipsas).

Trimorphodon tau, Cope, supra.

Symphimus leucostomus, Cope, supra.

Masticophis margaritiferus, Schl.

Oxybelis acuminatus, Wied.

Elaps aglaeope, Cope.

Ancistrodon bilineatus, Gthr.

Bothriechis brachystoma, Cope.

BATRACHIA.

Liyla rugulosa, Cope.

Cystignathus melanonotus, Hallow.

Cystignathus gracilis, *D. B.* Not distinguishable from specimens in the Mus. Compar. Zoology from Uruguay, except in less depressed extremity of the muzzle. The same species from Vera Cruz.

Scytopis allenii, *Cope.*

Fingers free and teeth in fasciculi between nares and otherwise generally as in P. xsignatus; but the muzzle is broadly rounded, there is a black band from eye to middle of sides, followed by numerous large black spots on yellow ground; femora not cross-barred above, with large light spots on black ground.

The black scapular bars of this species are broad, and are not angulated and converging as in S. xsignatus, but are parallel; two black bars on sacral region diverge towards the groin. There are several black spots in the axilla, and longitudinal black line on front and back of humerus and three on front and under side of humerus. Tibiac vermiculated on under surface above with an incomplete outlining of cross bars. Teeth between nares. Proportions of limbs generally as in the common variety of S. xsignatus; head equal foot beyond tarsus less the last phalange and two-thirds the tibia; foot 1.5 head and body. Orbit equal muzzle to beyond nares; belly immaculate, throat smooth. Heel nearly to nares. Length head and body 15.25 lines.

Habitat. Para Brazil. One specimen, No. 473 Mus. Comp. Zoology, Cambridge, Mass. Pebas Equador, Prof. Orton. Named for my friend, Prof. Harrison Allen, of the Pennsylvania University.

HYLA PULCHRILINEATA, *Cope.*

Form that of H. arborea. Fingers free, toes webbed to the base of the penultimate phalange. Dilatations well developed. Vomerine teeth in a single transverse series opposite the posterior margin of the internal nares; the latter much larger than the ostia pharyngea. Tongue slightly free behind. Canthus rostralis distinct, lores concave. Eyes large, prominent; membranum tympani one-fourth their size. The skin is smooth above, and the areolae of the abdomen are unusually weakly developed. No dermal appendages to the limbs or body. The extended hind limb brings the heel to the front of the orbit.

	mm.
Length total axial	38.
" to eye not axial	58.
" to posterior margin tympanum	11.7
" fore limb	22.8
" hind limb	58.5
" foot	24.5
" tarsus	12.
Width at canthus oris	12.4

Ground color above pale ashy brown. A strong citron yellow band passes round the muzzle, below the tympanum, and along the side to the groin. On the side it is wider, slightly undulating, and bordered above and below with slate color, which forms a pale blotch below it on the groin. A narrow unmargined, bright citron yellow line extends from the end of the muzzle to the vent, medially; and a similar one passes above the canthus rostralis and orbits along a line equidistant between the vertebral and lateral lines, joining the latter at the groin. The femora are finely yellow above and behind, and a yellow longitudinal line marks the tibia on both the inner and outer sides. The pigment of the metatarsus does not extend on the outer digit.

This pretty and uniquely marked species was brought by William M. Gabb, member of the Academy and Chief of the Geological Survey of the Island of San Domingo, from the eastern part of that island. The thumb can be opposed to the fingers as in the species formerly referred to *Litoria.** The sacral diapophyses are narrower than usual in the genus. The fronto-

*Two species were described by Dumeril as L. marmorata and L. punctata, from Australia. On the union of these with Hyla, I changed their names to H. thyposticta and H. dimolops respectively (Journ. A. N. Sci., 1866, p. 85), as there were Hylae already described under those names.

parietal bones are more extensively ossified than in most species of Hyla, and constitute an approach to Scytopis,* Cope. The species is the first true Hyla discovered in the West Indian subregion.

The species brought by this naturalist from the same locality are :—

Dromicus parvifrons, Cope.

Uromacer catesbyii, D. B.

Amphisbaena innocens, Weinl.

Anolis semilineatus, Cope.

Anolis cœlestinus, Cope.

Anolis distichus, Cope. *A. dominicensis* Lütk. is a variety of this species.)

Anolis cybotes, Cope. *A. rüsei* Reinht. and Lütk.

Trachycephalus marmoratus, D. B. var.

Hyla pulchrilineata, Cope.

Lithodytes ricordii, Dum. Bibr.

It may be mentioned in this connection that a valuable catalogue of West Indian Reptiles and Batrachia was issued by Reinhardt and Lütken in 1863 in the Naturalist. Foren. Vidensk. Meddel. Kjobenhavn. A few *doubles emplois* occur in its pages, as follows. Their *Anolis trinitatis* I think is a variety of A. alligator, D. B. Numerous specimens are in Mus. Smithsonian. *Amphisbaena antillensis*, Rhdt. and Lütk. is Diphalus fenestratus, Cope. *Liophis Andreae*, R. & L., is the young of Dromicus fugitivus, Donnd. *Hylodes riseii*, R. & L., is Lithodytes lentus, Cope, and H. *antillensis* is H. auriculatus, Cope. Though this paper of the Danish naturalists was read one month before that of the writer, in which these Hylodes were described, it was evidently published much later, as they quote in it a paper of the writer's, which was not issued till 1863.

Among West Indian Anoles it is to be added, that the A. grahami Gray is established on a young A. iodurus, and that A. porcatus is A. principalis; also that A. stenodactylus is not a valid species.

HYLA POLYTAENIA, Cope.

Hyla rubicundula, "Reinhdt. & Lütk." Günther P. Z. Soc. Lond., 1868, 489, Tab. X, fig. 3, nec. Reinh. et Lütk.

Fingers one-third palmate; toes only palmate to the extremity of the basal phalange of the longest toe. No dermal margins on body or limbs. Tongue entirely attached behind. Vomerine teeth in short transverse fasciculi entirely behind the line of the posterior margin of the inner nares. Choanae smaller than nares. Tympanum less than one-fourth eye. Skin above everywhere smooth. Digital dilations moderate; eye large; head wide; muzzle short; loveal region concave.

* Four species of this genus are enumerated in my genera of Arcifera (Journ. Acad. 1866) but were not named. They are S. venulosus (Hyla Daudin); S. acuminata (Hyla Cope); S. allenii Cope and S. ruber (Hyla Daudin).

		Inches.
Length from end muzzle to orbit		.20
" " "	behind tympanum	.40
" " "	veub (oxial)	1.30
"	of fore limb	.90
"	of hind limb	2.00
"	of foot	.90
"	of harsus	.56
Diameter eye		.39
Width head behind		.41

The pigment of the upper surfaces extends to near the edge of the lip and in a band on humerus and femur, covering three outer fingers, an outer metatarsus and two outer toes. A grey-brown band extends along the border of the lip above the axilla to the groin ; a second and wider extends from the nares through eye and tympanum to groin. In our specimen the reddish-cream color of the dorsal region is marked with indistinct dap ; in a second, with nine longitudinal grey-brown lines, of which a vertebral, and one from above the lores and over each orbit to groin are band-like. In both, a similar band bounds the antebrachium, tibia and metatarsus, and the posterior margin of the pigment on the femur. In the lined specimen there are additional lines on the lips humerus and femur.

This species has the opposable thumb and slight palmation of some of the Hylae referred to Litoria. It is in general allied to H. palliata, but has the toes much less palmate, and the vomerine teeth more posterior.

This species is figured by Günther as the H. rubicundula of Rhdt. & Lütk. as above. It is however not that species, which differs according to the original description in Danish, in first, having the vomerine teeth between the nares: second, in having the tongue half free; third, the palmation of the feet extends over one phalange more, and fourth, that of the fingers is better developed.

From Brazil ; collected by G. Sceva, of the Thayer expedition to that country, under Prof. Agassiz. No. 906 Mus. Comparative Zoology, Cambridge.

STEREOCYCLOPS INCRASSATUS, *Cope, sp. et. gen. nov. Phryniscidarum.*

Char. gen. Of section I. of Phryniscidae with Hypopachus and Calophrynus. The prefrontals are fully developed and form a continuum with each other and with the fronto parietals. Tongue large. Membranum tympani thin, concealed. No dorsal or parotoid gland ; no metatarsal shovel. Coccyx united by two condyles. Xiphisternum cartilaginous, much dilated and entirely in contact with the coracoids. Anterior portion of the sclerotica ossified, so as to form a hard annulus round the cornea. Pupil round. Toes free.

Char. Spec. The whole form is much depressed, and the physiognomy approaches Pipa. The cranial box partakes of this and presents a strong median longitudinal crest. Tongue large ; equal inner nares. A short frenum across the palate behind. The vomer is cartilaginous between the nares, except on axis. Gape large, the muzzle projecting slightly beyond it. No canthus rostralis, nostrils latero-superior. Limbs short, humerus and femur included in the skin. Toes very unequal, the inner and outer very short; related thus, 1-2-5-3-4. An obtuse tubercle at the base of the outer toe. The epidermis is everywhere thickened by a chitin-like deposit, which is readily cracked. It is thickest on the soles, the tarsi, and the gular region.

Color everywhere leather-brown ; a narrow white line from end of muzzle to vent.

	MM.
Length of head and body	.057
" " hind limb from knee	.0495
" " tarsus	.009
" " remainder of foot	.0245
" " fore limb from elbow	.0200
Width between angles mandible	.020
" " orbits	.009
" " nostrils	.004

Found near Sao Matheos, south of Rio de Janeiro, by Messrs. Hartt and Copeland, of the Thayer Expedition to Brazil, Mus. Comparative Zoology, Cambridge, Mass., No. 855.

This is a remarkable type, with a certain resemblance to Engystoma. It is the first type among the Raniformia which betrays even a remote resemblance to Pipa.

Hypopachus inguinalis, *Cope, sp. nov.*

This species is of about the same size as the H. variolosus Cope, and like it has the toes partially webbed at the base. It differs by many marked characters throughout.

Muzzle rounded conic, projecting beyond lip; nostrils superolateral. Width of head behind orbits, double length to opposite the same point. A groove from orbit to humerus. Diameter of former equal length of muzzle from the same. Mandible with symphyseal knob little marked ; gular slits large ; tongue flat, ovate, largely free and thin behind, without free border in front. Nares large, double the small ostia pharyngea. Two metacarpal tubercles close together ; fingers slender, with subarticular knobs. The metatarsal tubercles with cutting edges in nearly the same line without blackening of the sheath, the inner the longer. No tarsal fold. Skin everywhere smooth, except some minute pappillae on the sacro-coccygeal region.

Coloration. Above a pinkish leaden, with a more or less indistinct narrow vertebral line from the end of the muzzle. A large and a small black spot on the groin and one on the knee. A large black spot on the scapula ; a pair of blackish lines which converge from the orbits to the inter-scapular region, then diverge and form an imperfect circle on the middle of the back. Sides of head blackish ; a yellow bar from orbit to humerus. A black bar across closed femur and tibia above. The femur is a strong pink, and is sometimes spotted behind and sometimes not. Belly with delicate reticulate brown lines on yellow ground, sometimes obsolete. Total length, 04″ 4‴; do. to orbit behind, 8‴. Fore limb, 02″ 2‴; hand, 01″. Hind limb, 04″ 1‴; harsus, 9‴. Entire foot, 02″ 03‴.5.

Habitat. Vera Paz, near the ruins of Coban. Sent to the Smithsonian Institution by Henry Hague. This gentleman has made highly interesting observations on and contributions to the Natural History of that once populous, but now almost unknown region, which have been communicated to the Smithsonian Institution.

The known species of this genus is Hypopachus variolosus Cope (*H. seebachii* Keferstein Göttingen, Nachrichten, 1867, 352. Archiv. f. Naturgesch, 1868, 293, tab. IX., f. 1, 2. *Engystoma variolosum* Cope. Proceed. Acad. Nat. Sci., Phila., 1866. *Systoma* do. Journ. A. N. Sci., 1867, 194,) which is found in Costa Rica. Keferstein well separates this species from Systoma on account of its claviculus, though it is not certain that it is not Copea Steindachner. In an essay on Costa Rican Batrachia this author enumerates eight species. Of these it may be remarked that *Bufo sternosignatus* Günther has been described by an older author under a prior name. *Oedipina uniformis* Kef. is an interesting Plethodont salamander, apparently the same as the *Opheobatrachus vermicularis* of Gray. No generic characters are given which are not possessed by species of Oedipus. I may mention here that I have hitherto regarded the latter genus as identical with Geotrition, and no author has presented characters by which to distinguish them. I find, however, that the European genus possesses two premaxillaries, the American one; on this ground they may be separated. In the same way Spelerpes pophyriticus (vel *salmoneus*) has two premaxillaries, and all the Spelerpes proper but one. I therefore refer the first to a new genus under the name of Gyrinophilus.

RANULA AFFINIS, *Peters, Cope.*

This species is extensively distributed. We have it from Pebas, Equador, Coban Guatemala, and the Rio Verde, Tehuantepec, Mexico. Günther, after examination of this frog, says (Zoological Record, 1868,) that it is "Hyloid," an expression we fail to comprehend, as he certainly cannot mean that it bears any relationship to Hyla.

The digital relations, if such they can be called, are not larger than in the Rana sylvatica, which has just passed its metamorphoses. It is in fact most closely allied to the group of Rana to which R. temporaria belongs, as already perceived by Peters, who calls it *affinis* on this account. Like it, it possesses a dorso-lateral dermal fold, as is common in Hylorana.

Steindachner proposes to united Hylorana and Polypedates. On this Günther remarks that this herpetologist could not have devoted much study to them, as they differ in the presence and absence of this dorso-lateral dermal fold respectively. Günther's criticism, however, like most of those which he too frequently directs at the labors of his fellow-students, is really applicable to himself.

So far as the "Catalogue of Batrachia Salientia in the British Museum" is concerned, no characters to distinguish them can be found. But I pointed out, some years ago, that the difference consisted mainly in the structures of the distal phalanges characteristic of each : also that Hylorana is much nearer to Rana, and is only to be distinguished from it generically, without the interposition of any possible form which would not unite them. The T-shaped phalange in some Hyloranae is so weak, while the expansion of the tip of the same in Rana temporaria and others, is so distinct, as to render the permanent distinction of the two genera a mere matter of future discovery.

LIMNOMEDUSA MACROGLOSSA, *D. B.*

Having had an opportunity of examining the sternum of this species for the first time, I find that it possesses the styloid xiphisternum which I have indicated as characteristic of the typical group Cystignathi of the family Cystignathidæ, and it must therefore be referred to the neighborhood of Cystignathus. Besides other points, Limnomedusa, Cope, is distinguished from Cystignathus by the vertical pupil.

Keferstein states that I erroneously ascribe an osseous stylus of the xiphisternum to the genus Borborocaetes Bell. The facts are as follows : This genus was distributed by Günther in the Catal. Bat. Sal. Brit. Mus. in two widely different groups, Cystignathus, and one he called *Limnodynastes.* I first pointed out* that this series of species differed radically from Cystignathus and its allies, in the *scutiform cartilaginous* xiphisternum, and also in the large cranial frontanelle.

Up to that time the Australian species called *Limnodynastes* had never been received other than specific characters, as that by which it was stated by Günther to differ from Cystignathus, viz., the transverse extension of the series of vomerine teeth, is one included in the range of many well-known genera, as Rana, Lithodytes, and Cystignathus itself. The South American species named by Bell long previously, Borborocaetes, differ only from those of Australia in the shortening of these series, and not more than Cystignathus taeniatus does from C. albilabris.

GOMPHOBATES BILIGONIGERUS, Cope.

Gomphobates notatus, Reinhdt. and Lütken, Vid. Medd. Copenhagen, 1861, 33 Tab. IV, f. 3. *Liuperus biligonigerus,* Cope, Proc. Ac. N. Sci., Phila., 1860, 517. Uraguay.

EUSOPHUS NEBULOSUS *Cope, Cystignathus nebulosus Girard.* It is probable that the Cystignathid described by Günther, P. Z. S., Lond., 1868, 482, as *Cacotus maculatus,* is a variety of this species. It agrees in all respects except in having a black suborbital spot, and line on the canthus rostralis, which Girard's types do not exhibit. Günther places it among his Bombinatorina. It is scarcely necessary to observe that it has not the least affinity to Bombinator.

* Nat. Hist., Review 1865.

APPENDIX.

ZONURUS TROPIDOSTERNUM, *Cope, sp. nov.*

Char. Scales $\frac{12}{14}$=16, lateral ventral, pectoral and gular keeled, the dorsal keeled and very rugose. Caudal scales trihedral spine-like. Internasal reaching rostral. Dark-brown, yellow below.

Descr. This species belongs to the typical group and is near the Z. griseus of the Cape, but differs in many characters. The rostral is in contact with the internasal, which is much longer than wide, and of course separates entirely the supranasals. It is well separated from the frontal by the frontonasals. The other head plates are similar, except that there are six rows of temporals, the longest seven deep ; those of the Z. griseus are much larger, including the two marginal auriculars, which are rudimental in the new species. All the plates of the head are excessively rugose, with longitudinal striae. Upper labials six, the fifth not more elevated than the others ; inferiors, six ; infra-labials, five ; all in contact, and without larger scales within them. Gular scales in 22 series from angles of mandible ; those of the neck abruptly larger, mucronate, forming a rudimental collar. Median ventrals nearly smooth, laterals mucronate keeled. No lateral fold ; lateral scales increasing regularly in size from the ventrals, sub-round, widely separated from each other by minutely granular intervals, strongly muconate keeled. Dorsal scales in 24 series from nape to opposite femur, all strongly mucronate keeled, and rugose ; the median series like the others. Caudal whorls very spinous, the scales not serrate, but striate on the surface. Femoral pores, seven on each side ; preanal plates small, equal, except two marginal a little longer.

Muzzle to vent	0 m 09′′ 2′′′	Width head...	0 m	.02′′
" " ear.......	04′′ 4′′′	Hind limb.....	"	04′′ .2′′
Fore limb..........	3′′ 2′′′	" foot.....	"	02′′

Color. Below and upper lip to ear, yellow ; above rich brown, with several indistinct blackish cross-shades, head above, wood brown.

Habitat. Madagascar, Mus. Essex Institute, No. 500.

EXPLANATION OF PLATES.

PLATE IX.

Claudius angustatus, Cope. Yucatan, Mus. Smithsonian, Proc. A. N. Sci., Phila., 1865. This plate with the others presented to the author by Joseph Jeanes.

PLATE X.

Cachryx defensor, Cope, Proc. A. N. S., Phila., 1866, 124. Yucatan, Mus. Smithsonian.

PLATE XI.

Laemanctus alticoronatus, Cope l. c. 124. Mus. Smithsonian, Yucatan.

To Brevet Major-General A. A. Humphreys,
Chief of Engineers U. S. Army.

Sir—At a recent meeting of the American Philosophical Society it was stated by one of the members that there remained on file in the Engineer Bureau, U. S. A., several reports of explorations in the Territories of the United States, awaiting the necessary funds for publication.

The Secretaries of the Society were thereupon directed to address you on the importance of rendering the scientific parts of the reports, and more especially those relating to the geology of the regions traversed, accessible to the public, with as little delay as possible.

The American Philosophical Society, ever mindful of the object of its organization, "for promoting useful knowledge," feels particular solicitude in everything that concerns the great mineral resources of the interior of the continent, called by President Grant the strong box of the nation, and knowing that the geological explorations referred to have been made by men eminent in science, and deserving of the confidence of the community, is anxious that the results of their labor, acquired at great cost to the government, shall not be superseded, or the wise cautions contained therein rendered nugatory, by explorations conducted in the interests of private speculations.

The liberal appropriation granted by the last Congress to the geological survey of Nevada and Utah under Clarence King, Esq., has caused the Society to hope that an application for the means to publish the scientific results already obtained, and now on file, may not be without success.

In conclusion, we would add that the present communication, as directed by the Society, is intended for use, at such time and in such manner as you may think most proper for carrying out the object desired, and to aid you, so far as lies in the power of the Society, in rendering assistance, as you have heretofore done, to the great scientific and industrial interests of our country.

Signed, Charles B. Trego, E. Otis Kendall, John L. Leconte, J. P. Lesley, Secretaries American Philosophical Society.

Office of the Chief of Engineers,
Washington, D. C., July 8, 1869.

Gentlemen—Your letter of the 26th ultimo, respecting the publication of Reports of Explorations, affords me great satisfaction, since it informs me of the powerful aid of the American Philosophical Society in securing authority to complete some of the chief objects of the explorations of our Territories by disseminating the information obtained as to their resources and the means for their development.

It gives me pleasure to state that the Secretary of War has sanctioned the publication of the Report on Geology, by Dr. Hayden, in connection with the exploration of the Yellowstone and Missouri rivers, and that it is now in the hands of the printer, and will soon be ready for distribution.

The results of Mr. Clarence King's surveys in Utah and Nevada, will be published as soon as they are prepared, Congress having made provision for it. The Report of Captain, now Brevet Brig. Gen. J. H. Simpson, has not been printed. It is hoped, however, that authority for the publication of the scientific portions at least will be given, and to this end your letter will afford valuable aid.

There are no other reports of explorations on the files of this office.

Cordially thanking the Society for its support, I have the honor to be, very respectfully, your obedient servant,

A. A. Humphreys,
Brig. Gen. and Chief Engineer.

Synopsis of the Extinct Mammalia of the Cave formations in the United States, with observations on some Myriapoda found in and near the same, and on some Extinct Mammals of the caves of Anguilla, W. I., and of other localities.

By Edward D. Cope.

The following list is published in consequence of the discovery by the writer of a number of species of Mammalia in a cave breccia in Virginia. As the number of species previously described as having been found in similar situations is but small, they have been added. I have not inserted the extra-cave species of the beds known as Champlain, since it is not certain that they represent parts of the same fauna, though it is highly probable that they do. The coexistence of a number of species apparently still living on our territory, with some restricted to South America, and with others entirely extinct, is a point of considerable interest. The cotemporaneity of man with the Mastodon on this continent is not a matter of doubt*; and the coexistence of the Mastodon and recent peccary D. torquatus, and the extinct D. compressus is equally certain. These species were cotemporaneous at Galena, with a fauna quite similar to that which I found in Virginia.

The cave breccia consists, in the localities where examined by me, of a number of irregular masses, occupying depressions and short galleries, in the southeast side of a line of hills in Wythe County, Virginia. When these masses are excavated from their beds the floor and roof of a portion of a cave is exposed, with the stalactites, stalagmites, and usual incrustations. Sometimes the termini of the masses could not be reached, and they wound about between large blocks of limestone which once, no doubt, had lain on the floor of a subterranean chamber.

The teeth and bones were discovered at three different points; two of them near together, on the property of Abraham Painter, and the third about three miles on the same side of the same ridge. The Kanawha (New) River cuts the hill at the latter point, and on the side of a bluff the cavity occurred, containing Castor, Dicotyles, etc. On the other side of the same ridge, three miles further in the same direction, I examined several similar cavities of breccia, but could find no organic remains, while Abraham Painter, an old resident and careful observer, informed me that the deposit could be found on the hill side, in continuation of those on his property, for a distance of two miles in the opposite direction.

The limestone of this ridge abounds in the Carbonates of Lead and Zinc, and there can be little doubt that they predispose the rock to easy decomposition. It is also probable that, as Lesley shows, the decomposition has been followed by the successive deposit, as a precipitate of the more insoluble Silicates of those metals. This is rendered highly probable by the mode in which the silicates occur with reference to the carbonates. While the latter are distributed through the limestone rock

* See Leidy, Nott and Gliddon Indigenous Races of the Earth, p. xviii.

in place, the former occupy irregular pockets, caverns and veins. They occur as incrustations, sometimes tubular and of singular tenuity, as well as in masses.

The breccia caverns no doubt had their origin in the same way. The ready decomposition of the limestone has permitted them to be rapidly formed and filled again.

It is interesting to note that the only similar bone deposits occur in the galena bearing Hill Limestone of Illinois. These have been described by Drs. Leconte and Leidy, and their species are included in the present list.

MEGALONYX JEFFERSONII *Harlan*. Fragments of teeth. Found also in caves in Tennessee, Georgia and Alabama.

STEREODECTES TORTUS, *Cope, gen. et. sp. nov.*

This animal is represented by a nearly perfect upper incisor tooth, and fragments of numerous others. It appears to be a rodent, and the tooth in question presents several points of resemblance to that of Arctomys monax, from which it does not differ much in size. The characters which determine its distinction from that genus are very important, and indicate widely different affinities. The central pulp cavity is exceedingly small, and the tooth for a length no doubt considerably above that of the A. monax, solid, with that exception. At the distal fractured extremity it is narrowly linear in the plane of compression of the tooth, while at the proximal fracture it is round, and of perhaps a shade greater diameter. The anterior face of the tooth is as usual, covered with an enamel layer about as thick as that in Arctomys, which extends round the outer face, covering its anterior two-fifths, and is very slightly decurved on the inner plane face. Viewed from the centre of the arc which the tooth describes, the shaft is seen to form a slight sigmoid. The posterior narrowed margin forms a still stronger sigmoid, throwing the extremities of the shaft in opposite directions. I have not observed this torsion in any living genus of Rodentia, except in abnormal specimens.

The specific characters are as follows: A section of the shaft is a nearly isosceles spherical triangle. Distally the inner face is more nearly plane than the outer, while proximally the outer is the less oblique of the two. The anterior face is convex in section, and regularly continuous to the outer side. There is a slight groove below the edge of the enamel on the inner side, and a few weak transverse indications across the shank. The enamel is nearly smooth, under the microscope displaying weak, minute striae, much as in Arctomys. The arc in profile is a perfectly regular segment of a circle. The color is white, and this in a matrix where the yellow color of incisors of other Rodentia is well preserved.

	Lines.
Length of chord between outer circumference at fractured ends	16.
Long diameter proximal end	2.8
Short " " "	1.8

I am unable to throw much light on the affinities of the animal which bore these teeth. They are more compressed than in the Beaver, and deeper than in the Vischaca; they are not so narrowed anteriorly as in the agutis. The solidity is only approached by the Castorides ohiensis, and to some degree Amblyrhiza inundata, of the same period.

Castor fiber, *Linn.* *C. Canadensis, Kuhl.*

Portion of mandible with three molars, not distinguishable from recent specimens.

Neotoma magister, *Baird.* Mammals of North America, p. , tab.

Said to be larger, and otherwise different from the following. Found in the Bone Caves near Carlisle, in the great Appalachian Valley, in Pennsylvania.

Neotoma ?floridanum, *Say. et. Ord.*

A superior molar, incisors, and other portions. The first is not larger than in recent animals, and does not conform in peculiarities to those ascribed by Baird to his N. magister from the Pennsylvania Bone Caves. The latter is, however, described from mandibular pieces.

The recent Neotoma of this species is exceedingly common in all of the caves which I examined. Their marks can be found from near the mouths to the most remote recesses. They build, in dry places in the more distant chambers, nests of complete and durable construction. In such a chamber in the Hoge's Cave, Montgomery County, Va., I found a number of these nests near together and fastened by interwoven sticks and corn-husks in some mass, to the points and crevices of the rocks. The upper surface of the pile, in which the nest was made, was composed apparently of chewed linden bark, forming a soft, tough, and nearly white material. This surface was always oblique, and enclosed a round cavity, large enough to hold one's two fists, which was entered by a mouth a little more contracted than the whole diameter. Numerous fresh seeds of the Celtis pumila lay about them. They are sweet, and the small tree which produces them is abundant where the traces of the cave were found. Seeds undistinguishable from these are abundant in the limestone breccia with the remains of Neotoma, and testify to the identity of habit of this species in the days of Tapirs, Peccaries and Sloths.

Arctomys monax, *Gmel.* The Ground Hog. One nearly perfect ramus mandibuli with all teeth but the last molar, not distinguishable from recent examples.

Found also at Galena. (See Leidy, Trans. Amer. Phil. Soc., XI., p. 100.)

Arvicola, *Sp.* Noted by Leidy, l. c., from Galena, Ill.

Geomys bursarius. Leidy, l. c., p. 100.

Found at Galena by Dr. E. D. Kittoe with numerous other species enumerated by Leconte and Leidy.

Hesperomys ?leucopus, *Raf.*

Molar teeth undistinguishable from those of this common mouse.

TAMIAS LAEVIDENS, *Cope, sp. nov.*

This ground squirrel is indicated by the distal half of a mandibular ramus, with adjacent fragments, probably of maxillary and squamosal. The successional first molar appears above the alveolar border, and another tooth apparently is in place, but so encrusted with calcite, as to be quite obscured.

This species differs in three marked peculiarities from the T. striatus. The first molar has two anterior cusps instead of one ; they are separated by a deep groove ; there is also a little cusp between the external two. The incisor teeth are not striate grooved on their anterior face, as in T. striatus, though they have three narrow grooves on the outer longitudinal angle ; they are wax yellow anteriorly. Third, the ramus is more slender, especially in the portion anterior to the molars ; the depth at the mental foramen is just half the length between the first molar and the base of the incisor above. As in T. striatus, this foramen is nearer the superior outline of the ramus. There is less curvature visible in the inferior face than in some individuals of the existing species.

	Lines.
Length ramus auterior to m. 1	2.6
Depth at mental foramen	1.4
" " first tooth	1.7
Diameter incisor	1.
Depth at m. 4	2.2

SCIURUS PANOLIUS, *Cope, sp. nov.*

A small squirrel of the size of the Chipmunk (Tamias striatus), but of the type of dentition and form of the Sciurus hudsonius. It is represented by a ramus mandibuli, containing two molar teeth, and the included portion of the incisor, the coronoid, and vertical ramus being lost. Numerous fragments, including incisors, etc., are probably to be referred to this species.

The ramus is quite flat, being perfectly plane on the inner face, below the molars ; its diameter below the first is equal to that at the incisive alveolar margin above. The series of molars is very little oblique to the plane of the ramus, and, judging by the positions of the anterior three, not curved. There is, therefore, but a slight projection of the alveolar border on the inner face of the ramus. The least depth of the edentulous portion, equals the chord from the base of the first molar to the edge of incisive alveolus. The mental foramen is near the middle of this length, and a little above the middle of its depth. The anterior margin of the masseteric fossa, is below the posterior third of the first molar.

The two molars are well worn, the first being successional: the animal was therefore adult. The worn faces are concave; the inner anterior point of the margin is the most elevated, while the two external lobes are in both the most prominent. There is also a slight emargination on the inner face. The first molar is about as long as wide, the second a little wider than long, and slightly oblique forwards and inwards; the inner and outer lateral margins in each are about equal. In profile the first is slightly the more elevated of the two.

Measurements.

	Lines.
Length of ramus from maxillary foramen to incisive alveolus above	5.35
Length of bases of two anterior molars	1.39
" from base of m. 1 to do. of incisor	1.7
" " mental foramen to base of incisor	1.55
Least depth ramus (near mental foramen)	2.
Depth ramus at first tooth	2.6
" " third "	2.4
Width " second "	1.2

These indicate a much stouter form than in the Tamias striatus.* The foramen mentale is lower in position; the series of molars is much less oblique to the axis of the ramus than in the chipmunk, and the incisor tooth is stouter. As compared with the S. hudsonius the measurements are absolutely one third greater, indicating a difference in size of nearly two to one. Viewed from above the thickness of the ramus at the middle in Sc. panolius is proportionately very much less, while at the incisive margin there is less difference; the two measurements being equal in S. panolius, the incisive much narrower in Sc. hudsonius. The first molar in the existing species is narrower outside than inside and simple; in Sc. panolius, equal and emarginate.

This little species has not furnished sufficient materials to indicate its relationships fully; but it is smaller than any true squirrel now inhabiting the United States.

Lepus sylvaticus, *Bachm.*

Numerous molar and incisor teeth from both jaws, and two partially broken rami of the mandible. One of these is broken off behind the third molar; another complete only as far as the usual line of the coronoid process, and containing the second, third and fourth molars. These portions are similar to those of the common species now found throughout the eastern district of North America. Also from Galena; see Leidy l. c. XI, p. 100.

Anomodon snyderi, *Leconte.* Amer. Journ. Sci., 1848, 103. Journ. Ac. Nat. Sci., Phil., III, 171, Tab.

A large and remarkable insectivore known only as yet from an incisor tooth from Galena.

Blarina, *sp.*

A nearly complete ramus with dentition perfect, of about the size of that of the common B. talpoides was found, but unfortunately mislaid.

* See Baird. U. S Pac. R. R. Expl. VIII. Tab. XLVI. 2 and 1.

VESPERTILIO, *sp.*

Numerous bones of bats occur in the breccia. A portion of maxillary with teeth was preserved, but fractured in the attempt to expose it.

TAPIRUS HAYSII, *Leidy.*

Several inferior maxillary molars. They all have a rather greater anteroposterior diameter than those of the existing Central and South American species.

EQUUS ? COMPLICATUS, *Leidy.* *E. americanus*, Leidy.

Upper and lower milk and permanent molars.

DICOTYLES NASUTUS, *Leidy.* Proceed. Acad. Nat. Sci., Philada., 1868, Several molar and canine teeth.

DICOTYLES COMPRESSUS, *Leconte.* *Platygonus compressus*, Lec., etc. Amer. Journ. Sci., 1848, 102. *Dicotyles*, Leidy, Trans. Am. Soc., XI, p. 97, also X, 324.

Not found by me in Virginia; abundant at Galena and elsewhere.

CARIACUS VIRGINIANUS, *Gray.* *Cervus*, Bodd.

Molars and other fragments of this species are perhaps the most abundant in the breccia. One posterior portion of ramus mandibuli with tooth in situ is in the collection.

BOS ? ANTIQUUS. *Bison*, Leidy.

Molar teeth.

URSUS AMPLIDENS, *Leidy.* Proceed. Acad. Nat. Sci., 1853.

A single posterior lower molar of this species, identical with that described by Leidy from a ravine near Natchez.

URSUS AMERICANUS, *Linn.* Leidy, Journ. Ac. Nat. Sci., Phila., III, 169.

From various caves; not found by me in Virginia.

PROCYON PRISCUS, *Leconte.* Leidy, Journ. Acad. Nat. Sci., III, 169.

Perhaps the same as the next. From Galena.

PROCYON LOTOR, *Linn.*

A posterior inferior molar, not distinguishable in any point from a specimen from a New Jersey peat swamp, both identical with the common raccoon.

MIXOPHAGUS SPELAEUS.

This animal is represented by a molar tooth, which though somewhat imperfect is so characteristic as to require notice. It appears to have been derived from the lower jaw from the behind position of the sectorial. It resembles the tubercular sectorial of the bear, but is even less acutely tuberculate, and is a little smaller than the same tooth in the raccoon. The surface of the crown exhibits concavities between small pointed cusps. The outer margin is a low ridge of four cusps. In front it rises into a more elevated cusp. Here also the tooth is wider, and presents a wider plane of the crown. Part of the inner margin is here broken away, but a little behind its middle a stronger cusp rises, one-third of the width within the inner margin. The posterior margin is slightly elevated, and in front of it is another very small cusp, similar to those on the external margin.

The characters are less carnivorous than those in Ursus, and approach remotely the smoothness of Cercoleptes. There are indications of two roots, one of which is broken away. The arc of the base of the crown determines the position of this one, and of the anterior margin of the tooth. The strong anterior tubercle is slightly transverse, and the anterior face near its crest being preserved, indicates the extremity of the crown to have been but little beyond. Hence the following measurements:

	Lines.
Length to crest of transverse tubercle	3.7
Width at median outer tubercle	2.5
Depth crown between roots	1.8
Width of root	1.6

GALERA PERDICIDA,* *Cope, sp. nov.*

This is a small carnivore of the Lutrine group of the Mustelidae, apparently allied to Mephitis and Lutra. It is only represented by a left ramus of the mandible, with dentition complete. Its characters are as follows: Dentition $\frac{?}{3}$, $\frac{?}{1}$, $\frac{?}{3}$, $\frac{?}{2}$. The tubercular molar is relatively as in the allied genera, but without sharp tubercle; the sectorial characterizes the genus as distinct from the two mentioned. The posterior lobe is without the marked internal and external acute tubercle seen in Mephitis, nor the tubercular crest of Lutra, but is rounded and slightly concave. The median crests, inner and outer, are strongly developed, and with the anterior, quite as in Mephitis.

The jaw pertained to an adult individual of smaller size than the common skunk, Mephitis chinga. The bases of the crowns of the first and second premolars, and to the outer side of the canine are surrounded by a well marked cingulum. The length of the crown of the molar is greater in proportion to the length than in the skunk. The axis of the coronoid process is as in it, at right angles to that of the ramus. The latter is straighter on the inferior border than in the skunk, and exhibits a marked difference in the angle being nearly on the same line, and not raised above it, as in the species of American skunks and otters, figured by Baird.

Measurements.

	Lines.
From angle to outer incisive alveolus	15.6
Depth at coronoid	8.
From base condyle to tubercular molar	5.
Length sectorial molar	3.6
Width " "	1.2
Height from basal shoulder	2.
Depth ramus at tubercular	2.7
" " at pm. 2	3.1
Length of crown of canine	3.

* The pedant would write this *perdicicida.*

There are two mental foramina in the specimen, one below the third, the other below the first premolar. The crown of the canine is contracted and curved; slightly flattened on the inner side.

Recapitulation.

Whole number of species	27
Number extinct	14
Genera extinct	5
" of neotropical type	6

Helices are extremely abundant in the matrix, with a few other molluscs. They have been identified for me by my friend, Geo. W. Tryon, as follows:—

Mesodon dentiferus, Binney.
" major, Binn.
" albolabris, Say.
Xolotrema appressa, Say.
Xolotrema palliata, Say.
Stenotrema sp. near hirsuta.
Anculotus carinatus.

Associated were numerous vertebræ of Crotalus and perhaps Tropidonotus, fragments of Trionyx and Cistudo, and Menopoma. Also fragments of a Unio, and the ungueal phalange of a bird of prey. There were no human remains of any kind discovered in the breccia.

A collection of fossils of similar character to the preceding, was obtained by Dr. Samuel Harrison of Easton, Talbot co., Maryland, and is preserved in the cabinet of the Baltimore Academy of Natural Sciences. The specimens were exhumed in the course of excavating for marl on the farm of Lambert Kirby, in Oxford Neck, Talbot County. They consist of a considerable number of fragments of the Elephas americanus, Leidy, with two molars, the tusks, and maxillary, premaxillary and parts of frontal bones. Fragments including parts of antlers, not distinguishable from Cervus canadensis, and Cariacus virginianus; the humerus of a Chelydra not distinguishable from that of C. serpentina and of the largest size the species is known to attain; and a portion of the margin with posterior costal and vertebral bone of Cistudo eurypygia Cope, sp. nov. A molar tooth accompanied the above, which resembles that of the half grown Elephas primigenius or E. columbi, but has not the lateral curvature of the latter.

In the earth on the floors of the caves which abound in the lime-stone region of South Western Virginia, the remains of the existing Mammalia of the country may always be found. I have procured Lynx, Vulpes, Procyon, Cariacus, Didelphys, etc. In one chamber the fresh food, apparently of a raccoon, was found, consisting of fresh hazel nuts, wild plum, choke cherry, chicken grapes, acorn, etc. In many, human remains occur, with beads, needles of bone, etc.

In Erhardt's Cave, Montgomery County, Virginia, the writer found four or five specimens of a new Anophthalmus, the A. pusio of Horn, at a distance of not more than three hundred feet from its mouth. The species is small, and all were found together under a stone. Their movements were slow, in considerable contrast to the activity of ordinary Carabidæ.

Myriapoda are the only articulates which can be readily found in the remote regions of the caves, and they are not very common in a living state. I append a list of these, with their congeners of the outer world, which I collected in the mountainous region. Many of them have been kindly named for one by my friend Dr. H. C. Wood, the author of the Monograph on the American species.

SCOLOPENDRIDÆ.

OPISTHEMEGA POSTICA, Wood, Journ. Acad. Nat. Sci.

This species, or a variety of it with the posterior pair of limbs considerably stouter than the specimens from North Carolina, described and figured by Wood, is one of the most abundant species in the mountains of southwestern Virginia. It occurs every where under stones, etc., and is very active. Its great peculiarity is the modification of the posterior pair of limbs into a pair of stout jaw-like members, which like the anterior jaws are used in offence and defense. They seize the finger with them easily, and penetrate the skin with their sharp chitinous points, though not as effectively as with the jaws. Thus armed at both extremities, they are even less pleasantly handled than the Scolopocryptops sexspinosa, which is also common in the same country. An undescribed Scolopocryptops, with a green body and reddish head, is also common.

LYSIOPETALIDÆ. *Wood, defin.*

The genera of this family appear to the writer to be two, defined as follows:

Annuli without pores. SPIROSTREPHON.

Annuli with two pores on each side the median line. PSEUDOTREMIA G. N.

SPIROSTREPHON LACTARIUS, Brandt, Wood Monograph Myriapoda N. A., 192, *Julis lactarius*, Say.

Not uncommon.

PSEUDOTREMIA CAVERNARUM, *Cope, sp. nov.*

This animal inhabits the deepest recesses of the numerous caves which abound in Southern Virginia, as far as human steps can penetrate. I have not seen it near their mouths, though its eyes are not undeveloped, or smaller than those of many living in the forest. Judging from its remains, which one finds under stones, it is an abundant species, though rarely seen by the dim light of a candle even after considerable search. Five specimens only were procured from about a dozen caves.

Segments twenty-nine, without dorsal keel or groove, but quite convex in antero-posterior section, and somewhat swollen at a dorso-lateral point, forming a slight shoulder and slightly quadrate transverse section. The shoulder becomes much stronger on a few anterior segments. Surface of the annulus rugose, above most so on the shoulders; laterally to the legs longitudinally (with the axis) coarsely many striate. Posterior annuli but slightly compressed, the last unarmed. Diameter of anterior segments rapidly decreasing to the head. Lateral pores not distinct on anterior segments. An impressed line crosses the latter at the inner lateral pore. Basilar segment smooth, not emarginate in front. Front sparsely hairy ; lateral region rather prolonged, openly emarginate. The antennæ as in the other known American species of this family, are elongate and hairy, the relative lengths of the joints being : third longest, 3, 5, 4, 2, 7, 8, 1. Eyes in well developed triangular patches in depressions behind the antennæ.

Length 11 lines ; diameter 1.1 line ; segments of specimens of considerably larger size, while two taken in copulâ were rather smaller. Color varying from a nearly white to a pale red.

Taken in Erhart's Cave, Montgomery Co., and Spruce Run and Big Stony Creek caves, in Giles Co.

Pseudotremia vudii, *Cope, sp. nov.*

This species differs much from the last, and resembles rather P. caesioannulatus of Wood. The points separating it from the latter will be pointed out below.

Number of segments same as in the B. cavernarum, twenty-nine, but they are neither convex nor rugose nor coarsely striate, but marked with a very minute, irregular longitudinal striation. Segments cylindric, without shoulder, but with a small point directed backwards on the posterior margin of the lower part of the annulus, which is enlarged on the front segments. This elevation is furnished on the anterior and posterior regions, and probably everywhere, in an uninjured condition, with a bristle. On the anterior segments a hair in front of each pore. Front plane, with finer and coarser hairs sparsely distributed. Labral margin with an open notch. Antennæ hairy, with a bristle at the distal extremity of each joint. Lengths, 3rd, 5th, 4th, 2nd, 8th, 7th, 1st ; the eighth joint longer than in A. cavernarum. Eye patch triangular, not in a depression. Posterior segments considerably compressed, the last scutum with four transparent marginal bristles ; extremity of body slightly recurved. Total length, eleven lines.

Color pinkish-brown, with a pale band from below to the external pore on each side of each annulus. Top of head black.

A single specimen, the exact locality not preserved, but probably Montgomery Co., and, I think, not from a cave. I have conferred on it the name of my friend Dr. H. C. Wood, Jr., to whom we are indebted for a system of the Myriapoda, and the means of studying the American species. It differs from the A. caesioannulatus of his monograph, in the rounded dorsum without keel or groove, the 29 instead of 32 segments, and the coloration. The eye patches are not in a depression, nor is the labrum deeply emarginate, as Wood describes.

JULIDAE.

SPIROBOLUS AGILIS, *Cope, sp. nov.*

This is the pigmy of the genus, and is not less distinguished by the small number of its segments, and the greater activity of its movements. The short antennae, and anteriorly produced second segment, are precisely those of other species of the genus.

Segments thirty-eight, smooth above, but with delicate, irregular longitudinal striae below. Front higher than wide, smooth, not punctate, but with a faint trace of median groove. Two rows of hairs on and above the labral margin. Bristles of the legs weak. Preanal plate transverse narrow elliptic. Antennæ sparsely hairy. Total length, eight lines. Color, wood-brown, with a reddish posterior marginal band to each segment; front and antennæ pink.

Giles County, Va.

CAMBALA ANNULATA Cope, *Julus annulatus* Say, J. A. N. S., 1st, II., 103. *Spirostrephon* Newport, Wood. ? "*Julus lactarius* Say" Gray et Newport not of Say. *Cambala lactaria* Gray and Newport.

Gervais and Wood have pointed out the error of Gray and Newport in regarding this animal as the the *J. lactarius* Say, but have not suspected that it is the *J. annulatus* of the same author. The species is quite rare, as I have seen but one specimen, which I took in the Spruce Run Cave on the Kanawha River, in Giles Co., Va. It has considerable superficial resemblance to the *Spirostrephon lactarius*, and is one of our most elegant Myrapoda. In generic characters it has the second annulus of Julus, and the short thick antennæ of Spirobolus, but adds a speciality in the almost obliteration of the visual organs. These are reduced to a single linear series of not very distinct occelli immediately adjoining the margin of the basilar segment on each side.

Segments sixty-one; color deep mahogany brown above. Total length 2 in. 2 lin.

Say's description applies exactly to our specimen. It would not be safe to insist that this is the *Cambala lactaria* of Newport, but it most probably belongs to the same genus, characterized by linear eye-patches.

JULUS MONTANUS, Cope, *sp. nov.*

This species is in most respects similar to the J. pennsylvanicus as given by Wood. There are two impressions on the vertex; the antennae are elongate; the last scutum is prolonged into a moderate straight mucro, and the posterior segments are quite pilose. The color is a dark brown with a series of blackish dots on each side. It differs from J. pennsylvanicus solely, so far as can be ascertained, in having 69 instead of 63 segments, and in the median portions of the same being smooth, and the inferior portions closely many grooved, instead of having "above punctae which give rise to obsolete grooves," Wood.

Mountains of Giles and Montgomery Counties.

POLYDESMIDÆ, Latr.

POLYDESMUS VIRGINICUS.

POLYDESMUS CORRUGATUS, *Wood.*

Andrognathidæ, *Fam. nov.*

A group intermediate between the suborders Strongylia and Sugentia. Characters. The labium a broad slightly cordate plate, extending beneath the consolidated elements of the front, and having a slight membranous marginal attachment externally, leaving a small oval orifice at the anterior extremity. The mandibles rudimental, extremely minute, far within the margin of the inferior face of the head, composed apparently of two segments. Segments of the body consolidated. Preanal segment an uninterrupted cylinder.

Andrognathus,* *Cope, genus novum.*

Char.—Joints of the antennae five, the sixth and seventh confluent, and with the closely joined fifth, forming a club, supported by the short proximal joints; segments of the body numerous, (over fifty in the only species,) muzzle short.

This singular genus is one of the hitherto unknown forms connecting the suctorial group of Myriapoda with the mandibulate. It furnishes a clue also to the structure of the suctorial mouth of the former group, which appears to have been as yet unexplained. Thus we see that the mandibles disappear, and the labium extends, and uniting by its margins on either side leaves the mouth a transverse fissure. With a further union of the mandibles with a prolonged labrum on each side, we would have a form of Sugentia, perhaps like Brachycybe of Wood, between which and the Polydesmidae the present genus stands. Like many of the members of the latter family, this one occurs under bark of decaying logs, though its food is more probably of a soft character, as the decomposing fungi often found in such situations or the bodies of dead insects and molluscs.

Andrognathus corticarius, *Cope, sp. nov.*

This is a rather slender and cylindric species with fifty-six segments, having rather short, strong, lateral laminae projecting abruptly from all except the anal. The dorsal portion of the segment is convex above the lamina, but less so than the ventral. The anterior laminae are transverse but the majority have an oblique anterior truncation. Non sheathing part of each segment slightly convex, and divided on the median line by a groove, within which runs a delicate thread or bead, which is raised on the lower part of the segment, and extends throughout the length. Upper surface of segment also divided transversely by one annular groove, the raised portions being minutely rugose. The same rugosity exists below the laminae. The anterior shields and laminae at least, have a fine pubescence. The antennae and front are densely pubescent. Labral margin flat, not emarginate. The muzzle is not so long as the antennae, and less contracted than in Wood's figure of Brachycybe. Anal annulus elongate, smooth, truncate, enclosing the short lateral anal plates. Length nine lines; proportions slender. Color in life, a very pale yellowish brown, lighter below.

From Montgomery County, Virginia.

* ανηρ man, γναθος jaw.

II. Description of two large extinct rodents from Anguilla, West Indies, with remains of human art associated.

AMBLYRHIZA, *Cope.*

Molars curved prismatic, rootless, some composed of four, others of five dentinal columns, separated by more or less transverse plane laminae of enamel; the whole enclosed in a sheath of cementum. The fangs contracted, closing one or more of the dentinal columns at the base. Triturating surfaces plane, subquadrate, or subtrigonal. Incisors narrow, with very small pulp cavity for much of the length; anterior plane transverse, the enamel equally folded in a narrow band on the inner and outer faces. Digits subungulate.

The characters of the genus ally these animals to the Chinchillae, and do not present more than a small number of differences, though important ones. Thus the closure of the dentinal columns below, indicates either a limit to the formation and protrusion of teeth of the same degree of complication, or the entire termination of such process, as in the root bearing types. It presents in fact an interesting transition between the monophyodont and diphyodont structures. There are two extinct genera related to the Chinchillae, with which the present may be compared; Archaeomys Laiz. Par. and Megamys D'orb. The first is said only to differ from Lagidium in the presence of an additional dentinal column, so that the form of the root is to be presumed to be the same; it therefore differs from Amblyrhiza in that respect, as well as in having the dentinal columns $\frac{4}{3}$ instead of $\frac{5}{4}$. The known species are from the fresh-water limestone of Allier, France. Megamys patagoniensis is only known from a tibia and rotula, and its dental characters are therefore not ascertainable. I cannot refer the present animal to that genus with any probability. The species is much larger than that described by D'orbigny.

AMBLYRHIZA INUNDATA, *Cope.* Proceed. Acad. Nat. Sci., Philada., 1868, p. 313.

The remains of this large rodent were found in a mass of breccia, which was thrown out in the excavations made in a cavern in the small Island of Anguilla, W. I. The remains occurring in that most eastern region of the West Indian Zoological district, might be anticipated to have a special interest in connection with the history of the submergence of a once great continent. With this impression, the writer examined a quantity of the above breccia and cave deposit, which was brought to Philadelphia as a probably available phosphatic manure. It was found to be valueless for this purpose, and the only result of the outlay was the discovery of the Amblyrhiza. Most of the fragments were dressed from a single block. There were in this the extremity of a right femur with patella, shafts of various long bones, fragments of pelvis and maxillary bones, with three molars, and two partially complete, and other much broken incisors. The teeth were scattered among the bones, and are so related in size to most of them, as to induce the belief that they all belong to the same animal. This is strengthened by the occurrence of the distal portion of the right femur of another individual in another mass, and the entire absence of bones or fragments which could be referred to any other animal. In the matrix occurred Turbo pica L., whereby the postpliocene age of the deposit is to be inferred.

The molars belong to an animal of the average size of the Castoroides ohiensis Foster, and as the epiphysis of the femur is not yet coössified, and the animal is young, I have no doubt, the proportions of the species are quite equal to those of the beforementioned largest of known Rodentia. This is confirmed by the proportions of the femora, whose shaft and condyles are larger than those of the ♀ Cervus elaphus of four years old, with which I have compared it. What the bulk may have been, is difficult to infer without additional portions of the skeleton, but it is sufficiently obvious that this ancient chinchilla exceeded the Virginian deer, and more than equalled the American Black Bear in this respect.

Three molars are preserved, two of which present four dental columns, and one three. These columns are transverse, the first, which I assume to be anterior, transverse; the second the longest, the third shortened inwardly, and slightly curved round the very small fourth, which occupies a posterior-external angle of the crown. All are separated by rather thick enamel laminæ. The form of the crown of the largest presents two sides of a square anteriorly and externally, the inner side bilobed in correspondence with the two anterior columns; the posterior strongly convex backwards and outwards. The other, similar molar, differs in the posterior outline being more nearly transverse, and the anterior outlines being united by a continuous curve. The large portion of the third tooth preserved is perhaps the external; it is a part of a nearly regular transverse oval.

The first described molar is strongly curved posteriorly, and its diameter narrows regularly to the contracted base; there is a shallow groove at the junction of the anterior enamel lamina with the inner wall. This groove is much more strongly marked in the second described, but ceases before attaining the contracted extremity. The shank of the tooth is less curved than in the other. The contraction is less gradual than in the first, but is strongly marked at the base, where the pulp cavity is not wider than one of the columns.

	Lines.
Length anterior face No. 1 (on curve)	14.3
Diameter crown (longitudinal)	6.
" " (transverse)	5.7
" root (longitudinal)	4.
Length anterior face No. 2	14.3
Diameter shank (longitudinal)	6.
" " (transverse)	5.

A portion of one of the inferior incisors of some forty-six lines in length, and another shorter piece, furnish characters of the species and genus. The inner face of the tooth is plane, and at right angles to the anterior; the outer is rounded obliquely inwards; the inner face is broad and not prolonged ; the curve of the tooth is in one plane, and the depth is about equal to the width. A narrow fold of the enamel embraces the anterior border of the inner and outer faces ; it is folded back at a right angle within and with a truncate angle without. The enamel is sculptured into numerous close, fine longitudinal grooves, which do not inosculate. The separating ridges number 14 near the middle of the tooth, those near the borders being the strongest. One, strongest of all, is on the external turn of the enamel, and near it numerous interrupted ridges have a slightly oblique direction.

The incisors are, as in the modern representatives of the Amblyrhiza, of more slender proportions than in the beavers, Arctomys, and other rodents, and their extinct predecessors. They are, also, relatively less stout than those of the Castoroides. Their sculpture is quite similar to that seen in the Lagidium and other chinchillas.

	Lines.
Width anteriorly	6.
Depth	5.7

Having requested Dr. Rijgersma to make further search in the localities where the preceding specimens were obtained, that gentleman made a special trip to Anguilla, and made a successful search among the debris and in the caves, whence the supposed phosphatic earth had been excavated. He found a considerable number of bones and five additional molars of Amblyrhiza ; also seven molars referred below to a distinct and allied genus (Loxomylus Cope) with numerous incisor teeth belonging to both genera.

Two adjacent molars of the first named, are in excellent preservation, and the posterior displays one dentinal column more than any other tooth ; it is, therefore, probably the posterior superior. They all display the curved shank and plane crown and contracted root already described. A portion of a superior incisor measures 1.35 mm. in transverse diameter, and 1.4 mm. in depth.

A distal phalange (figured) displays clearly the subungulate character of the genus, in its straight shaft and depressed, truncate extremity. It was found with a few of the teeth and other bones of this species, which are distinguished from the others by their bright red color.

On a third examination of the locality Dr. Rijgersma found some masses of breccia, in one of which is enclosed a very fine superior incisor of the left side, probably belonging to this species. Both extremities are broken off, but the remaining fragment measures 7 in. 5 lin. in length; the width of the anterior or enamel covered face is nearly eight lines, and the depth eleven lines; the latter measurement somewhat increased by the partial crushing of the shaft. The enamel exhibits the usual longitudinal ridges, but there are two stronger a little within the external margin, and another strongly marked, a quarter inch within the inner margin. This tooth indicates an animal as large as the largest known Castoroides, for though the incisors of some of the latter slightly exceed those of the present animal, these teeth have a larger proportion to the general bulk in Castoroides than in Amblyrhiza.

The extremity of the femur is remarkably broad and depressed ; it expands a little at the condyles. The trochlear groove is but little raised above the plane of the anterior (superior) face of the femur, while its lateral bounding ridges are strong, the inner the more prominent. The width of the groove is about equal to the transverse diameter of the tuberosity on the inner side, and greater than that of the outer. The faces of the condyles are quite inferior, and sub-depressed, the outer extending rather more posteriorly than the inner. Both are so separate from the trochlear groove as not to have had any continuous face with it; this is not entirely clear, as the surface is slightly injured at the point of connection. The inter-condyloid fossa is continuous both with the inferior face of the femur, and with the trochlear groove, without separating ridges, as many rodents exhibit. Just above the inner condyle there is a strongly marked fossa of a regularly rounded form.

The general character of the two femora confirms those of the teeth, as of a large rodent. The form and relations of the articular faces differ alike from those exhibited by Carnivores, Ungulates and Edentates. The patella, which pertains to one of the femora, is an elongate bone, with thinned and rounded distal extremity. The proximal portion is lost, but at the fracture the section is very convex. More distally it is flat.

	In.	Lin.
Width femur just above condyles	2	3.7
Depth " " "		14.
Width at tuberosities	3	4.8
" trochlear groove, distally		16.
" inner condyle		14.2
" outer "		18.
" intercondyloid fossa		7.
Length fragment patella	2	6.
Width at middle "		14 6
Depth at fracture		10.4

Loxomylus, *Cope*.

Molars straight, prismatic, composed of three dentinal columns, one of which is incurved, but none closed at the base. The triturating surface very oblique in the vertical direction, indicating the greater elevation of the teeth at one extremity of the series than the other. A horizontal obliquity of the dentinal columns is produced by their lateral displacement. Enamel plates but slightly curved. An external cementum layer.

This genus differs in many points from Amblyrhiza ; these are, the lack of one and two dentinal columns ; the double obliquity of the crowns, the absence of curvature, and less closure of the base. It is nearer to Archaeomys Laiz. et Par., but differs in two points ; that the upper molars have but three dentinal columns like the lower, instead of four, and that the horizontal grinding surface is oblique. This last peculiarity alone seems to distinguish it from Lagidium and Chinchilla, indicating a relation to the latter similar to that between the great extinct beaver of Europe Trogontherium cuvieri, and the existing genus Castor.

Loxomylus longidens, *Cope.*

This large rodent is represented by seven molar teeth and probably some incisors and bones of the skeleton; all except one tooth in the collection made by Dr. H. E. Van Rijgersma in the caves, and cave breccia taken from the caves in the island of Anguilla, West Indies.

I cannot distinguish the incisors as belonging to this species, and they are probably identical in character with those of the Amblyrhiza inundata, as is generally the case with nearly allied genera and species of Rodents.

A section of all except the terminal teeth is an oblique rhomboid, the longitudinal diameter being but little greater than the transverse. A single terminal tooth (either superior posterior or anterior inferior), is narrowed in the terminal column. All the teeth possess one longitudinal groove on one side and two on the other, which are covered but not obliterated by the cement layer. The teeth, though much straighter and more slender than those of Amblyrhiza, yet possess a light lateral, though no antero-posterior curvature; those of the upper and lower series curving in opposite directions.

				Inches.
Length of a median molar				1.7
Antero-posterior diameter (oblique)				.52
Transverse	"	(both of crown)		.43
"	"	terminal molar		.39
Longitudinal	"	"	"	.56

One tooth of this species was taken from a mass containing molars and incisors of A. inundata, and the species is without doubt of identical age with it. Its molars indicate a less robust animal; but I find no incisors which indicate an animal of generally small size. An inferior incisor to which adheres a portion of a molar apparently of this species, is not distinguishable from that of the A. inundata. It measures .11 in. in length and .012 in width anteriorly. This species was probably as large as but more slender than the Amplyrhiza.

The Island of Anguilla could not readily have supported a fauna of which these huge rodents formed a part. Such large animals have no doubt ranged over a more extended territory. This, and other facts mentioned by Pomel, lend probability to the hypothesis of the latter author, that the submergence of the ranges connecting many of the Islands of the Antilles has taken place subsequent to Pliocene times.

Associated with the preceding remains, Dr. Rijgersma discovered a highly interesting relic of the stone age of the human inhabitants of this portion of the West Indian Islands. I use the term stone age in a chronological sense only, since the region in question possess chiefly coral rock, and little or none that is adapted for conversion into cutting instruments, so that the inhabitants resorted to the use of animal products, as teeth, bones and shells. The implement found by Dr. Rijgersma is a long ovate spoon-shaped scraper or knife, cut by human hands from the lip of the large Strombus gigas. The ribs of the external surface and the smooth internal surface are easily distinguished, and the distinct natures of the lamellar and prismatic layers have been evidently well understood by the artificer, who has ground away the latter in order to put a sharp edge on the former at one end. This edge is sharp, and mainly well preserved. The implement has a greater median width, and smoothly ground thick margin ; the end of the plate is obtuse and with thick edge, almost entirely composed of the prismatic layer. It has evidently been held in the hand, and been used after the manner of the stone chisels of the North American Indians.

The cotemporaneity of man with postpliocene Mammalia in Europe and North America may be considered as established. It is, however, an important question to decide whether man occupied successively regions more and more remote from a supposed place of origin by migration, or whether a cotemporary postpliocene existence can be traced over the whole earth. His remains were not found by Lund after remarkable and extensive investigations into the postpliocene cave fauna of Brazil, though human remains from caves not far from Rio Janeiro, are in the Academy's Museum. What the precise age of these is, cannot now perhaps be stated. On the Peninsula of Florida Prof. Wyman has found remains of Man, but not associated so far as I can ascertain with any extinct species of Mammalia.

The present shell-chisel was found by Rijgersma under circumstances precisely similar to those attending the discovery of the gigantic rodents. Some portions of each of the species described were embedded in the breccia, and others occurred loose in a red earth in cavities of the breccia. The chisel has the color and constitution of the latter teeth and bones, and was found with them in this earth. Some of the teeth are even more fresh looking and less stained than the chisel. Though the evidence is not quite conclusive, yet the inference is very strong that the Amblyrhiza and Loxomylus had human cotemporaries.

If now these large herbivorous animals lived before the submergence of the mountains, whose peaks the present Virgin and other West Indian Islands are, we are enabled, with due regard to the slenderness of the evidence, to suggest human co-existence with that great geological event. A probability is thus added in favor of the lateness of the period of submergence of a former Caribbean continent, as already suggested by Pomel.

III. On two extinct Marine Mammalia from the United States.

ANOPLONASSA, *Cope.*

This genus is represented by a considerable portion of the mandible. No other fragment has as yet come under my observation. The portion does not extend posterior to the symphysis, but the latter is very long, and the rami slender, indicating a form of muzzle quite like that of a gavial or a Squalodon. It is strikingly different from the latter genus in being for the most part edentulous. The foramina of the dental arteries issue numerously along the outer margin of the superior face of the ramus, and are more or less connected by a longitudinal groove. Shallow alveoli for two representatives of teeth on each side, indicate a peculiar character of the genus. The two largest alveoli occupy the extremity of the symphysis, looking upwards and forwards. They are closely approximated, and are together wider than the mandible immediately behind them, which expands to support them. They are shallow, with rugose floor, which is somewhat elevated medially, and perforated by numerous nutritious foramina. The other alveolæ are nearly twice the middle of the mandible behind the anterior pair. They are much smaller than the latter, and equally shallow, and of a longitudinal ovate form; the fundus is rugose, not elevated, and furnished with nutritious foramina, which are smaller than those of the edentulous gum.

That true teeth occupied these positions, appears to me doubtful, from their shallowness, and small foramina. I rather suppose them to have been knobs or bosses, possibly corneous in structure. The edges of the mandible resemble those of such edentulous Cetacea as Hyperaodon and Xiphius, and indicate not very distant relationships to tooth bearing types. The mental foramina are large and subdivided, so that the largest and posterior opening is inferior, the superior anterior.

The affinities of this very curious genus appear to be in a general way with the aberrant Cetacea. The nearest types appear to be on the one hand Sirenia, and on the other, Squalodon. How remote it may be from either, it is difficult to state; of approximation to either little can be said. Should the posterior part of the ramus exhibit teeth, their character would indicate its Sirenian or Cynorcoid relationships. We can now only indefinitely regard it as a shore loving Cetacean, with a long slender beak, which it must have used much as nippers, perhaps probing mud or deep cavities, but for what kind of food it is difficult to imagine.

ANOPLONASSA FORCIPATA, *Cope.*

The length of the portion of the mandible described is seven inches, six lines. The transverse diameter differs very little to a point half way between the alveolæ, where it is gently contracted; it is then slightly expanded, and presents an obtusely projecting outline at the extremity. In profile the symphyseal extremity curves gently upwards from the point where it first contracts, so that the ridge separating the alveolæ is quite elevated. In transverse section the fragment is almost practically an isosceles spherical triangle, with a straight superior side. The superior face is however slightly convex in section, and a little elevated above the dental grooves on each side. There is a slight groove on each side of the symphysis below, which becomes very strongly marked distally. They diverge and continue to the extremity through the mental foramina, and reaching the upper surface nearly meet again. They enclose a strong symphyseal ridge, which is distally divided by a groove.

Measurements.

	m.
Length of fragment	.1920
" to second alveolus	.0735
" of " "	.0140
" of first "	.0240

Width distally	.0325
" least	.0270
" proximally	.0320
" of distal alveolus	.02
" of second "	.65

This species was found with a number of rolled fragments of Mastodon not far from Savannah, Georgia. The specimen is silicified, is dense and heavy, and slightly worn. Its color is black, and it resembles in all respects the remains of the Mastodon accompanying. It is preserved in the Museum of Comparative Zoology, Cambridge, Mass., and was lent me for examination by Prof. Agassiz, the director.

HEMICAULODON, *Cope.*

This genus is established on a right upper incisor of a large Sirenian Mammal allied to the Dugong.

The form of the tooth is that of a compressed, slightly curved cylinder, with distal and proximal vertical diameters equal. There are two open grooves on the inner and one similar on the outer side, the former enclosing a broad bead. The transverse diameter posteriorly is less than that anteriorly. The substance of the tooth is composed of a large axis of osteo-dentine surrounded by a broad cylinder of dentine, which is in turn surrounded by a thick stratum of cementum. The dentine is marked at regular distances by annuliform ridges, which are more or less undulate. They become gradually more distant distally. These ridges can be traced through the cementum. The cementum is everywhere entire, and is thicker distally. It presents externally a few longitudinal grooves at irregular distances, and numerous fine striæ irregularly disposed.

The pulp cavity is small and compressed; how far it extends into the shaft is uncertain, as it is choked by hard debris; but at the lowest point it is much contracted and sublinear. But a portion of the triturating surface is preserved; it truncates the tooth upwards and backwards in relation to its axis, as would be anticipated in a superior incisor.

The characters of this genus ally it to Halicore and Rhytiodus Lartet. In Trichechodon Lankester, the dentine does not present the external transverse ribs; the same character distinguishes it from Halitherium Kaup; in both these genera there is a distal acumination not visible in Hemicaulodon. Ontocetus Leidy from the Miocene of North Carolina, which I suppose to be a large Sirenian allied to Halicore, presents very weak and approximate dentinal ridges on part of its surface. It differs from this genus in the acuminate form of the tooth, and it probably presented a conic apex as in Trichechodon.

The comparison with its nearest allies is as follows. Both Halicore and Rhytiodus have the upper incisors dilated and flattened distally, and with a narrow oblique triturating surface. This extremity is, according to Owen, the only portion of the tooth which is exposed beyond the gum. In the present genus no such expansion exists so far as observed, and the truncation and exposure of the tooth, takes place at a point which would correspond to the basal third of the fang in those genera. In the latter this point is deep within the alveolus. It is therefore much shorter, even supposing its extremity to have been broken off, and worn on the fractured surface. Both the above genera possess a layer of enamel on the external, and a sheath of cementum on the internal side; in this genus there is a thick sheath of cementum all round. The plane of the worn surface is in Halicore oblique to the short diameter of the shaft of the tooth (see Lartet on Rhytiodus, Bull. de la Soc. Geol. de France, 1866, Pl. XIII), while in the present species it is oblique to the long diameter.

HEMICAULODON EFFODIENS, *Cope sp. nov.*

The transverse diameter of this tooth is greater anteriorly than posteriorly. The ribs of the dentine are strongly marked and distant. The dentinal layer is about one half the thickness of the osteodental axis, and three times that of the cementum.

	Metres.
Greatest length of specimen	.015 .00
" diameter	.007 .40
Least "	.004 .50

The external surface of the cement is slightly rugose from interruptions of striæ. The widths of the tooth increase very little from the basis to the worn surface.

The only specimen of this remarkable species which I have yet seen is considerably larger than the corresponding portion of the Indian Dugong. It was first brought to notice by Dr. Samuel Lockwood, of Keyport, Monmouth co., N. J., who obtained it from the Eocene marl pits at Shark River, Monmouth co.

EXPLANATION OF THE PLATES.

PLATE III.

Fig. 1.—1 a. Galera perdicida, Cope.

" 2.—2 a. Mixophagus spelaeus, Cope, double nat. size.

" 3.—3 a. Sterodectes tortus, Cope, external and posterior views of superior incisor.

Fig. 4.—Tamias laevidens, Cope, double nat. size.

" 5.—Sciurus panclius, Cope, 5 a, right ramus of mandible from above; both double nat. size.

Fig. 6.—Tapirus haysii, Leidy, inferior molar; 6 a, another inferior molar, from above.

The above are of the natural size, except where stated otherwise.

PLATE IV.

Fig. 1.—1 a. Amblyrhiza inundata, Cope, inferior incisor; 1 a, from the outside; nat. size.

Fig. 2.—Do. molar, from behind; 2 a, crown, grinding surface, nat size.

" 3.—Do. two posterior superior molars from the side; 3 a, grinding surface; nat size; 3 b, root of do. from behind.

Fig. 4.—Do. right femur, from above; 4 a, distal end of same, slightly restored from specimen of fig. 5. One half nat. size.

Fig. 5.—Do. right femur of second individual from the outer side; one half nat. size.

PLATE V.

Fig. 1.—Amblyrhiza inundata, distal phalange, lateral view; 1 a, anterior view.

Fig. 2.—Leptomylus longidens, Cope, two molars, lateral view; 2 a, crowns of do.

Fig. 3.—Leptomylus or Amblyrhiza, premaxillary teeth and bones from below, showing incisive foramen.

Fig. 4.—Human implement made from Strombus gigas., 4 a, lateral view.

Fig. 5.—Anoplonassa forcipata, Cope, mandible from above; a, from the side.

Fig. 6.—Hemicaulodon effodiens, Cope, incisor from the side; a, trituurating surface.

Stated Meeting, August 20, 1869.

Present, four members.

JUDGE LOWRIE, in the Chair.

A letter from Prof. Coppeé announced the return of Marianna's History of Spain.

A letter from the President nominated Dr. Bell to prepare an obituary notice of Dr. Meigs, deceased.

A letter from Dr. Leidy accompanied a donation of three highly ornamented Ojibwa pipes to the Museum of the Society by Mr. Clark.

A letter from the Mayor of the XVI Arrondissement of Paris requested a donation of the Publications of the Society for a Public Library in that precinct.

Letters of acknowledgment were received from the Society at Moscow, April, 1869, for Proceedings No. 77; the Vienna Academy, XIII. ii. 73–77; Society at Rome, 77; at Bordeaux, March 12, 76, 77; Lisbon Academy, March 28, 1868, List. Catalogue, I.; B. N. H. S., 78, 79, 80; Am. Ant. Soc., XIII. iii.; R. Island Soc., 81; Yale Coll., 81; Wisconsin H. S., 81.

A letter circular from the President of the Congrès International d' Archéologie Préhistorique à Copenhagen, 27 Aout, 1869, date March 1, 1869, was read.

Donations for the Library were announced from the Observatories of Turin, Dorpat and Prag; the Academies and Geological Societies of Berlin and Vienna; the Natural History Societies at Bonn, Harlem, Bordeaux, Montreal, Salem and Philadelphia; the Antiquarian and Historical Societies at Copenhagen and Worcester; the Oriental S. at New Haven; the London Meteorological, Chemical and Zoological Societies; Sir James Clarke, Charles Ritter d' Elvert of Brünn; Prof. C. H. Hitchcock, Dr. S. D. Gross, the Surgeon General U. S., and the Public Library of Cincinnati.

The death of Prof. Cleveland, in Philadelphia, August 18, aged 67, was announced by Prof. Trego.

And the Society was adjourned.

Stated Meeting, Sept. 17, 1869.

Present, seven members.

Mr. Fraley, Vice-President, in the Chair.

A letter accepting membership was received from Joseph D. Hooker, dated Royal Gardens, Kew, July 12th, 1869.

Letters acknowledging receipt of Transactions XIII. 3, were received from the Boston Pub. Lib.; Mass. Hist. Soc.; Harvard, Yale, and Amherst College Libraries; New York Hist. S., Hospital, and State Library.

Letters acknowledging receipt of Proc. 81, were received from the Essex Inst.; Boston Pub. Lib.; N. Y. Hist. Soc., and Cincinnati Observatory.

A letter from M. Carlier to Mr. Durand was read, promising the official documents in the matter of the Michaux Legacy to be forwarded by the hands of Mr. Biddle now in Europe. All the forms of French law are now satisfied, and M. Germain of Pontoise has given M. Carlier a receipt in full of all demands in settlement of fees.

Mr. Price, after remarks explanatory of Michaux's known tastes and intentions, offered the following:

Resolved, That the Committee on the Michaux Legacy be authorized to make inquiry whether the trust under the will of André Francis Michaux may not be executed in whole or in part within the Fairmount Park; with authority to communicate with the Commissioners of the Park upon the subject; and to make report to the Society.

The resolution was agreed to.

A letter from Mr. Sullivant to Mr. James was read, referring to the discovery of a posthumous work by Schwarz the bryologist. On motion, permission was granted to Mr. James to select from the Muhlenberg herbarium certain mosses for Mr. Sullivant to examine, in reference to Schwarz's determinations, to be returned to their places in the herbarium.

Donations for the Library were received from the Berlin Academy, Teyler Museum, Paris Geographical and London R. Astronomical Societies, Mr. Scudder at Boston, Silliman's Journal, the Franklin Institute and the Medical News.

"The Arawak Language of Guiana in its Linguistic and Ethnological Relations," by D. G. Brinton, M. D., was offered for publication in the Transactions, and referred to a committee consisting of Mr. Lesley, Mr. Chase, and Mr. Haldeman.

"A second addition to the History of the Fishes of the Cretaceous of the United States, by Edward D. Cope," without illustrations, was read by title and referred to the Board of Secretaries.

"The maintaining Forces of Cosmical Motions," was the title of a paper read before the Society, by Judge Lowrie; a discussion ensued in which Mr. Price, Mr. Lesley and Mr. Fraley took part. Mr. Lesley dissented from the opinions expressed in the paper, so far as any claim was set up to a discovery calculated to effect a radical change in the accepted methods of regarding planetary motion.

Mr. Marsh described the peculiarities of the Meteor of August 24th, and others, belonging as he suspected to a group passing the earth during the day time in the United States, and therefore only the last of which became visible at or after sundown.

Pending nominations Nos. 227 to 640, and new nominations 641, 642, were read. And the Society was adjourned.

SOME SUGGESTIONS ON THE MAINTAINING FORCES OF COSMICAL MOTION.

By Walter H. Lowrie.

I desire to submit for consideration some suggestions tending to the production of a true theory of the force by which the revolutions of the planets are maintained against the tendency of attraction to draw all bodies to a common centre, or a solution of what Sir John Herschel calls "the theorem" of the conservation of the *vis viva* of cosmical motion.

I know of none hitherto received except that composed of the postulate of an original impulse and the law of inertia: that a body set in motion by a single impulse and out of relation with other bodies moves forever with its initial velocity and direction. Such a proposition is evidently not a product of induction, for no body was ever known to be in such a case or to move thus; and therefore it defines no actual class of motions whatever, as every physical law ought to do. Indeed philosophy never treats of things out of their relations. This is, therefore, a mere metaphysical idea, meaning only this, that, in the investigation of motions so as to find their system, the mind demands a cause for every change in their degree or direction.

It very properly assumes an original propulsion; because motion exists, and its origin could not possibly be a matter of human observation. But the theory founded on this law goes beyond the law, and treats of bodies that are *in* relation with each other, and then assumes, that, by reason of this relation, that is, by the attraction of a primary body upon its secondary, motion may be changed in direction without being changed in degree; and thus, according to it, the original propulsion is the true motive power of all cosmical systems, while the only function of attraction is to deflect tangential into elliptical motion and hold it there.

Now this theory is both logically and philosophically vicious; because it takes our idea of absolute motion and uses it as a true expression or law of relative motion; and because, while treating attraction as deflective of tangential motion, it overlooks the question, that it may also retard and suppress it, and thus it treats this force as absolute in degree while relative in direction.

An idea or rule that is absolute in its character can tell us nothing about actual things, though it may regulate our mode of thinking about them. In this instance it bids us seek a cause which maintains cosmical motion against the centralizing force of attraction. We must seek it in this cosmos, just as it is, with its countless bodies, all moving in harmony and yet with countless forms and degrees of motion.

It is impossible to find it in a single initial impulse given at the start of the motion; because the force of attraction of each body on the others would everywhere affect the motion thus given, deflecting, retarding, accelerating, reversing and finally absorbing it, without its having any capacity, as a *vis viva*, of recovering itself. The initial impulse once given, becomes, as a cause, past and ended, and its assumed effect is uniform velocity forever; but it does not assume to resist the retarding, accelerating and other disturbances that assail the body, and it is impossible that it can do so. Nor can it resist the attraction of its central body, which is constant in its direction, and also in its degree so long as the distance is unchanged. A force that interferes to deflect a moving body must thereby decrease its velocity, and the more direct the interference the greater is this decrease, as a direct one may stop it altogether.

In order to get a clear conception of some of these retardations and accelerations, it is necessary to get beyond the motion of each body, in so far as it is merely relative to its primary, and consider it in a more absolute way. Take the moon in its revolution round the earth, starting with it at its first quadrature. Then it is 240,000 miles in the rear of the earth. It must of course overtake the earth, as it does at full moon, and pass on to its second quadrature, where it will be 240,000 miles in advance of the earth; and then, in another half lunation, it must fall back, relatively, twice 240,000 miles to the same relative position from which we started with it.

And it is well to notice that this motion, apparently a circle round the earth, is really, in relation to the sun and in a long period, a series of alternate small undulations on each side of the earth's orbit, the longer ones being on the outside and the shorter ones on the inside, and the difference between their chords being nearly a million of miles; and while the moon is making this slow motion in relation to the earth, it advances near fifty millions of miles with the earth along its orbit round the sun. No other satellite moves so slowly, because no other is so little held by the attraction of its primary compared with that of the sun, which is 2.2 of the earth's, while, in relation to most other satellites, it is measured by thousandths, and in relation to only the two outer satellites of Saturn and Uranus does it rise above hundredths.

Take also the earth in its revolution round the sun. Its apparently circular orbit changes entirely when we take into account the sun's motion in its own orbit, said to be 150 millions of miles a year. If we start with the earth at its vernal equinox, it is 95 millions of miles in the rear of the sun, and in six months it moves forward to a position as far in advance, with the chord of its curve elongated 75 millions of miles by its motion with the sun. Passing its autumnal equinox to the inside of the sun's orbit, it sweeps back in another six months to its original relative position in the rear of the sun, and yet, having moved with the sun, it is found 150 millions of miles in advance of the position whence we started with it, and 115 millions in the rear of its position six months before, and its real annual orbit turns out to be an immense scollop, the loop of which on the sun's orbit is 115 millions of miles wide, the motion being really retrogressive during the second half of each year, and the length of its real journey in absolute space along its real orbit being near twice as great in the first half of the year as in the second half.

Thus all the planets and satellites have orbits consisting of very long curves in the outer half of each revolution, connected together by short curves, some of them loops, in the inner half, and perform journeys immensely greater in absolute space in one than in the other. Surely it is impossible that these alternations of fast and slow motion can be accounted for by the single transient impulse given to each body at the start of the system. Surely we are required to find some constant abiding or constantly renewed force to account for such phenomena. What is it?

Where shall we find the force that prevents the consolidation and centralization threatened by the force of attraction? Of course we must find the answer in the phenomena of our solar system, that being the only one of which observation gives us any competent knowledge. Philosophy cannot go back to find it in the phenomena of creation, for that is not phenomenon for us, and therefore that process must ever remain transcendental to us, until we can witness it in some other system and transfer it by analogy to our own; the only way in which we can know anything of our own personal origin.

All these regulated and phenomenally self-sustaining movements have a strong analogy to life, though we do not conceive of life as a mere property or movement of matter in a system. Phenomenally and statically it is the normal interaction of all the particles of a given system that sustains and constitutes its life; though this definition cannot deter us from our natural seeking after the dynamics of the system, the forces and causes of this interaction. And so it is in our investigation of the solar system.

We have given to us, by observation of it, over one hundred cosmical bodies, each revolving about some other, which is also moving, and each having a force attractive of all others, and moving at such a distance and with such velocity that it is neither drawn to nor driven from its central body. We find therefore a permanent system of moving and attracting bodies, and for convenience in the study of this fact, we analyse it into two forces—bodies attracting and bodies moving, or, more simply into attraction and motion; though in physics and apart from bodies, these last are nothing but abstract ideas, being the mental instruments by which we handle the actual and concrete forces—bodies moving and attracting.

We infer that the forces of attraction and of motion balance each other so as to prevent both consolidation and dissolution; but neither, by itself, can maintain the system. Without seeking after the origin of these motions, it is enough for us, that, at any given instant of time, they balanced the force of attraction. Then the question arises—how is this system of motions maintained? Or more definitely thus—given a satellite revolving round a planet, itself round another body and it round another, how is the motion of the satellite maintained? What is there in the forms and forces of this system that constantly restores the proper degree of motion in the satellite amidst the retardations and accelerations which we have discovered?

The readiest illustration of the system is the motion produced when a ball at the end of a string is swung from right to left around one's hand as one moves rapidly in the same direction around a path, composed of a series of curves or loops all turning to a common centre. If we analyze the motion of the ball, we find that, while, relatively to the hand, it is nearly circular, it really performs a very complex figure relatively to the centre of the greater circle in which the person moves, passing an equal or nearly equal portion of time on each side, and yet with a much shorter path and slower motion on the inner, than on the outer side; this difference being always increased with the rapidity of the motion in the larger circle and with the slowness of that in the smaller one. Thus the ball's motion may resemble that of the most remote planets or of our moon, consisting of a series of alternate long and short undulations, or that of the other planets and satellites, being a series of scollops or of alternate long and short curves looping into each other.

And while the ball is performing this motion, the hand does not keep on the line of the greater circle, but performs a series of motions alternately on each side of it, corresponding in form to the larger ones of the ball; and in this its motion resembles the small motion of the planet on its orbit, no planet having a satellite ever moving exactly along its theoretic orbit.

Let the moving ball represent the tangential, and the string the attractive force of the whole movement, and we have the statical condition of a balance of forces. But the tangential force, not being a *vis viva*, would soon give way to the other, if there were no recuperative arrangement in relation to it, and our illustration directs us to the actual arrangement. It consists of the constant motion of the central force. This is the key to the dynamics of the system: attraction by a constantly and peculiarly moving central body. Of course both bodies exert this force, though that of the central body is always immensely greater than that of the other: it is all one force acting along the same line.

This is the moving force that maintains the motions of its dependent bodies, and we find no repulsive force; though, for distinctness of thinking, we find it necessary to analyze the motion into radial and tangential elements, and consider these as representing two colliding forces. A system of forces is an essential element of every system of actual things, and there can be no motion within the system except what is given or upheld by the very forces that constitute the system, supposing of course no interference from without.

This is a force constantly acting, and moving as it acts, ever changing the position whence it acts and therefore the direction of its action; always departing from its point of action and therefore from the very results which its action in each moment tends to produce; always fluent in itself and always fluent in its effects.

As the planet sweeps, with its unsteady rythm of undulations, along its own series of scollops or loops, called its orbit, the satellite sweeps tangentially throughout that orbit; and thence, obeying the attractive force of the planet without giving up the force of its own motion, bends its course into a curve which carries it out far beyond the planet's orbit, and, still further obeying the same force, it hastens forward with it until, passing in advance of it, its speed is checked by the same force, and it swings round through the same orbit and is, by the force of its own motion, carried far inside of it, where it reduces its speed, because, by reason of the forward motion of the planet, this motion can there make but little draft upon it, and waits until the planet again passes in advance of it and renews its force, when it rises again through the orbit, and repeats the same series of movements. Here then is the force that corrects all the irregularities of motion in the system, checks all accelerations and revives from all retardations. By analogy to the term central force, I venture to call it the orbital force of cosmical motion, because it proceeds from a body moving in its orbit. I think I have said enough to present the subject sufficiently to those who desire to think about it.

But it is impossible to stay the mind at this point; it must seek to find the next link backwards in the chain of causes. If thus planets move and maintain the motions of their satellites, then the sun must move in a similar way to maintain the motions of the planets; and we have evidence that it is so. And the sun also must have its moving centre, and so on indefinitely. This too we may suppose, though we have no direct evidence of it.

This ought not to surprise us; for no where, in the acquisition of knowledge, does observation carry us back to the Great Centre of all causes, nor often to very remote ones; and yet it is a natural process of our philosophic faith to reach out and assume a cause for every thing, and we do assume it in harmony with the character of the effect; physical or spiritual, moral or intellectual, personal or impersonal, according to its demands. Thus only can we fill up the inevitable gaps which experience and observation leave to be supplied in every investigation; and thus we are continually led back to the assumption of causes, principles and ideas that can be, as it were, felt by the mind, and which yet transcend all the definitions and manipulations of deductive logic. All our abstractions are natural reachings of the mind towards the absolute in some special aspect of it, and often we make thereby very valuable acquisitions.

And certainly it is not desirable that we should have capacity to start from first causes and deduce from them all the systems and events of the universe; for our happiness depends, not upon the reach of our minds, but upon their continued and proper growth; and this can be only a gradual process, rising from the observation of things and events and from a study of their dynamics to proximate causes, and from a co-ordination of these to more remote and higher ones, without any supposable end to the means or to the functions of our progress. A mind whose chief function is growth cannot commence with the condition to which it aspires, for then it could have neither growth nor aspiration.

And it is not chargeable as a vice, that we are compelled to postulate forces beyond the special system which we are studying, analogous to those found in it, nor even if we postulate others within it. Every system of actual things requires such postulates to connect it intellectually with some higher system, or to furnish it with at least a provisional foundation, or to give completeness to its structure; and especially every phenominally self-sustaining system requires us to postulate and then seek within itself the forces by which it is maintained, besides its initial force proceeding from without. Thus every class of plants and animals has within itself the forces by which the creative act is maintained, though always dependent on the larger system of the universe; and the science of physiology is founded on this assumption.

In the study of language, having no history of its origin, we may assume that it was a gift by God to man; but, thus received, it could be but very feebly maintained as a mere treasure of the memory, and in the very form in which it was bestowed; and, in order to account for its continuance in all its varieties, with its degradations, restorations, additions and improvements, even with a fundamental identity of structure, we must postulate other mental forces, which, with memory, constitute our faculty of language, and then proceed to seek them out.

And so it is with law, government and religion, with all their rules, forms, rites, symbols, and principles of faith and conduct. Their origin may be beyond our reach; but we are not, for this reason, prevented from learning that memory is the mere servant of other faculties in maintaining them through all the changes which they, with man, undergo, and that it is a prominent function of our life to work out our own development of them, and to improve by doing so.

I now venture to suggest very generally and briefly some of the consequences that would seem to follow from the admission of the dynamical views here presented.

1. We must give up Sir Isaac Newton's mode of accounting for the elliptical form of cosmical orbits. I expressed this in August, 1860, to the Academy of Science and Arts at Pittsburgh, founding it merely on the fact that all cosmical centres are themselves moving. The foregoing considerations now make this result more obvious.

2. There are many forms of cosmical motion, treated as inequalities, which are as normal elements of the special or partial system in which they are found as are the eccentrics on the axis of a steam engine, and they are not abnormities or disturbances produced by the forces of bodies out of the system, though they may themselves, in some cases, be disturbed, exaggerated, obliterated or even reversed by such forces. I venture to name as belonging to this class, the moon's annual equation, the motion of apsides, variations of eccentricity and of major axis, and also the recession of planetary nodes, including the procession of the equinoxes

3. This orbital force requires great inequalities of relative as well as of absolute motion, and presents a very obvious explanation of the inequalities of the moon's motion as the earth, with its unequal velocity,

passes from perihelion to aphelion and back. Considering the real form of the moon's orbit in relation to the sun and to the earth and its distances from each, and the very small angles of eight minutes formed at the sun by the radius of its orbit at its quadratures, and of one minute at its syzigies, it does not seem that such inequalities can be mere disturbances of the moon's orbit by the central force of the sun.

4. This force would seem also to require a change in the mode of calculating cosmical disturbances. Instead of starting us from the basis of an ideal ellipse, depending on a transient force of unknown quantity, it gives us real ones depending on a constant force for each case, which may be calculated. The forms thus given must be the true normal forms of the respective orbits, and departures from them must alone be treated as disturbances.

I have only to add that, however unsatisfactory it always is to eliminate any element of a system by declaring it anomalous, yet I do not see how this is to be avoided in relation to the satellites of Uranus, if the observations reported about them are accurate.

Stated Meeting, October 1, 1869.

Present, twenty-two members.

Prof. CRESSON, in the Chair.

A letter accepting membership was received from Linant Bey, dated Cairo, April 20, 1860.

An extract from a letter from M. Carlier to Mr. Durand respecting the Michaux Legacy was read.

An extract of a letter from Mr. Lesquereux to the Secretary respecting Mr. Schimper's Palæontologie Végétale was read.

Donations for the Library were received from M. Linant de Bellefonds Bey, the British Association, the London Geological Society, Mr. Gore, F. R. S., and the Boston and Montreal Natural History Societies.

The death of Dr. Dorr, member of this Society, at Germantown, Sept. 18, aged 73 years, was announced by Mr. Fraley.

Prof. Mayer laid before the Society an abstract of the photographic observations of the total eclipse of the 7th of August at Burlington, Iowa, with numerous photographic plates and illustrations.

Prof. McClune exhibited a drawing of the appearance of the Sun to the naked eye made by Prof. Gummere and himself, and described some of the phenomena of the eclipse.

Prof. Morton exhibited a copy of the photograph picture got by Mr. Whipple in 40 seconds, for Prof. Pierce's party of observation; the object being to obtain by a longer exposure than usual with sun pictures, an image of the corona. Photographs of the protuberances required but 5 to 16 seconds; those of the sun before total immersion were exposed but the one 500th of a second, a narrow slit in a flying trap-cover serving to sweep a beam of light across the plate.

Mr. Chase gave the results of his further discussion of Mr. Dines' weather records in England.

Pending nominations 627–642 were read.

And the Society was adjourned.

TIDAL RAINFALL BY P. E. CHASE.

Since the publication of my paper on the Tidal Rainfall of Philadelphia, (Proc. A. P. S. v. x, pp. 523–537), Mr. Dines has continued his discussion of "the moon's influence upon the fall of rain" (Proc. Meteorolog. Soc. for April 21, 1869), adding forty years' observations at Chiswick to those at Cobham, which he had previously examined.

The evidences which I have adduced of "establishments" in the tidal rainfall, and of more strongly marked characteristics in low latitudes, forbid any general inferences from observations at two stations which are so near each other, and in so high a latitude as Cobham and Chiswick. But my study of laws that have been developed by records at more than a hundred different observatories, in Europe, Asia and America, led me to look for additional confirmation of those laws even in the valuable abstracts which rendered Mr. Dines so skeptical. I accordingly "smoothed" the irregularities, both in the Cobham and in the Chiswick tables, and arranged and treated in a similar manner President Caswell's observations at Providence, R. I., from December 1831, to May 1860, and the Toronto observations from March 1840, to January 1849. The results are given in the following Tables.

LUNAR DAILY RAIN AT PROVIDENCE, COBHAM, CHISWICK AND TORONTO.

Lunar Days.	Fall at Providence. Dec. 1, 1831 to Nov. 30, 1841	Dec. 1, 1841 to Mar. 31, 1851	Apl. 1, 1851 to May 31, 1860	Providence Normals. 1831—41	1841—50	1851—60	1831—60	Lunar Days.	Cobham Normals	Chisw'ck Normals	Toronto Fall	Toron'o Normals
1	7.58	13.34	20.45	649	871	1051	2572	1	2096.59	2123.32	5.75	562
2	12.07	12.78	15.42	720	819	946	2485	2	2064.42	2146.70	13.10	627
3	13.10	13.43	9.10	798	785	843	2425	3	2072.13	2148.28	10.65	624
4	13.98	8.73	12.51	828	796	811	2434	4	2102.64	2139.65	7.92	571
5	13.22	13.53	15.95	818	862	818	2498	5	2112.27	2105.04	6.47	552
6	9.92	19.33	9.80	847	905	821	2572	6	2066.98	2032.78	9.80	606
7	13.64	10.83	13.19	932	882	834	2648	7	2010.92	1967.77	11.16	682
8	23.02	11.94	15.00	961	854	843	2657	8	2024.04	1985.24	12.66	710
9	10.13	15.75	13.43	864	850	804	2518	9	2095.94	2082.71	11.23	667
10	10.54	12.04	9.63	748	817	739	2304	10	2142.59	2155.38	7.91	593
11	8.14	14.26	10.85	728	727	701	2156	11	2139.12	2145.07	8.18	554
12	17.15	5.53	11.72	772	633	707	2112	12	2117.62	2100.55	7.70	578
13	8.67	10.31	8.77	810	592	754	2156	13	2079.44	2054.24	10.82	636
14	14.43	9.42	15.53	817	600	812	2229	14	2033.18	2009.76	11.37	668
15	16.41	8.93	14.01	762	639	836	2237	15	2026.34	1995.83	11.66	630
16	5.36	10.14	10.74	689	706	827	2222	16	2050.26	1993.59	7.97	554
17	8.51	14.53	14.26	712	777	814	2304	17	2039.80	1949.40	4.97	516
18	16.25	12.09	12.30	824	835	802	2460	18	1998.82	1900.17	10.23	547
19	15.15	11.90	12.19	896	894	807	2597	19	2002.99	1941.88	8.70	615
20	13.98	18.96	10.57	889	942	868	2698	20	2077.74	2085.00	10.66	667
21	11.20	12.96	17.37	870	935	956	2761	21	2146.76	2213.61	14.02	666
22	15.89	15.08	19.31	871	876	990	2737	22	2118.39	2200.21	6.17	631
23	12.75	11.89	9.27	862	801	975	2639	23	2016.49	2059.24	10.01	622
24	14.03	10.67	19.17	826	746	971	2538	24	1962.35	1932.40	10.34	642
25	10.69	11.83	13.57	783	713	970	2466	25	2002.72	1904.18	12.16	652
26	12.96	9.59	16.55	763	747	941	2451	26	2065.88	1921.18	6.23	644
27	9.25	11.12	12.62	763	862	920	2559	27	2103.81	1922.79	14.62	612
28	16.47	19.43	12.03	758	991	958	2706	28	2139.50	1936.00	6.53	548
29	8.77	18.35	20.77	704	1021	1033	2758	29	2167.64	1992.72	5.93	491
30	10.34	12.92	13.81	646	952	1081	2678	30	2148.55	2067.47	8.83	496

The foregoing Normals not only corroborate the inferences in my previous papers, but they also show that the eastward movement of storm waves, which has been so clearly demonstrated by Prof. Henry, prevails to some extent in the Eastern, as well as in the Western Continent. The Toronto observations cover so short a period, that their independent value in determining the form of the lunar monthly raincurve is small, but when compared with the observations at Philadelphia and Providence, they show that a similar lunar influence is felt at each station, modified by the local establishments.

An extensive investigation and comparison of observations may be necessary, to determine whether the direction of storm-progression in England is determined, either wholly or in part, by the trend of the Doffrafield Mts., or is owing mainly to the earth's rotation. In consequence of Alpine influences I should look for indications in Central Europe, of a subordinate system of storm-waves, moving nearly in the line of the meridian, or at right angles with the general system of the globe.

AN ABSTRACT OF SOME OF THE RESULTS OF MEASUREMENTS AND EXAMINATIONS OF THE PHOTOGRAPHS OF THE TOTAL SOLAR ECLIPSE OF AUGUST 7, 1869.

By Alfred Mayer, Ph. D.

Professor of Physics and Astronomy in the Lehigh University, Penna.

I have the honor to lay before the American Philosophical Society a few results of my measurements and examinations of the Photographs of the Total Solar Eclipse of Aug. 7, 1869, taken at Burlington, Iowa.

The Photographic expedition, of which these photographs are part of its results, was organized by Prof. Henry Morton of Philadelphia, under the authority of Prof. J. H. C. Coffin, U. S. N., Superintendent of the American Nautical Almanac.

The expedition occupied three stations in Iowa; viz. Burlington, Mt. Pleasant and Ottumwa, respectively under the charge of Professors Mayer, Morton and Himes.

Burlington is situate in Lat. N. 40° 48′ 21.″58; Long. 0h. 56m. 13.88s. W. of Washington. It was 7 miles N. of the centre of the moon's shadow.

The telescope used was by Merz & Mahler of Munich, and is the property of the Central High School of Philadelphia. It is equatorially mounted; of 6.42 inches aperture and of 9 feet focus, and is driven by one of Fraunhofer's friction governor clocks.

The sun's image was formed on the plate of the camera by a Huyghenian eye-piece, the lenses of which were specially computed to give the least aberration when they formed an image of the sun in the camera of 2.04 inches diameter. The image of a reticule of two spider threads at right angles to each other was also projected on the plate with the sun's image, and these threads were by me accurately adjusted, the one parallel, the other at right angles to the celestial equator; thus, the photographs have given precise position-angles of the contacts and of the protuberances.

A plate having a transverse slot of $\frac{1}{40}$th of an inch in breadth shot across the eye-piece by the action of a spring and thus gave the exposure during partial phase. The duration of this *flash* of the sun upon the camera has, since the eclipse, been made by me the object of an experimental determination, and by means of an electrical break-circuit clock and chronograph, I have found that the exposure of the collodion plate to the sun's image was almost exactly the $\frac{1}{500}$th of a second.

[Prof. Mayer here exhibited the camera used; explained the action of the exposing plate and how by its fall the time of exposure was electrically recorded on a chronograph fillet; and showed the arrangement of the aparatus by which he determined the time of exposure.]

While taking the photographs during partial-phase only 2 inches aperture of object-glass was used; but, during totality the full aperture was employed and the slide-plate allowed the whole beam to fall upon the plate. The exposure of the totality photographs varied from 5s. to 7s.

Forty-one perfect photographs were taken during the eclipse, and five of these were obtained during totality, which lasted 2m. 42s. The five totality pictures were taken in one minute and thirty-nine seconds.

[Prof. Mayer here exhibited copies on plate-glass, taken from the original negatives with an orthoscopic lens, and also copies on paper enlarged to about five inches in diameter. A large diagram showed more distinctly to the members the forms and positions of the protuberances.]

Photograph No. 4, taken 2.8 seconds after *observed* contact, shows a depression in the sun's limb at the position of first contact, and from this depression shoots into the sun a high lunar mountain, whose position measured from the S. point of the cusp, is about $\frac{1}{4}$th of the distance to the N. point of the same. Mr. W. S. Gilman, Jr., of New York, who observed with exquisite skill at Sioux City, Iowa, informed me that he obtained his time of first contact by seeing this mountain peak thrust itself into the sun's limb before a flattening occurred from the contact of the lower general surface of the moon.

[Prof. M. here gave an account of the geometrical methods used to determine the times and angles of contact from measurements on the cusps of the sun.]

The time of first contact deduced from approximate measures on two plates gave 13h. 2m. 1.24s., Burlington Sidereal Time, which is 1.1s. before contact as observed by Prof. Coffin, and 0.1s. before Dr. Gould's observation. From measures on another plate we deduced 13h. 1m. 57.3s., which is 4s. before contact as observed by Dr. Gould, and $\frac{6}{10}$th of a second after contact as determined by Prof. Young with his new spectroscopic method of observation.

Measures on plate No. 8 gave for the position-angle of first contact	—70°	48′
Computed angle	—71°	
Difference	—0°	12′
Plate 41 gave for position-angle fourth contact	108°	34′
Computed angle	108°	0′
Difference	+0°	34′

Sixteen spots were visible on the sun's disc during the eclipse. Two large spots, one in the S. W. quadrant, the other in the N. E., are beautifully defined on the photographs. Near the eastern point of the sun's limb is a remarkably beautiful and characteristic spot, greatly fore-shortened from its position so that the penumbra has disappeared on the west side of the umbra, against which rests the large bright faculae, which enclose the spot, while one bridges over the spot in a N. E. direction and seems to divide it into two portions. I here exhibit drawings of the spot in the S. W. quadrant which show the rapid changes which took place in the form and dimensions of this spot in 1h. 59.5m., the interval between the times of taking the plates from which they are drawn.

On plate 4, we see the umbra and penumbra of a general circular outline, with an intensely white projection into the N. W. point of the margin of the penumbra. The mean diameter of the umbra is 6,600 miles.

Plate 42 shows that the circular outlines of umbra and penumbra have changed into elliptical boundaries, the direction of the longer axis being N. W. and S. E. The umbra has widened in this direction 4″, or 1796 miles, and has, in the transverse direction, narrowed its breadth 5.″5, or 2357 miles, while the outward projections of the umbra (which can be identified on plate 4) have become greatly lengthened.

Photograph No. 15, of the series, shows this spot *bisected* by the limb of the moon.

All the photographs show a gradation of shade from the border of the sun inwards. This shading of the source of light is due to the absorption of the peripheral rays which necessarily pass through a greater thickness of the dense solar atmosphere, than those which emanate from the central portion of the disc.

We also observe on the photographs close to the limb of the moon, a bright glow like that of early dawn, which on plate No. 11 can be distinctly traced to 18″ beyond the limb of the moon. If this phenomenon cannot be explained in mode and in *measure* by diffraction, it must be due to a lunar atmosphere, though it is difficult to reconcile its existence with the inappreciable refractive effect on small stars, and especially on double stars, when occulted by the moon.

I will not attempt at present a complete description of the plates obtained during totality. I merely refer you to the diagram which I have prepared, and call your attention to those of the most remarkable protuberances. These protuberances I have numbered from 1 to 12, going from N. through E. to N.

No. 4, on the eastern limb of the sun, has the appearance of an eagle with outspread wings resting on the trunk of a tree which leans towards the north, on plate No. 27, where the base of the protuberance is cut off by the advancing moon, the resemblance to an eagle on the wing is perfect. The form of this object indicates instability, and impresses one with the idea that it is a great travelling whirl of flame, the direction of whose rotation—as indicated by the position of "the wings" and the projection of one on the other—is retrogade or in the same direction as the hands of a watch. I have examined with care the successive photographs of it, and although at first I thought the last impression differed from those preceding in that the wings had become longer and more in a line with each other, yet, on subsequent examination, I could not really decide that a perceptible motion had taken place during the time of totality.

The position-angle of the N. side of the base of this object is 96° 25′; its height is 1′ 22″, or 36,700 miles, and the spread of the wings is 9° 31′, or 70,800 miles.

On the western limb of the sun we see the remarkably large and massive protuberance No. 8. It is shaped like an albatross head, with the beak and under-side of the head resting on the periphery of the moon. On a photograph taken at Ottumwa, Iowa, just before the sun came out, this protuberance had the exact appearance of an albatross head, with the beak open, holding a rounded mass between the extremity of the jaws. It lies between the position-angles of 2[illegible]0° 13′ and 245° 46′; its length is 15° 33′, or 115,700 miles, and its greatest height is 75″, or 33,600 miles.

The protuberance No. 10, bears the most striking resemblance to a caterpillar, out of whose head issue two horns; the one nearest the front being the higher of the two, and terminated with a knob or ball from which comes a broken line of light to the border of the moon. Its mean position is 287° 33′ and it extends through 11 degrees or 81,800 miles. Its maximum elevation, which is at the head of "the caterpillar" is 52″, or 23,300 miles.

We here give a table of the position-angles and heights of the protuberances. Those on the eastern limbs of the sun, viz: 1 to 7 inclusive, were determined from measurements on the first plate of the totality series, taken 17.1 seconds after second contact; those on the western limb of the sun were determined from the last plate of totality, taken 50 seconds before third contact.

The angles of position of prominences, 1 to 7 inclusive, should be *diminished* 32.′5, to make them correspond to the positions they had on the first plate of totality; for reasons which are given in my official report.

Table of the position-angles and heights of the Prominences.

No. Prominence.	Position-angles.	Height.
1	55° 9′ to 57° 59′	22″
2	66° 14′ to 72° 21′	22″
3	87° 15′	75″
4 (base of)	96° 25′ to 98° 4′	82″
4 (tip of N. wing)	90° 39′	
4 (tip of S. wing)	100° 10′	
5	101° 23′ to 118° 36′	136″ (nebulous cloud.)
6	146° 25′ to 149° 30′	45″
7	156° 46′ to 161° 59′	37″
8	230° 13′ to 245° 46′	75″
9	273° 27′	
10	282° 13′ to 293° 12′	52″
11	315° 54′ to 321° 12′	44″
12	342° 7′ to 343° 58′	15″

Observations on the application of photography to the determination of the times of contacts during the transit of Venus in 1874 *and* 1882.

We here venture a few remarks, showing the peculiar value of photography in the observations of the transits of Venus.

It has been shown that the sun's image was photographed on the camera plate with an exposure of only $\frac{1}{500}$th of a second; and the duration of exposure for any other instrument can be determined with as great precision by the method which I employed.

The instant the mechanical movement exposes the plate, it also records the time of that exposure on a chronograph connected with a break-circuit clock, and thus we have an accurately delineated *figure* of the transit corresponding to a *time* marked on the face of the clock employed; and this correspondence of figure and time is unaffected with personal equation either of sight or of hearing. Now if the error and rate of the clock can be entirely freed from the personal equation of the observer who determined them, and if the longitude of the station be found by the coincidences of the beats of a sidereal clock with those of a break-circuit mean solar clock placed at the observatory of the first meridian, we have the most accurate means of obtaining the *absolute* times of contacts at the station of observation.

Thus we see how applicable will be photography to these observations, for the data of the solar parallax will be given either by observing *the absolute time* of the ingress or of the egress (which method is alone of value in the transit of 1874), or by determining *the duration* of the transit of Venus over the solar disc. The photographs are *permanent* phenomena on which we can repeat our measures at leisure, with every appliance of precision, while it is impossible to attain a similar degree with eye and ear, from the difficulty of micrometically measuring at a *precise* instant the distance of Venus from the sun's limb, and from the (recorded) distortions of Venus at contacts.

It will also be of great value to have a photographic record of the appearance of Venus at the contacts, for, *if* the disc of the planet then should appear on the plate to depart from a circle and have attachments to the sun's limb, these distortions can be measured and allowed for.

An idea may be formed of the apparent size of Venus during its transit of the sun's disc, from the fact that the umbra of the solar spot in the south-west quadrant is 15$''$ in diameter, and that Venus at transit will subtend an angle of about 70$''$; so that the planet would appear on the plate as a disc $4\frac{2}{3}$ times the diameter of this spot, or, as a disc of .107 inch diameter on an image of the sun of 3 inches in diameter.

The negatives of these photographs I find from trial will stand a magnifying power of 50 under the micrometer, and as 1$''$ of arc will equal $\frac{1}{700}$th inch on a solar image of 3 inches diameter, we can, with the above mentioned power, divide a second into ten parts. This supposes, however, that the bisection by the micrometer thread is on a perfectly well defined point, and this does not exist in the outlines of any photograph, and especially is the limb of the sun indistinct on account of its shading, and of the manner in which the silver is deposited in the collodion film.

From actual experience in measurements under the micrometer, I find that we cannot, as yet, hope to make a bisection on the sun's limb closer than $\frac{1}{2}$ of a second. On the boundary of the umbra of a well defined solar spot, we can read to $\frac{1}{4}$ of a second, and from this I should think the $\frac{2}{10}$ of a second might probably be attained as the limit in a reading on the imb of the image of Venus.

But with measures as close as these, and the tables of Venus brought to the accuracy which existing unreduced observations can give, we may reasonably hope for a determination of the solar parallax comporting with the most exact astronomical measures of this century.

The Lehigh University, Pa., 7th September, 1869.

Stated Meeting, Oct. 15, 1869.

Present, eleven members.

Prof. Cresson in the Chair.

A letter from Prof. Newton of Yale College, to the Secretary, in behalf of M. St. Claire Deville, Director of the New Observatory at Paris, requesting exchanges, and announcing the transmission of the Bulletin of the Observatory, was read, and, on motion, the Observatory was ordered to be placed on the list of correspondents to receive the Proceedings.

Letters acknowledging the receipt of Transactions, Vol. XIII., Part 3, and Proceedings No. 81 were received from the Peabody Institute at Baltimore, and the New York Lyceum of Natural History.

Donations for the Library were received from Prof. Zantedeschi, the Essex Institute, the Boston S. N. H., the American Academy of Arts and Sciences, Mr. E. M. Stone, of Providence, the New York Lyceum, the Philadelphia Academy of Natural Sciences and Medical Journal, and the State Department and Coast Survey Bureau at Washington.

The Committee to which was referred the Memoir of Dr. Brinton, entitled the "Arowack Language of Guiana," &c., reported in favor of its publication in the Transactions; and on motion of Mr. Fraley it was so ordered.

Prof. Cresson laid before the Society a profile of the elevations attained by the recent flood in the Schuylkill river, for a distance of 34,200 feet above the dam at Fairmount, and from the dam to Chestnut street Bridge, with a table of heights reached by the floods of previous years. He ascribed the extra elevations, at certain points along the profile section, to the obstruction which a narrowing of the water basin, or a change in its direction, should produce. Instead of the usual difference of 1.8 foot, between the levels of the surface of the water, at the head and at the foot of Fairmount pool, there occurred a difference of 20 feet, at the height of the flood. Oscillations in the flood-level, averaging six minutes in duration, were observed on the shores, and in the forebay, near the dam, the greatest of which was about 18 inches in vertical extent. The maximum velocity of the water was about nine miles an hour where it passed over the dam.

Height of Water above.		*Water Works Guage.*	*City Datum.*
1822 Ice flood of	Feb. 21..........	9.08	...... 13.17 feet.
1839	Jan. 26..........	10.17	...... 14.25
1840	Feb. 10..........	7. 0	...... 11.09
1841	Jan. 7..........	8. 0	...... 12.09
1846	March4..........	7. 1	...... 11.17
1850 Summer	July 19..........	8. 0	...... 12.09
1850 Autumn	Sep. 2..........	10.92	...... 15.01
1857	....	7. 0	...... 11.09
1869	Oct. 4..........	11.64	...... 15.73

Nominations for membership were read and balloted for.

On motion, the New Bedford Public Library was ordered to be placed on the list of correspondents to receive the Proceedings from the beginning.

The ballot-boxes were then examined by the presiding officer, and the following persons declared duly elected members of the Society:

Miss Maria Mitchell, of Vassar College, N. Y.
Mrs. Mary Somerville, of England, now of Naples.
Mrs. Elizabeth Agassiz, of Cambridge, Mass.
Charles Darwin, of England.
George Rawlinson, of England.
Louis Gruner, Ecole des Mines, Paris.
Carl Vogt, of Geneva.
Carl T. E. Von Siebold, of Munich.
Carl Fr. Naumann, of Leipsig.

Ferdinand Von Hochstetter, of Vienna.
George Von Frauenfeld, of Vienna.
Philip T. Tyson, of Baltimore.
Edward Hopper, of Philadelphia.
Charles Bullock, of Philadelphia.
Alfred M. Mayer, of South Bethlehem, Pa.
George W. Anderson, of West Haverford, Pa.

And the Society was adjourned.

Stated Meeting, Nov. 5, 1869.

Present, fifteen members.

Mr. Fraley, Vice-President, in the Chair.

Mr. Edward Hopper was introduced to the presiding officer and took his seat.

Letters accepting membership were received from Miss Maria Mitchell, dated Vassar College, Pokeepsie, Oct. 22d, Mrs. Agassiz, dated Cambridge, Nov. 1, and Prof. Alfred M. Mayer, dated Lehigh University, S. Bethlehem, Oct. 26, 1869.

Letters of Envoi were received from the Academies at Vienna, Göttingen, Stockholm, the Royal Society, and the Manchester Literary and Philosophical Society.

Donations for the Library were received from the Acade mies at Stockholm, St. Petersburg, Copenhagen, and Philadelphia; the Societies at Riga, Moscow, Bamberg, Frankfort am Main, Manchester, Quebec, and Montreal; the Geographical and Geological Societies of Vienna, the Observatory at Göttingen, Prof. Rütimeyer at Basil, the Observatory of Montsauris, the Anthropological Society and School of Mines, at Paris, the Royal Society, and Meteorological Committee, R. Geographical, Zoological and Asiatic Societies at London, the R. Geological Society at Dublin, the Franklin Institute, Prof. Kirkwood, and the Cornell Library at Ithaca, N. Y.

A Communication for Publication in the Proceedings of the Society was received from Dr. Hayden, entitled Field Notes on the Geology of Colorado and New Mexico, by F. V. Hayden, U. S. Geologist.

On motion, permission was granted to Mr. George Harding to have a photographic copy made of the Society's engraved likeness of Chief Justice Marshall.

Mr. Price, as Chairman of the Michaux Legacy Committee, reported that the Society was now in possession of the documents sent by M. Carlier, and moved the following resolution, which was adopted;

RESOLVED, That the thanks of the American Philosophical Society are due and are hereby cordially tendered to M. Auguste Carlier, for his devoted attention to and successful accomplishment of the establishment of the claim of the society for the legacy given by the will of the late André François Michaux for its use, and that the officers of the society be requested to transmit a copy of this resolution to him, in testimony of their grateful appreciation of his disinterested services in the matter of said claim.

A paper entitled Second Addition to the History of the Fishes of the Cretaceous of the United States, by Ed. D. Cope, was presented and its reading postponed. (See page 240.)

And the Society was adjourned.

Stated Meeting, Nov. 19th, 1869.

Present, fourteen members.

Mr. Cresson, Vice-President, in the Chair.

A letter, dated Paris, Oct. 25th, 1869, was read from M. Carlier, informing the Society officially of the termination of his duties as agent for the Society in the matter of the Michaux Legacy.

Circular letters were read, dated Nov. 1, 1869, from Mr. Axel Erdmann, chief of the Geological Survey of Sweden, announcing the transmission of charts and pamphlet descriptions of the Survey, and requesting exchanges.

Donations for the Library were received from the Swedish Survey, the Geographical Society of Paris, the London Astronomical Society, the Boston Society of Natural History, Yale College, Dr. Newberry, the New Jersey Historical Society, the General Superintendent of Freedmen Schools at Washington, and Dr. J. W. Hoyt of Wisconsin.

A communication was read entitled "On Comets and Meteors, by Daniel Kirkwood, LL. D., Professor in Indiana University." (See page 215.)

A communication was read by Judge Lowrie, entitled a search for a "Normal Cause of the Recession of Cosmical Nodes." (See page 220.)

Dr. G. B. Wood exhibited a number of Indian relics, disinterred from a bed of sand in the neighborhood of his residence in Southern New Jersey, consisting of portions of the skull and leg bones of a man, who had been buried in a sitting posture, with the face towards the East; and a finely wrought celt, or hatchet to be held in the hand, and a flaked spear-head, buried with the corpse. The bones were not fossilized; but their cancellated tissues were filled with fine sand, and their age appeared very considerable when a comparison was instituted with those of the skeleton of a white man, buried in the same neighborhood, about a century ago. There were also obtained, from that neighborhood, rubbed and furrowed hammer-heads, a large and well formed pestle, other implements apparently made out of Delaware pebbles, and a large quern, or mill-stone, of rock brought also from a distance. A ridge, composed chiefly of oyster-shells, near by, is popularly accounted for by supposing it to have been formed of the refuse of the food of the aborigines. Dr. H. C. Wood explained it as an out-crop of a shell-bed of Eocene Tertiary age. This is the more interesting, as the Tertiaries of New Jersey have been supposed to belong exclusively to the Miocene age.

Dr. H. C. Wood communicated to the Society some recent experiments which he had made with Veratria, after which he considered it proved, that purgation was connected especially with the action of the pneumo-gastric nerve-system.

The minutes of the Board of Officers and Members in Council were read.

Dr. Carson described the character of the Memoir upon the Physiological Qualities of American Hemp, and the reasons influencing the Board to recommend it, not for the Magellanic, but for an extra premium, in accordance with the action of the Society, of date Feb. 12, 1864; whereupon, on the motion of Mr. Fraley, it was

Resolved, That an appropriation of one hundred dollars be made from the income of the Magellanic Fund, for the payment of the said premium, and that said sum be transmitted to the author of the essay, with a suitable certificate engrossed on parchment, of the award of said premium, said certificate to be under the Seal of the Society, and to be attested by the signature of the officers thereof.

Resolved: That said essay be published in the proceedings. (P. 226.)

New nominations Nos. 643 to 648 were read.

ON COMETS AND METEORS.

By Daniel Kirkwood, LL. D., Professor in Indiana University.

Read before the American Philosophical Society, Nov. 19, 1869.

The comets which passed their perihelia in August, 1862, and January, 1866, will ever be memorable in the annals of science, as having led to the discovery of the intimate relationship between comets and meteors. These various bodies found revolving about the sun in very eccentric orbits may all be regarded as similar in their nature and origin, differing mainly in the accidents of magnitude and density. The recent researches, moreover, of Hoek, Leverrier and Schiaparelli, have led to the conclusion that such objects exist in great numbers in the interstellar spaces; that in consequence of the sun's progressive motion they are sometimes drawn towards the centre of our system; and that if undisturbed by any of the large planets they again pass off in parabolas or hyperbolas. When, however, as must sometimes be the case, they approach near Jupiter, Saturn, Uranus or Neptune, their orbits may be transformed into ellipses. Such, doubtless, has been the origin of the periodicity of the August and November meteors, as well as of numerous comets.

In the present paper it is proposed to consider the probable consequences of the sun's motion through regions of space in which cosmical matter is widely diffused; to compare these theoretical deductions with the observed phenomena of comets, ærolites and falling stars; and thus, if possible, explain a variety of facts in regard to those bodies, which have hitherto received no satisfactory explanation.

1. As comets now moving in elliptic orbits owe their periodicity to the disturbing action of the major planets, and as this planetary influence is sometimes sufficient, especially in the case of Jupiter and Saturn, to change the *direction* of cometary motion, the great majority of periodic comets should move in the same direction with the planets. Now, of the comets known to be elliptical, 70 per cent. *have direct motion.* In this respect, therefore, theory and observation are in striking harmony.

2. When the relative positions of a comet and the disturbing planet are such as to give the transformed orbit of the former a small perihelion distance, the comet must return to the point at which it received its greatest perturbation; in other words, to the orbit of the planet. The aphelia of the comets of short period ought therefore to be found, for the most part, *in the vicinity of the orbits of the major planets.* The actual distances of these aphelia are as follows:

I. *Comets whose Aphelion Distances are Nearly Equal to* 5.20, *the Radius of Jupiter's Orbit.*

Comets.	Aph. Dist.	Comets.	Aph. Dist.
1. Encke's	4.09	7. 1766 II.	5.47
2. 1819 IV.	4.81	8. 1819 III.	5.55
3. De Vico's	5.02	9. Brorsen's	5.64
4. Pigott's (1743)	5.28	10. D'Arrest's	5.75
5. 1867 II.	5.29	11. Faye's	5.93
6. 1743 I.	5.32	12. Biela's	6.19

II. *Comets whose Aphelion Distances are Nearly Equal to* 9.54, *the Radius of Saturn's Orbit.*

Comets.	Aph. Dist.
1. Peters' (1846 VI.)	9.45
2. Tuttle's (1858 I.)	10.42

III. *Comets whose Aphelion Distances are Nearly Equal to* 19.18, *the Radius of Uranus's Orbit.*

Comets.	Aph. Dist.
1. 1867 I.	19.28
2. Nov. Meteors.	19.65
3. 1866 I.	19.92

IV. *Comets whose Aphelion Distances are Nearly Equal to* 30.04, *the Radius of Neptune's Orbit.*

Comets.	Aph. Dist.	Comets.	Aph. Dist.
1. Westphal's (1852 IV.)	31.97	4. De Vico's (1846 IV.)	34.35
2. Pons' (1812)	33.41	5. Brorsen's (1847 V.)	35.07
3. Olbers' (1815)	34.05	6. Halley's	35.37

The coincidences here pointed out (some of which have been noticed by others,) appear, then, to be necessary consequences of the motion of the solar system through spaces occupied by meteoric nebulæ. Hence the observed facts receive an obvious explanation.

In regard to comets of long period we have only to remark that, for any thing we know to the contrary, there may be causes of perturbation far exterior to the orbit of Neptune.

3. From what we observe in regard to the *larger* bodies of the universe —a clustering tendency being everywhere apparent,—it seems highly improbable that *cometic and meteoric* matter should be uniformly diffused through space. We would expect, on the contrary, to find it collected in cosmical clouds, similar to the visible nebulæ. Now, this, in fact, is precisely what has been observed in regard both to comets and meteors. In

150 years, from 1600 to 1750, 16 comets were visible to the naked eye ;* of which 8 appeared in the 25 years from 1664 to 1689. Again, during 60 years, from 1750 to 1810, only 5 comets were visible to the naked eye, while in the next 50 years there were double that number. The probable cause of such variations is sufficiently obvious. As the sun in his progressive motion approaches a cometary group, the latter must, by reason of his attraction, move toward the centre of our system, the nearer members with greater velocity than the more remote. Those of the same cluster would enter the solar domain at periods not very distant from each other; the forms of their orbits depending upon their original relative positions with reference to the sun's course, and also on planetary perturbation. It is evident also that the passage of the solar system through a region of space comparatively destitute of cometic clusters would be indicated by a corresponding paucity of comets. By the examination, moreover, of any complete table of falling stars we shall find a still more marked variation in the frequency of meteoric showers.

Previous to 1833, the periodicity of shooting stars had not been suspected. Hence the showers seen up to that date were observed *accidentally*. Since the great display of that year, however, they have been regularly *looked for*, especially at the November and August epochs. Consequently the numbers recently observed cannot properly be compared with those of former periods. Now, according to the Catalogue of Quetelet, 244 meteoric showers were observed from the Christian era to 1833. These were distributed as follows :

Centuries.	*No. of Showers.*	*Centuries.*	*No. of Showers.*
0 to 100	5	1000 to 1100	22
100 to 200	0	1100 to 1200	12
200 to 300	3	1200 to 1300	3
300 to 400	1	1300 to 1400	4
400 to 500	1	1400 to 1500	4
500 to 600	20	1500 to 1600	7
600 to 700	1	1600 to 1700	7
700 to 800	14	1700 to 1800	24
800 to 900	37	1800 to 1833	48
900 to 1000	31		

A remarkable secular variation in the number of showers is obvious from the foregoing table. During the 5 centuries from 700 to 1200, 116 displays are recorded ; while in the 5 succeeding, from 1200 to 1700, the number is only 25. It will also be observed that another period of abundance commenced with the 18th century. A catalogue of meteoric stonefalls indicates also a corresponding increase in the number of ærolites, which cannot be wholly accounted for by the increased number of observers. Now, there are two obvious methods by which these variations may be explained. Either (1) the orbits of the meteoric rings which

*See Humboldt's Cosmos, vol. IV. p. 538, The writer called attention to this variation as long since as 1861.

intersect the earth's path were so changed by perturbation towards the close of the 12th century as to prevent the appulse of the meteoric groups with the earth's atmosphere ; or, (2) the nebulous matter is very unequally diffused through the sidereal spaces. That the former has not been the principal cause is rendered extremely probable by the fact that the number of epochs of periodical showers was no greater during the cycle of abundance than in that of paucity. We conclude, therefore, that during the interval from 700 to 1200 the solar system was passing through, or near, a meteoric cloud of very great extent ; that from 1200 to 1700 it was traversing a region comparatively destitute of such matter ; and that about the commencement of the 18th century it again entered a similar nebula of unknown extent.

The fact that the August meteors, which have been so often subsequently observed, were *first* noticed in 811, renders it probable that the cluster was introduced into the planetary system not long previous to the year 800. It may be also worthy of remark that the elements of the comet of 770 A. D., are not very different from those of the August meteors and the 3d comet of 1862.*

Adopting Struve's estimate of the sun's orbital velocity, we find the diameter of the nebula traversed in 500 years to be 14 times that of Neptune's orbit.

It is remarkable that with the exception of Mars the perihelia of the orbits of all the principal planets fall in the same semi-circle of longitude—a fact which can hardly be regarded as accidental. Now, if the orbits were orginally circular, the motion of the solar system through a nebulous mass not of uniform density would have the obvious effect of compelling the planets to deviate from their primitive orbits and move in ellipses of various eccentricities. It is easy to perceive, moreover, that the original perihelion points of all the orbits would be on that side of the system which had passed through the rarer portion of the nebulous mass. We have thus a possible cause of the eccentricity of the planetary orbits, as well as of the observed distribution of their perihelia.†

4. The particles of a cometic mass, being at unequal distances from the sun, will tend to move at different rates and in somewhat different orbits. This tendency will gradually overcome the feeble attractive force between the particles themselves. The most distant parts will thus become separated from the nucleus, and move in independent orbits. The motion of such meteoric matter will be in the same plane with that of the parent comet ; the orbit of the former, however, being generally exterior to that of the latter. The connection recently discovered between comets and meteors, and especially the fact that the period of the

* The interval between the perihelion passage of 770 and that of 1862 is equal to 9 periods of 121.36 years. Oppolzer's determination of the period of 1862 III. is 121.5 years. Hind remarks that the elements of the comet of 770 are "rather uncertain," but says "that the general character of the orbit is decided." It may be worthy of remark that a great meteoric shower, the exact date of which has not been preserved, occurred in 770.

† This suggestion is due to R. A. Proctor, F. R. A. S., the distinguished author of "Saturn and its System."

November group is somewhat greater than that of the comet of 1866, are in striking harmony with the views here presented.

5. Owing to this loss of matter, periodic comets must become less brilliant, other things being equal, at each successive return ;—a fact observed in regard to the comets of Halley and Biela.

6. The line of apsides of a large proportion of comets will be approximately coincident with the solar orbit. The point towards which the sun is moving is in longitude about 260°. The quadrants bisected by this point and that directly opposite extend from 215° to 305°, and from 35° to 125°. The number of cometary perihelia found in these quadrants up to July, 1868, (periodic comets being counted but once) was 159, or 62 per cent.; in the other two quadrants, 98, or 38 per cent.

This tendency of the perihelia to crowd together in two opposite regions has been noticed by different writers.

7. Comets whose positions before entering our system were very remote from the solar orbit must have *overtaken* the sun in its progressive motion; hence their perihelia must fall for the most part, in the vicinity of the point towards which the sun is moving; and they must in general have very small perihelion distances. Now, what are the observed facts in regard to the longitudes of the perihelia of the comets which have approached within the least distance of the sun's surface? But three have had a perihelion distance less than 0.01. *All* these, it will be seen by the following table, have their perihelia in close proximity to the point referred to:

I. *Comets whose Perihelion Distances are Less than* 0.01.

Perihelion Passage.					*Per. Dist.*	*Long. of Per.*	
1.	1668, Feb.	28*d.*	13*h.*		0.0047	277°	2′
2.	1680, Dec.	17	23		0.0062	262	49
3.	1843, Feb.	27	9		0.0055	278	39

In table II. all but the last have their perihelia in the same quadrant.

II. *Comets whose Perihelion Distances are Greater than* 0.01 *and Less than* 0.05.

Perihelion Passage.				*Per. Dist.*	*Long. of Per.*	
1.	1689, Nov.	29*d.*	4*h.*	0.0189	269°	41′
2.	1816, March	1	8	0.0485	267	35
3.	1826, Nov.	18	9	0.0268	315	31
4.	1847, March	30	6	0.0425	276	2
5.	1865, Jan.	14	7	0.0260	141	15

The perihelion of the first comet in table III. is remote from the direction of the sun's motion; that of the second is distant but 14°, and of the third, 21°.

III. *Comets whose Perihelion Distances are Greater than* 0.05 *and Less than* 0.1.

Perihelion Passage.	*Per. Dist.*	*Long. of Per.*
1. 1593, July 18*d.* 13*h.*	0.0891	176° 19′
2. 1780, Sept. 30 22	0.0963	246 35
3. 1821, March 21 12	0.0918	239 29

With greater perihelion distances the tendency of the perihelia to crowd together around the point indicated is less distinctly marked.

8. Few comets of small perihelion distance should have their perihelia in the vicinity of longitude 80°, the point opposite that towards which the sun is moving. Accordingly we find, by examining a table of cometary elements, that with a perihelion distance less than 0.1, there is not a single perihelion between 35° and 125°; between 0.1 and 0.2, but 3; and between 0.2 and 0.3 only 1.

Bloomington, Indiana, *September* 14*th*, 1869.

A SEARCH FOR A NORMAL CAUSE OF THE RECESSION OF COSMICAL NODES.

By Hon. Walter H. Lowrie.

Read before the American Philosophical Society, Nov. 19, 1869.

The analogy between the recession of the nodes of all the planets and satellites of the solar system, including that of the earth, called the precession of the equinoxes, is so complete and manifest that the mind, on the discovery of it, naturally inclines to attribute them all to like causes. These phenomena have not been so treated heretofore, but have been regarded as disturbances produced by various causes, the influence of which I do not feel entitled to question, while I think there is a normal cause which ought to be considered.

It seems to me to be a proposition of axiomatic plainness, that, in any system or sub-system of moving bodies, all its periodic motions ought to be presumed normal, rather than abnormal, that is, the causes of them ought to be first sought in the plan of the system itself; and only when this search fails ought we to suspect them to be disturbances caused by forces which are alien to the system. Thus, all the periodic motions of the planets ought to be presumed to depend on their relation to the sun, until the contrary appears; and all the periodic motions of the satellites ought to be presumed to depend upon their several planets.

Our scientific systems consist only of the elements from which, and of the order by which we construct them, and are, therefore, charged with all the defects of our knowledge and constructive skill. In the early stages of astronomy, many phenomena were treated as exceptional and disturbing, which are now known to be normal pulsations of the *vis viva* of the solar system, because now this force is better comprehended. And the same is true of all growing sciences. All our scientific systems are accustomed to discover that their ideals of nature are often very unreal, and that the perturbations, which they attribute to nature, belong only to themselves. Newly discovered facts or principles must always cause some derangement or re-arrangement of the old furniture of the school that admits them.

Now that we know that the solar system is a part of a much grander system, in which the sun itself revolves, we have a fact which is, in many respects of great astronomical importance, and which did not enter into the inductions of former times ; and considering its character, it is not unnatural to suppose that it is an essential element in all the motions of the system. If this be so, then our whole system of astronomical dynamics must, to some extent, open up to admit its influence and to submit to such modifications as it may require.

This fact can no more be without influence on the motions of the planets, than can be the revolution of the planets on their satellites. It necessarily made a great change in our knowledge of the form of planetary orbits, though it may not greatly change our reasoning about them. And yet, what is the parallax of a star worth to us now, unless we know whether the sun's motion (say 150,000,000 miles a year) was taken into account, and whether the base of the parallactic angle was 190,000,000 + 75,000,000 miles, or 190,000,000—75,000,000, or some chord of intermediate length ? How, without this, shall we value any ancient observation of the place of a star, or the record of stellar movements supposed to be made in the construction of the pyramids ? It may now be thought better to take one, or ten, or more years of the sun's motion in the base of such an angle.

Such changes in scientific theories do not often make any serious changes in the laws which observation had discovered as facts, but rather account for them, and show the common bond that unites them in nature and in reason. When the centre of cosmical motion was transferred from the earth to the sun, the laws of the solar system, as they had been learned before, were not annulled. When light changed its base from EMISSION to UNDULATION, the laws of optics were not seriously affected. A law may be true as an expression of observed phenomena, even when its principle is unknown or mistaken, or when it is erroneously supposed to be itself a final and independent principle.

I think the normal cause, not to speak of disturbing ones, of the recession of the nodes can be found in the system or sub-system to which the motion belongs, and that it is the same everywhere. It seems to me to be a necessary consequence of the inclination of the dependent to the principal orbit, and, so far as we know, this form pervades the whole solar system.

True, we know not yet the direction of the real orbit of the sun, and, therefore, cannot tell how the other orbits are inclined to it. But we know that all the others have different inclinations, and that, therefore, not more than one, and probably none, of them coincides with the sun's. And if the observations of Sir William Herschel and his successors, on the course of the sun, are near the truth, then it is proved that all are so inclined; and we do not mark recessions on the sun's orbit because we have not yet found where it is. Finding the law that recession of nodes always accompanies their existence, we naturally expect a like cause for all cases, a cause growing out of like relations to the main force of the system or sub-system; and therefore we ought to study how the central force operates on a dependent body moving in that form.

Let us be sure, even at the risk at an unnecessary presentation of rudiments, that we have a right possession of this phenomenon of the recession of the nodes, and that it is a phenomenon of the earth's motion. It is, of course, difficult for a person unused to the study of the motions of the solar system to form or retain very clear conceptions of all their changing complications. He will often be mistaken in his geometry of the heavens, and may seldom have the pleasure of more than a transient confidence in his conceptions about it. Occupying a revolving and rotating position, and obliged to find from it the courses and velocities of the shifting currents of the cosmical ocean, and fix them by the floating landmarks of the skies, he will often get confused and suspect himself incompetent.

We shall not need to go beyond the instances of the earth and moon to get illustrations of this motion sufficient to show its unity of form and unity of relation to the central body. It is involved in the geometrical conception of a cosmical system, that, where its orbital planes differ in inclination, each must internode with all the others by a line passing through their common centre, and this is the line of its nodes. But if the planes always maintained the same direction in space, there could be no motion of nodes, and these cross-roads of the skies would be less important and interesting than they now are.

It is admitted that the axes of rotation of all the planets and satellites, except the earth, are fixed and stable, so that they change direction only *with* their orbital planes and not *in* them, and it is supposed that the earth alone tilts *in* its plane. It is admitted also that all these planes except the earth's have a constant warping or tilting motion westward, and that their bodies tilt *with* them, and this causes these planes to cut through any fixed plane further westward in each revolution, and the lines of their nodes to recede on any such plane, and the ecliptic is taken as such a one; but it is supposed that a similar appearance is produced, relative to the earth, by a tilting of the earth itself *in* its plane, marked by its equator on the ecliptic, and not by a tilting *of* its plane. If this be so, then the earth has the same tilt *in* the moon's plane also, and this would be a further anomaly.

Possibly these differences of statement may be accounted for from the fact, that, besides our ignorance of the sun's motion, the recession of nodes can have value for us only as the nodes are stations on the earth's orbital plane, and can be noted as crossings of this great highway; and, of course, the ecliptic can be no measure of its own inclination, or revolutions, or recession. Certainly the ecliptic does appear to have a tilting motion, completing a revolution in 25,868 years, so that the sun, in that time, will appear to pass over all the stars that are between the tropical circles. And why should we treat this as only an apparent motion of the earth's orbital plane, while admitting that it is real in all other cases?

It may help us here if we take notice of a class of cases wherein there is a real tilting of the axis of rotation of a body *in* its orbital plane. They are all cases where a body moves in two planes at once; as a planet with a satellite, having an inclined orbit, where there is a conflict of two forces, represented by the two planes, and an accommodation between them. Here we assume that the earth, without the moon, would have no tilt or change of direction of its axis *in* its own plane. But it is also in the moon's plane, and this has a tilting revolution round the earth in 19 years. Then this relation of the earth and moon is analogous to their connection by a lever, representing their mutual attraction in the line of the moon's nodes, the fulcrum being their common centre of gravity. If the earth's axis had a fixed position on this lever, it would go with it, and thus have a real tilt *in* its own plane equal to double the inclination of the moon's plane. But it is held by the greater force represented by its own plane and its centre, so that this tilt is very small, called its nutation, having a period of nineteen years, and being only another aspect of the revolution of the moon's nodes. It would perform an ellipse round the ideal pole of the heavens; but, by its combination with the greater motion of the earth's pole by the recession of *its* nodes, it becomes a series of 19-year scollops in that ellipse. Here is a case and a cause of tilting *in* a plane, which no doubt exists in all planets which have satellites, and even in the sun itself, and I think that no other such a case is known to astronomy.

We know of no cosmical cause for this fixedness of axes of rotation; but, without it, we could have no science of astronomy, no measure of time, no measure of direction or position beyond the earth itself; for upon this depends, directly or indirectly, all our astronomical measures. If the earth's orbital plane tilts and revolves, and thus changes the direction of the earth's axis, it is with so slow a movement as not to embarrass the observations and calculations of a human lifetime, and scarcely those of human history, but only to mark those immense periods by which eternity is terraced off before and behind us. If this plane does thus revolve, and if its axis is inclined to the axis of the earth, no matter what may be the dip of its tilt, the poles of the two axes will revolve around each other, and always maintain to each other the same angle of inclination, unless there be some cause that affects the fixedness of one of them.

We are to seek the cause of recession of nodes in a system so constructed and so operating, by the force of cosmical attraction, that this very force will appear to be the cause, and that we may see its mode of operation, if it be really there. To illustrate such a structure, we may take any planet or satellite of the solar system ; for all alike have this cosmical force and this inclination of orbital plane, and this recession of nodes.

We take the moon in its revolution. Because of this inclination, one half of its orbit is above and the other half below the plane of the earth's orbit. While the earth is sweeping around in its great orbit, it swings the moon around it, as upon an epicycle of which the earth is the centre. A proper conception of these two motions in relation to each other gives us the direction of the central force which produces the moon's motion.

It is never directed from a point fixed as the centre of the orbit, nor from a straight line, constituted by a motion of such a point, but from a centre always moving in a line curving eastwardly, and in a direction differing from that of the moon's orbit according to the different inclinations of the earth's and the moon's orbits. It is the very force which bears the moon forward in space, and yet, by reason of the form of their connection, it is always moving laterally and eastwardly out of the centre of the moon's plane, and tending also to push forward through and beyond the plane, and thus it is all the while exerting its force in a sort of twisting of the moon's orbit into perpetual accommodation to the curve of the orbit of its primary.

The result of this is, that no matter what may be the position of the moon's plane, this force, always departing from a right line, constantly draws the moon down or up through the plane of the earth's orbit sooner in each successive revolution; and this is equivalent to a westward warping or tilting motion of the moon's plane, so that it cuts that of the earth more and more westward in each revolution; and this would constitute a constant recession of the nodes, even if there were no other causes of it; and it ought not to be overlooked.

If this is a correct reading of this force and its dependent motions, which I submit to those who may consider the subject worth thinking about, then the central force of every planet operates in precisely the same form on its satellites, where their orbital planes are inclined, varied only according to their degrees of inclination. And, of course, the sun (assuming its motion to be as heretofore stated) operates in the same way upon all the planets, so as to produce a recession of their nodes; and the phenomenon of recession of nodes, even if not entirely normal, has a perfectly normal cause.

It follows also, that wherever we find a constant recession of the nodes of a secondary body, we may naturally infer that its primary is itself revolving around some central body; though it will be impossible to say that this product of the central force may not be entirely merged in the product of some disturbing force.

Dr. Whewell regards the discovery of the precession of the equinoxes, resulting from the attraction of the sun and moon on the earth's equatorial protuberance, as a remarkable example of the consilience of inductions; but surely this consilience is more impressive when we notice that that form of attraction is enterely singular, not being known to exist in any other, even analogous, case; whereas, the form here suggested applies to every case where there are revolving nodes; that it presents the motion as a perfectly normal consequence of the central force of each system or sub-system, operating directly upon its dependent body according to the relation of its orbit; and that it recognizes a physical, along with a formal, unity in the plan of the whole system, and satisfies the second of Newton's "Rules of philosophizing," that "Natural effects of the same kind are to be referred to the same cause, so far as can be done." The other theory has this difficulty to contend with: that we suppose all planets to have equatorial protuberances, as an effect of rotation; and, so far as we know, all have inclined axes; and yet we do not attribute to them precession of equinoxes and recession of nodes as two different motions. Both exist, but only as different aspects of the same motion.

But the views here presented are not without serious difficulty in their ulterior application. If the cause here suggested is true, then it seems natural to seek some proportion in time between the revolutions of the nodes and those of the central bodies on which they depend; a proportion modified by the differences of relation in space and time in which the several secondaries stand to their primaries. I do not discover the law of such a proportion, or even that it surely exists. If it were discovered it would probably be of use in seeking the period and orbit of the sun's revolution.

So far as our knowledge goes at present, we find that it always requires many revolutions of a planet or satellite for one revolution of its nodes, and they differ very greatly. In one revolution of its nodes Mercury revolves in its orbit over 500,000 times; Venus, 100,000; the earth, 25,000; Mars, 27,000; Jupiter, near 7,000; Saturn, 2,200; and Uranus, 428. No others revolve in so short a *time* as those of the earth. Among the satellites, the moon revolves 230 times for one revolution of its nodes; Jupiter's 2d satellite, 3,000; its 3d, 7,000; its 4th, 11,000 times.

And in all known cases the central body revolves more frequently than the nodes of its dependent. Thus the earth revolves in its orbit near 19 times for one revolution of the moon's nodes; Jupiter $2\frac{1}{2}$ times for once of the nodes of its 2d satellite, 12 times for its 3d, and 45 times for its 4th satellite. All this would seem to indicate a period for the sun's revolution round its unknown centre, which would be a very small fraction of any estimate of it that I have seen, founded on observations of stellar parallaxes. I find no clue to the solution of this apparent anomaly; I hope some other inquirer may.

ON THE MEDICAL ACTIVITY OF THE HEMP PLANT, AS GROWN IN NORTH AMERICA.

By Dr. Horatio C. Wood, Jr., Prof. of Botany, University of Pennsylvania; Secretary of the Committee of the College of Physicians of Philadelphia on the Revision of U. S Pharmacopeia.

A prize essay, read before the Amer. Phil. Soc., Nov. 19, 1869.

Almost from time immemorial various preparations of the hemp plant have been used in India for the production of a peculiar intoxication. These, or allied preparations have also in modern times been largely used in medicine. It has been thought by some that the hemp of India is specifically distinct from the European plant, but there are really no specific differences, the former differing from the latter only in minor particulars, such as size, the results of the modifying influences of soil and climate. As the drug has become an important article of commerce, attempts have been made to obtain the medicinal principle, a peculiar resinoid body, from plants grown in Great Britain, by which it has been determined that although the resin does exist in such plants, yet it is in so small quantity, that they are not available for manufacturing purposes. The summers of England appear to be too cool to enable the hemp to elaborate its peculiar resin in any quantity. The world has, therefore, been dependent upon India for its supplies of this widely used narcotic. The plants with which the following experiments were made, were raised in the vicinity of Lexington, Kentucky. They were male plants, which had been grown for the purpose of fertilizing seeding female plants, and which having fulfilled that office, were of no further value to the cultivator. They were obtained for me, by R. B. Hamilton, Esq. of Lexington, to whom my thanks are due for the trouble taken by him to aid my investigation.

The first experiment was as follows: an ounce and a half of the powdered leaves, were treated with hot alcohol, although not to exhaustion. The tincture thus made was evaporated and an alcoholic extract obtained. About $4\frac{1}{2}$ P. M., Sept. 23d, I took most of this extract, in a lump, which a druggist estimated to contain from 20 to 30 grains. No immediate symptoms were produced. About 7 P. M., a professional call was requested and forgetting all about the hemp, I went out and saw my patient. Whilst writing the prescription, I became perfectly oblivious to surrounding objects but went on writing, without any check to or deviation from the ordinary series of mental acts, connected with the process, at least that I am aware of. When the recipe was finished, I suddenly recollected where I was, and looking up, saw my patient sitting quietly before me. The conviction was irresistible, that I had sat thus many minutes, perhaps hours, and directly, the idea fastened itself that the hemp had commenced to act, and had thrown me into a trance-like state of considerable duration, during which I had been stupidly sitting before my wondering patient.

I hastily arose and apologized for remaining so long, but was assured

I had only been a very few minutes. About $7\frac{1}{2}$ P. M. I returned home. I was by this time quite excited, and the feeling of hilarity now rapidly increased. It was not a sensuous feeling, in the ordinary meaning of the term; it was not merely an intellectual excitation, it was a sort of *bien-être* — the very opposite to *malaise*. It did not come from without; it was not connected with any passion or sense. It was simply a feeling of inner joyousness; the heart seemed buoyant beyond all trouble; the whole system felt as though all sense of fatigue were forever banished; the mind gladly ran riot, free constantly to leap from one idea to another, apparently unbound from its ordinary laws. I was disposed to laugh; to make comic gestures—one very frequently recurrent fancy, was to imitate with the arms the motions of a fiddler, and with the lips the tune he was supposed to be playing. There was nothing like wild delirium, nor any hallucinations that I remember. At no time had I any visions, or at least any that I can now call to mind; but a person, who was with me at that time, states that once I raised my head and exclaimed, "Oh, the mountains! the mountains!" Whilst I was performing the various antics, already alluded to, I knew very well I was acting exceedingly foolishly but could not control myself.

I think it was about 8 o'clock, when I began to have a feeling of numbness in my limbs, also a sense of general uneasiness and unrest, and a fear lest I had taken an overdose. I now constantly walked about the house, my skin to myself was warm, in fact my whole surface felt flushed; my mouth and throat were very dry; my legs put on a strange, foreign feeling, as though they were not a part of my body. I counted my pulse and found it 120, quite full and strong. A foreboding, an undefined, horrible fear, as of impending death, now commenced to creep over me; in haste I sent for Dr. H. Allen, and he being out, directly afterwards for Dr. Thomas. The curious sensations in my limbs increased. My legs felt as though they were waxen pillars beneath me. I remember feeling them with my hand and finding them, as I thought at least, very firm, the muscles all in a state of tonic contraction. About 8 o'clock, I began to have marked "spells"—periods when all connection seemed to be severed between the external world and myself. I might be said to have been unconscious during these times, in so far that I was oblivious to all external objects, but on coming out of one, it was not a blank, dreamless void upon which I looked back, a mere empty space, but rather a period of active but aimless life. I do not think there was any connected thought in them; they seemed simply wild reveries, without any binding cord; each a mere chaos of disjointed ideas. The mind seemed freed from all its ordinary laws of association so that it passed from idea to idea, as it were, perfectly at random.

The duration of these spells to me was very great, although they really lasted but from a few seconds to a minute or two. Indeed I now entirely lost my power of measuring time. Seconds seemed hours; minutes seemed days; hours seemed infinite. Still I was perfectly conscious during the intermissions between the paroxysms. I would look at my watch, and then after an hour or two, as I thought, would look again and find that scarcely five minutes had elapsed. I would gaze at its face in deep disgust, the minute hand seemingly motionless as though graven in the face itself; the laggard second hand moving slowly, so slowly. It appeared a hopeless task to watch during its whole infinite round of a minute, and always would I give up in despair before the 60 seconds had elapsed. Occasionally, when my mind was most lucid, there was in it a sort of duplex action in regard to the duration of time. I would think to myself it has been so long since a certain event, an hour for example, since the doctor came, and then reason would say, no it has been only a few minutes, your thoughts or feelings are caused by the hemp. Nevertheless I was not able to shake off this sense of the almost indefinite prolongation of time, even for a minute. The paroxysms already alluded to, were not accompanied with muscular relaxation. About quarter before 9 o'clock, I was standing at the door, anxiously watching for the doctor, and when the spells would come on I would remain standing, leaning slightly, perhaps, against the doorway. After awhile, I saw a man approaching, whom I took to be the doctor. The sounds of his steps told me he was walking very rapidly, and he was under a gas lamp, not more than one-fourth of a square distant, yet he appeared a vast distance away and a corresponding time approaching. This was the only occasion, in which I noticed an exaggeration of distance; in the room it was not perceptible. My extremities now began to grow cold and I went into the house. I do not remember further, until I was aroused by Dr. Thomas shaking or calling me. Then intellection seemed pretty good. I narrated what I had done and suffered, and told the doctor my opinion was, that an emetic was indicated both to remove any of the extract still remaining in my stomach and also to arouse the nervous system. I further suggested our going into the office as more suitable than the parlor, where we then were. There was at this time a very marked sense of numbness in my limbs, and what the doctor said was a hard pinch, produced no pain. When I attempted to walk up stairs my legs seemed as though their lower halves were made of lead. After this there were no new symptoms, only an intensifying of those already mentioned. The periods of unconsciousness became at once longer and more frequent, and during their absence intellection was more imperfect, although when thoroughly roused, I thought I reasoned and judged clearly. The oppressive feeling of impending death became more intense. It was horrible. Each paroxysm would seem to have been the longest I had suffered: as I came out of it, a voice seemed constantly saying, "you are getting worse—your paroxysms are growing longer and deeper—they will overmaster you—you will die."

A sense of personal antagonism between my will power and myself, as affected by the drug, grew very strong. I felt as though my only chance was to struggle against these paroxysms; that I must constantly arouse myself by an effort of will, and that effort was made with infinite toil and pain. I felt as if some evil spirit had control of the whole of me, except the will power, and was in determined conflict with that, the last citadel of my being. I have never experienced anything like the fearful sense of almost hopeless anguish and utter weariness which was upon me.

Once or twice during a paroxysm, I had what might be called night-mare sensations; I felt myself mounting upwards, expanding, dilating, dissolving into the wide confines of space, overwhelmed by a horrible, rending, unutterable despair. Then with tremendous effort, I seemed to shake this off, and to start up with the shuddering thought, next time you will not be able to throw this off, and what then! Under the influence of an emetic I vomited freely without nausea and without much relief. About midnight, at the suggestion of the doctors, I went up stairs to bed. My legs and feet seemed so heavy I could scarcely move them, and it was as much as I could do to walk with help. I have no recollection, whatever, of being undressed, but am told I went immediately to sleep. When I awoke early in the morning, my mind was at first clear, but in a few minutes the paroxysms, similar to those of the evening, came on again, and recurred at more or less brief intervals until late in the afternoon. All of the day there was marked anæsthesia of the skin.

At no time were there any aphrodisiac feelings produced. There was a marked increase of the urinary secretion. There were no after effects, such as nausea, headache, or constipation of the bowels.

The following notes were kindly furnished by Dr. Thomas: "I was called at 8½ P. M. to Dr. H. C. Wood, and was informed he had taken an over-dose of extract-cannab. indic. I found him presenting at first glance, the mental condition and excited manner of mild alcoholic intoxication. His powers of ratiocination were but slightly impaired. The most prominent psychological manifestation was a constant and overwhelming dread of impending death, which no amount of assurance could relieve for more than an instant; with this was combined an almost entire loss of the faculty of appreciating time—moments seeming to his disturbed consciousness to be hours in length. He stood and walked without difficulty, and his voice was natural in tone and accent. Pupils widely though not completely dilated; pulse moderately full, and numbering 106 beats per minute, increasing in frequency to 118 per minute within the following twenty minutes and becoming decidedly weaker. The extremities were cool and growing colder. Zinci Sulph. was now ordered with the view of evacuating the stomach of any of the drug which might remain unabsorbed, as well as for any possible revulsive influence it might exert. At ten minutes after 9, when the emetic was obtained, the pulse was found to have increased in frequency still farther (136) and to have proportionately decreased in volume. Within 15 minutes following, the feet meantime having been soaked in hot mustard water, free emesis took place, and the pulse rapidly fell, improving at the same time in quality. At 10.15 it was 104 per minute, and it remained about the same for the succeeding hour. The warmth of skin was at this time restored. The mental state varied but little throughout. At 11.15 I resigned the case to Dr. Allen."

The foregoing experiment proves that the Kentucky hemp does contain an appreciable quantity of the resinous active principle or principles, but it was merely tentative, and was not intended to determine the proportionate amount.

In order to determine the proportion of extract obtainable, the following experiment was performed:

Six ounces of the dried leaves of male Kentucky hemp plants were treated with hot alcohol and then exhausted with a little ether. The tinctures thus obtained were mixed and evaporated. The extract thus procured weighed 252 grains. One drachm of it was rubbed up with a strong solution of the Carbonate of Soda to remove fatty matters, &c. It lost nineteen grains or 32 per cent., very nearly one-third of its weight. Six ounces of the leaves, therefore, yielded rather more than two and two-thirds drachms of an extract, from which every thing soluble in an alkaline solution had been removed. The method employed resembles that of the Messrs. Smith of Edinburgh. They obtained from 6 to 7 per cent. of their purified extract from the plant grown in India. I obtained 4 to 5 per cent. of the extractive, and as the operation was on a small scale and conducted by one totally unversed in practical pharmacy, there can be no doubt that there was sufficient loss to bring up the proportion fully to 5 per cent.; moreover the American leaves were probably not so thoroughly dried as the Indian.

The therapeutic powers of this extract were not tested.

To test the matter further, I exhausted three ounces avoirdupois with hot alcohol, and the resultant tincture was placed in the hands of Hance, Griffith and Company, Manufacturing Chemists of this city.* Four-fifths of this tincture were evaporated by them to the consistency of a syrup, and to it was added ten times its bulk of water. The precipitate was washed and dried. When given into my hands, it was a softish greenish, adhesive resin. Of this I took $\frac{3}{4}$ of a grain dissolved in a mixture of alcohol and ether. It produced marked cerebral disturbance amounting to a mild intoxication.

These symptoms were similar to those heretofore detailed, but very much milder. There were, however, no marked periods of unconsciousness, merely a feeling of hilarity and a total inability to fix the attention except for a very short period and also some prolongation of time.

Of this same resinous extract, my friend, Carl Früh, a graduate of the Philadelphia College of Pharmacy, took one grain. He first felt the influence of it about supper time. His head felt as if some one was violently compressing it and at the same time there was a feeling of hilarity, with an uncontrollable desire to talk and laugh, so that those around him asked him what had come over him.

At supper he was almost ravenous and ate so much that it was noticed by others. Upon attempting to concentrate his thoughts upon any subject, he found it required a very painful effort. In attempting to compound a prescription, he found it impossible to remember more than one ingredient at a time, and even this was almost beyond his powers. In the evening he went to a lecture at the College of Pharmacy. Although he understood all that was said, yet he could not remember it a moment, and at times would forget his surroundings and then suddenly wake up to find himself sitting in the lecture room. Later in the evening he attended a society-meeting, and afterwards went out with a fellow student, but has no recollection of what was said or done. There was a good deal of pria-

*Now Hance, Brothers and White.

pism during the night, and a state of venereal excitement was induced, lasting several days. During the night, urine was passed very freely. Before this, he had taken two grains of Herring's extract with the result of producing similar symptoms, which were, however, no more intense than those caused by the single grain of the American resin.

Messrs. Hance and Griffith prepared the resin from the remainder of the hemp tincture, by first agitating with milk of lime, filtering, precipitating by sulphuric acid, agitating with animal charcoal, again filtering, concentrating by evaporation, and precipitating the resin by the addition of twice the bulk of water. The resin thus obtained was tested by my friend, Dr. Richardson, in the Pennsylvania Hospital, by permission of Dr. Da Costa, the attending physician. One-fourth of a grain of it was found to be sufficient to produce decided therapeutic results; in some cases acting very pleasantly as a hypnotic and calmative; in others, causing evident sensorial disturbance, but rather aggravating than alleviating the distress of the patient.

Having at that time a lady under my care, subject to severe attacks of neuralgia, I supplied her with some of the drug in $\frac{1}{4}$ grain pills. Of these she found one was always sufficient to induce a quiet sleep of some hours duration, from which she generally awoke free from pain. After the limited supply of this preparation was exhausted, I tried with her a similarly prepared extract made from imported India hemp plants, but a grain of this did not suffice to quiet the pain and induce sleep.

The above experiments are certainly sufficient to prove that the hemp plant, as grown in Kentucky, contains a sufficient abundance of the active principle, to be capable of yielding a supply to the pharmaceutist. If I am correctly informed, the India plant is worth at wholesale prices, about a dollar a pound in our market. The male seeding plants in Kentucky, after they have shed their pollen, are worthless. It was with such plants the experiments were instituted. A considerable supply of them might be obtained, so Mr. Hamilton writes me, for little more than the expense of gathering them, or if the demand should exceed the amount of such male plants, the leaves of the female plants when ready to be cut for the fibre might be obtained on the same terms.

A more important consideration than the mere monetary one, is the probability that, when the plants were raised near home, a more uniform product would be obtained.

There can be no doubt, that under certain circumstances cannabis indica supplies a medical need, which no other drug will so exactly meet. Yet, the extracts as kept in the shops, even when honestly made, vary so indefinitely in strength, and indeed are so generally almost inert, that the use of this narcotic has been largely abandoned in consequence. It is very probable that this variation depends to a certain extent upon differences in age and modes of cultivation, &c., of the plant. If this be so, the growth of the plant under the eye of the pharmaceutist will give him the opportunity of learning the conditions best fitted for developing in it the active principles.

The U. S. Pharmacopeia apparently recognizes the fact of the variance of the hemp extracts of commerce and directs a purified extract. The process of preparation given, consists simply of dissolving the crude extract in alcohol and evaporating. Unfortunately this does not meet the difficulty, since the solubility of the extract in alcohol is no certain measure of its activity. There are many inert matters existing in the plant which are soluble in alcohol, so that a fair amount of extract may be yielded by a specimen which contains almost no resin. This may occur to a certain extent even if India hemp plant be the subject of the trial and is very certainly the case when plants from other localities are employed.

In order to throw some light on this subject the following experiment was made : 100 grains of a fine looking extract made from India plants wholly soluble in alcohol, were rubbed up with a solution of potash, dissolved in alcohol, passed through animal charcoal precipitated by a strongly alkaline solution, filtered, and the resin carefully washed and dried. The resultant weighed 58 grains. Even if we allow as much as 12 per cent. for waste, there was, therefore, present in the original extract 30 per cent. of inert matters, which corresponds very closely with the amount of inert matter contained in the extract prepared by myself from the American plant. That the matters removed by potash are inert I proved in regard, at least to the American extract, by taking them in considerable amount without any perceptible effects being induced. In view of the above mentioned facts, it would seem advisable to replace in the U. S. Pharmacopeia for 1870, the present *Extractum cannabis purificatum* by a preparation to be called *Resina Cannabis,* and to be made by precipitating the concentrated tincture, by water rendered strongly alkaline by the presence of soda or potash.

Such a mode of preparing is essentially that originally published by the Messrs. Smith of Edinburg. The resin, as obtained by himself in this way, corresponds pretty closely with that described by the latter gentlemen in their original paper. It is fawn colored, in very thin layers, but when in mass, is blackish. It is neutral to test paper, and is apparently, a simple, active principle ; at least I have not been able to separate any organic principle from it. At one time, I strongly suspected the presence in it of an alkaloid, because its action on myself was so similar to that of the mydriatics.

In order to determine this point, a concentrated tincture was treated with water acidulated with acetic acid, filtered, and to the clear solution thus obtained an alkali was added, but no precipitate was afforded—neither did tannic acid produce any. This experiment was repeated, sulphuric acid being substituted for the acetic. The same negative result was obtained.

Again, a concentrated tincture was treated with freshly precipitated oxide of lead, filtered, the lead removed by the hydro-sulphate of ammonia and the water acidulated with sulphuric acid, was added. Upon again filtering, the clear solution obtained, did not respond to any of the tests for an alkaloid : dilute water of ammonia, filtered through the lead, gave no precipitate with muriatic acid, showing the absence of an insoluble organic acid.

Stated Meeting, Dec. 3d, 1869.

Present, fifteen members.

Dr. Wood, President, in the Chair.

Letters of acknowledgment and envoy, and donations for the Library, were received from the Swedish Bureau of Statistics, Prussian Academy, Physical Society at Geneva, M. M. de Mortillet and de Reffye, Captain Toynbee, the Linnean Society, Franklin Institute, Editors of "Nature," Mr. Isaac Lea, Mr. Dubois, Prof. Haldeman, and Mr. Worthen, of Illinois.

Mr. Du Bois exhibited to the Society, some specimens of silver coin which have just been struck at the Mint, in illustration of the plan suggested in a pamphlet which lies on the table. There are three pieces of the same devices, of 50, 25, and 10 cents. There are also two pieces of 50 cents, of various devices, with a view to afford a choice, in case the plan should be adopted and legalized. The head of Liberty on one of these, wearing a cap, is copied from the statue at the Capitol.

The dies were designed and executed by the present engraver of the Mint, Mr. William Barber; with the aid of the Hill Engraving Machine.

The main idea which lies at the root of the proposed plan, is, that *gold* is, properly speaking, the only measure of market values; while *silver* should be used only as a subsidiary or fractional currency. It may, or it may not, be of full weight, corresponding to the average comparison with gold. If it is so, it is sure to be snatched away, exported, or buried, whenever a suspension of specie payment occurs. If it be of reduced weight, it will still circulate and perform its functions, although the gold be missing. But at such reduced weight, it should be legally limited, as to amount of issue; and there should also be a close limit of legal tender. With these two safeguards, it would be equally current, whether gold were at a premium, or at par, as compared with bank paper.

The measure of weight last concluded upon, in striking these specimens, is 154 grains for the half dollar; the lesser pieces in proportion. This is four-fifths of the weight of the present silver coins. It also agrees (very closely) with ten grammes of French metrology. Further, it would be 220 *new grains*, if the proposed plan of decimalizing the avoirdupois pound be accepted. And once more, it allows the Mint to buy silver for this coinage, at any line of premium on gold under 30 per cent. as compared with bank notes.

It would therefore, if legally adopted, be current immediately. Further details will be found in the pamphlet referred to.

Mr. Du Bois also exhibited a *medal* just struck at the Mint, to celebrate the union of the two oceans by Railway. On the obverse is the head of President Grant, from an original design. It was deemed proper to indicate under whose administration this great work was completed. On the reverse is a scene representing a train of cars passing from ocean to ocean, through mountainous ranges; with a legend from the Scripture, "Every mountain shall be made low."

The medal was struck by order of the Director of the Mint, Gov. Pollock, and the dies were made by Mr. Barber.

The opportunity is also taken to show a head of Rittenhouse, in wax, executed by the same artist, from the bust in the Society's hall. It is intended to form the obverse of a medal, by reduction on the engraving machine already spoken of.

Prof. Hayden explained the character of the MSS. Journal of his recent explorations in the Rocky Mountains.

The Annual Report of the Treasurer was read.

The Annual Statement of the Trustees of the Building Fund was read, and the Society was adjourned.

Stated Meeting, Dec. 17th, 1869.

Present, fourteen members.

Dr. Wood, President, in the Chair.

Letters were read from Mr. H. A. Homes, of Albany, State Librarian, from the Natural History Society at Newcastle upon Tyne, and from Dr. F. V. Hayden, withdrawing his paper, on account of its ensuing publication by the Department of the Interior at Washington.

Donations for the Library were received from the London Geological Society, the Boston N. H. Society, Mr. Homes of the N. Y. State Library, the College of Pharmacy, Mr. David Paul Brown, Mr. Hector Orr, Gen. A. A. Humphreys and the Department of the Interior.

A letter was read from the Chairman of the Publication Committee, Mr. James, relative to the publication of Dr. Dewey's Report on Carices. On motion of Nr. Fraley, the papers were recommitted to the original Committee, Mr. Durand, Mr. James and Dr. Ruschenberger.

A communication was made by Mr. P. W. Sheafer of the following records of well borings in the Wilksbarre coal region:

From P. W. Sheafer's Note Book, Engineer of Mines, Pottsville, Pa.

Oxford Shaft near Hyde Park, Luzerne county, Pa.

180 ft. deep to the Diamond coal, which is about 7′ thick.

At 33 ft. cut a 5′ coal through a gangway on which the shaft water is sent to surface; at 65 ft. cut a 6′ Coal.

Further down the Lackawanna is the crop of the 14 ft. Coal, which lies below the Diamond about 80 ft. A small Coal bed divided by a seam of rock lies between.

Audenried Shaft, near Wilkesbarre. From manuscript of Supt. Kendrich, April 5, 1862.

	Surface.
16′	Sand and Loam.
56 =40′	Sand Stone Rock.
70 =14′	Slate.
80 =10′	Coal.
120 =40′	Slate.
$120\frac{1}{2}$= $\frac{1}{2}$′	Coal.
$160\frac{1}{2}$=40′	Slate.
$166\frac{1}{2}$= 6′	Coal.
$176\frac{1}{2}$=10′	Fire Clay.
$226\frac{1}{2}$=50′	Slate.
228 = $1\frac{1}{2}$′	Coal.
238 =10′	Fire Clay.
259 =21′	Mixed Sand Stone.
264 = 5′	Slate.
269 = 5′	Coal.
296 =27′	Fire Clay and Slate.
328 =32′	Mixed Sand Stone.
335 = 7′	Coal.
338 = 3′	Fire Clay.
395 =57′	Black Rock.
400 = 5′	Coal.
415 =15′	Mixed Sand Stone.

Empire Shaft near Wilkesbarre, April 5, 1862, from Surveyor Allerbach's notes, who got it from Broderich, Supt.

From Surface	to bottom of	10′	Vein	Coal is	80′
"	"	$7\frac{1}{2}$′	"		134′
"	"	5′	"		220′
"	"	14′	"		$300\frac{1}{2}$′

April 5, 1862. Copy of *Dundee Shaft*, near Monticoke, Wyoming Valley, from Section in Lentz & Co.'s Office, by P. W. Sheafer, E. M., from F. Koerner. Dip 4° S. E.

28′	Surface.
2′ 6″	Coal.
9′ 6″	———
6′	Fire Clay.
21′	Sand Stone.

	10′		Fire Clay.
	13′		Sand Stone and Slate mixed.
	6′		Slate.
		6″	Coal.
	3′		Slate.
	2′	6″	Coal.
	10′		Slate.
		6″	Coal.
	16′		Slate.
		4″	Coal.
		6″	Slate.
	7′		Sand Stone.
	6′		Fire Clay.
	4′		Slate and Sand Stone.
	5′		Slate.
	4′		Sand Stone and Slate.
	8′		Fire Clay.
	10′		Slate and Fire Clay.
	6′		Sand Stone.
	2′		Fire Clay.
	12′		Slate and Sand Stone.
	11′		Slate, pump.
	2′	6″	Coal.
	14′		Slate.
	15′		Sand Stone.
	17′	6″	Fire Clay and Slate.
	23′	6″	Sand Stone.
		10″	Coal.
		5″	Slate and Coal.
	33′	6″	Slate.
318′	2′	0″	Coal. *Fossil Shells.* No Vegetable impr.
	5′		Sand Stone.
	16′		Slate, Fire Clay, Benches of S. Stone.
	5′	0″	Sand Stone.
	6′		Soft Fire Clay.
	5′	6″	Hard Fire Clay.
	32′	6″	Sand Stone.
	1′	6″	Coal.
	4′		Slate.
	15′		Dark colored Sand Stone.
	20′		Shells. Sand Stone.
	12′		Slate.
	440′	08″	

This shaft was continued to a depth of 700 feet. Its remarkable scientific feature is the fossil shells at a depth of 318 feet.

A communication from Dr. R. J. Roscoe, of Carlisle, Scoharie county, N. Y., to the Librarian, relative to certain supposed fossils of high grade and great size found in the Laurentian rocks of Essex county, New York, fragments of which were brought by Dr. Le Conte, and deposited in the Museum of the Academy of Natural Sciences, in Broad street, was read and commented upon by the Librarian, who explained that they were plications of alternate layers of metamorphosed limestone and sandstone deposits; and that Dr. Leidy had described similar, but much larger ones (one weighing perhaps 20 tons), in the marble quarries near Attleborough, Penn., in a subsilurian group of perhaps the same age. The sheets of graphite covering the plicated layers prove, no doubt, the organic origin of the calc-spar layers; but the present form of the mass ought not to be taken as the original form of the animal organism.

Dr. Geo. B. Wood communicated his experiments and views on the revival of peach and other fruit trees, by the application of potash to their roots. A discussion followed, in which Dr. Coates, Dr. Emerson, Prof. Trego, Judge Lowrie and Gen. Tyndale joined.

Dr. G. B. Wood described a discovery which he believes that he has made, and which, if verified by further experiments, will be of great value to the agricultural interests of the country. Potash, combined with one or more of the vegetable acids, is an essential ingredient in vegetables, particularly in fruit, which, it is probable, cannot be produced without it. Sometimes fruit-trees cease to bear, prematurely; and, in relation to peach trees, it is well-known that, in this vicinity, after producing a few crops, they not only cease bearing, but perish themselves in a short time; whereas their natural life is 50 or 60 years or more. The fact seems to be that potash is wanting in the soil in sufficient abundance to allow the tree to continue to bear fruit continuously. Dr. Wood believes that by supplying potash to the tree, so that it shall reach the radicals, and be absorbed, the deficiency may be supplied; the fruit-bearing power is restored, and the tree itself, if prematurely perishing, revived. He was led to this conclusion in the following way: Having a considerable number of peach trees, which had entirely ceased to bear fruit, and were themselves obviously decaying, and believing, with most persons, that the cause lay in the worms at the root of the tree, he put in operation a plan which he had seen his father perform, more than fifty years since, of digging around the base of the stem a hole four or five inches deep, scraping away all the worms that could be found burrowing at the junction of the stem and root, and filling the hollow thus made with fresh wood-ashes, recently from the fire, and of course retaining all their potash. The ashes were used with the view of destroying the worms that might have escaped notice. This was done in the autumn of 1868. In the following spring he was himself astonished at the result. The trees appeared to have been restored to all their early freshness and vigor. They put forth bright green leaves, blossomed copiously, and bore a crop of fruit such as they had never borne before; many of the branches breaking down under their load of peaches. In reflecting on these results, Dr. Wood came to the conclusion that all this change could not possibly have been produced by the destruction of a few worms; and, besides, there were several of the peach trees treated, in which no worms could be found. He was thus led to the belief that the real cause of the revival of the trees was the ashes, the potash of which, being dissolved by the rains, had descended along the roots to their rootlets, and presented to them the very food for want of which the trees were dying. He has, accordingly, had hundreds of various kinds of failing fruit trees treated in this way this fall, in the expectation of an abundant harvest next year. Should he live till then, he will inform the Society of the result. Should he not live, the experiment will at least have been put on record.

In answer to an inquiry, Dr. Wood said that the soil was of all kinds, sand, loam, and clay.

Dr. Coates remarked that trees at first grow slowly, and have but little chance to get potash from the limited area which they occupy. For instance, around the body of large trees there are seldom other growths.

Dr. Emerson gave his experience of peach growing. The peach, brought from Persia, loves a mild climate, and suffers when brought North, unless protected. When first brought to this country it grew luxuriantly, in all parts, well. Of late years, however, owing to the clearing away of the forest, which afforded it the same kind of protection which, in Northern Europe, was given it by glass, it has become limited to the soft climate of the peninsula between the Delaware and Chesapeake Bays, where it has no disease and bears abundantly. The "Yellows," however, although looked upon as a disease spreading from tree to tree, is in fact produced by colonies of a parasite, which propagates under favor of a low constitutional condition of the tree, produced by the failure of the necessary climatic protection. As to the nourishment of the tree, salts, espepecially of potash, are very nutritive. But there is another element in wood ash, phosphorus, which is the prime mover of all vegetable life. Dr. Emerson described one of his unpublished experiments, with a peach orchard, which yielded inferior fruit, but only as to *color;* otherwise the fruit was as good as others. He gave a top dressing of 200 or 300 ℔s. of superphosphate to the acre, and the next year his peaches brought 10 or 20 cents more in the market. At a certain exhibition, some pears of a very high color were displayed, which brought a very high price. Their rearer had used dog dung in quantities, which lent additional force to Dr. Emerson's belief that phosphoric acid heightened the color of his peaches.

Dr. Wood repeated that his experiment bore especially upon the mode of application of the potash. The spreading of potash over the surface of the land produced no great result. But, when placed where the rain water could carry it along the descending roots down to the rootlets, it is immediately absorbed by the plant, and produces its effects.

Judge Lowrie said that he bought, in 1838, a wild place near Pittsburgh. It was covered with forest trees and underbrush. He cleared away the undergrowth and weeds. Within three years he discovered that all the walnut and hickory trees were beginning to die, although in rich soil, and 4 or 5 feet in diameter, and some of them one hundred feet high. In the course of two years none were left. The oaks, maples, lindens and elms were not affected.

Prof. Trego said that in Bucks county, black walnut trees, planted along the fences, grow and flourish well, and are not hurt by standing quite alone as shade trees. He had placed wood ashes around the foot of a fine pear tree, banking it up around the tree, but it had no effect. Peach trees have many roots running horizontally, and the rootlets are near the soil. To this Dr. Wood replied that, according to his observations, they descend into the ground obliquely.

General Tyndale said that the finest peach grounds in the United States are the highlands of Southeastern Tennessee; the tops of mountain spurs of the Cumberland plateau, around Chattanooga, above the conglomerates of the Coal Measures and the cavernous limestones of the sub-carboniferous, two thousand feet or more above sea-level, and many hundred miles in the interior of the country.

The stated business of the meeting being in order, the Report of the Financial Committee was read, and, on motion, the appropriations, recommended therein for the ensuing year, were passed, as follows:

Salary of Librarian	$700 00
Salary of Assistant to Librarian	360 00
Salary of Janitor	100 00
Binding Books	150 00
Subscription to Journals	50 00
Petty expenses of Librarian	100 00
Hall account	200 00
Insurance account	160 00
Publication, in addition to the interest of the publication fund.	2,000 00
General expenses, other than the above, and including the commissions of the Treasurer	750 00
	$4,570 00

Pending nominations, Nos. 643 to 648 were read.

Mr. Fraley moved that the subject of cleaning and varnishing the portraits of the Presidents of the Society, be referred to the Committee on the Hall, with power to act.

And the Society was adjourned.

SECOND ADDITION TO THE HISTORY OF THE FISHES OF THE CRETACEOUS OF THE UNITED STATES.

By Edw. D. Cope.

Beryx insculptus, *Cope.*

This species is established on a specimen obtained by Samuel Lockwood, Director of Public Schools for Monmouth county, N. J., from the lower green sand-bed in the same county. A second specimen was found by Jno. Meirs, in the dark clay marl, just below the upper green sand-bed, at Hornerstown, Monmouth county. This one is in possession of Prof. O. C. Marsh, of Yale College.

The species is stout, and covered with very large, thick scales. The fins are not well preserved, but radii of all but the pectorals remain, and are of stout proportions. The scapular arch and cranium are strongly marked with narrow, elevated ridges, which form a reticulate relief. The scales are large and narrowly exposed below the lateral line, There are seven longitudinal series below this line, and not less than two above; there are twenty-three in the lateral line, and possibly a few more, as the point of departure from the suprascapula is lost, and greater part of the cranium broken away. The sculpture of the scales consists of a series of radiating ridges, whose interspaces are equal to them, and whose extremities project as short acute points. These ridges are interrupted at a short distance from the middle of the exposed surface, forming irregular obtuse elevations, while the middle of the area is divided by shallow grooves into irregular areas. The whole are sometimes crossed by one or two shallow interrupted concentric grooves. The tubes of the lateral line do not extend behind the middle of the exposed area, and are acute, and with an areolate rugose surface. The depth of the body near the middle is 3 in. 3 lin. below the lateral line; at a short distance behind this point, there is 1 in. 2 lin. above this line, if there are only the two series of scales, visible in the specimen. The length of the species is 5 in. 7.5 lines to what is probably the posterior margin of the pectoral arch. Depth of the caudal peduncle at the base of the fin 1 in. 1 l. Length of a ventral ray 1 in. 7.5 lines, as far as traceable. The dorsal and caudal rays are very stout; a series of small smooth scales continues the lateral line on the middle of the tail.

As compared with the Beryces of the European Cretaceous, B. radians is at once excluded on account of its small scales, and B. germanus, on account of the granulation of the same, as described by Agassiz. The B. levesiensis Mant. (*B. ornatus Ag.*) presents several series of acute mucrones, instead of the single series of the present species, while in the B. microcephalus Ag. the areolation of the middle area of the B. insculptus is wanting, and a greater breadth of the scale is exposed. The B. zippei, from Bohemia, is a much smaller species, and betrays no such strong sculpture of the cranial bones.

This species has not been found in the upper green sand-bed of the New Jersey cretaceous.

SPHAGEPŒA ACICULATA, *gen. et sp. nov.*

Char. gen. This genus is represented by a slender, acute spine, which may be referred either to a Pycnodont or Chimaeroid family. It is nearly straight and slender, and with a thin projecting anterior margin, which is deeply notched from the tip to a short distance above the base, so as to produce an acute dentition. There are no teeth behind, but two prominent ridges separated by a deep groove. Sides of the spine longitudinally grooved.

This spine may possibly be referable to a Plectognath fish. It resembles the spine figured by Dixon (Geol. Sussex XXXII. 7) as belonging to Microdon nuchalis, a Pycnodont. Agassiz, in the Poisson Fossiles, does not ascribe any such species of this family, and says that in Pycnodus the dorsal spines are quite low.

Char. specif. General form much compressed, but the section of the edentulons portion is as broad as deep. Sides with two elevated ridges, of which the anterior only is continued to near the tip, and is gradually broken into a series of tubercles near the base. Length 5.5 lines ; greatest width .75 line. This delicate remnant was discovered by my friend Thomas Kite, a naturalist of Cincinnati, Ohio, in the cretaceous green sand of the upper bed at the pits of the Pemberton Marl Company, Birmingham, N. J.

SPHYRÆNA CARINATA, *Cope, Proc. Ac. Nat. Sci. Phila.* 1868, 92.

Founded on a shed example of one of the long teeth, taken from the matrix attached to the dorsal vertebræ of the Elasmosaurus platyurus. The tooth is not very different in outline from that of the S. speciosa Leidy, *i. e.*, sub-triangular, and no more than twice as long as wide at the base. The anterior margin is the more oblique, and its smooth face is margined by a faint line posteriorly, and is continued over the extremity, forming a short obtuse barb on the posterior face. The obtuse face of the tooth behind, sculptured with six or eight deep grooves, which are separated by acute ridges, which do not extend over more than half the length of the tooth. Length a little less than six lines.

From the upper cretaceous of the neighborhood of Fort Wallace, Kansas.

ENCHODUS PRESSIDENS, *Cope.*

This species is similar in size to the E. ferox Morton (Leidy Pr. A. N. Sci. 1855, 397) but differs in the form of the premaxillary bone, and the large tooth which it supports. The basis of the latter is compressed at the base transversely to the axis of the premaxillary bone, so that it has a crescentic section, the concavity backwards. At the middle of the tooth, the section is an equilateral triangle, with an angle (one cutting edge) anteriorly, the inner angle rounded. The plane face of the tooth is thus much reduced in width, and is narrower at the basis than at the middle of the crown. There is moreover a longitudinal groove just in front of the posterior (outer) cutting edge. There is another groove on the other side of the same edge, on the posterior face, and another more marked just inside the anterior cutting edge. In all these points it differs from the E. ferox, where the section is lenticular, the base triangular ovate, the outer face widening downwards and no grooves. In E. pressidens the base of the tooth projects well beyond the anterior margin of the front of the premaxilliary, while in the E. ferox the reverse is the case. Length of tooth 20.5 lines ; transverse width at base 6 lines; longitudinal do. 3.7 lines. Length premaxilla 31.8 lines. depth 15.5.

Two specimens from the cretaceous green sand of New Jersey.

PNEUMATOSTEUS, *Cope.*

This genus is established on a caudal vertebra of peculiar character, It is opisthocoelian, and without trace of suture of either neural or haemal arches. The elements constituting the haemal arch appear to be diapophyses ; they are divergent, and probably do not unite distally ; they are directed more posteriorly than anteriorly. Their proximal boundary is apparently indicated by an indistinct elevation, perhaps the position of the original suture. The neural arch is split above by a deep median anterior fissure, on each side of which the narrow zygapophyses diverge. There is no zygantrum. The base of the broken neural spine is very small, and is as long as wide; it may probably have had but little elevation.

The structure of the bone is exceeingly light, and the external osseous layer very dense. In order to reduce the weight consistently with the size, the lateral and inferior faces are excavated by deep concavities terminating in pits. There are two on each side separated by a longitudinal ridge-like septum, which is plane with the expanded rims of the cup and ball. The superior pits are beneath the base of the neural spine, and nearly meet under the floor of the neural canal. The inferior concavity is very large, and extends from rim of cup to ball, and is divided longitudinally by a thin laminar hypapophysis. The bases of the diapophyses are wide, and extend from the base of the ball, three-fourths the distance on each side to the rim of the cup.

The form of the vertebra is compressed. The ball is more convex transversely than vertically, and presents a slightly double convexity in profile. This is produced by a slight transverse contraction at the inferior fourth of the vertical diameter. The floor of the neural canal is raised to the superior margin of the ball.

This vertebra resembles the fourth in advance of the first bearing chevron bone in Lepidostues. It differs from it generically, solely in the completeness of the neural arch abone, since it is longitudinally fissured in the existing genus.

PNEUMATASTEUS NAHUNTICUS, *Cope.*

The specific characters of this fossil are as follows : The cup is a vertical oval, slightly truncate below, and openly concave truncate above. Its form is not unlike that seen in some of the Pythonomopha. The neural arch is much contracted transversely opposite the neural spine. The surface of the bone is very smooth, except a few slight rugae near the rim of the cup.

Measurement.

	In.	Lin.
Length of centrum..............................	1	0
Width " " between lateral septa...........		7.1
Depth of cup....................................		8.4
Width " "		7.9
Depth of ball.....................................		8.5
Length base (?) pleurapophysis..................		6.8
" " neurapophysis........................		7.
Width neural canal (external, front)...............		5.2
" " " (internal, behind)..............		2.8

The large cells are exposed by the fractures of portions of the bone. The largest are at the posterior base of the haemal arch and at the sides of the articular ball, one of the former 1.5 line in diameter. These measurements indicate a gar of six feet in length, if of usual proportions.

The specimen on which this species is established was found by the writer on a pile of miocene marl on the plantation of Nathan Edgerton, in Wayne county, North Carolina. Its interstices are filled with a hard clay matrix, similar to that which adheres to cetacean remains in the hard stratum in the lower part of the miocene shell-bed of that region. Whether it were originally transported from a cretaceous stratum, is not readily ascertainable, as the porous and dense structure of the bone receives fractures rather than rounding from transportation, which cannot be distinguished from those miocene specimens. The color is black. Mus. Cope.

CROMMYODUS IRREGULARIS, Cope. *Phacodus irregularis,* Cope Proc. Bost. Soc. N. Hist. 1869.

The name Phacodus having been given by Dixon to a genus of fishes allied to Pycnodus, from the Tertiary of Sussex, England, the present genus must receive a new name.

ISCHYODUS LATERIGERUS, *Cope sp. nov.*

This species is of about the same size as the I. mirificus Leidy, and presents marked characters. Its extremity is much prolonged, and more flattened than in any other species from the United States. The outer and concave side is elevated by the extent of the anterior exterior crests, which is also remarkably prolonged beyond the dental area which it supports. When the two mandibular rami are in place, it follows from the above, that the median line of the beak is occupied by a deep concavity, which is walled in by the high anterior outer crest. The posterior outer crest is also well developed, and is also prolonged acutely beyond the posterior dentinal area. The latter is oval and very small, less than .33 the anterior. The anterior is long and narrow ; its middle marks the anterior extremity of the great inner area. The latter is large in all dimensions, and is undivided. Below it is a slender intero-lateral column. The mandible is thoroughly and regularly curved outwards and backwards. The external terminal column is largely developed vertically.

This species approaches the I. smockii m. but is double the size, is more compressed and curved, and differs much in the small posterior area, and very long anterior outer crest.

	In.	Lin.
Total length mandible (restored)	6	6
Depth at extremity		9
“ “ anterior crest	1	6
“ “ posterior “	2	5
Length posterior outer area		7
“ anterior “ “	1	7.5
“ “ “ “ with crest	2	6
“ inner area	2	10.5

From the upper cretaceous green-sand bed at Hornerstown, N. J. Discovered and presented to the writer by Jno. Meirs, proprietor of the excavations at that place.

Ischyodus solidulus, *Cope, sp. nov.*

No distinct external crests, and no anterior outer dentinal area. The posterior outer dentinal area is very small, and looks inwards from the gradual elevation of the outer superior margin. The inner area is very large and undivided, and is accompanied on the inner margin by a slender column, which issues in the posterior corner of the symphyseal plane. The terminal area of the beak instead of having the usual narrow oblique form, is the round extremity of a narrow column. Inner and outer margins, anterior to the large area, of equal elevation, regularly curved outwards without angulation.

	In.	Lin.
Length (restored)	2	6.5
“ to end inner area	1	9
“ “ “ posterior outer		10.5
“ of “ “		2.5
“ “ inner	1	9
Depth at “		9.2
“ “ posterior	1	2
“ “ beak		4.5

This species is nearest the I. divaricatus m. It differs in many respects, among which are the absence of anterior outer area, and of prominence of the inner lip, and the great reduction of the terminal column. Its lack of dental development allies it to the Leptomylus m. Size, small.

From the same locality and donor as the I. laterigerus.

Pristis attenuatus, *Cope.*

Tooth slender, width at base less than one-sixth length, thick and straight. Posterior face straight, with a wide groove, anterior curved backwards, obtuse with a faint median longitudinal groove. Posterior face at the tip of the tooth, oblique. No striae.

Length 26.7 lines ; width 4.5 lines ; depth at base 3 lines.

This species is much more slender than the P. agassizii Gibbes, the only species which resembles it. Found by Prof. W. C. Kerr, State Geologist of North Carolina, at Flower's marl pit, Duplin Co., N. C.

ERRATA.

Page 100, Eighteenth line from the bottom, read "proposed" for "prepared."

Page 167, twelfth line from the bottom, for "relations" read "dilatations."

Page 168, eighteenth line from bottom, omit "been."

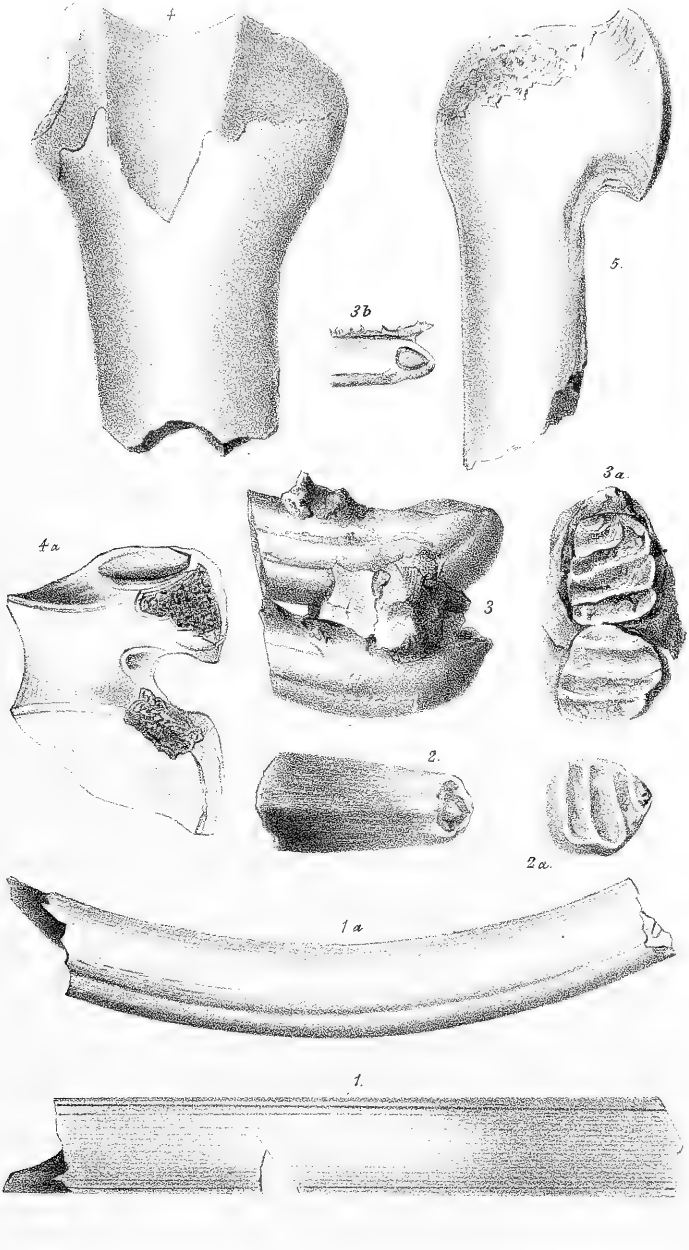
Page 168, seventh line from bottom, for "Esophus" read "Eusophus."

Page 171, fifteenth line from bottom, for "miles" read "miles distant."

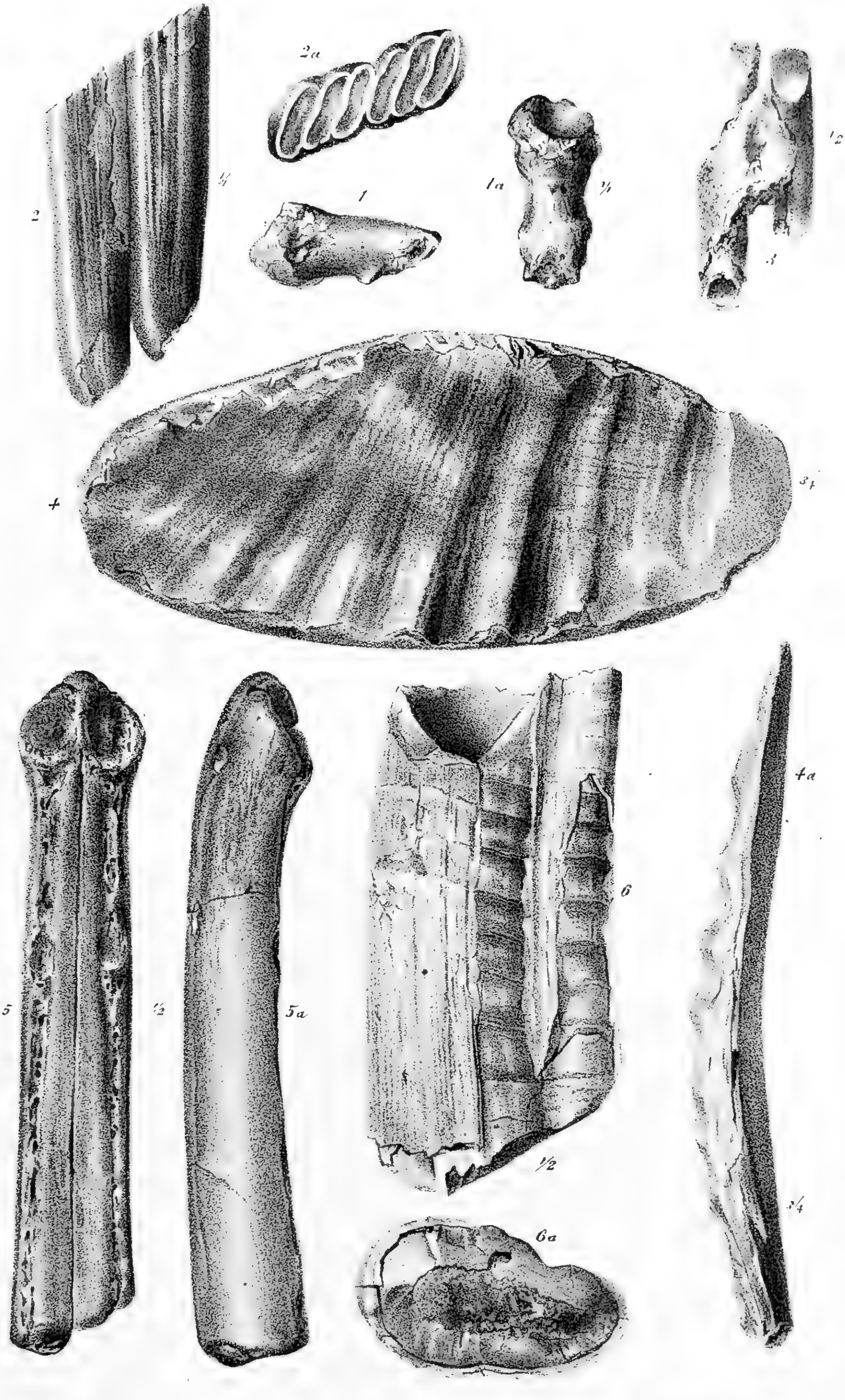
Page 188, line 15, omit "not."

Page 188, line 17, for "though" read "and."

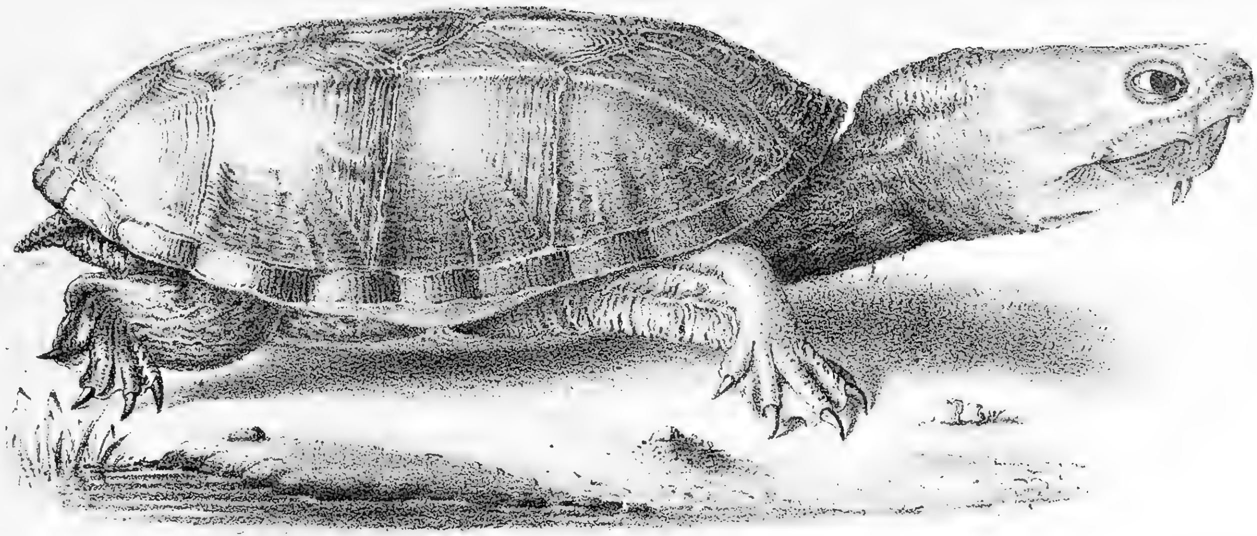
1. Galera perdicida. 2. Mixophagus spelaeus. 3. Stereodectes tortus.
4. Tamias laevidens. 5. Sciurus panolius. 6. Tapirus haysii.



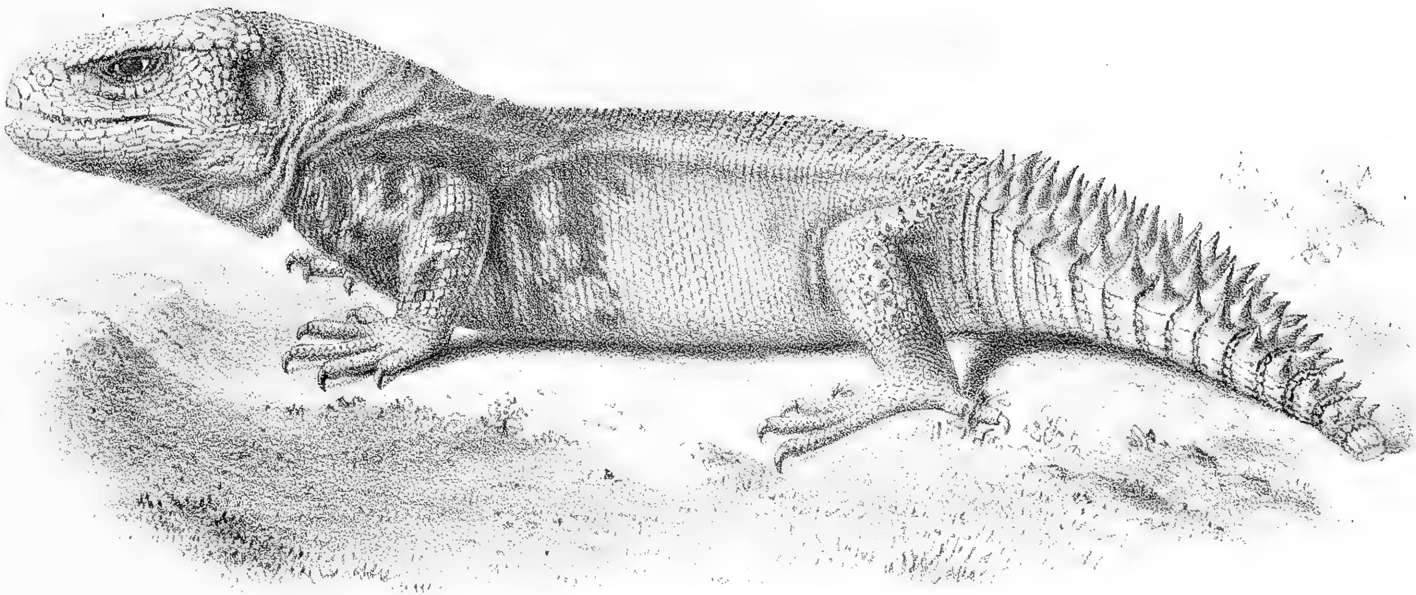
Amblyrhiza inundata, Cope.



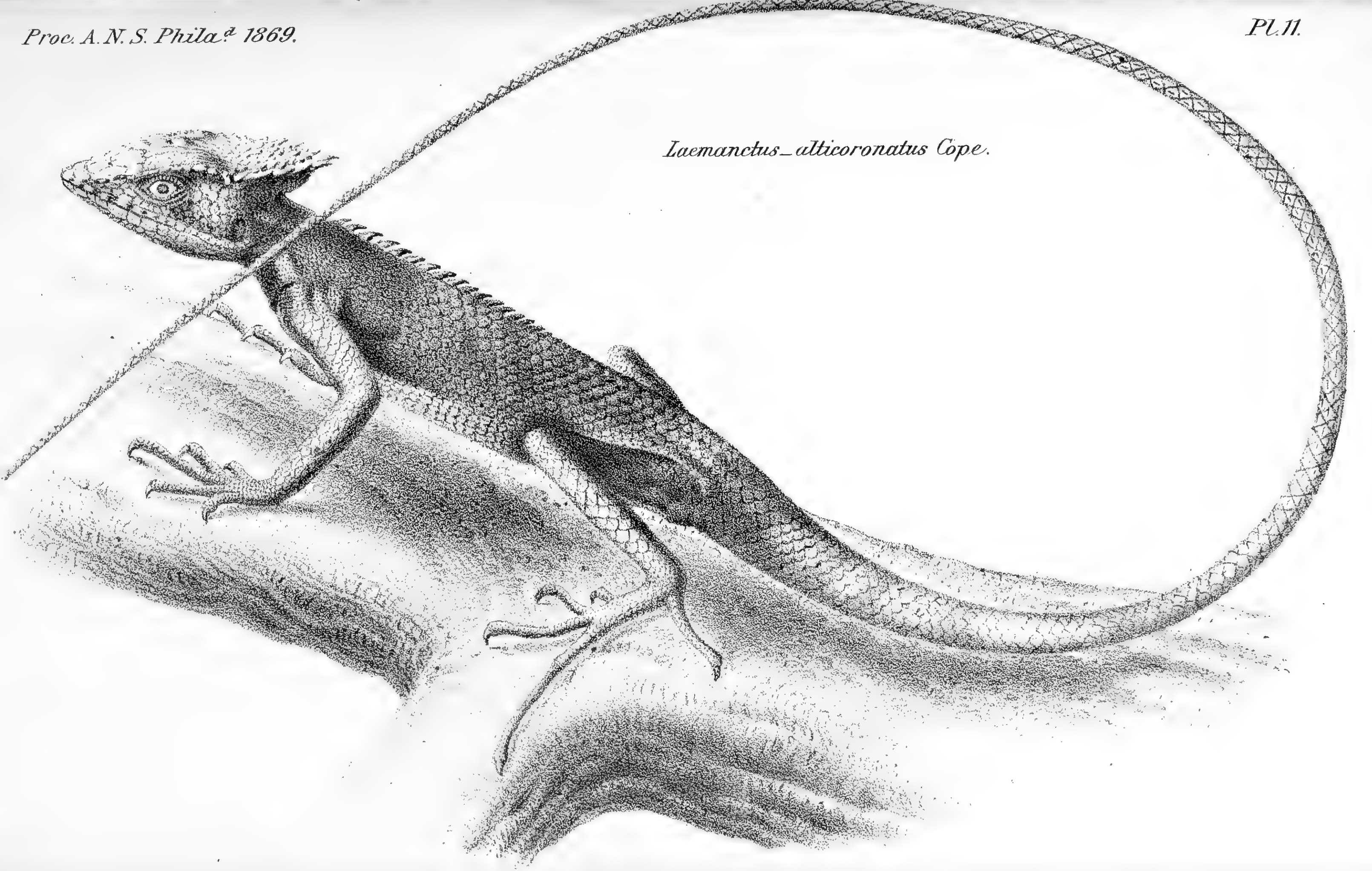
1. Amblyrhiza inundata 2 – 3. Loxomylus longidens. 4. Shell implement.
5 Anoplonassa forcipata. 6 Hemicaulodon effodiens.



Claudius angustatus Cope.



Cachryx defensor Cope.



Laemanctus_alticoronatus Cope.

NOTICES AND DESCRIPTIONS OF FOSSILS, FROM THE MARSHALL GROUP[112] OF THE WESTERN STATES, WITH NOTES ON FOSSILS FROM OTHER FORMATIONS.

By Alexander Winchell, Director of the Geological Survey of Michigan.

The following notices and descriptions were drawn up in March last, but their publication has been delayed by pressing and unremitting engagements, which continued, very unexpectedly, through the entire Summer.

These studies are based chiefly on specimens from Tennessee and Ohio. The Tennessee specimens were submitted (with others) by Prof. James M. Safford, about three years ago, and the conclusions have very recently been announced in his Report on the Geology of that State. The Ohio specimens consist of fossils communicated from time to time, during two or three years past, by Rev. Herman Herzer, and of a series of fossils collected by Prof. E. Andrews, along a section extending from the Blue Limestone, near Cincinnati, along the Ohio river to the Coal Measures,[113] and others collected in Central Ohio and western Pennsylvania.

In order that the references in the following pages may be made intelligible, I subjoin the section communicated by Prof. Andrews:

Section along Ohio river from Adams to Lawrence counties, Ohio.

Coal Measures.

No. 1.	Measures embracing beds of Iron Ore	207 ft.
	Coal, Underlying measures,	157 "
No. 2.	Coarse-grained sandstone of Coal Measures, Clays and Iron Ore,	38 "
No. 3.	"Sub-carboniferous Limestone" of Ky., overlying the "Knobs" of the Kentucky Reports,	46 "

Waverly Series.

No. 4.	Sandstones containing, above, marine plants, *cauda-galli* and other fucoids, and near the bottom, nodules of Kidney Iron Ore. At the bottom is a mass of sandstone and Iron Ore embracing, probably, the fossils of Sciotoville, Flagg's Hill, &c.	258 "
	Sandstones	114 "
No. 5.	Fossiliferous ferruginous sandstone of Rockville, Sandstones with Fucoids, Shales containing the *Goniatites* described by Dr. Hildreth,	127 "
No. 6.	"City Ledge," 5 ft. above black shale	4 "
	Waverly black shale. Fish-bed, *Lingula subspatulata*, *Discina capax?* Ganoid scales, &c.	16 "
	Lower Waverly beds with Fucoids	127 "

[112] For other papers by the author, on the Geology and Paleontology of this group, see "First Biennial Report" of the Geological Survey of Michigan, 1860; Amer. Jour. Sci. and Arts [2] vol. xxxiii, p. 352: ib. xxxv, p. 61; Proc. Acad. Nat. Sci., Phil., Sept., 1862, p. 405; ib. Jan., 1863, p. 2; ib. July 1865; Pro. Amer. Phil. Soc., No. 81, (vol. xi) 1869, p. 57: Geology of Tenn., 1869, pp. 364–5 and 440.

[113] This section was read in substance, at the Chicago meeting of the American Association, in Aug., 1868.

No. 7. Ohio Black Shale, embracing beds of fire-clay and *septaria*, 320 "

No. 8. { Buff-colored limestone, arenaceous ("Cliff Limestone") with beds of lenticular Iron Ore near the bottom.

No. 9. Brown and light colored clays (Dr. Locke's "Marl").

No. 10. { Middle or Flinty Limestone, underlaid by yellow clay containing thin layers of limestone.

No. 11. Blue Limestone.

The "Waverly," of Ohio, is regarded by Prof. Andrews, as extending from the "Subcarboniferous Limestone (No. 3), to the "Ohio Black Shale" (No. 7). The Chemung and Portage may be embraced in No. 6.

No. 7 is generally regarded as the equivalent of the "Genesee Shale," of New York.

No. 8 is found to contain the following Niagara species: *Trematopora tubulosa*, Hall; *Caryocrinus ornatus*, Say; *Retepora aspero-striata*, Hall; *Obolus imbricatus*, n. sp.;[114] *strophomena striata*, Hall; *S. rhomboidalis*, Wahl; *S. Niagarensis*, Win. & Mar.; *Hemipronites subplanus*, Con. sp.;[115] *H. hemiaster*, Win. & Mar.; *Orthis elegantula*, Dalm. sp.; *Cornulites flexuosus*, Hall;[116] *Spiriflra sulcata*, Hising, sp; *Atrypa reticularis*, Dalm. A. *neglecta*, Hall; *A. cuneata*, Hall; *Meristella nitida*, Hall, *Pentamerus* sp?; *Platyostoma Niagarense?* Hall,[117] *Orthoceras* sp?; *Dalmania limulurus*, Green sp., *Calymene Niagarensis*, Hall.

No. 9 of Andrews' section contains the following species, some of which are known to belong to the Clinton group: *Rusophycus clavatus* and *bilobatus*, Hall; *Fenestella prisca*, Hall, and *Obolus imbricatus?* n. sp.

It will be noticed that the characteristic fossils of the Waverly Group are traced to near Shafer's, on Oil Creek, Pa., at a locality said to be "200 to 300 feet below the coal," where we find such species as *Chonetes pulchella* Win.; *Lingula membranacea* Win.; *Hemipronites inequalis*, Hall sp.; *Syringothyris typa*, Win.; *Spirifera Carteri*, Hall; *Discina Gallaheri*, Win.; with others common to the Waverly and later formations. At Kinzua, Pa., however, which is stated to be "300 or 400 feet below the Coal Conglomerate," we seem to have passed into the limits of another fauna. Not a single species can be recognized as belonging to the Waverly. On the contrary, *Spirifera disjuncta* (Phillips) Hall, a species of the Chemung Group, of New York, is conspicuous and well determined. Fragments of lamellibranchs which appear to belong to the Chemung

[114] Shell small, nearly circular, with a slightly projecting beak in the ventral valve, false area very small and inconspicuous, central median ridge distinct but delicate, becoming broader anteriorly, and vanishing in front of the centre; a longitudinally oval scar on each side of the central ridge. Surface marked, especially in the older shells, by numerous concentric imbricating lamellae of growth. Transverse diameter 5-16 inch; length of ventral valve about the same. This is a smaller species than *O. Conradi*, Hall, with a more lamellose exterior, and, so far as I have been able to observe, a different cardinal structure.

[115] Several specimens, agreeing very well with the description and figures of New York specimens, but apparently *not* the same as the Illinois specimens referred to this species. (Ill. Geol. Rep III, 349).

[116] The single specimen has the rings somewhat constricted below, instead of regularly convex as in *C. arcuatus* Con.

[117] A carinated shell, more appressed laterally than the carinated varieties figured by Prof. Hall.

species *Avicula longispina* and *acanthoptera*, Hall, are also abundant, as well as a *Rhynchonella*, which differs from any known Waverly species.

It seems, therefore, from these indications, that the line separating the Chemung and Waverly, passes between these two horizons; and that we have here positive paleontological and stratigraphical evidence of the superposition of the Waverly above the Chemung, as I have heretofore argued.[118]

The fossils from Tennessee identified with species of the age of the Marshall (or Waverly) Group, will undoubtedly be regarded as possessing considerable interest, as this is the first paleontological determination of the extension of this group into that State. They are mostly embraced in a thin deposit of dark, silicious, bituminous shales, emitting an agreeable aromatic odor,[119] and resembling in physical characters, the shales of the Kinderhook Group, of Illinois. This resemblance suggests the belief that the Hickman shales of Tennessee are a prolongation of the Kinderhook shales; and that they will yet be traced along both sides of the Coal Measures, from Indiana and Illinois across the western extremity of Kentucky.[120]

ZAPHRENTIS IDA? Win. (Proc. A. Nat. Sci., Phil., July, 1865). From Hickman county, Tenn., and Sciotoville, Ohio, (See Andrews' section). The Tennessee specimens are without epitheca, and lack the profound wrinkles of growth belonging to the types of this species, from Rockford, Ind. They also enlarge upward somewhat more rapidly. The Ohio specimen is extremely similar to these.

TREMATOPORA? VESICULOSA, Win. (Proc. A. Nat. Sci., Phil., Jan., 1863, p. 3). Several good specimens from Sciotoville, Ohio.

118 See especially Proc. Amer. Phil. Soc., No. 81, p. 57, and Proc. Acad. Nat. Sci., Phil., July, 1865, p. 110.

119 See further notices of these rocks, Geology of Tenn., chap. XI, sec. I.

120 Descriptions of these fossils are embraced in the late Report on Tennessee, in a paper embodying notices of some fossils from the "Carboniferous Limestone," of that State. As Prof. Safford has questioned the correctness of my identification of *Spirifera Logani*, I embrace this opportunity to state that I have reinvestigated the question and remain of the same persuasion as before, though I admit there is room for differences of opinion. I have five specimens of *S. imbrex*, (to which Prof. Safford refers the specimens in question) from the typical locality, at Burlington, Iowa. The Tennessee specimens differ from these as follows: They are larger, heavier and coarser shells; the sinus is more deeply sunk, relatively broader, and more distinctly defined, and it is greatly produced in front, while that of *S. imbrex* is scarcely at all produced; it embraces from 10 to 12 costæ, while that of *S. imbrex* embraces only 6 or 8; the fold, instead of being obsolete, and a mere undefined swell, is raised into a prominent, crest-like, acute ridge, especially toward the front; the dorsal valve is flattened from the middle of the fold to the extremities; the area is not flat, and is striated in both directions; the costæ, besides being smaller, are less numerous, except in very old specimens; they are crossed only by fine concentric striae, and remote irregular grooves, instead of coarse, regular, imbricating striæ raised into nodes on the crests of the costæ, as is the case with the surface of *S. imbrex*, when well preserved.

On the contrary, these specimens agree with *S. Logani*, especially in the following distinctive characters; "Dorsal valve depressed toward the cardinal extremities, and broadly curving to the base; mesial fold very prominent, extremely elevated and subangular in front, not defined at the margins. Ventral valve very gibbous at the sides, marked by a broad, deep, undefined mesial sinus which, in the middle of the shell, occupies fully one-third of the width, sloping abruptly to the cardinal extremities, and extremely produced and elevated in front, in a sub-triangular extension;" the area is concave, vertically and longitudinally striate.

The correct identification of these Tennessee specimens is important, as having a bearing on the question of the equivalencies of the "Silicious Group," of Safford.

Lingula subspatulata? M. & W. (Ill. Geol. Rep. III, 437, pl. 13, fig. 1). From Tennessee, and No. 6, Rockville, Ohio. The single specimen from Tennessee, showing the inside of (apparently) the ventral valve, is not over one-third the length of the specimen figured in the Illinois Report; but it otherwise agrees with the description in outline, surface markings, position of beak and faint radiating lines along the middle.

Lingula sub-spatulata was described from the "Black Slate," of Union county, Ill. At Vanceburg, Ky., and other localities on both sides of the Ohio river, is a black shale embraced within the Waverly series, (see No. 6, Andrews' section) which contains a small *Lingula*, not easily distinguishable from the Tennessee specimen. If the Ohio, Kentucky, and Tennessee specimens are really identifiable with the Illinois species, it appears strange that the latter should be found in a geological position so much lower. There seems to be occasion for the query, whether the Illinois equivalent of the Vanceburg Shale has not become confounded with the "Black Shale," by the disappearance of intervening beds; and also, whether the entire mass of the "Black Shale," of southern Ohio, Indiana and Illinois, does not, in fact, belong in a position considerably above the Genesee Shale, as Verneuil, Owen and others long ago suggested.[121]

I am led to suspect that *L. sub-spatulata*, M. & W., is identical with my *L. membranacea*.[122]

Lingula membranacea, Win. (Proc. Acad. N. S., Phil., Jan., 1863). From near Shafer's, Penn.

Discina Saffordi, n. sp.

Shell rather small, outline nearly circular, but generally a little flattened posteriorly, and also on each of the postero-lateral boundaries. Upper valve rather depressed conical, with the beak midway between the centre and the posterior side; under surface presenting a faint but distinct linear ridge extending anteriorly from the beak one-fourth the diameter of the shell. Lower valve very depressed convex, with an apical pyriform indentation having a blunt spur projecting from its broad anterior end; no perforation visible. Exterior of both valves ornamented with numerous fine, unequal, concentric striæ; interiors smooth, except the faint vascular markings near the borders.

This curious species most resembles in general appearance, *Discina Lodensis*, from the Genesee Shale; but the pyriform indentation of the ventral valve, the finer external striæ and the inconspicuous foramen will serve to distinguish it.

From dark bituminous Shales just above the "Black Slate," of Hickman county, Tennessee.

121 The "Black Shale," of northern Ohio, Ontario and Michigan, is undoubtedly the "Genesee," as is proven both stratigraphically and paleontologically. (See Proc. Amer. Phil. Soc., No. 81, p. 77, &c.)

122 I take occasion to remark that *Gyroceras? Rockfordensis*, M. & W., (Ill. Rep. III, p. 459) from Rockford, Ind., is identical with my *Cyrtoceras Rockfordense*, described in Proc. Acad. Nat. Sci. July, 1865.

Discina capax? White (Proc. Bos. Soc. Nat. Hist.) From Black Shale (Bed No. 6), Rockville, Ohio.

These specimens resemble *D. Lodensis* in size and markings. They differ in the more prominent and more excentric beak of the dorsal valve. The striæ of *D. Lodensis* are also more regular and more sharply raised, and it is a larger species. It is smaller and thinner than the types of *D. capax*, but I hesitate to pronounce it distinct.

Discina Gallaheri, Win. (Proc. A. N. S., Phil., July, 1865). Collected by Prof. Andrews, at Granville, Licking county, Ohio,—adherent on a *Spirifera;* also, from near Shafer's, Penn.

The Ohio specimens differ from *D. Gallaheri* only in size—being one-half the diameter, or less. The indentation of the dorsal valve is lenticular in outline, and extends nearly from the posterior margin to the centre of the valve. Along the middle of the indentation on the inside is a ribbon-shaped impression, bounded by a sharp, elevated ridge on each side, and divided by a similar, parallel ridge running along the middle of the impression. Each portion of this impression is marked by extremely delicate, raised, transverse lines, which would seem to indicate that the impressions are not the foramen, but a portion of the shell. The foramen may have been a delicate slit occupying the place of the median ridge dividing the two impressions. In *D. Saffordi* the foramen appears to be similarly wanting, and it may have been equally slit-like during life.

The Pennsylvania specimens are mere casts of the non-perforate valve, slightly oval in outline, with irregular, concentric wrinkles, a sub-central beak elevated one-third the smaller diameter of the valve. One of the three casts bears apparently the impressions of the ribs of some costate shell, suggesting that this individual, like the Ohio specimens, may have been parasitic. The larger of these casts are fourteen-sixteenths by eleven-sixteenths of an inch in diameter.

Producta concentrica, Hall (Iowa Geol. Rep. 517, pl. vii, fig. 3; 10 Rep. N. Y. Regents, 180; see also, Winchell, Proc. A. N. S., Phil., July, 1865, p. 115). From yellowish-brown calcareo-argillaceous beds, and from calcareo-silicious shales of Tennessee. Also, from Sciotoville, Ohio.

The Tennessee collection contains one specimen showing both valves, one showing the ventral, and one both sides of the dorsal valve. Another specimen exhibiting the exterior of a ventral valve, resembles the forms named *P. Shumardianus* by Prof. Hall; but this name is probably a synonym of *P. concentrica*.

Producta semireticulata, Fleming.

Collected by Rev. H. Herzer, at Newark, Licking county, Ohio; by Prof. E. Andrews, at Sciotoville (where it is abundant); from bed No. 5, Rockville; from a point $2\frac{1}{2}$ miles west of "Cincinnati Furnace," Vinton county, Ohio (in the upper Waverly); and in large and characteristic specimens from near Shafer's, on Oil Creek, Venango county, Penn.

Producta Cooperensis? Swallow.

From bed No. 4, Sciotoville, Ohio.

There are several specimens of this form, and they differ from specimens of *P. Cooperensis* from Burlington, Iowa, principally in a much shallower ventral sinus and a larger size. In size, and in the peculiar arrangement of the granulations of the inner surface, they resemble *P. duplicostata*, Win., but the costæ are less developed, and there are fewer spines distributed over the general surface. These forms resemble, not a little, *P. viminalis*, Hall, from the Burlington Limestone, but the costæ are less pronounced, and the ventral valve enlarges less rapidly. This is possibly the species which has sometimes been referred to *P. Cora*, D'Orb.

PRODUCTA GRACILIS? Win. (Proc. Acad. N. Sci., Phil., July, 1865.) From bed No. 4, Sciotoville, Ohio.

The numerous casts from this locality do not preserve the striations as strongly as the types of this species; but they are too broad for *P. parvula*, and the ventral valve is not sufficiently produced. It is desirable yet to make comparisons with specimens of *P. minuta*, Shum.

PRODUCTA MORBILLIANA, Win. (Phil. Proc., July, 1865, p. 113.) From bed No. 4, Sciotoville, Ohio.

PRODUCTA ARCUATA, Hall (Iowa Rep. 518, pl. vii, fig. 4, a. b). Quite abundant in bed No. 5, Rockville, Ohio. Quite identical forms occur also at Granville, O.

CHONETES MULTICOSTA, Win. (Proc. A. N. S., Phil., Jan., 1863, p. 5.) In yellowish-brown calcareo-argillaceous beds and dark bituminous shales in Hickman and Maury counties, Tennessee.

There are two dorsal valves in Prof. Safford's collection. They agree with this species, except that the striæ are considerably more obscure than even in the typical specimens; and the external surface is minutely granulated.

This species ranges from the base of the Yellow Sandstones, at Burlington, Iowa, into the base of the Burlington Limestone.

CHONETES PULCHELLA, Win. (Proc. A. N. Sci., Phila., Sept., 1862.) A single ventral valve occurs among the specimens from Tennessee. It exposes only the inside, and hence the number of ribs cannot be satisfactorily ascertained. A slightly divergent spine appears at each extremity of the hinge line.

Several clearly marked specimens from Newark, Ohio, occur in Prof. Andrews' collection. These exhibit, however, three or four hollow spines each side of the beak.

Other specimens from near Shafer's, on Oil Creek, Pa., are almost perfectly identical with these.

CHONETES FISCHERI, N. & P. (Jour. A. N. S., Phil., vol. I). From dark bituminous shales, Tennessee.

CHONETES GENICULATA? White (Proc. Bos. Soc. N. Hist. IX, 29). From bed No. 5, Rockville, Ohio.

The few imperfect specimens in the collection agree with forms occurring at Burlington, Iowa, in the Yellow Sandstones, and sometimes referred with doubt to *C. geniculata*. I suspect they may all prove to be *C.*

pulchella, Win. The type-specimens of *C. geniculata* are from Clarksville, Mo., and, besides presenting the characteristic geniculation in the ventral valve, appear to have a rather shorter hinge line than these specimens.

Chonetes Illinoisensis, Worthen (Trans. St. Louis Acad. Sci. I, 571). Occurs in bed No. 5, Rockville, Ohio.

Hemipronites inequalis, Hall sp. (Io. Geol. Rep. 490, pl. ii, fig. 6, a—c.) Collected by Rev. H. Herzer, at Newark, Ohio, and by Prof. Andrews, at Granville. Collected, also, by the latter in Pennsylvania, near Shafer's.

Hemipronites umbraculum? Schloth. (Die Petrefact. I, p. 256, and II, p. 67.)

Collected by Rev. H. Herzer, at Newark, Ohio, and by Prof. Andrews, in bed No. 4, at Sciotoville and bed No. 5, Rockville, and also, near Shafer's, Penn.

It may well be doubted whether the large specimens ranging through the equivalents of the Marshall group, in the Western States, really belong to the foreign species to which they have generally been referred.

Orthis subelliptica? W. & W. (Bos. Proc. VIII, 292.) From bed No. 4, Sciotoville, Ohio. A single imperfect specimen.

Orthis Michelini? L'Evéillé.

From bed No. 5, Rockville, Ohio; from Granville, Licking county; from Vinton county; and also, from near Shafer's, Penn.

The specimens from all these localities agree with each other and with specimens commonly referred to *O. Michelini*. It is a form probably identical with that from Clarksville, Mo., referred to *O. Vanuxemi*, by Prof. Hall. The smaller, flattened specimens approximate *O. flava*, Win., from the Burlington Sandstone, while a large, transversely oval specimen from Rockville, approaches *O. resupinata*, except in much smaller size. In the considerable convexity of some of the dorsal valves (especially from Shafer's), and also in the cast of the muscular scars, they differ from *O. impressa*, Hall. If there are any permanent specific distinctions among the widely extended American forms commonly referred to *O. Michelini*, it will require extended and careful comparisons to make them out.

Spirifera hirta? White & Whitfield.

The single specimen from silicious Shales, Tennessee, is considerably larger than specimens from Burlington, Iowa, the typical locality, and perhaps the area is a little more extended laterally.

Spirifera extenuata, Hall (Iowa Rep. 520, pl. vii, fig. 6). Collected by Rev. H. Herzer and Prof. Andrews, at Newark, O.

Spirifera Waverlyensis, n. sp.

Shell semi-circular, without plications (on the cast). Ventral valve with an elevated, nearly flat, transversely furrowed and vertically striated area, reaching the whole length of the hinge-line, which is scarcely less than the greatest width of the valve. The plane of the area forms a right angle with the plane of the valve. Surface more rapidly convex near the margin than between the beak and the middle; lateral slopes, also, gently convex. Sinus deep, well defined, occupying nearly one-fourth the width of the valve, slightly produced anteriorly. Dental lamellæ extending three-fifths the length of the valve, not approximated at the rostral extremity. Muscular scars striate. Surface of cast destitute of plications, but deeply marked toward the front by wrinkles of growth.

Transverse diameter, one and five-eighths inches ; antero-posterior diameter, one inch ; height of area, three-eighths of an inch.

This species is more completely destitute of plications than any other in rocks of the same age ; and this character, together with the length, width and flatness of the area, renders it necessary to admit it as new.

SPIRIFERA CARTERI, Hall (*S. Vernonensis*, Swallow). Very abundant in bed No. 4, Sciotoville, Ohio ; rare in bed No. 5, Rockville. A single specimen labelled Granville, is, probably (judging from the matrix), from Sciotoville. Occurs also, near Shafer's, Penn.

SPIRIFERA MARIONENSIS, Shum. (Mo. Geol. Rep., Pt. ii, p. 203, pl. C., fig. 8, a—d.) Several specimens from bed No. 4, Sciotoville, Ohio. These specimens agree tolerably well with the description of this species, and with specimens from Clarksville, Mo. This seems to be a species, however, which exhibits a tendency to graduate on the one hand, into *S. biplicata*, and on the other, into *S. Carteri*. Young specimens exhibit a well defined ventral sinus, with about two incipient plications; and having, at this age, sharper dorso-lateral angles, they closely approximate *S. biplicata*. Large specimens, on the contrary, can scarcely be distinguished from *S. Carteri*, save by the less pronounced sinus and fold.

There are, indeed, six species described from rocks of this age, which need to be re-examined and compared, viz : *S. Marionensis*, Shum., 1855; *S. Carteri*, Hall, 1857–8 ; *S. biplicata*, Hall, 1858 ; *S. Vernonensis*, Swallow, 1860 ; *S. Osagensis*, Swal., 1860 ; and *S. Missouriensis*, Swal., 1860. The three first are, perhaps, distinct species—possibly all the others.

SPIRIFERA SUBROTUNDATA, Hall (Iowa Geol. Rep., p. 521). From bed No. 4, Sciotoville, Ohio.

On some of the casts no striations are certainly seen, except over a limited space one side of the beak.

SPIRIFERA BIPLICATA? Hall. A single imperfect specimen, from No. 4, Sciotoville, Ohio. See remarks above on *S. Marionensis*.

SPIRIFERINA SOLIDIROSTRIS, White (Bos. Jour. VII, 232). Collected by Rev. H. Herzer, at Newark, Ohio, and by Prof. Andrews, from bed No. 4, Sciotoville, and bed No. 5, Rockville.

SYRINGOTHYRIS TYPA, Win. (Proc. Acad. N. S., Phil.) This species occurs quite abundantly in Ohio. Mr. Herzer and Prof. Andrews have furnished over a dozen specimens from Newark. In bed No. 4, Sciotoville, it forms, with *Spirifera Carteri* and several other species, the principal mass of a highly ferruginous stratum of sandstone. It occurs freely, also, near Shafer's, in Pennsylvania.

From Newark specimens may be worked out good views of both valves, and of the bifariously striated area. Traces of the pseudo-deltidium may also be seen, and it appears that the dental lamellæ are very deep, but the essential structure of the genus does not appear. There is one exceptional specimen, which may be a dorsal valve distorted by pressure exerted at the hinge extremities. If undistorted, it belongs, evidently, to a distinct species.

In many of the Sciotoville specimens, the fissured tube and other details of the internal structure of the genus are distinctly shown, but there is difficulty in isolating the specimens from the mass.

A specimen in Prof. Andrews' collection from Newark, which has the beak of the ventral valve somewhat less elevated than usual, and the area considerably vaulted, presents on the cast of this valve generic (?) characters which have not before been noticed. The whole width of the broad sinus, in the middle of the valve, is occupied by a pair of very peculiar occlusor scars, separated by the shallow impression of a low median ridge. Each scar appears somewhat like the representation of the head of a sheaf of wheat—the divergent and pendent heads of grain being turned toward the extremities of the shell. The two scars together are an inch broad, and of equal length. These characters recur in a specimen from Shafer's, Pennsylvania.

I have some suspicion that *Syringothyris typa* is identical with *Spirifera capax*, Hall. The principal distinction, so far as I observe, consists in the lobular, anterior prolongation of the ventral sinus of the former. In a specimen having a transverse diameter of $3\frac{1}{2}$ inches, and a height of area of $1\frac{3}{8}$ inches, the ventral sinus projects three-fourths of an inch beyond the general front of the shell. All of my specimens present this character; but it does not appear in the description and figures of *S. capax*. As this is a character which probably bears a relation to the age of the shell, it may be that *S. capax* was described from immature specimens. If so, this species should be known as *Syringothyris capax*.

Spirigera Hannibalensis, Swallow (St. Louis Trans. vol. I, p. 649). Several good casts from bed No. 4, Sciotoville, some of which show both valves. Impressions of the exterior are common, showing that this species flourished to luxuriant dimensions. A pair of spines is preserved, with a bit of smooth shell attached.

Spirigera Ohiensis, Win. (Proc. A. Nat. Sci., Phil., July, 1865, p. 118.) From bed No. 4, Sciotoville, Ohio.

Rhynchonella Sageriana, Win. (Proc. Acad. N. Sci., Phil., Sept., 1862, p. 407.) Six specimens from dark bituminous shales, Tennessee. Also, from Newark, Ohio; bed No. 4, Sciotoville; Granville (abundant,) and from "Cincinnati Furnace," Vinton county, where it is of frequent occurrence.

This is a common and widely distributed species. I have heretofore known it from remote parts of Michigan, and from Medina, Ashland, Cuyahoga, Summit and Licking counties, Ohio.

Rhynchonella Missouriensis, Shum. (Mo. Report II, 204.) From bed No. 4, Sciotoville, Ohio.

Rhynchonella Marshallensis, Win. (Proc. A. N. S., Phil., Sept., 1862.) From Granville, Licking county, Ohio.

CENTRONELLA? FLORA, n. sp.

Shell broadly ovate, rather rectilinear along the cardinal slopes, broadly and slightly sinuate, or not, along the ventral commissure; general form of each valve a segment of a sphere. Surface of shell very finely and sharply striate both longitudinally and concentrically.

Length, fifteen-sixteenths of an inch; breadth, fourteen-sixteenths; thickness of both valves seven-sixteenths.

This species is broader and less rostrate than *C. Allei*, Win. (Proc. A. N. S., Phil., July, 1865, p. 123,) and also less tumid around the margins, besides being much more distinctly striate.

Though I am not positive of the generic relations of this species, it appears to be congeneric with *C. Allei*. These species are both ornamented with beautiful terebratuloid punctations, and both exhibit the elongated ribbon-like muscular markings on the ventral valve which also characterize the well-determined species *C. Julia*. In one of the specimens referred (provisionally) to *C? Flora*, there is a low, but elongated median septum in the dorsal valve, from which, near the beak, proceeds, on each side, a thin horizontal, longitudinal plate, reaching half the length of the septum. In the ventral valve, the dental lamellæ are feebly developed, and, instead of reaching the inner surface of the valve, they curve toward the median line and join each other, leaving a small space between the transverse septum thus formed and the surface of the valve—being thus a kind of *shoe-lifter septum inverted*,—or, more strictly, a trough-like plate, as in *Camarophoria*, but not, like that, supported by a median vertical plate. It is worthy of consideration whether these distinctive characters are not of generic importance. The structure noticed in this specimen connects *Pentamerus* with *Terebratula*, as *Camarophoria* connects *Pentamerus* with *Rhynchonella*. I reserve the subject for further study.

From bed No. 4, Sciotoville, Ohio.

PERNOPECTEN? COOPERENSIS, Shum. sp. (Mo. Geol. Rep., Pt. ii, p. 206, pl. C, 15.) Herzer's collection, Newark, Ohio.

The single internal cast referred to this species is rather too narrow—having about the form of *P. limæformis*. It is marked by about fifteen coarse radiating grooves, with some traces of smaller intermediate ones.

Messrs. Meek and Worthen have expressed a strong suspicion (Ill. Geol. Rep. III, p. 454), that *Pernopecten limæformis* and *P? Shumardianus* are but varieties of *Avicula Cooperensis*, Shum. I embrace the opportunity to correct the impression of these authors that the surface characters of *P. limæformis* have not been seen in a perfect state of preservation. I have impressions of exteriors of this species upon fine (almost lithographic) stone, in which the most delicate characters are much more perfectly preserved than they generally are in fossils retaining the actual shell. Gutta percha restorations from these moulds are perfectly destitute of fine radiating striæ. On the contrary, they exhibit very fine, sharp and regular concentric striæ, and obsolete traces of a few straggling, irregular, discontinuous, broad folds or undulations. This species is also distinctly narrower than the others. With little doubt, its validity should be admitted.

Pernopecten limatus? Win. (Proc. A. N. S., P., July, 1865, p. 126.) Newark, and bed No. 4, Sciotoville, Ohio.

Like the other Ohio representatives of the species of this family, the specimens of this species are considerably larger than the Iowa types.

Aviculopecten Newarkensis, n. sp.

Dorso-ventral and antero-posterior diameters and length of hinge line as the numbers, 14, 10 and 7. Left valve rather convex, its cardinal slopes forming an angle of about 60°, and thus creating a sharper beak than is usual in this genus. Anterior ear somewhat inflated, with about six strong radiating striæ, finer intermediate ones, and numerous fine decussating striæ. Posterior ear a little smaller, flat, its posterior boundary nearly at right angles with the hinge. Beak scarcely exceeding the hinge. Surface marked with numerous fine, unequal, slightly wavy, delicately crenulated, radial striæ.

Dorso-ventral diameter fourteen-sixteenths of an inch; antero-posterior, ten-sixteenths; length of hinge line, seven-sixteenths.

The striæ are of the size of those in *A. tenuicostus*, Win., but they are less rigid, regular and uniform; the shell is less circular, and the umbo is more prominent.

Aviculopecten Caroli, Win. (Proc. A. N. S., Phil., Jan., 1863, p. 9.) From Newark, bed No. 4, Sciotoville, and from Granville, Ohio.

The specimens from Licking county are all right valves, and are much flatter than typical specimens of the same valve.

Aviculopecten occidentalis, Win. (Proc. A. N. S., Phil., Jan., 1863, p. 9.) From Newark, Licking county, Ohio. The largest specimen is twice the size of the Iowa types. A right valve of the same size, from Granville, shows also obsolete, irregular, radiating furrows around the margin of the cast.

Sanquinolites naiadiformis, n. sp.

Length two and a half times the height; laterally flattened below the umbo; dorsal and ventral margins parallel or nearly so—the ventral sometimes with a broad shallow sinus extending upwards over the valves and vanishing near the umbo; a distinct umbonal ridge flattening out near the postero-ventral angle, at which place the outline presents a rounded angulation; the postero-dorsal slope making, with the dorsum, an angle of 45°.

Length, $2\frac{3}{4}$ inches; height, one and one-sixteenth inches; thickness, half an inch.

The above description is based on a specimen from Hillsdale, Michigan. Mr. Herzer has sent a single specimen from Newark, Ohio, which agrees with this; but such is the state of preservation of lamellibranchs in this formation, that there is extreme difficulty in ascertaining their generic characters. Another specimen from Granville, Ohio, presents a still better specific accordance.

Sanguinolites (Cypricardia?) securis, n. sp.

Outline of shell sub-oval, anteriorly indented by a small lunule, over which hangs the small, incurved, approximated, sub-terminal beaks. A very prominent, sub-acute ridge runs from the beaks posteriorly and but little below the level of the straight indented hinge line. The greatest thickness of the shell is therefore near the flattened dorsal border. From this ridge the lateral surfaces proceed with slight curvature to the ventral margin, so that the united valves present a cuneate or somewhat axe-like form.

Length, one inch; height, thirteen-sixteenths; transverse diameter, nine-sixteenths.

This species is less elongate than *Cypricardia rigida,* and has a rounded, instead of truncate posterior extremity; the umbonal ridge, also, is nearer the hinge margin.

Collected by Rev. H. Herzer, at Newark, Ohio.

SANGUINOLITES MARSHALLENSIS, Win.

Occurs in bed No. 4, Sciotoville, Ohio.

ALLORISMA (SEDGWICKIA) HANNIBALENSIS, Shum. (Mo. Rep. p. 206). Specimens from Newark, Ohio, agree better with the Burlington (Iowa) forms usually referred to this species, than with Dr. Shumard's figure of the type.

CYPRICARDIA (?) RIGIDA, W. & W. (Bos. Proc. VIII, 300.)

A single specimen from Newark, Ohio, which does not show the "second ridge" between the main umbonal angle and the hinge, and which may result from dorso-ventral compression.

LEDA BELLISTRIATA? Stephens (Am. Jour. Sci. [2] vol. XXV, p. 26.) Five specimens from dark, bituminous Shales, Tennessee, are referred to this species solely on account of external resemblances. They have the peculiar form and sharp concentric furrows of the species. They are a little over an inch in length, but do not, in this, exceed specimens from Battle Creek, Michigan,—the typical locality. At the same time, no indication of hinge-structure has been observed, and the shell seems to have been thinner than usual for the species of this family. Should further discovery demonstrate that these specimens do not belong to *Leda,* they will perhaps fall into the genus *Sedgwickia* of McCoy; but I do not consider it allowable to propose a specific name to be based on discoveries of some future investigator.

CONOCARDIUM PULCHELLUM, White & Whit. (Proc. Bos. Soc. N. H. VIII, 299.) From Newark, Ohio.

SOLEN SCALPRIFORMIS, Win. (Proc. Acad. N. S., Phil. Sep., 1862, p. 42?.) From dark, bituminous shales, Tennessee. Like other species in the same situation, the shell is thin and fragile. This probably resulted from an insufficiency of calcareous matter in the waters which precipitated the argillo-bituminous materials of the rock.

SOLEN QUADRANGULARIS, Win. (Proc. A. N. S., Phil. Jan., 1862.) A fragment from Granville, Ohio.

PLATYCERAS HERZERI, n. sp.

Shell rather large, consisting of about two coils, which enlarge rapidly near the apex, and gradually through the last half of the whorl; laterally compressed, and dorsally sub-angulated, except near the aperture; irregularly plicated longitudinally, and marked transversely by deeply waved, lamellar striæ of growth indicating a coarsely and unequally crenate aperture.

Of this species two varieties may be recognized: (A) The typical form, differing from *P. paralium*, W. & W., in its excentric apex; (B) A form less profoundly plicated—perhaps because younger specimens. These forms I was at first inclined to regard as varieties of *P. haliotoides*, M. & W., but I believe the departures are too extreme and the mutually-concurring specimens too numerous for specific identity with the Illinois forms.

The largest specimens, when resting on the aperture, are an inch in height; the transverse diameter of the aperture is five-sixteenths of an inch, and the dorso-ventral diameter six-sixteenths.

Quite abundant at Newark, Ohio.

Platyceras haliotoides, M. &. W. (Ill. Geol. Rep. 458, pl. xiv, fig. 3). From Newark, Ohio.

Pleurotomaria Hickmanensis, Win. (Tenn. Geol. Rep).

Globose shells in an incomplete state of preservation, showing regularly convex whorls ornamented with numerous delicately raised and finely beaded revolving striæ, and a well-defined band, without distinct carina. The striæ limiting the band are not beaded, but all the others, on both sides, bear 50 to 60 granulations to the inch. The striæ are quite unequal in number and distribution, since they increase by implantation, with the growth of the shell. The base of the shell is about an inch in diameter, and seems to be perforated by a small umbilicus.

From dark, bituminous shales, Hickman county, Tennessee.

Pleurotomaria vadosa, Hall (XIII. Rep. N. Y. Regents, p. 108.) Numerous casts occur in bed No. 4, Sciotoville, Ohio, which are quite identical with casts from Michigan. Some imperfect moulds, larger than the typical forms, occur also in bed No. 5, Rockville, Ohio.

Murchisonia prolixa, W. & W. (Proc. Bos. Soc. N. H. VIII, 303.) Bed No. 4, Sciotoville, Ohio.

Murchisonia quadricincta, Win. (Proc. Acad. N. S., Phil. Jan. 1863, p. 19.) Bed No. 4, Sciotoville, Ohio.

Bellerophon cyrtolites, Hall. (XIII. Rep. N. Y. Reg.)

A single imperfect specimen from Granville, Ohio.

Conularia byblis, White. (Proc. Bos. Soc. N. H., Feb. 1862, p. 22.) From dark, bituminous shales, Hickman county, Tennessee.

I feel no doubt of the identity of this species. It possesses the same small isolated eminences or granulations ranged in a line along the crests of the ridges, which characterize well preserved specimens from Burlington, Iowa. From 60 to 75 of these eminences may be counted in the space of an inch.

Dr. White does not mention these granulations; only stating, "spaces between the ridges finely crenulate." Worn specimens develop a series of transverse bars between the ridges, which undoubtedly correspond in position with the granulations seen in unworn specimens. Compare with this species, *C. Gervillei* d'Archiac et Vern., Mem. Foss. Rhenish Prov. in Trans. Geol. Soc., Lond., vol. VI, p. 351.

Conularia Newberryi, Win. (Proc. A. N. S., Phil. July, 1865, p. 130.) From bed No. 4, Sciotoville, Ohio.

This shell was probably as large as *C. byblis.* It has the form of a quadrangular pyramid compressed in the direction of two opposite angles. It differs from *C. byblis* as follows:—Its form is much more distinctly angulated; the septa range from 17 to 44 to the inch, while in *C. byblis* they range from 56 to 128 to the inch; it bears a deep V-shaped furrow along each of the angles; within this furrow the septa are deflected abruptly toward the base of the shell, so that they meet from opposite sides at about a right angle; the septa also sweep toward the base with a gentle curve in their extension across the side of the pyramid, by which their centres are about two intervals lower than the portions in the ridge which bounds the angle-furrow. In *C. byblis* the septa-margins also trend toward the base, but they are more nearly straight from angle to centre. The septa, like those in *C. byblis* and many other species, are ornamented along their margins by delicate granulations. The species appears to have been at least three or four inches in length.

The septa toward the upper end become more direct, and I have little doubt that it was the apical portion of this species from which *C. Newberryi* was originally described.

Orthoceras Indianense, Hall. (XIII. Rep. N. Y. Reg.) From Newark and from bed No. 4, Sciotoville, Ohio. One of the specimens from the latter locality exhibits a broad constriction near the base of the outer chamber. From Newark are also fragments of an *Orthoceras* having an elliptic section and oblique septa.

Nautilus (Trematodiscus) trisulcatus, M. & W. (Proc. A. N. S., Phil., 1860, p. 470.) From bed No. 5, Rockville, Ohio.

Goniatites Marshallensis, Win.

From Newark, Ohio. Differs from *G. Lyoni*, M. & W. (=*G. Hyas*, Hall), in having the transverse section regularly curved instead of broadest near the umbilicus; in having the first and second lateral lobes rounded instead of acuminate; in having an additional accessory lobe and saddle, and in having the dorsal lobe broader and relatively longer.

Goniatites Shumardianus, Win. (Am. Jour. Sci. [2] XXXIII, 364, May, 1862.) From Newark, Ohio.

The specimens of this species, though fragmentary, exhibit nearly all the specific characters.

To the description of *G. Shumardianus* originally given, may be added the following characters, drawn from the Newark specimens: Accessory lobe concealed, same form as the lateral one, but only one-third its size, separated by a parallel-sided, circularly terminated saddle from a narrow, elongated, parallel-sided ventral lobe.

As the three species, *G. Allei*, *Shumardianus* and *propinquus*, are closely related in general aspect, their diagnostic characters may be here given in stronger contrast.

G. Allei wants the dorsal lobe—unless we regard the two first-lateral together with the dorsal saddle, as a bifid dorsal lobe—and has a closed umbilicus.

G. Shumardianus has a simple dorsal lobe and an open umbilicus.

G. propinquus has a shorter and narrower dorsal lobe than *G. Shumardianus*, with a closed umbilicus.

Goniatites Ohiensis, n. sp.

Compressed-globoid, deeply and broadly umbilicate. Dorsum rounded, sides considerably and somewhat obliquely flattened, so as to give the widest transverse section near the borders of the umbilicus, this diameter being to the dorso-ventral as 4 to 3. Dorsal lobe oblong, parallel-sided, obtuse, separated, by a broader and longer, obtusely rounded dorsal saddle, from a subclavate, acute lateral lobe, which reaches half its length behind the dorsal one. This lobe is followed by a very broad shallow saddle having its apex turned obliquely toward the dorsum. Second lateral lobe small, equilaterally triangular, situated on the brink of the umbilicus.

Greatest transverse diameter, fifteen-sixteenths of an inch ; dorso-ventral diameter, twelve-sixteenths; diameter of umbilicus, seven-sixteenths.

Differs from *G. Shumardianus* in its parallel-sided, obtuse dorsal, and linguiform, acuminate first lateral lobe ; also, in the oblique position of the lateral saddle. There is no species likely to be confounded with it unless it be *G. Andrewsi*, which has the sides more convex, and differs also in its acuminate-clavate dorsal lobe.

From Newark, Ohio. Collected by Rev. H. Herzer.

Goniatites Andrewsi, n. sp.

Compressed-globoid; deeply, broadly and abruptly umbilicate. Rounded on the sides, and more rapidly on the dorsum; greatest width close to the umbilicus ; transverse diameter to the dorso-ventral as 4 to 3. Dorsal lobe long, clavate, acuminate, separated by a sub-clavate broadly rounded saddle from the first lateral lobe, which is also clavate-acuminate, but a little broader than the dorsal, and a trifle shorter. This is followed by a very broad, obliquely situated saddle, having its dorsal side concave in the middle, and its umbilical side gently convex. The whorls are marked each by about four constrictions. In one specimen, which seems to preserve a portion of the shell, it is seen to present somewhat uniform, closely-set, transverse wrinkles in the region near the umbilicus. Casts of the umbilicus retain the impression of every whorl to the very apex, and show that this species attained seven or eight volutions, the later of which increased in transverse diameter more rapidly than the earlier.

From Newark, Ohio. Collected by Rev. H. Herzer.

Cythere crassimarginata, Win. (Proc. A. N. S., Phil., Sep.. 1862.) From bed No. 5, Rockville, Ohio. Some of the specimens attain twice the dimensions of the types of the species.

Phillipsia Missouriensis, Shum. sp.

From Newark, Ohio. Collected by Rev. H. Herzer.

All the known characters of the species are exhibited, except the granulations of the surface, which the state of preservation of the specimens renders it impossible to detect.

Phillipsia Tennesseensis, Win. (Tenn. Geol. Rep. p. 445.)

Glabella prominent, indented by a small, round, depressed, postero-lateral lobe, and isolated by a deep occipital furrow from a prominent occipital ring, which extends, narrowing in width and curving backwards, entirely across the border, fading out toward the short, acute genal angle. Border concave, bounded by a prominent ridge, outside of which is a linear groove limited peripherally by a sharply elevated, delicate, linear margin. Surface of glabella, accessory lobe and neck-ring covered with fine unequal granulations; a row of granules along the ridge of the border.

Pygidium broadly rounded, nearly twice as broad as long, apparently depressed ; axis with 8 or 9 rings, tapering to the posterior end, which is somewhat abruptly rounded off one-tenth of an inch from the extremity of the pygidium; lateral lobes with 8 or 9 segments becoming obscure posteriorly. Border about one-sixteenth of an inch broad, marked on the under side by nine rigid, sharply impressed parallel striæ. Exterior of the crest very finely and obscurely granulated. Length, about three-eighths of an inch ; breadth, five-eighths.

Other characters of this species are unknown. It seems to approach nearest to *P. articulata*, Hall sp. (XV. Rep. N. Y. Regents, p. 107.) From the Waverly of Ohio ; but is destitute of the anterior and middle furrows of the glabella. Neither does the description of that species give the surface characters, though comparison is made with *Proetus Missouriensis*, Shum., from the lithograpic limestone of Missouri, which is a granulated species. It differs from *Proetus* (*Phillipsia*) *ellipticus*, M. & W. (Ill. Geol. Rep. III, 460), from the Kinderhook group, in the characters of the cephalic border, in the absence of glabellar furrows, and in the border of the pygidium.

From calcareo-argillaceous beds, of yellowish brown color, and from calcareo silicious shales, Hickman and Maury counties, Tennessee.

Phillipsia Doris, Hall sp. (XIII. Rep. N. Y. Regents, p. 112, and Winchell, Phil. Proc., July, 1865, p. 133.)

Several small pygidia occur in the collection from bed No. 5, Rockville, Ohio.

Pleurodictyum problematicum, Goldf.

Well preserved specimens occur at Newark, Ohio. Collected by Rev. H. Herzer.

Murchisonia sp?

A fragment nearly three inches long, consisting of four whorls—probably about one or two whorls wanting at the apex and an unknown portion from the other end. The whorls are very oblique, the deeply impressed suture making an angle of 40° or 45° with the axis of the shell. The apical angle of the spire was not more than 18° to 25°. It most nearly resembles *M. quadricincta*, Win., but it has quite a different expression, besides being much larger and having more oblique whorls.

From near Shafer's, Pennsylvania.

From Newark is a *Sigillaria*, and a *Myalina* too imperfect for identification. Two or three species of *Fenestellidæ* occur at Sciotoville, Rockville, and in Licking county. Three species of crinoidal stems exist in Prof. Andrews' collection, from Newark, Granville and Sciotoville. A *Sanguinolaria* occurs at Sciotoville; and at Granville and Sciotoville is an interesting compound coral with minute tubes, whose specific details are well exhibited, though its generic position is undetermined.

ON SOME ETHEOSTOMINE PERCH FROM TENNESSEE AND NORTH CAROLINA.

By E. D. Cope.

Etheostoma, Raf.

The species of this genus are nearly allied to each other. I gave a synopsis of the three with which I was acquainted in 1866 (Trans. Amer. Philos. Soc., p. 400), and now add characters of two other species. They are to be compared with the E. peltatum, Stauffer, and E. maculatum, Girard.

A Scales 7-8—52-5—8-12.

I. Head 4.5 to base of tail; cheeks scaled.

R. D. XIII I.12 A II.8 Muzzle obtuse, wide; maxillary to line of pupil; maxillary teeth nearly equal: a series of separate spots on the sides behind scapula. E. NEVISENSE.

II. Head 3.6 to 4 times to origin caudal; cheeks naked.

R. D. XI–XII.12–13 A II.9 Muzzle compressed acute; maxillary to line of pupil; a larger series of maxillary teeth exteriorly; a series of eight spots on the sides connected by a band; eye near four times in head. E.? MACULATUM, var.

"R. D. XIV.14 A II.10 Maxillary to line of orbit." Girard. E. MACULATUM.

R. D. XIII.13 A.I.10 Maxillary to line of pupil. E. PELTATUM.

Etheostoma nevisense, Cope.

Sp. nov.

This is an elongate fish, with muzzle obtuse in profile, as well as wide, viewed from above; cheek, operculum and median dorsal line scaled; ventral line without spinous scales, one only present in the symphysis of the "coracoids." Isthmus very narrow. Anal fin with base a little shorter than second dorsal; the species may really be a Poecilichthys. Scales 8—53—11. First dorsal moderately elevated; second peculiar in spinous ray, well separated from the first dorsal. Caudal fin slightly forked.

Ground color above yellowish, crossed by nine dark chestnut quadrate spots on the median line, which are wider than their interspaces, and are connected at their ends by an undulate chestnut band. Below the latter a similar longitudinal band on the anterior half of the body. Six quadrate black spots on the sides, with a small spot between each. A dark band from end of muzzle to scapula; below it on operculum, a silver spot. A black bar below eye. Belly white. Caudal and second dorsal distinctly, pectoral and ventral, faintly black barred. A series of black spots along middle of first dorsal.

Length 3 in. 25 lin. Diameter orbit 2.2 lines. Depth at first ray second dorsal 4.8 lines; at occipital region 4 lines.

This species, though near the next in general appearance, is very different in details of structure, and I am not sure that it may not be referable to the genus Poecilichthys. It is based on one specimen which was taken in boisterous water at the falls of the Neuse River, 8 miles east of Raleigh, North Carolina.

ETHEOSTOMA MACULATUM, Girard.

Putnam Bull. Mus. Compar. Zool. No. I *Hadropterus maculatus*, Girard, Proc Acad. Nat. Sci., Phil. 1859, 100.

My specimens differ from that described by Girard as expressed in the table above, and they may be distinct. They differ among themselves thus : In two specimens the radii are DXI.13 ; in two XII.13, and in one XII.12. The type of E. peltatum, Stauff., differs also ; its anal radii should be expressed I.10, not II.9 as heretofore given. I am, therefore, not sure whether it belongs to this genus.

Several specimens from the upper waters of the Catawba River.

ETHEOSTOMA BLENNIOIDES, Raf.

From the headwaters of the Cumberland River, Campbell co., Tenn.

COTTOGASTER, Putn.

COTTOGASTER AURANTIACUS, Cope.

Jour. Acad. Nat. Sciences, Philada. 1868, 211.

One specimen from the French Broad River in Madison co., N. Ca., measuring 4 inches, 8 lines in length, more than twice the size of the types, and larger than any species of the group excepting Percina caprodes. Colors, bright yellow and black in life.

PERCINA, Hald.

In this genus the median line of the abdomen and thorax is protected by a series of enlarged spinous scales, as in Etheostoma. This is no doubt a protection to the belly from the rocky and stony bottoms which the animal haunts.

PERCINA CAPRODES, Raf.

From the South fork of the Cumberland River, Campbell co., Tenn.

POECILICHTHYS, Agassiz.

I. Branchiostegal membranes distinct throughout their length.

Slender ; head attenuated, muzzle not decurved ; depth 5.25 lines in length to base caudal ; first dorsal low, elongate RXII (XIII); scales small l. l. 55–62. Black with scattered crimson spots ; fins crimson not margined ; P. SANGUIFLUUS.

Stout, head short, muzzle abruptly decurved from orbits, latter large, scarcely four times in head ; dorsal line plane, depth 4.5 times in length ; first dorsal elevated R. X (XI–XII); scales larger l. l. 50–54. Black with crimson spots in rows of three and four ; fins crimson, yellow and black margined. P. CAMURUS.

Stout, head acuminate, muzzle not much decurved, dorsal line much arched, depth 4.5 in length ; first dorsal elevated (X–XI) XII ; scales largest l. l. 43–47 ; eye small, nearly five lines in length of head. Light, with narrow dark lines enclosing spaced quadrate red-brown spots ; below orange ; head brown lined, fins crimson bordered. P. RUFILINEATUS.

Like the last but D.XV, scales smaller l. l. 53, and dorsal line not arched. Light, with dark olive vertical cross-bars, and a few scattered crimson spots; red spots on middle first dorsal, other fins unspotted.

P. VULNERATUS.

II. Branchiostegal membranes united across thoracic region.

Slender, cylindric; muzzle acuminate depressed; orbit 4.5 times in head; depth 6.5 in length, D.VII small; P. very long, reaching the anal; naked below anteriorly; cheeks and operculum scaled; transparent in life, with dorsal and lateral spots. P. VITREUS.

POECILICHTHYS ZONALIS, Cope.

Journ. Acad. Nat. Sci., 1868, p. 212, tab. 24, f. 1.

The vertical bands which are represented as brown in the above figure, are a beautiful turquoise blue in life.

From a tributary of the French Broad River, Madison co., N. Ca.

POECILICHTHYS FLABELLATUS, Raf.

Putnam Bull. Mus. Comp. Zool. 1. (*Catonotus*) Cope, l. c. 213.

A very marked variety, perhaps species, represented by three specimens from the upper waters of the Catawba River, N. Ca. Scales much larger than in the types, 6—42–4—9–10; in the only adult there are but four vertical cross-bars below the dorsal fins, (six to eight in the usual variety) and the fin formula is much reduced, i. e. DVI–12 A II.6. In a younger specimen the D.VII–12 A II.8, and in a third, D.VIII–12 A II.7.6. The dorsal and lateral spots are more numerous than in the adult. Head in the latter 3.5 times in length to caudal. In other respects this form is like the type, except that in life the colors are paler.

POECILICHTHYS VITREUS, Cope.

Spec. nov.

This species is very unlike the others of the genus, having the cylindric form of Percina and Pleurolepis; it further resembles Pleurolepis pellucidus in the transparency of its muscles, but is to be referred to another genus on account of the reduction of its anal fin, and its complete scutellation.

The head is remarkably acuminate, the profile gradually descending and the under jaw received within the upper; the mouth is nearly terminal, and the extremity of the maxillary bone reaches barely to the line of the anterior margin of the orbit. Both cheeks and operculum are covered with large pectinated scales, the former as far as the preopercular bone. Opercular spine rudimental, flat, as in some individuals of P. flabellatus. The orbit is relatively small, its diameter being less than the length of the muzzle in advance of it, and a half less than one-fourth the length of the head. Depth of head at deepest point, one-half its length; its length 4.5 times in length of body to basis of caudal. The fins are not largely developed, except the pectoral, which is very long and acuminate, reaching the line of the vent. Br. VI. D. VII–14. A II.9. Ventrals cuneiform, a little over half the length of the pectorals. Caudal nearly equal or slightly concave. Scales 6—56—7, counted from the anterior ray of the second dorsal to the vent. On the anterior half of the dorsal region they are not continuously developed and are cycloid; a large part of the most anterior portion is naked. On the anterior fourth the ventral surface the scales are cycloid, not imbricate, and below the pectoral fins entirely absent. Other scales ctenoid. Caudal peduncle not deep nor constricted.

	Lines.
Total length	24
Of caudal fin	3.6
Of basis first dorsal	3.4
Of pectoral	8.4
Of muzzle,	1.5
Width of body opposite first dorsal	2.3

In life this species is nearly colorless, and the myocommata and other muscles are transparent. The viscera are perfectly visible, and in the specimen taken, the two ovaries with all the eggs in an advanced stage of development were seen with entire distinctness. There are seven imperfectly formed pale green blotches on the dorsal line, and a series of eight or nine on the lateral line of a linear form, arranged longitudinally, and of the same greenish tint. A few blackish specks between these, and below the eye; a large spot on operculum and line on canthus rostralis. Caudal fin faintly barred; other fins and lower surfaces immaculate; ventrals with white edge within.

One specimen taken in Walnut Creek, a tributary of the Neuse River, in Wake co., N. Carolina, late in November.

From the advanced condition of the eggs they must be excluded either in the Winter, or a very early Spring, for even that mild latitude. In its transparency this fish resembles the Pleurolepis pellucidus, Agass. When first taken its scales are entirely invisible, and it requires coagulation in alcohol before they can be readily detected.

The vomerine teeth of this fish are very few in number, and the maxillaries and mandibulars are very abruptly incurved.

Poecilichthys sanguifluus, Cope.

Species nova.

Of the same form as the P. flabellatus; i. e. elongate, with dorsal line not elevated, and very deep caudal peduncle. Head flat acuminate, the front descending very gradually, the mandible as gradually rising to its extremity. Orbit rather large, diameter equal to that of muzzle, and one-fourth length of head. Opercular spine well developed, the operculum scaled, cheek naked. End of maxillary marking line of pupil. Teeth of outer rows larger. Length head without spine, one-fourth total to basis caudal. Fins generally, especially the caudal, short; latter slightly rounded. First dorsal much elongate; first anal spine very large. In four specimens the fin and scale formulae vary as follows: 1st, Br VI. D.XII–12. A II–8; 2nd, D.XII–12. A II–9; 3rd, XII–13. A II.9; 4th, DXIII.12 A II.9. Scales 9—54-62—10.

	Lines.
Total length	31
Of head	7
Of caudal fin	4
Pectoral	5.6
Basis first dorsal	8.4
Depth at occiput	4

The coloration of this fish in life is very elegant, as follows: above black, shading to dark olive below, and with a narrow, repand, leather colored dorsal band; throat turquoise blue; sides and dorsal region marked with small circular spots of bright crimson irregularly disposed, and in considerable number. First dorsal uncolored, with a black spot at base anteriorly, and a dark shade through the middle. Second dorsal blood red, without border; caudal with two large crimson spots confluent on the middle line of the tail at the base, no border; pectoral and ventral not red bordered. A female has the 2D. C. and A. black barred, and not crimson.

This lovely species is common in the head waters of the South Fork Cumberland, in Tennessee.

POECILICHTHYS CAMURUS, Cope.

Species nova.

This species is nearly allied to the last. It is distinguished by many characters, of which some have been pointed out in the synoptic table. It is a stout, deep-bodied fish, not a slender one, and with the head as deep as the body and suddenly decurved from the orbit to the muzzle. The first dorsal is higher and shorter, though occasionally with the same number of radii. The scales are larger. In life the coloration though of the same type, is constantly different, and the females differ from the males as they do in the preceding and following species.

Maxillary bone opposite line of pupil; cheek extended, naked; operculum scaled, with a strong spine. Fins better developed than in P. sanguifluus. Formulae in five specimens; first, Br. VI D. X–13 A. II.8; 2nd, D X–13 A II.9; 3rd, D. XI–13, A. II. 8; 4th, XI–14 A II. 8; 5th, DXII–12. A II.8. Scales 7—52–4—8.

	Lines.
Total length	31
Of head	7
Of caudal fin	4
Of pectoral	6.2
Basis of first dorsal	7.2
Depth of occiput	5
At middle first dorsal	5.2

In life the color is blackish to very dark olive, with an obscure dorsal band of a paler shade; belly paler. Sides abundantly sprinkled with crimson spots, which are smaller than in the P. sanguifluus, and differ further in being arranged in short longitudinal series of threes and fours. First dorsal with a black spot at base in front, and a crimson one on the margin between the first and second radii. Second dorsal, caudal and anal, crimson bordered with yellow, which again is bordered with black on the edge of the fin; the crimson is deepest just inside the yellow margin in all three. The pectoral and ventral fins have a broad red margin. Thoracic region turquoise.

This species, like the last, occurs abundantly in the head waters of the Cumberland River, in Tennessee, in company with P. coeruleus, Hyostoma, and Etheostoma blennioides.

The females of the first two present a different appearance, in their olive colors, with dark vertical bars, and absence of red spots. All of the above species lie on the bottom, frequently beneath stones, with the head only projecting on the lookout for prey. Ordinarily they lie motionless, except occasionally inclining their position and exhibiting their gorgeous colors. The effect of these is heightened by the crystal clearness of the waters of the mountain streams, which reflect as well the beauty of a southern sky, and the noble trees and flowering shrubs that border them in the rich wilderness of the Cumberland range. Few more attractive spots to the naturalist can be found, and among its natural treasures, these peculiar little fishes are among the most curious. All the fishes of this group can turn the head from side to side, and they frequently lie in a curved position, or partially on one side of the body.

It is possible that one of the two species above described may be the P. maculatus (*Etheostoma*, Kirtl. *Nothonotus*, Agass), but which, I have in vain essayed to discover. It may be neither. The description of form and colors apply best to the P. sanguifluus, but its dorsal fins are those of P. camurus. If the statements "operculum double spined" and "anal I-7" are correct, it is manifestly different, but I suspect they are errors.

The caudal peduncle is represented to be much more slender than in our specimens, but this may also be inexact.

Poecilichthys vulneratus, Cope.

Species nova.

General form fusiform; body stout, depth 4.5 times in length to basis caudal, peduncle very stout; dorsal line scarcely arched. Top of head gently and regularly curved to end of muzzle, much as in P. sanguifluus. Orbit four times in length of head to basis of opercular spine, equal length of muzzle, cheek smooth, operculum scaled, with well developed spine. Fin rays DXIV. 13. A II 8. First dorsal large, not low, caudal truncate rounded, anal small. Scales small 8—53—9.

	Lines.
Total length	25
Caudal fin	3.8
Base first dorsal	7
Of head	5.6
Depth at occiput	3.4
At posterior margin first dorsal	4.6

Color in life, light olive, with about eight vertical dark olive bars on the side, which are interrupted above the lateral line. A few irregular crimson dots on the sides. Fins uniform transparent except the first dorsal and caudal; the former has a median series of red spots; the latter is pale orange, with a black margin; no fins cross-barred; D. 2, with a black margin.

From Warm Springs Creek, a tributary of the French Broad River, Madison co., N. Carolina.

This species is in general proportions intermediate between the P. rufilineatus and P. sanguifluus, but is in some points of coloration like the P. camurus. That it is not the female of P. rufilineatus is clear, though its size is similar to the smaller individuals of the latter. The coloration alone would indicate that it was a male.

POECILICHTHYS RUFILINEATUS, Cope.

Species nova.

Stout, the dorsal line elevated and descending regularly from the base of the first dorsal ray to the end of the muzzle. Muzzle short, regularly conic, about as long as the diameter of the orbit; latter smaller than in the other species, 4.5 times in head. Maxillary to line of pupil. Cheeks smooth, operculum scaly, with strong spine. Dorsal well developed; caudal peduncle deep, caudal fin small truncate. Scales larger than in the species above described; 6—41-7—7-8. Rays; 1st D. X. 12. A II.8. 2nd, D. XI. 12 A. II.8; 3rd, XI. 12, II.9; 4th, XI. 13, II.8; 5th and 8th, XII. 12 II.8; 6th, XII. 13, II.8; 7th, XII. 11, II.8.

	Lines.
Length of the largest	32.5
Of a second	31
Of head of latter	6.4
Of caudal fin	4.4
Of pectoral fin	6.4
Basis of first dorsal	9.3
Depth at occiput	2.3
At middle first dorsal	5.8

In males the color in life is pale olive for a ground above, with numerous narrow longitudinal lines, each on the adjacent margins of the two rows of scales. These include a number of quadrate spots of a mahogany or brick red color, which alternate with each other, but are not regular in position or number. Pectoral region turquoise blue, belly bright red orange. Head with two longitudinal mahogany-colored bands, and a spot of the same below the eye. Five red spots on each side of the head, on operculum, preoperculum, suboperculum, and on each lip. Pectoral, ventral, first and second dorsal and anal broadly crimson bordered, the last with a narrow black margin. Caudal fin brownish, broadly vermillion bordered, with a narrow black edging; two orange areas at the base. Anal vermillion with yellow base and black margin on posterior half.

Females are more olive, and the spots are partially confluent into vertical bars;—D. 2, C., and A. black barred. A male forms a variety with the quadrate spots obsolete and the D. 2, C., and A. with yellow margin inside the black.

This fish was abundantly seen in Warm Springs Creek, which flows into the French Broad River, in Madison co., N. Ca. Eight specimens were taken with some difficulty. The beauty of the species is scarcely exceeded by any of the preceding; if not so elegant, a male in summer attire is more gaudy. They inhabit shallow, swift waters with rocky bottoms, and take refuge under stones with great rapidity, whence much patience is required to draw them.

The conic form of the head, small orbit and elevated dorsal region, characterize this species among other points apart from coloration.

POECILICHTHYS COERULEUS, Storer.

From the South Fork of the Cumberland, Tenn.

BOLEOSOMA, Dekay.

Second dorsal larger than anal fin; vomerine teeth present; no series of abdominal plates; two osseous anal radii; scales well developed; premaxillary projectile, the labral dermal fold extended across the muzzle.

This genus is identical with Poecilichthys, excepting in the completion of the labral fold, which in the latter genus ceases on each side of the muzzle. The simple anal, formerly assigned as its character, I find to belong to one or two species which are so nearly allied to the type as to preclude their generic separation.

Synopsis of Species:

I. Anal radii, II.

Caudal peduncle thick, not contracted; cheek scaleless; branchiostegal membranes nearly distinct, spine rudimental; tail rounded; muzzle blackish. B. EFFULGENS.

Caudal peduncle contracted, dorsal line not elevated; cheek scaleless; branchiostegal membranes well connected, spine developed; tail truncate; crown and muzzle closely brown spotted above. B. MACULATICEPS.

II. Anal radii, I.

Caudal peduncle contracted, dorsal line not elevated; cheek scaled; branchiostegal rays well connected, spine strong; tail truncate; crown and muzzle unicolor. B. OLMSTEDI.

Caudal peduncle contracted, dorsal line not elevated; cheek smooth; D. 2 with 11–12 radii only; branchiostegal membranes connected, tail truncate; back and top of head closely speckled with black. B. BREVIPINNE.

III. Anal osseous ray wanting.

Caudal peduncle contracted, dorsal line arched from the nape; cheek ? naked; branchiostegal rays entirely distinct, spine well developed; tail truncate. B. AESOPUS.

The preceding definitions apply to considerable numbers of individuals from remote localities; these may be species, for the range of variation is very considerable, and such as is to be found nowhere else in a single species. Should they be found to present intermediate forms in regions not yet explored, they may be regarded as races, and as such, worthy of note.

BOLEOSOMA EFFULGENS, Girard.

Arlina effulgens, Girard, Proc. Ac. Nat. Sci., Phil., 1859, 64.

Char. Muzzle abruptly decurved, body elongate, slender; scales large. Fins very much developed, elevated and prolonged D. IX. 13. A II. 8. Cheek and pectoral region smooth, operculum scaled, branchiostegal membranes slightly connected. Muzzle and fins black.

Description. The mouth is horizontal, the premaxillary border below the lower margin of the orbit; maxillary to pupil. Dorsal line a little elevated above the occiput, greatest depth 6.25 times in length to origin caudal; length of head 4.2 in some (spine omitted). Opercular spine weak; orbit 3.75 times in head, equal muzzle. Scales 5—40—6. Fins all elongate; V I.6, cuneiform, reaching the anal; P. 11, narrow, reaching beyond the base of the anal. Anal spines weak, caudal very much rounded.

	Lines.
Total length	28.3
Of caudal fin	5
Of head	6
Of basis first dorsal	5.3
Of pectoral	6
Depth of first dorsal	6
Of second	3.7
Of head at occiput	3.2
Of body at middle first dorsal	4

The color of three specimens in alcohol is brown with traces of nine spots on the side. Muzzle, chin and spot below the eye black. Fins black, the second dorsal and caudal with whitish bars and specks.

Three specimens were taken in a tributary of Deep River, Guilford co., N. Ca., by my friend, Samuel C. Collins, Principal of the boarding school at New Garden, N. Ca., and kindly sent me for determination.

BOLEOSOMA MACULATICEPS, Cope.

Sp. nov.

R. D IX. 13 A II. 8. Head four times to basis of caudal fin; depth at middle of first dorsal 6.5 times in same. Scales 5—41—10. Fins largely developed. Orbit 3.75 times in head; opercular spine moderate.

Pale yellowish, with ill-defined series of dorsal and lateral spots and many speckles between. Top of the nape, head and muzzle marked with large brown spots. All the fins black barred.

	Lines.
Length	26.8
Pectoral fin	6
Median depth	3

This species is near the B. olmstedi, and may be only a variety. Its clean cheek and double anal spines are characteristic, as well the markings of the head. Common in the upper waters of the Catawba River, N. Carolina.

BOLEOSOMA OLMSTEDI, Storer,

et acctorum.

Not seen by me in Tennessee or North Carolina. The adult males of this species, as I have observed in Pennsylvania, are much larger, and more darkly colored, especially about the head, than the females.

BOLEOSOMA BREVIPINNE, Cope.

B. olmstedi brevipinne, Cope, Journ. Ac. Nat. Sci., 1868, 214.

The thick punctation of the dorsal region and nape, and crown and muzzle, are color peculiarities of this form. The cheek is smooth. In B. olmstedi it is scaled, though in badly preserved specimens they are occasionally rubbed off.

Many specimens from tributaries of the Ohio, i. e. the Kiskiminitas and Miami.

BOLEOSOMA AESOPUS, Cope.

Spec. nov.

The dorsal line descends regularly from the base of the first dorsal fin to between the orbits, and then curves more abruptly to the mouth. Mouth terminal; eye four times in head, once in advance of its front rim. The dorsal line descends from the first dorsal fin, to a somewhat contracted caudal peduncle. Dorsal fins much elevated, VII–14. Pectorals a little elongate, not reaching vent, but little exceeding the very moderate ventrals. A. 0.–10. Scales 5—47—8. Color light brown with six small dark dorsal spots, and ten similar small spots on the lateral line. A black bar round muzzle, and one below eye.

	Lines.
Total length	26.6
Of tail	4.3
Of pectoral fin	5.2
Depth at first dorsal	4.6
At nape	3.4
Of caudal peduncle	2.3

The form of this fish is rather that of a Poecilichthys, while the absence of spinous anal ray is peculiar to the present species. From the number of rays, 10, in the anal, it is probable that the missing spinous ray is represented by the first cartilaginous ray, and is not wanting. In general it is so near to the B. olmstedi, as not to be removed from the genus.

Found in the Loyalsoc Creek, in the Allegheny region, in Lycoming co., Penna., by Aubrey H. Smith, of Philada.

HYOSTOMA, Agass.

Cope, Jour. Ac. Nat. Sci., Phil., 1868, 214.

HYOSTOMA CYMATOGRAMMUM, Abbott.

From the head of the Cumberland, Tenn., and French Broad River, N. Ca. I consider *H. blennioperca*, Cope, l. c., as only a variation of this species.

HYOSTOMA SIMOTERUM, Cope.

Jour. Ac. Nat. Sci., Phil., 1868, 215.

From a tributary of the Clinch River, Tenn.

ON SOME REPTILIA OF THE CRETACEOUS FORMATION OF THE UNITED STATES.

POLYDECTES, Cope.

This genus is indicated by one, perhaps more teeth, which resembles in some respects those of the Crocodilian genus Thecachampsa. Crown of dense concentric dentinal layers, with small pulp cavity. Enamel with two prominent ridges separating inner from outer aspects, but approximated on the inner face, which thus included, is but one-third the circumference of the tooth. Ridges extending from tip to near base of crown, with a sulcus along the inner side of each. Crown acuminate, a little swollen at the base and above the middle. Section circular.

Polydectes biturgidus, Cope.

Crown a slender cone slightly curved near the base. Middle portion constricted, its surface marked with narrow obscure facets. On the inner face, a shallow groove within each of the bounding sulci, the two separated by an indistinct groove. The enamel is smooth and worn, and leaves no traces of other sculpture.

	Lines.
Length of crown	30
Diameter at base of do	10
" middle	6.
" above do	6.5

From the marl pits of James King, Sampson co., N. Ca. Discovered by Prof. W. C. Kerr, Director of the Geological Survey of North Carolina.

Liodon congrops, Cope.

Spec. nov.

This species is indicated by a posterior cervical vertebra which presents so many characters, as to render its exclusion from the present work scarcely proper. In size it bears some relation to the *Mosasaurus minor*, Gibbes, but is still smaller, and is separated at once by the round instead of depressed articular faces.

The posterior articular face is the round one; the anterior is slightly depressed; and opposite the diapophyses and neural canal slightly flattened, so as to give a slightly trilateral superior outline to the cup. It is not excavated above as in the species of Clidastes. The hypapophysis is broken, but its base is unusually long and wide. The infero-anterior limb of the short diapophysis descends to the edge of the cup, considerably below its middle. The space it encloses with its superior ridge which extends into the anterior zygapophysis, is reticulate striate. The whole surface below is minutely striate; the striæ become coarse as it approaches the ball. The latter is surrounded by a groove, and its margin projects acutely beyond the adjacent surface of the centrum. The latter is much contracted behind the ball, and the faces below the diapophyses are concave. Bases of neurapophysis striate. Neural arch broken away above. Neural caudal with an epapophysial ridge.

	Lines.
Length centrum with ball	20.8
" " to ball	18
" " " hypapophysis	5.8
Width base hypapophysis	5.5
Depth ball	10.4
Width "	11
" cup	12.6
Depth "	11.
Length base neurapophysis	12.

In profile the ball has a very slight obliquity looking upwards. From the Rotten Limestone of Alabama, discovered by E. R. Showalter, M. D.

LIODON VALIDUS, Cope.

Macrosaurus validus, Cope., Proc. Boston, 1869. *Nectoportheus validus*, Cope, Proc. A. N. S., Phil., 1868, p. 181; Leidy, Cretac. Rep. 74–75, Tab. VII, 19–20, III 1-2.

This species is represented by two cervical and four dorsal vertebrae of one individual, and a large dorsal of another, in the museum of the Academy; the former associated with numerous fragments—including part of an os quadratum, from L. T. Germain, Burlington co., N. J. Two dorsal vertebrae of a large individual in the museum of Rutger's College, several vertebrae with broken quadrate and other bones and teeth in my private collection, from near Barnesboro, Gloucester co., N. J., and a number of vertebrae in the collection of Prof. Marsh, of Yale College, further establish its character.

The *quadrate bone* is highly peculiar as above pointed out. The posterior descending hook of the proximal extremity is quite short, and is marked by an obtuse ridge which passes forwards and disappears immediately above the pit alongside the meatus. What especially characterizes this species and genus, and allies it to Clidastes, is the presence of a strong longitudinal angular ridge, which extends from the usual external angle of the proximal extremity, (which becomes here a process,) separating the outer aspect of the quadratum into two entirely distinct planes; one that of the meatus, the other that of the ala.

Two separate *opisthotic bones* accompany these remains, which were mixed up with those of the M. depressus. The vertebrae of the two species were easily separated. The quadrate bone also was identified by one accompanying the vertebrae of M. validus, in my own collection. I could not so readily assign the opisthotics to the proper species. I have assigned them here, because their glenoid cavities apply much more readily to the quadrate bone of the L. validus than of the M. depressus. As compared with the same bones of two Mosasaurus dekayi, they present three marked characteristics. First, they are relatively much shorter; second, the distal anterior process which fits within the squamosal is much more prolonged; third, the inferior of the two faces to which the squamosal is applied, is a continuation of the general inferior plane of the bone; in M.

mitchillii it is a different plane, like a rabbet. It may be added, that the glenoid cavity is narrower and deeper.

Four teeth from Barnesboro, indicate marked characters. They are much compressed as in L. mitchillii, and the posterior cutting edge is well developed and forms a narrowed extremity of an elliptic section. The anterior ridge less developed. In three crowns there is no trace of the unequal division by these edges, as in Mosasaurus sp. One probably from the premaxilla is more abruptly recurved than the others, with base rather expanded inwards. The distinguishing character of these teeth, which separates it from L. mitchillii, is the abundant longitudinal fluting, and striation of the enamel. The grooves are deeper and shallower, coarser at the base; the striæ are fine, continuous and rugose. These are not seen in L. mitchillii. The general form of the crown is short, broad at the base and well curved posteriorly and inwards.

	Lines.
Elevation of crown and pedestal	21
" " " alone	16
Antero-posterior diameter do. at base	12

The lateral element of the *atlas* is represented from the inner side in Fig. No. 3. The anterior termination of the inferior ala, and the articular face for the centrum, are as in M. mitchillii. The inner articular face is divided by a vertical depression; the posterior, or that meeting the odontoid process, is quite prominent and distinct. The anterior facet for the occipital condyle, is transversely divided by a depression.

The form of the *cervical vertebrae* is so much like that of the Mosasaurus dekayi, as to be readily taken for those of a small example of that species. The first dorsals, or those without hypapophysis, are more elongate than in the latter, and the body is more contracted, so that the ball presents a projecting rim all round. This is readily knocked off in the rough handling the specimens usually receive. The cup is also proportionately expanded. *Posterior dorsals* where the diapophyses issue half from the centrum, have the latter slightly depressed; where the diapophysis comes three-fourths from the body, the articular faces are a broad transverse ovate, well expanded on the margins, below which the surface is slightly striate. In the longer or anterior dorsals, the rudiment of zygosphen and zygantrum is well marked.

Unfortunately, no caudal vertebrae of this species have been preserved, —so that I do not know their form. The posterior dorsals are so much more depressed than in Liodon laevis that future discovery may justify the generic separation of the genus Nectoportheus which I originally applied to this animal.

For the largest measurements I refer to Dr. Leidy's Essay on Cretaceous Reptiles, where the description of the large specimens of Macrosaurus laevis belong to the present species, and have served in part as my types.

The following are the proportions of the smaller individual, from L. T. Germain:

	In.	Lines.
Length of centrum cervical (with ball)		34
Depth ball of same		18.5
Width " "		21
Length anterior dorsal		34
Width cup		24
Proximal width outer face quadratum		28
Length quadratum to lower edge pit		20
" opisthotic (see description)	3	4
" outer margin do	3	4

This was a large and powerful reptile, and probably more elongate in proportion to its bulk than the Mosasaurus, well deserving the name *Macrosaurus*, which Owen has applied to an ally.

From the upper Greensand Bed of the New Jersey Cretaceous.

THECACHAMPSA, Cope.

The species of this genus have long simple hypapophyses. In "Synopsis Extinct Batrachia and Reptilia N. A.," p. 63, the question as to the presence or absence of truncate or split hypapophyses as in Holops, etc., was left undecided.

TAPHROSPHYS MOLOPS, Cope.

In a specimen of this species which I found in place in the bottom of the green sand bed at Hornerstown, N. J., the lateral intersternal bones were distinctly seen in place. They present a rounded interior outline, and apply to an equal extent of the hyo- and hyposternal bones. They extend but one-third the distance to the median longitudinal suture, and are much as in the existing genus Podocnemis. The specimen observed measures 10.5 inches in width between the inguinal notches.

TAPHROSAURUS, Cope.

Suborder Streptosauria. Neural arch not coössified with the centrum, each neurapophysis attached in a rounded pit of the body.

This genus is proposed for the Plesiosaurus lockwoodii, Cope, Trans. Amer. Phil. Soc., 1869, 40. Were it a true Sauropterygian, I would continue to regard it as a Plesiosaurus, but it is, I have little doubt, one of the same type as Cimoliasaurus, which it resembles, except in the peculiar attachment of the neural arch. From the cretaceous clays of New Jersey, the No. 1 of Meek and Hayden.

Stated Meeting, January 7th, 1870.

Present, fifteen members.

MR. FRALEY, Vice-President, in the Chair.

Prof. Marsh, of Yale College, was introduced and took his seat.

A letter of envoy was received from the Central Physical

Observatory of Russia, requesting Vols. I–IX Trans. A. P. S., to complete its series, and Proc. Nos. 15, 62, 73, 74, 78, *et seq.*, which request the Secretaries were instructed to grant.

Letters of acknowledgment were received from the Bureau des Longitudes (xiii. 3,) (81); Venetian Institute of Sciences (77), and Leeds Philosophical Society.

Donations for the Library were received from the Institutions at Milan and Venice, S. S. Zantedeschi, Alianelli, and Ghirardini of Padua, Naples, and Milan, the Russian C. P. Observatory; the Academy at Berlin; Geographical Society at Paris; London Chemical, Leeds Philosophical, and Dublin Royal Societies; Dr. Haughton; Gard. G. Hubbard, of Cambridge, Mass.; the Boston N. H. Society; Franklin Institute; College of Physicians of Philadelphia, and the Librarian of Congress.

The Librarian reported the purchase of seven volumes of Comptes Rendus, (49, 50, 51, 52; 54, 55, 56,) for the Library.

A letter was received announcing the decease of Prof. A. J. Erdmann, Director of the Geological Survey of Sweden, at Stockholm, Dec. 1, aged 55.

A communication was read by the Secretary entitled, "Notices and Descriptions of Fossils from the Marshall Group of the Western States; with Notes on Fossils from other Formations; by Alexander Winchell, Director of the Geological Survey of Michigan." (See page 245.)

On motion of Prof. Cresson, the paper and section were referred to the Secretaries, with power to take order.

Prof. Cope communicated for the Proceedings a Paper on some Etheostomine Perch from Tennessee, and for the Transactions,

A Paper entitled, "On some Reptilia of the Cretaceous Formation of the United States," which, on motion of Dr. Horn, was referred to a committee, consisting of Mr. Lesley, Dr. Horn, and Dr. Rushenberger. Prof. Cope illustrated this paper by offering for the examination of the members present, unique specimens of a sauroid, found in the U. S. Armory grounds at Springfield, and described by Dr. Hitchcock, the true structure of which has but recently been made out, and explains the peculiar 8-shaped terminal impression so often discovered among the foot-tracks of the Connecticut River red sandstone. (See pages 261–71.)

Mr. Chase made some remarks about Solar and Electric Light, in reference to recent experiments to determine the mechanical equivalent of terrestrial light.

The report of the Judges and Clerks of the Annual Election was then read, declaring the following persons duly elected:

President.

George B. Wood.

Vice Presidents.

John C. Cresson,
Isaac Lea,
Frederick Fraley.

Secretaries.

Charles B. Trego,
E. Otis Kendall,
John L. LeConte,
J. P. Lesley.

Curators.

Franklin Peale,
Elias Durand,
Joseph Carson.

Treasurer.

Charles B. Trego.

Counsellors.

Alfred L. Elwyn,
John Bell,
Benjamin H. Coates,
Benjamin V. Marsh.

Pending nominations Nos. 643 to 648 and new nominations 649, 650 were read.

Mr. Lesley was nominated for Librarian by Prof. Cresson, and the Society was adjourned.

Stated Meeting, January 21, 1870.

Present, seventeen members.

Prof. Cresson, Vice-President, in the Chair.

Dr. Anderson, of Haverford, was introduced and took his seat.

A letter of acknowledgment was received from the Russian Observatory (78, 79, 80.)

A letter from M. Aglave, one of the editors of the Revue des Cours Scientifiques, No. 17, rue de'l'école de Médicine, requesting the Proceedings, was read, and the Secretaries directed to place the Review on the list of correspondents.

Donations for the Library were received from M. Zantedeschi, the Paris Geographical, and London Astronomical and Meteorological Societies, the Montreal Natural History Society, New York Lyceum, Philadelphia Journal of Medicine, and Numismatic Society, Mr. Stephen Colwell and Dr. Lea, the Smithsonian Institution, Dr. Hayden and Prof. Kirkwood.

The Committte to which was referred the Paper of Prof. Cope, for insertion at page 122 of the memoir now passing through the press, reported, recommending its publication and insertion at the place designated, and that so much of the plate accompanying it as illustrates *Megadactylus polyzelus*, be engraved and printed as an additional plate of the memoir. On motion, the recommendation of the Committee was adopted and the publication ordered.

Mr. Lesley referred to the accounts in the newspapers of the special violence of the late tornado at Cave City in Kentucky, and hoped that some accurate record would be made of the exceptional phenomena alluded to therein.

Mr. Fraley added that a proposition had been made at the recent meeting of the National Board of Trade in Richmond, to obtain from Government an appropriation for a National Telegraphic Storm Survey, and suggested the propriety of the Society taking initiative steps to accomplish so desirable an object.

Prof. Cope exhibited a molar tooth found in the Miocene of New Jersey, with a characteristic development of tuberculous processes on the crown. He exhibited fragments of the skeleton of a new species of tertiary whale found in N. Carolina; and also some extraordinarily thin and flexible paper-like plates of Itacolumite.

On motion of Mr. Fraley, Mr. Lesley was re-elected Librarian.

The Standing Committees were then individually nominated and elected as follows:

Finance—Mr. Fraley, Mr. J. F. James, Mr. Marsh.

Publication—Mr. Trego, Mr. E. K. Price, Dr. Carson, Mr. R. A. Tilghman, Mr. Lippincott.

Hall—Mr. Peale, Mr. S. W. Roberts, Gen. Tyndale.

Library—Dr. Bell, Dr. Coates, Mr. E. K. Price, Rev. Dr. Barnes, Rev. Dr. Krauth.

The reading of the list of surviving members was postponed on account of the lateness of the hour.

Pending nominations 643—648 were read, spoken to and balloted for; and new nominations 649—655 were read.

On motion of Dr. Carson, it was

Resolved, That when Corrections, Improvements or Additions to Papers (made subsequently to their presentation to the Society and the order for their publication) involve a greater expense than has been estimated by the Publication Committee, such corrections, improvements and alterations be referred to the Society for approval.

The ballot boxes were then examined by the presiding officer, and the following persons were declared duly elected members of the Society:

Prof. Oswald Seidensticker, of Philadelphia.

Mr. W. M. Tilghman, of Philadelphia.

Rev. E. E. Hale, of Roxbury (Boston), Mass.

John Greenleaf Whittier, of Amesbury, Mass.

Mrs. Emma Seiler, of Philadelphia.

And the Society was adjourned.

Stated Meeting, February 4th, 1870.

Present, ten members.

Mr. Fraley, Vice-President, in the Chair.

Letters accepting membership were received from Mr. W. M. Tilghman, dated Philadelphia, 1114 Girard street, Jan. 25, and Mrs. Emma Seiler, dated Philadelphia, Feb. 1, 1870.

Letters acknowledging the receipt of Proc. No. 82, were received from the Massachusetts, Rhode Island, New Jersey, and Georgia Historical Societies, and from the Peabody Institute in Baltimore.

The request of the Georgia Historical Society for a complete set of Proceedings A. P. S. was granted.

A letter was received from Prof. Charles E. Anthon, of the College of New York City, accompanying a donation for the Library of 44 numbers of the New York Numismatic Society Journal.

Donations for the Library were also received from the Russian Geographical, and Paris Ethnological Societies; Dublin Observatory; Boston N. H. Society; Amer. Antiquar. Society; Amer. Jour. S. and A.; Philadelphia Academy N. S.; Medical News and Library; Maj. Gen. Humphreys, and the Chicago College of Pharmacy.

The death of Horace Binney, Junr., at Philadelphia, on the 3d inst., aged 61 years, was announced by Mr. Fraley. On motion of Prof. Kendall, Chas. J. Stillé, Esq., Provost of the University, was appointed to prepare an Obituary notice of the deceased.

The extraordinary mildness of the Winter was illustrated by a fact communicated to the Secretary by Mr. Hector Orr, who watched carefully for two minutes the evolutions of a bat about the corners of Spruce and Third streets. Other members present gave similar illustrations; as for example, expanded blossoms gathered January 30th, in the open air: peach trees in blossom at Lock Haven, Pa., &c.

Mr. Chase communicated additional deductions from a study of the rain fall tables of the Philadelphia Hospital. (See p. 311)

Dr. Brinton introduced to the attention of the Society a valuable contribution to the study of the Choctaw language, in the form of a Grammar prepared by the venerable Missionary Byington, recently deceased. His long and zealous labors have resulted in the publication of a list of more than 75 works, including the Bible, in the Choctaw language. After four revisions of his Grammar, he was at his death engaged upon a fifth.

This manuscript, the fruit of 40 years' labor, has been forwarded to Dr. Brinton by Mr. Dana, Mr. Byington's son-in-law, and consists of portions of these five revisions, interlined, and somewhat confused in the order of its subjects, but thrown into two principal divisions, the first of which, on the Orthography of the language, is written out; while the other, on the Parts of Speech, will need to be carefully edited. Mrs. Byington and the other heirs, present it to the Society on condition that a committee be appointed to edit it, within a reasonable time. Mr. Folsom, a Choctaw gentleman, will soon be in Philadelphia, on a commission to publish the Laws of the Indian Government, and has promised his aid in proof-reading. The Grammar will probably make about 40 pages, 8vo., and require a few new types, obtainable at small expense. The Grammar will be of practical use in developing the civilization of the Tribes, as the language is extremely difficult. It has, moreover, peculiar claims to scientific attention; for the Choctaw, Creek and Chickasaw are affiliated dialects, spoken, at the time of the arrival of Europeans, by a people spread over a great part of the United States. There is no man now living capable of writing, or likely to attempt the construction of a Grammar of either of them.

A committee consisting of Dr. Brinton, Mr. Lesley, and Prof. Haldeman, of Columbia, Pa., were appointed to consider and report upon the subject.

On motion of the Secretary, the University of Indiana was placed on the list of corresponding societies to receive a complete set of the Proceedings, in answer to a request from Prof. Kirkwood.

On motion it was

Resolved, That the Secretaries be instructed to print with the next No. of the Proceedings, a list of the surviving members of the Society, and a request to all the members to send their proper addresses, and photographs for the Album.

Pending nominations Nos. 649 to 655 were read.

And the Society was adjourned.

Stated Meeting, February 18th, 1870.

Present, six members.

Prof. Cresson, Vice-President, in the Chair.

A letter accepting membership was received from John G. Whittier, dated Amesbury, 4th 2d mo., 1870.

A letter enclosing a photograph for the album was received from Daniel Wilson, dated Toronto, Univ. College, Canada, Feb. 8, 1870.

A letter acknowledging the receipt of Proceedings No. 82, was received from the Essex Institute, in Salem, Mass.

Donations for the Library were received from the Nicolai Hauptsternwarte at St. Petersburg; the Norwegian University at Christiania; the Society at Throntheim; the Austrian Academy and Geological Institute; the Görlitz Society; the Holland Academy and Natural History Society, and M. Höck; Sig. Lombardini; the new Geological Committee of Italy, at Florence; the Society of Physical and Natural Sciences at Bordeaux; Paris Geographical Society; London Astronomical Society and Society of Arts; Essex Institute; Dr. B. A. Gould; Dr. S. A. Green, of Boston; Mr. E. A. Stone, of Providence; the Franklin Institute and School of Design for Women, in Philadelphia; Col. W. W. H. Davis; the American Pharmaceutical Association; the Hon. Secretary of War of the United States; the U. S. Observatory, and the Chicago Academy of Sciences.

For the Cabinet was received a medal of bronze from the Batavian Society of Experimental Science, at Rotterdam, with the design:

Truth, erect, leaning on a Thyrsus, wrapped around the staff of which is the legend RERUM MAGISTRA: in her right hand, an anchor, pendant; before her, a tripod and flame; behind her, an altar supporting a pair of scales, and on its face the coat-of-arms of the Society; over her the legend, CERTOS FERET EXPERIENTIA FRUCTUS; on the reverse, a serpent with its tail in its mouth; outside of it, the circular legend IN MEMORIAM STEPHANI HOOGENDIJK FUNDATORIS MDCCLXIX—MDCCCLXIX; inside of it, the legend, SOCIETAS PHILOSOPHIÆ EXPERIMENTALIS BATAVA ROTERODAMI CENTESIMUM NATALEM CELEBRANS.

Mr. Price remarked upon the uncommonly mild weather, and reported a crowd of persons in Chestnut above 10th street, about 2½ P. M., collected to watch the flight of a bat, after which it remained clinging to a wall. During the hour previous to the meeting, a thunder storm passed over the city, and two houses were struck by the lightning.

Prof. Cope communicated descriptions of new cretaceous fossils from North Carolina, &c. (See p. 284.)

The minutes of the last meeting of the Board and Council were read.

Pending nominations Nos. 649—653 were read.

And the Society was adjourned.

Stated Meeting, March 4, 1870.

Present, eleven members.

Dr. Wood, President, in the Chair.

Prof. Seidensticker was introduced and took his seat.

A letter accepting membership was received from Charles Darwin, dated Beckenham, Down, Kent, S. E., Feb. 5th, 1870.

Letters of acknowledgment and of envoi were received from the Georgia Historical Society, Savannah, Feb. 15th, and T. A. Wylie, Librarian of the Indiana State University, Bloomington, Feb. 16, 1870.

A letter requesting exchanges was received from Dr. Jelinez, Director of the Imperial Central Meteorological Institute, Secretary of the Austrian Meteorological Society, [K. K. Centralanstalt für Meteorologie und Erdmagnetismus,] which was on motion referred to the Secretaries, with power to place that Institute on the list of correspondents to receive the Proceedings.

Donations for the Library were received from the Austrian Novara Expedition; the R. Prussian Academy; the Montreal, and Boston Natural History Societies; the American Oriental Society; Prof. J. D. Dana; the Philada. Academy Natural Sciences; the Maryland and Georgia Historical Societies, and the Adjutant General of Maryland.

The Committee to which was referred the acceptance of the Choctaw Grammar, prepared by the late Cyrus Byington, reported in favor of its publication by the Society, on the terms proposed by the heirs of the deceased missionary.

The President, Dr. Wood, made a communication on the subject of the Indian skeleton found upon his cranberry lands in Southern New Jersey.

He particularly called attention to the characters of the cranium, the separate bones of which had been skillfully put together by Prof. Leidy. The most striking peculiarity was the extraordinary breadth of the cranium, which exceeded that of most European heads; and altogether the size of the cranium was much greater than that of the head of the present race of Indians. The cranium was compressed behind; and the frontal bones had apparently been artificially somewhat flattened. Altogether, the head was very different from that of the ordinary Indians, and probably belonged to a race which had preceded that found here originally by Europeans. From the apppearance of the skeleton, it was probably more than 500 years old, perhaps 1,000. It was more changed than that of the Mastodon recently discovered in the same neighborhood, which, as Dr. Wood had been informed, was about four feet below the surface.

A communication intended for the Proceedings, was received from Prof. Kirkwood, of Indiana University, Bloomington, Ind., entitled "On Certain Meteoric Rings." (p. 299.)

A communication was made by Prof. Cope, "On Adocus, a genus of Cretaceous Emydidæ." (See p. 295.)

A verbal communication was made by Mr. Chase, on the subject of the Tides. After referring to the diametrically opposite conclusions expressed by Astronomer Royal Airy, and Prof. Challis, respecting the theoretical position of the tidal ellipsoid, and the claim of each, that his views coincide with those of Newton and La Place, Mr. Chase suggested, that a practical solution of the difficulty may perhaps be found by adopting the intermediate position, analogous to that of the barometic spheroid.

A communication intended for the Proceedings was presented by Dr. Brinton, entitled, "Contributions to a Grammar of the Muskokee Language." (See p. 301.)

Pending nominations Nos. 649 to 655 were read and new nomination No. 656. And the Society was adjourned.

VERBAL COMMUNICATION BY E. D. COPE, AT MEETING OF THE A. PHIL. SOC., FEB. 18, 1870.

Prof. Cope made some observations on the extent of the order Pythonomorpha as exhibited in cretaceous rocks of the United States. He stated that he was acquainted with twenty-seven species of the group, and that but three were enumerated in the last work on the subject. He defined two new species of Mosasaurus from New Jersey. One of medium size, was from the lower bed in Monmouth Co.; it had round articular vertebral faces, and a peculiar cariniform angle from the pit on the outside of the os quadratum. It was named *Mosasaurus fulciatus.* Another and larger species was described under the name of *Mosasaurus oarthrus*, as of about the proportions of the M. giganteus of Mæstricht, but with depressed vertical centra like those of the M. depressus. The quadrate bone differed from that of M. depressus and resembled that of M. dekayi. From Cook's middle marl bed (Cretaceous) of New Jersey.

He also alluded to the occurrence of the Rhinoceros, Dugons, etc., in certain beds in New Jersey, as indicative of the existence of Indian types at one time in this region. He added the genus Sus, at present unknown in the New World, but characteristic of the Palæotropical region. He said his knowledge of its existence depended on an imperfect posterior inferior molar, found near Squankum by Dr. Samuel Lockwood. He named the species *Sus vagrans*, and said it was near the size of the domestic hog.

FOURTH CONTRIBUTION TO THE HISTORY OF THE FAUNA OF THE MIOCENE AND EOCENE PERIODS OF THE UNITED STATES.

By E. D. Cope.

ESCHRICHTIUS, Gray.

Eschrichtius polyporus, Cope.

Species nova.

Character. Ramus mandibuli with coronoid process but little elevated; form compressed with narrowed acute superior margin, which is not flattened posteriorly. On its inner face a wide shallow groove, in which the inner series of foramina lie. Foramina of outer series large, numerous. Size large.

Description. This whale, from the form of the ramus mandibuli, is a finner, and from the slightly developed coronoid process, allied to the humpbacks. The coronoid, the anterior position of the dental foramen, and the angular process, confirm these relationships. Whether it be a Megaptera or Eschrichtius I am not prepared to state. Ear bullae of the forms of both these genera occur in the strata in which the present species was found, and future investigation must determine which are referable to the latter. Such a bulla of the form of and probably belonging to, Megaptera, has been named *Balaena mysticetoides*, by Emmons. (North Carolina Geol. Survey Tab.)

The fragment which on the present species is based, is the proximal two-fifths the left ramus mandibuli, with a considerable part of the condyle. The direction of the shaft from a short distance anterior to the coronoid process, is decurved. The inferior margin is slightly contracted below the coronoid process and then for a short distance convex, and narrowed into a ridge; anteriorly it is most obtuse or convex transversely. The inner face is plane at the coronoid process, the outer convex. Anterior to this point the convexity is strong; at the distal end of the fragment, much less marked.

The angular process has extended beyond the line of the condyle; its extremity is broken away. A wide groove separates it from the base of the condyle on the inner face of the ramus. The surface of the condyle is transverse to the plane of the ramus, and is strikingly elevated above the portion of the ramus anterior to it, being as high as the tip of the coronoid process. A low knob projects on the inner face of the ramus beneath its anterior part, and below the groove. The dental foramen is large, and is overhung by the thin incurved superior margin of the ramus. Its anterior margin terminates just behind the posterior part of the base of the coronoid process.

The pores of the inner series are small and numerous; the last one is a little anterior to the base of the coronoid process (34 lines). They are situated in a wide shallow groove, which occupies a portion of the inner face of the ramus below the upper edge. Their interspaces are not quite equal; thus twenty lines separate two, and four are included in thirty-six lines. The foramina of the external series are more numerous than in any of the other species from the Miocene of our Eastern States. As in others the last pairs are less spaced than the anterior. In a space of six inches and twenty lines, there are six foramina, the third from behind nine lines below the superior margin. Thirty-four lines separate the anterior pair; twenty-two the posterior. The last foramen is about a half an inch anterior to the plane of the last one of the inner side.

	Feet.	Lines.
Length of fragment	2	42
Depth just behind coronoid		56
" " in front of coronoid		66
" at fourth inner foramen		62
Diameter " " "		27

This ramus chiefly resembles that of Eschr. cephalus from Maryland. It is less compressed, though crushed, and less attenuated on the upper margin near coronoid process; the coronoid process considerably smaller. Outer series of pores more numerous and extending further back. Inner in a marked groove, which is wanting in E. cephalus. Outer wall of angular region more everted. Inferior wall of dental or mandibular canal descending from margin of foramen in E. cephalus and ascending in E. polyporus.

From the Miocene Marl of Edgecombe Co., North Carolina. Obtained by the writer under the auspices of the North Carolina State Geological Survey, under Prof. Wm. C. Kerr, Director.

Vertebræ, which as to size and structure would accord with the present species, are not uncommon in the same deposit; their description is reserved for a future occasion.

MESOTERAS, Cope.

Genus novum.

Character. Orbital process of frontal narrowed, exceedingly thick and massive at the extremity. Posterior lumbars and anterior caudals with short antero-posterior diameter. Premaxillary and maxillary bones depressed, the latter thin, horizontal, narrow. Otic bulla compressed.

This genius is allied to Balaena in the form of its vertebræ, and to some extent in that of its frontal bone. The flatness of the maxillary and premaxillary is rather that of Balaenoptera. The extraordinary mass of the superciliary portion of the frontal is peculiar to the species which forms the type of the genus so far as known.

Mesoteras kerrianus, Cope.

Species nova.

This species was discovered by Prof. Wm. C. Kerr, Director of the Geological Survey of North Carolina, in a bed of miocene marl, at a point where it is cut by Quanky Creek, a tributary of the Roanoke river, in Halifax county, North Carolina. A portion of the cranium had been noticed for some years projecting from the steep bank or wall of the small cañon of the creek, at about thirty feet below the surface of the ground.

Prof. Kerr, with the aid of a number of men, dug from its bed and elevated to the surface of the ground a large fragment of the cranium, including the greater part of the left maxillary and premaxillary bones, with a large part of the frontal. A large fragment of the right ramus of the mandible, an otic bulla, several lumbar and caudal vertebræ, with several broken ribs, were also obtained.

These remains indicate not only a species, but a genus new to science, and the largest extinct Balænoid yet discovered.

The principal mass includes from the posterior margin of the transverse process of the frontal, to within four or five feet of the end of the muzzle. The mass measures eleven feet six inches in length. The fragment of the ramus mandibuli measures thirteen feet; five feet are probably lost distally, and there is no trace of coronoid process at the point where it is broken off proximally. The length of the restored cranium would not be less than eighteen feet. This gives for the total length, estimating on the basis of Megaptera, seventy-five to eighty feet.

The orbital process is nearly in line with the maxillary, probably in consequence of pressure when lying in an oblique position. The whole cranium has been injured from the same cause, and the matrix usually soft, formed a solid investment of carbonate of lime from the carbonic acid liberated during decomposition, which required several days' labor to remove. The parietal, occipital, and other bones of the brain-case proper, were not recovered.

Description. The upper surface of the muzzle is but little decurved anteriorily. A portion of its outer margin, at the posterior part, is preserved, so that its width is known. The maxillary forms a rather thin lamina, and does not present any great median decurvature, as though the vomer was not prominent below. Perhaps this peculiar flatness is partly due to pressure, but the *premaxillary* presents a similar character, which is evidently normal. This element forms one margin of the mass, and the question as to whether the exposed face were the outer of the right, or the inner of the left bone, required some care for its solution. Anteriorly it is three inches in depth, near the posterior extremity, two inches. The greatest width near the middle, six inches. The margin next the remainder of the mass, is rather the more elevated; the external somewhat prominent and rounded. Beneath it a deep groove marks apparently the exit of a foramen. A groove in the same line is seen at various points throughout its length where exposed. This bone is thus much flatter than in any of the Finner whales, and resembles more that of the right whales. The outer face being nearly plane, it can scarcely be the vomerine face, which is concave, especially so in Balæna, for the accommodation of the cartilaginous axis. The foramina and grooves are equally present in both these genera, on the external side; I therefore conclude that the external side of the right premaxillary is the one exposed, and that the width of the muzzle includes the left premaxillary, and maxillary. The suture between the latter is not distinct, owing to the presence of longitudinal fractures. The width of the maxillary after the premaxillary is deducted, is not great, and is intermediate between that seen in Balaena and Megaptera. The right premaxillary may be traced for six feet two inches. Behind it a portion of the superficies of the cranium slopes towards the position formerly occupied as a blow hole.

The margin of the *maxillary* is horizontal, and rather thin. It becomes thicker posteriorly where it has been crushed back on the lateral orbital process of the frontal. Its acuminate extremity is seen lying on the latter.

The orbital process of the *frontal* is remarkably massive, and might at first be taken for the squamosal. Its posterior margin is free to within a foot of the probable position of the blow holes. This fact, in connection with its deep postero-inferior concavity in cross section, is conclusive as to its relations. The form is not horizontally expanded as in Megaptera, nor attenuated as in Balæna, but has rather the proportions seen in Reinhardt's figure of the young of Balæna mysticetus. (Om Nordhvalen Pl. III.) That is, it has subparallel anterior and posterior sides; the extremity a little widened by the production backwards of the posterior portion. The anterior portion also somewhat, though less, protuberant. The whole extremity truncate and remarkably thickened. Thus it is nineteen inches long, the anterior tuberosity seventeen inches deep, the posterior twelve inches deep ; the inferior outline nearly straight. The orbital concavity, which is continuous with the optic foramen, opens behind the posterior tuberosity, and is defined exteriorly by the expanded posterior margin of the bone. Thus the great tuberosity which gives character to the bone was above and in front of the eye.

The portion of the *mandible* preserved presents marked characters. The inner face is slightly concave, or plane, the external strongly convex. The inferior edge is narrowed, and the superior scarcely less so ; the inner face rounds a little to the former, and to a wide groove just below the latter. This groove is one inch wide near the middle of the ramus, and is marked by a series of many small foramina. These are closer together in the anterior, and regularly more widely spaced to the posterior portion. Thus anteriorly they are 2.5 inches apart ; posteriorly four inches separates them, and near the extremity of the series, six inches. I failed to find any foramina on the external face of the ramus. It is difficult, however, to believe that they are totally absent ; it may be that they are confined to the anterior portion, which has not been preserved. This peculiarity, if entirely established, marks the species as quite distinct from any heretofore known from characters of the mandible. The depth in this species, at the point where the foramina are four inches apart, is fourteen inches.

There are some other pieces apparently belonging to the cranium, whose exact positions I cannot now assign. One of these looks like a segment of ramus of the lower jaw, but the convergence of the superior and inferior outlines is too great. One face is plane-concave, the other convex flattened, with oblique superior and inferior faces, the latter the widest. Depth of plane, ten inches; do. exterior flattened face, 7.75 inches. Depth six inches from same point, 7.5 inches. The second uncertain fragment is long and with parallel margins. The outer face is strongly convex; the inner, at one extremity concave, so that a section would be half a crescent (the lower portion being lost). The inner face gradually becomes convex, though not strongly so, and the long diameter is transverse, while it is vertical at the anterior end. The former is seven inches; the latter eight inches. The fragment looks like the extremity of a premaxillary bone, possibly a maxillary, but it is scarcely appropriate to the premaxillary already described.

The periotic bones of the left side were preserved almost entire. The bulla has the flat inferior face of the genus Balæna, and the periotic processes are exceedingly short, shorter even than those of the species of Balæna (B. mysticetus and B. cisarctica). The external process is not longer than the posterior, and is compressed and deeply grooved longitudinally below. The posterior process is at right angles to the exterior, and as broad as long. It bears a sublongitudinal ridge near the middle of its inferior face; anterior to it, separated by an interval a transverse ridge occurs to which the edge of the thin lip of the bulla is attached. The anterior process contains the usual foramina, and is broader than long. The superior face of these bones is quite rugose. The bulla is more flattened, *i. e.*, has a shorter vertical diameter, than either that of Balæna mysticetus or B. cisarctica. The circumference is not a sharp edge as in B. cisarctica, but is truncate and rugose, at the inner extremity most so. At the external extremity the face gives way to a rounded edge. The inferior face is coarsely impressed punctate, and has a curved depression inside the anterior margin. The posterior margin is marked by the usual three grooves with intervening enlargements. The general outline, viewed from below is hexagonal, with the lengths of the sides as follows, beginning with the longest; posterior, anterior, interior, postero and antero-exterior equal, antero-interior very short. The bulla of B. cisarctica exhibit a long posterior and long interior side, connected by an arched outline.

The vertebræ are those of the genus Balæna. The general form of the centra of anterior lumbars and caudals, is abbreviated, especially the latter. The diapophyses of the former are thick at the base; one of those preserved may be a posterior dorsal, but the ends of the diapophyses are not preserved. In a caudal with very short diapophyses, which are a little nearer the basis of the chevrons than that of the neural arch, a small foramen penetrates the centrum from a point three inches above the base of the diapophysis, and issues at a point 2.5 inches below it. The articular faces are convex; there is a small rugose central area, and an external annular space with coarse concentric ridges.

Measurements.

	Ft.	In.	Lin.
Length of fragment of O. maxillare to extremity which reposes on frontal	9	8	
Width of same (with left premaxillary) at 42 inches from extremity.....................		16	

	In.	Lines.
Transverse diameter periotic bulla............	5	8.7
Longitudinal..............................	4	9.5
Vertical..................................	3	1.5
Length external periotic process..............	1	9.5
" posterior " "	2	2
Length centrum anterior lumbar No. 1........	10.75	
Vertical and transverse diameter do. each.....	12	
Width neural canal.........................	5	
Length diapophysis.........................	17	
Width do. at base..........................	7	
" " " middle......................	6	
Length centrum lumbar No. 2...............	10.5	
Both diameters of articular face..............	13.	
Width neural canal.........................	5.5	
" antero-posterior neural spine.........	5.	
Length centrum of a caudal.................	6.5	
Diameter articular face, (vertical)...........	14.	
" " (transverse)..........	14	6
" neural canal.....................	1.5	
" inter-chevron groove...............	3	

As compared with the described species, the characters of the Mesoteras kerrianus are well marked. Thus the ear bone is totally different from that of Eschrichtius cephalus and E. mysticetoides (*Balæna* Emmons, Leidy), and the mandibular ramus is not flattened above, as in E. priscus and E. expansus. The paucity or absence of external foramina distinguish it from the E. polyporus. Finally, E. leptocentrus presents generic characters in its known cervical vertebræ which will not probably be found in the present whale. Though these vertebræ of Mesoteras have not yet been found, I anticipate that they will present more nearly the characters of the genus Balæna, in accordance with the remainder of the structure. Perhaps they will be like those of Palæcetus of Seeley, and the two genera may be found to be the same.

It has been known to geologists and others for some time, that a skeleton of some kind had been exposed by the erosive action of the waters of a creek in Eastern North Carolina, and was to be seen lying in its bed diagonally across it. The writer recently visited the spot, and found the stream to be some fifty feet in width, containing water of from three to five feet in depth. The direction and extent of the skeleton was indicated by the proprietor, Jesse W. Parker, since the water concealed it from view. It would appear to extend very nearly across the creek, and have a length of 60 to 70 feet. Some of the vertebræ could be distinguished by feeling with a rod. When the waters are low towards the end of the summer, its length is exposed, and it can be used as a foot log by the traveller. On the bank near this skeleton were found portions of the skeleton of an adult firmer whale of some thirty feet in length.

Prof. Kerr, Director of the survey, succeeded in obtaining one or two of the lumbosacral vertebræ of the specimen which is above noticed. These were submitted to me at Raleigh. They belong to a right whale, or one nearer to Balæna than Balaenoptera. They are in fact identical in character with those of the species Mesoteras kerrianus, and belong probably to it. The following is a description of one of them from the posterior dorsal or anterior lumbar region.

Median line below, obtusely keeled, sides a little concave. Articular face with a large median elevated area, which is coarsely obsoletely rugose; the marginal area exhibits fine concentric rugosities.

Measurements.

	Inches
Length centrum	7
" basis of diapophysis	4.5
Depth " "	3.25
" articular face	8.5
Width " "	9.
Thickness of epiphysis	.75

The epiphyses are free and the individual is young.

A vertebra of similar character to, and rather larger size than any here described, was obtained by the writer near Nahumta, Wayne Co., N. Ca. The species would not appear to be rare.

This whale is named for Prof. Wm. C. Kerr, of Raleigh, who has vitalized the State survey, and is prosecuting it with advantage to all branches of science that lie within its scope.

SUS, Limaens.

Sus ? sp.

Represented by the crown of an inferior posterior molar of an animal not fully grown. Both extremities are broken off, but sufficient remains to indicate the genus of the animal beyond doubt.

The two principal lateral and adjacent median tubercles of the tooth present the characters of the same parts in the *Sus scropha*, and indicate a species of about the same size. A section of each lateral lobe is therefore slightly trifoliate, and the two inner ridges, whose sections constitute the lobes, are transversely deeply wrinkled. The margins of the broader outer lobes are also wrinkled, the wrinkles sometimes continued into shallow grooves on the outer face of the same. The convex outer face is marked by delicate concentric linear grooves, the apex of the lobe being the centre of the arcs. The anterior and posterior median tubercles are much the same as in *S. scropha;* in the former the crown is nearly three times as wide as long, as in *S. scropha*. The posterior median tubercle is sub-trilobed, and a little broader than long; surfaces of both tubercles rugose plicate. A pair of shallow longitudinal grooves on the outer face of each lateral tubercle.

The inferior face of the crown presents a not uncommon peculiarty in the isolation and deep conic form of the prolongations of the pulp cavity, which correspond to the tubercles. In another specimen which I refer to the *S. scropha*, these prolongations are connected by grooves which enclose diamond-shaped interspaces.

	M. M.
Width crown at base,	0.0163
" between apices lateral tubercles,	.007
Length, including median tubercles,	.014
" anterior median tubercle,	.003
Width " " "	.008

This is one of the interesting discoveries made by Dr. Lockwood, of Keyport, N. J., in the fossiliferous strata of his region. He obtained it of a farmer, with a number of other fossils of the upper marl bed in Monmouth Co., N. J. The farmer used the marl of that stratum as manure, and probably found the present specimen while digging it. The color of the tooth is black like that of other Miocene and Eocene fossils of that region, and though on application to a flame it shows the existence of a small amount of carbonaceous organic matter, it does not give out the odor perceived in the post-tertiary bones of New Jersey, when burned.

Recently, my friend, Oliver N. Bryan, sent me from Stafford Co., Virginia, a similar posterior molar from the inferior series of a hog. On contact with a flame it evolves such an odor of organic matter, and combustion leaves such distinct traces of carbon, that I am unwilling to consider it a fossil. It is stained of a strong red color, which does not penetrate far below the surface as does the black in the specimen above described. Its posterior median tubercle is accompanied by a smaller tubercle on the inner side; behind it an opposed pair of rudimental proportions follows, and as the crown narrows to a sub-acute termination, a still lower median tubercle finishes the series. The anterior extremity of the tooth is broken away. In these unused crowns, the edges of the tubercles are crenate, and the inner and median lobes and tubercles are coarsely plicate.

THINOTHERIUM, Cope.

Family *Hippopotamidæ.* Dentine thrown into transverse ridges on the basal half of the second inferior incisor, otherwise probably as in Hexaprotodon, or with three superior incisors at least.

This genus is indicated by a second inferior incisor of the right side. It resembles that of the genus Hippopotamus, but differs in the annulate character of the surface of the dentine of the proximal portion of the fang. The worn exterior face near the extremity, indicates the friction of the usual large second superior incisor, while a correspanding worn surface on the opposite side of the extremity, indicates the presence of the inner or third superior incisor characteristic of Hexaprotodon and not found in Hippopotamus. The base of the fang exhibit the usual short pulp cavity, and is compressed, not rounded, as in Hippopotamus and Chœropsis, as though there were an additional, or third inferior incisor also. Apex of tooth narrowed obtuse.

Structure of dentine concentric.

THINOTHERIUM ANNULATUM, Cope.

Species nova.

Second inferior incisor slightly curved both outwards and upwards. Section of basal half, a vertical oval; beyond the middle, at worn surfaces, quadrangular, with one angle upwards and the extero-inferior side convex. This is occasioned by the presence of a third flattened side, besides the two worn faces, at right angles with the interior worn face. It presents a short longitudinal groove, which may be abnormal. Extremity narrowed, sub-round, obtuse. The direction of the outer worn surface is outwards and backwards.

	M. M.
Total length,	0.0543
Vertical diameter at base,	.0117
Transverse " "	.0075
" " near tip,	.006

The color of the tooth is dark red, and it has not penetrated far into the dentine. On application to a flame, a very faint odor of organic matter may be perceived, and a slight trace of carbon may be detected. The surface is considerably worn, so that it cannot be determined whether there was a coat of enamel originally or not. It was discovered in Stafford Co., Virginia, at the same locality from which the molar of the hog above described, was procured. They have both been rolled, and are both of a red color.

The Thinotherium annulatum was a small Hippopotamus-like animal, about the size of the wild boar. As it was no doubt like its recent allies, a shore-and-swamp-loving beast, I name it from θιν the shore, or θηςίον, a wild animal.

The discovery of the Hippopotamus in America, by O. N. Bryan, and the hog, by Dr. Lockwood, is of considerable interest. Neither types have been heretofore known in either extinct or recent condition (except as introduced), and are, therefore, not included in Leidy's recent Synopsis of Fossil Mammalia of North America, in the Journal Acad. Natl. Sciences, Phila. De Castro, in an essay entitled, "De la Existencia de la grandes Mammiferos Fossiles en la Isla de Cuba," Havana, 1865, states that remains of Hippopotamus occur in the Island of Cuba, referring them to an extinct species. Leidy remarks on this,* that they are probably recent, and cites examples of specimens used for making artificial teeth by dentists, having been brought to him as fossils.

MYLIOBATIS, Cuvier.

MYLIOBATIS GLOTTOIDES, Cope.

Spec. nov.

Established on three specimens, one of which presents a series of eight teeth very convex in longitudinal as well as transverse direction. On the median line the teeth are suddenly swollen, forming together a broad obtuse median ridge. The lateral portions on either side are each slightly convex, and thin off to a margin which embraces but a single series of lateral teeth. Each transverse tooth is nearly straight, the extremity slightly and abruptly curved backwards. Each tooth is both wider (longer) and deeper than in most of the described species. The worn surface forms a subtriangular concavity.

* Proceed. Acad. Nat. Sci., Phil., 1868, 179.

	Lines.
Length of eight teeth over convexity..................	41
" of stoutest tooth............................	6.3
Depth of vasodentine of do..........................	7
Width of same tooth (over convexity).................	28

Laminar face obtusely angulate on the median line below.

This species is thick-toothed as in M. pachyodon and M. holmesii, but they are not so clearly three-ribbed in section as this one. The M. rugosus is somewhat similar, but is much wider, with more curvature of teeth and double row of laterals.

From the marl pits of the Freehold and Squankum Company, in the Eocene bed at Farmingdale, Monmouth Co. N. J.

MYLIOBATIS RECTIDENS, Cope.

Represented by seven consecutive teeth extending from the concave triturating surface, to the end of the series. There are two lateral series of teeth on each side, of which several of those of the inner series at least are wider than long. Those of the median series are entirely plane, and with perfectly straight transverse sutures. The series is very slightly convex in both directions.

	Lines
Length of seven teeth.................................	38
Width of each median tooth..........................	15
Depth of vasodentinal layer..........................	4

This species is to be compared with the M. vicomicanus m. In it there are twice as many (12) teeth in a series of the same length and width as the present ; the median series are recurved at the extremities ; in this one straight.

This species is from Harrisonville, N. J., from marl excavations which are chiefly in the upper bed of Cretaceous green sand. The rusty color of the specimen indicates that it came from the upper part of the excavation, and therefore probably from a miocene stratum which Prof. Cook shows frequently overlies the green sand proper.

COELORHYNCHUS, Ag.

COELORHYNCHUS ACUS, Cope.

Established on a portion of the muzzle of a fish similar in some respects to the C. rectus, Ag., but smaller than it and much less than the C. ornatus, Leidy, from the same locality. The fragment presents a single median cavity, and externally nineteen ridges separated by narrow grooves ; in the C. ornatus there are from thirty to forty in the same portion of the length. Diameter 1.3 lines. From the Eocene Marl of Farmingdale, Monmouth Co. N. J. I am indebted to A. J. Smith, Superintendent of the pits, for this and other valuable specimens.

ON ADOCUS, A GENUS OF CRETACEOUS EMYDIDÆ.

By E. D. Cope.

ADOCUS, Cope.

Proceed. Acad. Natl. Sciences, Phila., 1868, 235.

Character. Anterior and posterior lobes of the plastron abbreviated, narrowed, and not emarginate. Eight paired sternal bones ; twelve sternal scuta, the humerals extending anteriorly, the pectorals and gulars both small. A series of plates—"intermaginals" within the marginals, on the sternal bridge. Rib heads, i. e. the capitula, wanting in the species whose costals have been examined.

This genus was originally described with *Emys beatus* Leidy from the Cretaceous Green Sand of New Jersey as the type, and its primary character was regarded as the absence of the costal capitula. In the synopsis of extinct reptilia of New Jersey, published in Prof. Cook's Geological Survey of that State, five species were numerated, as follows ; *A. petrosus*, Cope, *A. firmus*, Leidy, *A. beatus*, Leidy, *A. pravus*, Leidy and *A. agilis*, Cope. The two species first enumerated having subsequently been found to possess well developed costal capitula, I referred them to Emys, in the "Synopsis of extinct Batrachia and Reptilia of North America," p. 126. My specimens of *A. agilis* being at the time very imperfect, it was not described.

In the present essay I propose to point out its characters, as well as those of the other species of the genus. Two species are added, the whole number being then five. One of these is from the Cretaceous deposits of Wyoming, the others from New Jersey.

The plastron in this genus presents marked peculiarity. The great reduction of the anterior and posterior lobes gives it a form pointing to that of Staurotypus. The anal scuta are of large size, and the humero-abdominal scutal suture (in A. agilis) extends across just in advance of the inguinal notch. The abdominal is the widest pair of scuta, in consequence of the relatively great longitudinal extent of the bridge ; their anterior outline falls a little behind the axillary notch. The humeral scuta have a remarkable anterior extent, so much so as to lead to the suspicion that they were confluent with the pectorals, or perhaps wanting. In the case of *A. pectoralis*, having only the hyosternal bones, I was induced to think that they were really the pectorals, and that the abdominals were the true humerals, as is seen in the genus Pleurosternum ; the posterior position of the humerals in the latter being owing to the existence of an additional pair of sternal bones. An examination of that structure in *A. agilis* and *A. wyomingensis*, dispels this view, and shows that the true pectorals are much shortened, and have an anterior position, and that the gulars are also small. and narrowed, the genus approaching Chelydra in these respects.

The lateral series of abdominal marginals is seen in the existing genera Macrochelys and Dermatemys. The affinity of Adocus is to the latter, but the entire acuminate free lobes of the plastron, distinguish it well. The lateral marginal scuta in *A. agilis*, *A. wyomingensis* and *A. pectoralis* are very distinct in our specimens, while I have seen it in only one of the two or three in which the bridge is preserved in A. beatus. In A. pravus I have not seen it, but the contracted entire xiphisternal elements pointed out by Leidy are quite like those of A. beatus, to which it is indeed very nearly allied.

The narrowed form of the posterior lobe is best seen in the specimen of A. wyomingensis described by Leidy, and in a specimen of A. beatus noticed by me in Synopsis Batr. Rept. N. A. p. 129. I there state that it is emarginate, an error consequent on a certain assymetry of the specimen, and its fractured condition. In A. agilis it is apparently rather better developed.

The form of the anterior lobe is easily seen to be narrowly reference to my figure of *A. pectoralis* (Syn. Bat. Rept. N. A.) Tab. VII fig. 1), or Leidy's figure of *A. pravus* Cretac. Rept. N. Am. XIX fig. 1. In the nearly perfect specimen of *A. vyomingensis* this portion is broken away, but Leidy describes this portion of a specimen, which has the character of the above species.

The species differ much in the relative stoutness of their shells, especially of the plastron. A pectoralis is the stoutest as well as the smallest; A. pravus and A. agilis are the thinnest, the latter the largest of the genus. No portions can be certainly ascribed to the crania of this genus.

In specimens of A. agilis, A. pravus, and A. beatus, the longitudinal median suture of the plastron presents much irregularity from the union of the alternating bones across the point of meeting of four, by an oblique portion of the suture.

Thickness of hyosternals less than four times in the transverse extent of same; intermarginals shorter; mesosternal prolonged posteriorly; smooth below; small. A. PECTORALIS.

Thickness of hyosternals one-eighth transverse extent of same; above with slightly impressed dots or delicate grooves, closely placed; larger, vertebral bones wider, A. BEATUS.

Sternum thick; vertebral bones narrower; carapace more coarsely longitudinally impressed grooved; mesosternal deeply received; lateral intermarginals elongate. A. VYOMINGENSIS.

Plastron quite thin; mesosternal deeply received into hyosternals. A. PRAVUS.

Plastron quite thin; mesosternal occupying an open concavity of the hyosternals; surface everywhere delicately impressed punctate and grooved; intermarginal scuta very long and narrow. A. AGILIS.

ADOCUS PECTORALIS, Cope.

Pleurosternum pectorale, Cope. Proc. Ac. Nat. Sci. Phila., 1868, 236; Trans. Amer. Philos. Soc. XIV, 1869, 130; Tab. VII, fig. 1.

Indicated by a pair of perfect hyosternal bones from the upper Cretaceous marl bed near Medford, Burlington Co, N. J.

ADOCUS BEATUS, Leidy.

Emys beatus, Cretaceous Reptiles, N. Amer. p. 107 Tab. XVIII, fig. 1-3. *Adocus beatus*, Cope, Proc. A. N. S., Phila., 1868, 235. Geological survey, N. Jersey, App. C. p. 734.

Not uncommon. It is considerably less stout than the preceding. The edges of the posterior lobe of the plastron are thinned out by an submarginal groove. As in other Emydoids there is a marked concavity for each pubic bone. The suture between the hyo- and hyposternal bones is less interlocking than in *A. agilis*, and less fine than in *A. pectoralis.* I have suggested that it may have possessed a slight mobility in life. Its face is longitudinally grooved in the hyposternal, and a corresponding convexity of the face of the hyosternal fits it. In a specimen from Medford, N. J., the posterior lobe is 5 inches 9 lin. long, and 5 inches, 8 lin. wide at the inguinal notches. Hyosternal of nearly equal thickness ; medially 7 lines.

ADOCUS VYOMENGENSIS, Leidy.

Emys vyomingensis, Leidy, Proc. Ac. Nat. Sci., Phila., 1869, p. 66. *Baptemys wyomingensis*, Leidy, loc. cit., 1870, January.

Best known from an almost complete specimen consolidated by the contained mass of mineral. There are three intermarginal bones, of which the middle one is more elongate than the others. There is a weak carina on some of the posterior vertebral bones. The posterior marginal bones are not revolute. The costal bones are delicately grooved in the length of the carapace. The anterior extremity of the anterior sternal lobe is narrowed, prominent, and truncate. Length of the whole animal about two feet.

Found near Ft. Bridger, Wyoming Territory, by Dr. Van Carter.

The genus Baptemys to which this species is referred by Leidy, appears to be the same as Adocus.

ADOCUS PRAVUS, Leidy.

Emys pravus, Leidy. Proc. Aca. Nat'l. Sci., Phila., 1856, 303. Cretaceous Rept. U. S. 108. *Adocus pravus*, Cope. Synopsis Batr. Rept. N. Am. 129.

This species is as yet known only from the original specimens, in the collection of the Geological Survey of New Jersey. The plastron is thinner than in three preceding, and the hyosternals embrace the mesosternum extensively. This distinguishes the species from *A. agilis* where the mesos'e nal emargination i much wider than deep. Width of an'erior lobe of sternum at epi-hyosternal suture, four inches.

Upper bed of Cretaceous Green sand, New Jersey.

ADOCUS AGILIS, Cope.

Geological Survey of New Jersey, App. C. p. 734.

Represented chiefly by an almost complete plastron from the excavations of the West Jersey Marl Company, in the upper bed of the upper Cretaceous Green Sand of New Jersey.

This specimen belonged to an individual of larger size than any heretofore referred to the genus, and one characteristically ornamented by a peculiar sculpture.

The extremities of both lobes are broken off ; the margin of the posterior is thinned out, and carries an acuteness of edge to the inguinal notch where the margin is quite thick. The outline of the caudal scuta is very convex anteriorly ; that of the femorals is gently convex towards the front. The suture between the hypo- and xiphisternals is nearly transverse below; on the upper face it sends a process into the hyposternals forwards, which is acuminate; the hyposternals send a marginal process backwards beyond the line of the median suture, which is squarely truncate; its outer edge is the margin of the bone. The impressions of contact of the pubes are well marked; they are strongly incurved, and are not very different from those seen in Cistudo. The bridge of the plastron is preserved, and furnishes attachment for three marginal bones; perhaps fractions of others also. The suture between the abdominal and humeral scuta is convex backwards, and unites with an inner angle of the anterior of the intermarginal series of the bridge. There are three in the latter series, all longer than broad, but the middle one relatively much narrower than the others, as it is six times longer than wide, with parallel sides. That anterior to it is more hexagonal and wider, presenting an angle inwards for union with the suture between the abdominal and humeral scuta.

About half the mesosternal bone is preserved. It is a transverse diamond with truncate extremities. Its posterior angle is therefore very open, but is not rounded. No suture bounding either humeral or gular scuta is visible on it; the anterior angle is broken away. The anterior portion of the episternal bone preserved has a regular convex outline, and is quite thin.

The sculpture of the inferior surface is a slight imitation of that seen in some species of Trionyx. It is closely shallow-punctate, or like small rain-drop impressions. These are irregularly distributed on the anterior part of the plastron, and on the posterior lobe in obliquely decussating series.

Measurements.

	M. M.
Width of plastron at bridge, . . .	0.2879
Length between mesosternum and xiphisternum,	0.21
Width posterior lobe at inguinal notch, . .	0.1835
" mesosternum, ...	0.091
Length "	0.0695
" hyosternum medially, . . .	0.09
Thickness " " . . .	0.012
" " at marginal suture, . .	0.007
Length abdominal suture, . . .	0.1063
" femoral " . . .	0.087
Length median intermarginal suture, . .	0.0825
Width " " " . .	0.015
Estimated length plastron, . . .	0.45
" " carapace, ...	0.56

This species, the largest of the genus, is found in the upper green sand bed of the upper Cretaceous of New Jersey. The specimen from which the above description was taken, was found by my friend I. C. Voorhees, in the pits of the New Jersey Marl Company, and by the permission of the latter submitted to the writer.

ON THE PERIODS OF CERTAIN METEORIC RINGS.

By Daniel Kirkwood.

I. The Meteors of April 20th.

In the *Astronomische Nachrichten*, No. 1632, Dr. Weiss called attention to the fact that the orbit of the first comet of 1861 very nearly intersects that of the earth, in longitude 210°; the point passed by the latter at the epoch of the April meteoric shower. A relation between the meteors and the comet, similar to that recently detected between the November meteors and the comet of 1866, was thus suggested as probable. Is this hypothesis in harmony with facts? and if not, are our present data sufficient for determining with any reasonable probability, the true period of the April meteors?

Dates of the April Shower.—Professor Newton selects the following from Quetelet's Catalogue as belonging to this period :*

1.	B. C. 687,	4.	A. D. 1093, '4 '5, and '6
2.	" 15,	5.	" 1122, '3
3.	A. D. 582,	6.	" 1803,

Period of the First Comet of 1861.—The elements of this body were computed by Oppolzer, who assigned it a period of 415 y.4. Now while it is true that the interval from B. C.. 687 to A. D. 1803, is very nearly equal to 6 periods of 415 years, the slightest examination will show that this period does not harmonise with *any of the intermediate dates.* This fact, then, without further discussion, seems fatal to the hypothesis that the period of the meteors is nearly equal to that of the comet.

What is the probable period of the ring?—The showers of 1093—6 and 1122—3 at once suggest a period of from 26 to 30 years. The nodal passage of the densest portion of the ring at the former epoch may be placed any where between 1093 and 1096, and that of the latter, in either 1122 or 1123. The entire interval from B. C. 687 to A. D. 1803 is 2490 years, or 88 periods of 28 y.295 each; and the known dates are all satisfied by the following scheme :

B. C. 687	to B. C. 15	....672.000	years=24	periods of	18,000y each.
" 15	to A. D. 582	....597.000	" =21	"	28.429 "
A. D. 582	to "1093.714	...511.714	" =18	"	28.429 "
" 1093.714	to "1122.143	....28.429	" = 1	"	28.429 "
" 1122.143	to 1803	...680.857	" =24	"	28.369 "

These coincidences indicate a period of about $28\frac{1}{3}$† years, corresponding to an ellipse whose major axis is 18.59. Hence the distance of the aphelion is very nearly equal to the mean distance of Uranus. It will also be observed that the time of revolution, which seems to have been somewhat lengthened about the Christian era, was previously one-third of the period of Uranus.

II. The Meteors of December 11th—13th.

In the catalogue of Quetelet we find the four following extraordinary displays which belong undoubtedly to this period. Observations made in

*Silliman's Journal for July, 1863.

† Herrick assigned a value of 27 years. See Silliman's Journal for April, 1841, p. 365.

England, 1862, indicate also a more than ordinary number of meteors at the December epoch in that year.

1. A. C. 901. "The whole hemisphere was filled with those meteors called falling stars, the ninth of Dhu'lhajja, (288th year of the Hegira) from midnight till morning, to the great surprise of the beholders, in Egypt."—*Modern part of the Universal History*, 8vo. Vol. 2, p. 281. Lond. 1780. The date of this phenomenon corresponds to the December epoch, A. D. 901.

2. 930. "Averse remarquable d'ètoiles filantes en Chine."

3. 1571. "On vit à Zurich 'du feu tomber du ciel'".

4. 1830, 1833, and 1836. The maximum seems to have occurred in 1833, when as many as ten meteors were seen simultaneously. "Dans la nuit du 11 au 12 décembre, on vit, à Parme une grande quantité d'étoiles filantes de différentes grandeurs, qui se dirigeaient presque toutes avec une grande vitesse vers le SSE. A 10 heures et $\frac{1}{4}$, entre les seules constellations du Bélier et du Taureau, on en compta environ une dizaine."

5. (Doubtful.) 1861, 1862, and 1863. Maximum probably in 1862. The meteors at this return were far from being comparable in numbers with the ancient displays. The shower, however, was distinctly observed. R. P. Grey, Esq., of Manchester, England, says the period for December 10th—12th was, in 1862, "exceedingly well defined."*

These dates indicate a period of about $29\frac{1}{8}$ years. Thus:

901 to 930..... 1 period of 29.000 years.
930 to 1571.....22 periods of 29.136 years.
1571 to 1833..... 9 periods of 29.111 years.
1833 to 1862..... 1 period of 29.000 years.

III. The Meteors of October 15th—21st.

The showers of the following years (see Quetelet's Catalogue) belong to this epoch:

1. 288. "Apparition en Chine."

2. 1436 and 1439. In each year a remarkable apparition was observed in China.

3. 1743. (Quoted from Herrick, in Silliman's Journal for April, 1841.) "A clear night, great shooting of stars between 9 and 10 o'clock, all shot from S. W. to N. E. [Qu. N. E. to S. W.?] One like a comet in the meridian very large, and like fire, with a long broad train after it, which lasted several minutes; after that was a train like a row of thick small stars for twenty minutes together, which dipt N."

4. 1798. "Brandès marque, à Goettingue, un grand nombre d'étoiles filantes dans les observations simultanèes qu' il fait avec Benzenberg."

These dates indicate a period of about $27\frac{1}{2}$ years:

288 to 1439......42 periods of 27.405 years each.
1439 to 1743......11 " 27,636 "
1743 to 1798...... 2 " 27.500 "

If these periods are correct, it is a remarkable coincidence that the aphelion distances of the metoric rings of April 18th—20th, October 15th—21st, November 14th, and December 11th—13th, as well as those of the comets 1863 I, and 1867 I, are all nearly equal to the mean distance of Uranus.

*Silliman's Journal for May, 1863, p. 461.

CONTRIBUTIONS TO A GRAMMAR OF THE MUSKOKEE LANGUAGE.

By D. G. Brinton, M. D.

1. Historical notes on the language, its dialects, affinities, and literature.
2. The Alphabet.
3. Remarks on Buckner's "Maskωke Grammar."
4. The Muskokee verb.
5. Specimen of the language.

I. Historical Notes.

The Muskokees, (*este muskókee*, or *muskokvl'ke*), or, as they were called by the English settlers, the Creeks, when first known to Europeans, occupied most of the territory now embraced in the states of Georgia, Alabama, and Florida. They were divided into a number of towns, each governed by a civil ruler, the *mekko* or king, and a war-chief, and all subject to one potentate, in whose family the supreme power was hereditary in the female line.

Their geographical position brought them early into contact with the white race, and many Muskokee names are preserved in the ancient Spanish narratives. Most of these, when given the Spanish pronunciation, are still intelligible to the natives, and some of the town names are those of towns (*i. e.*, bands), still in existence. The narratives of De Soto's expedition (1539-40) contain many such, and the town of Tocobaga, mentioned by Hernando d' Escalante Fontanedo,[1] who was wrecked on the coast of Florida in 1552, is still found among the Creeks in the Indian territory. The latter writer lived several years among the natives, and gives a word or two of their language. One of these, *se-le-tega*, which he translates "run to the look-out," I repeated, with the Spanish pronunciation, to Mr. S. W. Perryman, Speaker of the House of Warriors of the Creek Nation, an educated and intelligent native, without informing him of its alleged meaning. He at once translated it "run thither," the look-out being probably intimated by a gesture. Other Muskokee words given by Fontanedo are : Otapali, properly oti palin, ten islands ; and Tampa, properly timpe, near to it.

In the year 1570, Juan de la Vandera, a Spanish officer at the post of St. Helena, north of the Savannah river, sent a detachment inland to seek the town of Coosa, mentioned in such extravagant terms by the survivors of De Soto's expedition. The report of this exploration has been published by Mr. Buckingham Smith in his "Colleccion de Documentos sobre la Florida." It contains the names of a number of native villages. These I read to Mr. Perryman, who promptly identified several of them, as Aḥoya, two-going ; Ara-uchi, a place where a tree named ara grows ; Gwataro, properly coahtari, dry cane; Issa, deer; Satapo, properly satape, persimmon tree ; Solameco, properly solv mekko, buzzard king ; Tasqui-

[1] Memoir of Hernando d' Escalante Fontanedo. Translated by Buckingham Smith, Washington, 1854.

qui, a town still in existence; Coosa, the Cherokee name of the Creek nation.

The missionary labors of the Spanish Jesuit and Dominican ecclesiastics were in all probability partially among the Creeks, especially those of Father Juan Rogel.[2] We know that vocabularies and grammars were prepared by these devoted men, all remnants of which, so far as they relate to the Muskokee tongue, are lost.

I must not overlook one extremely valuable linguistic memorial brought to light by Mr. Buckingham Smith. It is a letter written in the Apalache dialect of Florida in the year 1688, and republished by Mr. Smith in facsimile. The word Apalache, in Choctaw Apvlvchi (v=ă short), means to help, helping, or helpers, and Apalachic′ ola, apvlvchokla, is allies, literally, helping people. An examination of the letter shows that it is in a dialect closely akin to the modern Hitchitee, which is one of the branches of the Muskokee.

The Muskokee has several dialects, the most important of which are the Main Creek, or Muskokee proper, and the Hitchitee. These two differ so much that a native accustomed only to the one cannot understand the other. The words are largely the same, and when they differ, usually correspond in the number of their syllables. It is in accent, terminations, permutation of consonants, and change in quantity of the vowels, that most of the variations seem to consist. Between these two, the Alibama and Coösady dialects intervene, both partaking more closely of Hitchitee than of Main Creek. The Seminole language of Florida is not distinct from the Main Creek, as has so often been stated; not more, Mr. Perryman informs me, than the English of New England differs from that spoken in the southern states. There are, however, Seminoles who speak Hitchitee, and others Mikasuke, a dialect akin to Hitchitee.[3]

The latter, in what it differs from Main Creek, approaches the Chikasaw, which is a dialect of Choctaw?[4] The difference between Hitchitee and Choctaw is not greater than between Hitchitee and Muskokee. This whole group of tongues, which has been denominated the CHAHTA-MUSKOKEE group, does not show greater diversity among its members, than the Romanic group of Aryan tongues. This affinity is often of advantage in studying their grammatical structure, as I shall have occasion to point out, relying for the Choctaw on the unpublished "*Grammar of the Choctaw Language*," of the late Rev. Cyrus Byington, which extremely valuable work has been in my hands.

The Muskokee was probably reduced to writing the first of any of the

[2] "The people among whom Roger [Rogel] and Villareal now [1566] began their mission, were evidently a branch of the Creeks."—Shea, *Hist. of the Cath. Missions among the Ind. Tribes of the U. S.*, p. 57. The later labors of Father Rogel, on the "Rio Dulce," were not among the Cherokees, as Shea supposes, (p. 59,) but still with the Creeks, as appears evident on examining Rogel's original letters, contained in the rare work of Alcazar, *Chrono-historia de la Comp. de Jesvs en la Provincia de Toledo.* I published a translation of these letters in *The Historical Magazine*, Nov., 1861, p. 327.

[3] For specimens of Mikasuke and Hitchitee, see *The Historical Magazine*, Aug. 1866, p. 239. The latter is also called Chelokee. The geographical names Okee-chobee, Okee finokee, etc., are Hitchitee, and not Main Creek.

[4] The Choctaws and Chikasaws can readily understand each other.

aboriginal tongues north of Mexico. In 1562, René Laudonnière, coasting among the sea-islands between the mouths of the Savannah and St. John rivers, collected a vocabulary, which unfortunately he did not think of sufficient interest to insert in his narrative.[5] Father Rogel applied himself with success both to the words and structure of the tongue,[6] but his manuscripts are not known to be in existence. Consequently, the earliest specimens of Muskokee proper, except the few words given by Fontanedo, date after the settlement of the colony of Georgia by the English. The Moravian missionaries who settled at Ebenezer, near Savannah, attempted to study the language in order to use it in converting the natives. Their success was poor, though they collected a number of words. In writing them they used the Greek alphabet, as better adapted to express the native sounds. Hence we find in their reports such strangely familiar-looking words, as *τυτκα* fire, properly tvtke, *ἁσσε* sun properly hasse, *σιλλ-απάιχα* shoe, etc.[7] The use of the accents in their vocabularies is one advantage over the modern alphabet. I believe, however, no translation was ever published in this character, and the missionaries soon became discouraged in their proselytizing efforts.

The first printed books in Muskokee, which I have been able to find, were published in 1835. One of them is a translation of the Gospel of John, by the Rev. John Davis; the other a duodecimo tract of 35 pages, entitled:

A short sermon: also hymns, in the Muskokee or Creek language, by Rev. John Fleming, missionary of the American Board of Commissioners for Foreign Missions (Boston, 1835).

Since that date a number of religious and educational works have appeared, the titles of some of which in my possession I add:

Nakcokv Setempohetv. Introduction to the shorter Catechism, translated into the Creek language by Rev. R. M. Loughridge, A. M., and Rev. David Winslett. Second edition, revised and improved. Presbyterian Board of Publication, Phila., 1858, 12 mo., pp. 34.

Nakcokv es Kerretv Enhvteceskv. Muskokee or Creek First Reader, by W. A. Robertson, A. M., and David Winslett. Second edition. New York, 1867, 12 mo., p. 48.

Nakcokv esyvhiketv. Muskokee Hymns, collected and revised by Rev. R. M. Loughridge, A. M., and Rev. David Winslett, interpreter. Fourth edition, revised and enlarged by Rev. W. S. Robertson, New York, 1868, 12 mo., pp., 221.

Cesus oh uyares. I will go to Jesus. Translated into Creek by Thos. Perryman and Mrs. A. E. W. Robertson, Tullahassee Mission, American Tract Society, no date: 12 mo., pp., 23.

A Grammar of the Maskókee or Creek Language, to which are prefixed lessons in spelling, reading, and defining. By H. F. Buckner, a mission-

[5] He says: "mettant par escrit les termes et locutions indiénnes, jé pouvois entendre la plus grande part de leur discours." *Hist. Notable de la Floride*, p. 29.

[6] He says: "In six months I was able to speak and preach in it." *Letter of 9th Dec.*, 1570. These early students, to take them at their word, must have had more linguistic talent than our generation is favored with.

[7] Urisperger, *Nachrichen. Anno* 1734.

ary under the patronage of the Domestic and Indian mission board of the Southern Baptist Convention. Assisted by his interpreter, G. Herrod, superintendent of public instruction, mecco Creek nation, etc. Published by the Domestic and Indian mission board of the Southern Baptist Convention, Marion, Alabama, 1860, 8 vo. pp. 139.

Messrs. Buckner and Herrod also published a translation of the Gospel of John, and Mrs. Robertson, a translation of a tract on the Sabbath. The Laws of the Nation and various other works have likewise appeared. The Nation, I may here state, numbers about 14,000 souls, and about one-half of the male population can read, so it is of considerable importance that the structure of the language be ascertained.

II. The Alphabet.

The need of a uniform alphabet for American tongues is nowhere more vividly shown than in Muskokee. More than one-half of the limited literature I have above mentioned is unintelligible to educated natives on account of the discordant alphabets used. Not less than *five* different ones have been devised. That now generally adopted and certainly best adapted for practical utility to the Nation, is based upon the English sounds of the letters. It was agreed to by many interpreters and chiefs at the Old Agency, in 1853, and has been introduced in all printed works since, except those of Messrs. Buckner and Herrod. It contains thirteen consonants, and six vowels. The vowel sound of a in *fate*, the sound th, and the consonants b, c, d, g, j, r, q, v, x, and z, are wanting, although in the Hitchitee dialects the b occurs. The remaining consonants are given their English values, and the letters r and c are introduced to represent sounds not in our tongue. The r is an aspirated l, slightly guttural, quite similar to the Welsh ll. The c is pronounced tch, soft, as in *wretch*. The w is always surd, as in *we*, *weak*. The vowels are :

a the Italian or Spanish a.
e as in *me*.
i as in *pine*.
o as in *note*.
u as in *wood*, or *rule*.

v represents the neutral vowel, and is really ă short. No accents are used, although both accents and signs of quantity should be employed to express the language correctly. No nasals are provided for, although very soft nasals do occur, and are represented in Mr. Fleming's alphabet by diacritical marks, and in that of Mr. Buckner by the Spanish ñ following the vowel.

The absence of sonant letters and of decided nasals is the chief difference between this and the Choctaw alphabet, and explains much of the apparent diversity between the two tongues. Thus the Choctaw sinti, snake, becomes in Muskokee ceto, the sonant being changed to its surd, and the nasal dropped ; Ch. shakba, arm, shortens the first vowel to v, and permutes the labial, becoming Mus. svkpa; and again Ch. iubi becomes Mus. hufi, thigh.

Mr. Fleming gives two sounds to a, one as in father, the other as in wash; e as a in paper; i as ee in meet; ai as i in pine; and represents the r by hl, Of course this materially alters his orthography.

Mr. Buckner makes use of the Agency alphabet, with these changes: ch for c; i as in pin; ii as i in pine; u as in rule; o as in not; the Greek ώ for o as in go; θ as oo in took, foot. These changes, he claims, are neccessary to represent the language accurately, but both the natives and the missionaries have told me this is a mistake. There is really no such sound in Muskokee as o in not, and Buckner's error arose from the shortening effect of k after the sound of a, as in rakko, great. Furthermore, the distinction he draws between θ and u is imaginary, as he himself half confesses in a note to p. 22 of his Grammar. As his work is the only attempt ever made to display the grammatical structure of the language, it will be a service to philology to point out several serious errors into which he has been betrayed. I am enabled to do this from information furnished me by Mrs. A. E. W. Robertson, of the Tallahasse mission, who is excellent authority on the language, and from the unpublished manuscripts of the late Rev. Cyrus Byington, from which I have drawn that which relates to the Choctaw.

III. Remarks on Buckner's "Maskώkee Grammar."

Nouns. The author (p. 52) remarks that common nouns are not varied on account of number; and that names of people are pluralized by the suffix vlki. The rule should be that most nouns denoting an agent form their plural by adding lke, as pasv a sweeper, plural pasvlke; some others indicate the plural by adding take, which also forms the plural of pronouns, and in writing it is important to distinguish which word is pluralized, as the position of the suffix is in both cases the same; thus, ce wvnv take, your (pl.) sister, but ce wvnvtake, your sisters.

The declension of the noun is given by Buckner under three headings, the first form, the nominative case, and the objective case. The first form always ends in a vowel, the nom. case in t, the objective in n. The possessive case, he says, is formed by prefixing the possessive pronoun to the thing possessed. Mrs. Robertson divides the cases into nominative, possessive, objective, relative, and vocative. The nominative ends in t, but with "continual exceptions," not for euphonic but for grammatical reasons still obscure. The possessive case is the simple form of the noun, but requires the possessive pronoun after it, as it did in old English, *e. g.* "John his hat." The declensions given are as follows:

	Buckner.	Mrs. Robertson.
1st form	Cane John	
Nom.	Canet	Canet
Object,	Canen	Canen
Possessive		Cane
Relative		Canen
Vocative		Cane.

Cane em eslafkv, John his knife.

I think that any attempt to give paradigms of Muskokee nouns in this manner will be incorrect. Those "continual exceptions" will still remain obscure. We are so inveterately accustomed to the declensions of the Aryan tongues, and to case-endings, that we think every language must have them. Such is not the case. None of the Chahta-Muskokee tongues have anything of the kind. They express the relations of words in a sentence by a complicated but strictly regular system of particles or elementary sounds, each sound, when combined, retaining its original significance, which are called "post-positive particles" or "article-pronouns." These are divided into two classes, the definite and the distinctive, and are subject to numerous changes. They can be used with all parts of speech, and supply the place of case-endings, and modal terminations. The Muskokee terminal series t, it, et, vt, corresponds to the Choctaw at, vt, et; the objective and relative forms are the Choctaw nasals *a* and *o*; and the possessive form is the same in both tongues; *e. g.* Choc. Chan in chuka, John his house. There is still wanting an analysis of the Muskokee article-pronoun, and no grammar of the language can be drawn up correctly till this is done.

Adjectives. On the comparison of adjectives Mr. Buckner says (p. 68): "The comparative degree is formed by prefixing sin to the positive, and the superlative is formed by prefixing ri to the comparative, as cvmpe, sweet; sincvmpe, sweeter; risincvmpe, sweetest." In fact, both these latter are in the comparative degree; sin is the particle es, governing a pronoun in the relative, and the expression should read es en cvmpe, sweeter than it; the r or er prefixed to the es, simply expresses a stronger comparison, as er es en cvmpe, still better than it. The superlative is formed not by a prefix, but by the suffix mahat, in the nominative, and mahan in the oblique cases, as cvmpe mahat, sweetest.

Mr. Buckner's rule for the plural of adjectives is: "Adjectives of two syllables form their plural by inserting the contracted form of the first syllable between the two syllables of the singular," as tvphe, wide, pl. tvptvhe. This rule is very incomplete. There are in Musokee two classes of adjectives, the first closing the root with a single consonant, the second with a double consonant, or with two consonants. The first form their plural by adding vke to the root, as here, good, pl. hervke, cate, red, pl. catvke, lane, pl. lanvke. The second class form their plural by inserting the first two letters of the root between the two closing consonants, as hvlwe, pl. holhvwe, lvwke, pl. lvwlvke, svfke, pl. svfsvke, lowvcke, pl. lowvcloke. Many of this class transpose the consonants, apparently for the sake of euphony; as kocukne, pl. kocuncoke, cvfekne, pl. cvfencvke. Some of them also form their plural as those of the first-class; as yekce, pl. yekcvke, afvcke, pl. afvckvke. Some in both classes insert ho before the terminal consonant; as hiye, pl. hihoye, holwvke, pl. holwvhoke; cvpvkke, pl. cvpvkhoke. Lekwe, rotten, has two plurals, one, lekhowe, applied to animal matter, the other, leklewe, to vegetable matter.

There is also a dual of adjectives, which Buckner does not mention. It is not frequently used; cvfekne, pl. cvfencvke, dual cvfencvkvke; yekce, strong, pl. yekcvke, dual, yekcvkvke. These occur only in the second person.

Throughout Mr. Buckner's work his division of words is faulty, and adds much to the difficulty of the language. He is much too positive in his views, and his translations are frequently far from literal. His Grammar cannot be relied upon as a safe guide in any sense, and while he is deserving of much credit for his industry in collecting material, the arrangement of and the deductions from that material must be condemned.

IV. The Muskokee Verb.

The congugation of a verb in an American language is a prodigious task. In analysing the Muskokee verb I shall avoid as many complications as possible, and speak only of active verbs, in their first transitions (when the object is presumed to be always in the third person and the singular number), in their first form, and affirmative signification.

Roots. Muskokee verbs have two roots. The first is formed by dropping the termination etv of the infinitive mood, as nvfketv, to strike, root nvfk, kicetv, to tell, root kic. The second root is formed by inserting h before the final consonant of the first root, if there is but one consonant; and by inserting i between the two final consonants if they are two; and if they are the same, the latter is changed into y; *e. g.*

kicetv	1st root kic	2nd root kihc
letketv	letk	letik
vkhottetv	vkhott	vkhotiy
merretv	merr	meriy

Moods. The ordinary form of the Infinitive ends in etv. The sign of the subjunctive is the particle omat, added after the tense sign. It corresponds to, and is probably derived from, the Choctaw subjunctive particle kmvt. The Imperative has a future as well as a present form, corresponding in this with most other American languages, and not a rare exception as Buckner thinks.

Tenses. The imperfect tense has not less than five forms. The first refers to something which has transpired to-day, the second to what transpired yesterday, the third to an occurrence usually only a few weeks ago, or, as we would say, "lately," the fourth to an action or event long since completed, but within the memory of the speaker, while the fifth imperfect, called the indefinite or historic tense, refers to transactions of which the subject of the verb has no personal knowledge, nor is directly connected with.

The future tenses are the simple, the compound, and the progressive futures. The progressive futures are formed by adding to the first and second roots the termination vran, and subjoining the tense signs of either past, present, or future tenses. They express the idea of being about to, or having been about to, perform an action, and when formed from the fifth imperfect, convey the sense of obligation or necessity. It will thus be seen that both in formation and signification they present a striking analogy to the first and second periphrastic conjugations—those from the participles in rus and dus—in Latin.

All the above tenses are formed from the first root of the verb. The perfect tense, is formed as in Latin, from the second root, by adding to it the terminations of the present.

The tense-signs are as follows :

Present, es, the e dropped in the first person singular, and lengthened in the first person plural.

Imperfect,	first,	is
	second,	vnks
	third,	emvtes, emvtvs, or emvts, the e dropped in the first person singular.
	fourth,	vntvs
	fifth,	vtes
Future,	simple,	vres, the v dropped in first sing.
	compound,	tares, used after the fifth imperfect with its final s dropped, *e. g.* nvfkvyvte tares.
	progressive,	vran added to the root.

Perfect, is, to second root, the i shortened to v when it comes before y.

Persons. The persons are indicated by inseparable personal pronouns between the root and the tense sign. They vary in the different tenses according to the following table:

	Sing. 1st pers.	2nd,	Pl. 1st	2nd	3d
Present, and third imp.,	i	etsk	e	atsk	ak
First, second, fourth, and fifth imp.	vy	etsk	ey	atsk	ak
Simple future,	a	etsk	ey	atsk	vk

The third singular is wanting.

There is a dual form of the verb when two persons or things are *spoken of*,—an objective dual, in a sense. It is formed by prefixing torkor (probably a corruption of the Choctaw tuklo, two) and making changes in the first syllable of the root, according to rules with which I am not acquainted. The pronouns remain in the singular form, as letkis I run, torkorkis we two run.

Negative form. The negative form of the verb is made by inserting the negative particle ak (Choctaw, ik), after the root, which latter may undergo euphonic changes, *e. g.* kicis, I say, kicakis, I do not say.

It was my intention to give a complete paradigm of the active, affirmative, simple verb, in the first transition, but as I am not able to exhibit this satisfactorily at present, I shall omit it. I shall therefore conclude this article by a partial analysis of a specimen sentence in the language, and a comparison of it with the same in Choctaw, thus showing the affinities of these tongues.

V. Specimen Sentence.

Acts. ch. XIV, verse 11:

And when the people saw what Paul had done, they lifted up their voices, saying in the speech of Lycaonia: The gods are come down to us in the likeness of men.

In Muskokee:

Momen estet, nake Pal momecaten hecakof em opunvkv-en-haken kvwvpa kvtes, Likeonv em punvkv ofvn, Hesake tvmese este omvket ye pun hvtvpeces, mahaket.

Translation.

Momen, and, the conjunctive particle with the terminal n, which throws the clause into the oblique case or sense.

estet, the people, compounded of este and the definite article-pronoun nominative t, literally, people the.

nake, the thing, or things.

Pal momecaten, that Paul had done.

hecakof, when they saw.

em, their.

opunvkv, word; en, its; haken, sound.

kvwvpakvtes, they lifted up, fifth imperfect.

Likeonv em punvkv ofvn, Lycaonia its language in.

Hesaketvmese, gods, from hesaketv, life, and emese, source or font, "source of life." This is the word commonly employed by the missionaries for God. Col. Hawkins, in his Sketch of the Creek Country, spells it E-sau-ge-tuh E-mis-see. Mr. Perryman tells me that it is probably a word coined by the English, and not of native origin.

este omvket, men resembling.

ye, hither, pum, to us; hvtvpeces, have descended; makaket, saying.

In Choctaw (the nasals in italics):

Mihma okla hash ot, Pal vt nana yvmihinchi na pisa mvt, Laikeonia anumpa ho okla anumpulit chitoli hosh, Chitokaka vhleha yvt hatak *o* chiyuhmit aka mintit *a*yvt hvpim vlvshke ; ahanchi tok.

Translation.

Mihma, and, with the definite oblique termination.

okla, people, hash ot, pronoun of renewed mention definite, the aforesaid ones, they.

Pal vt, Paul he; nana, the responsive pronoun definite; the thing which, what.

yvmihinchi, he had done.

na—mvt, when, pisa, they saw.

Laikeonia anumpa h*o*, Lycaonian speech the, h*o* is the distinctive article pronoun in the oblique case.

okla anumpulit hosh, the people, the aforesaid ones (hosh) spoke; chitoli, loudly.

Chitokaka, gods, vhlehay vt, they indeed, article pronoun definite.

hatak *o* to men, distinctive and oblique, chiyuhmit, resembling.

aka, below, mintit, coming toward, *a*yvt, here, "coming toward this place below."

hupim, to us; vlvshke, have come, from ula, to come.

ahanchi tok, they said. The particle tok throws the verbs into the remote imperfect tense.

The strong similarity in the construction of the two languages is very evident from these specimens.

Stated Meeting, March 18, 1870.

Present, eleven members.

MR. FRALEY, Vice-President, in the Chair.

A letter accepting membership was received from Mrs. Mary Somerville, dated Naples, Feb. 14, 1870.

Letters of envoy were received from the Royal Academies at Munich, (Dec. 1,) and Vienna, (Aug. 20,) from the R. Society of Zoology at Amsterdam, (Dec. 9,) and the Society at Giessen, Sept. 2, 1869.

Letters of acknowledgment were received from the Societies at Giessen, (77–80), Gottingen, (78–80), Bremen, (73–80), Prof. Bunsen, (78, 79), Historical Acad. at Madrid, (XIII. 1, List, Cat. I, 71, 72, 77), R. Academy at Amsterdam (78–80), R. Library, Hague, (78–80), Observatory at Prague (78–80).

A circular letter respecting the celebration of its 25th anniversary festival, on the 27th of March (April 8th), was received from the Society at Riga.

A letter was read from Captain C. F. Hall, dated Washington, D. C., March 12, 1870, enclosing a petition to Congress, in favor of his proposed Third Arctic Exploring Expedition. The petition was laid upon the table for the signature of the members and others.

Donations for the library were received from the Societies at Moscow, Emden, Frankfurt, Lille, Bordeaux, Montreal and Madison; from the Berlin Academy; Paris Geographical Society; Royal Institution of G. Britain, London; Chemical and Antiquarian Societies; Greenwich Observatory; Dublin Geological Society; Dr. Haughton; the American Antiquarian Society; New York Lyceum; Dr. Geo. B. Wood; and the Peabody Institute.

A Circular from the Smithsonian Institute announced another transmission of correspondence for the 20th April; all envoys to be in Washington by the 15th.

Prof. Cope communicated the results of his examinations of the locality, two miles S. W. from Woodbury, where from 30 to 60 skeletons, some of them women and others children, were lately exhumed, and the greater part broken up, and spread upon compost heaps. Dr. Leidy has recovered one pretty complete skull, which he exhibited before the Academy of Natural Sciences, at its last meeting, and expressed a decided opinion in favor of its European origin. Professor Cope's opinion was equally confident, that the remains were those of no aboriginal Indian race. Professor Trego suggested that they belonged to that early Finnish or Swedish Colony, which attempted a settlement on the banks of the Delaware, a short while previous to the arrival of the Hollanders and Quakers, under William Penn. The bodies were all taken from a shallow trench, not more than 8 feet wide by 16 long; they had been laid in two tiers or stages, one above the other, and there was no relic, ornament, tool, weapon, or fragment of clothing, to suggest relationship to any age or race; and no appearance of a tumulus.

Prof. Cope exhibited three large photographic pictures of figures of the human foot incised in upper cretaceous red sandstone, near Topeka, thought by western men to be fossil impressions. The shadows in the photographic copies showed plainly the nature of the marks, for the ball of the great toe was an elevation, instead of a depression, and the cutting was carried round the ends of the intervals between the toes. A discussion of the use of the foot in aboriginal picture writing followed.

Dr. Carson recalled the exhibition of a sculptured rock, showing rivers and game, a sort of guide map, taken from the Susquehanna River banks, by Prof. Walter R. Johnson, at the Academy of Nat. Sciences or Historical Society, about 1836 or 1837, and expressed his desire that it should be re covered for use, in comparison with later discoveries.

Dr. Brinton being questioned as to the amount of credence to be given to Baron De Waldeck's alleged Elephant or Mastodon figures, supposed to be recognisable among the hieroglyphics of Mexico, replied that he had had the opportunity of examining M. Charancy's photographs, and agreed with the latter, that no such figures could be made out from the original designs, but that the figures in question were symbolically compounded of man and serpent, and appear as such in MSS. recently published by the French government.

Mr. Lesley instanced the mammoth, etched on a plate of ivory, found in a cave in France, to clear away any serious improbability from the way of supposing a like physical reminiscence of the Mastodon in this country. He referred, also, to the fact, that the Ancient Egyptian B was graphically represented by the human leg, A by the arm, T by the hand, and that what is called the comb, may have been meant for the footmark. In the earliest stage of human life the foot and the foot-print were of superior importance to the hand and its work. But in the second stage of aboriginal life, the hand took precedency of the foot, as symbol of force and skill, combining thought with feeling, the reasoning power with the instinct. It soon entered into the synod of symbolic gods, with its fingers, and obtained a special worship for its hand-print.

Dr. Coates related the origin of the Arabic cyphers on the hypothesis, that they were constructed by posturing with the hands and fingers, singly and in combination.

Pending nominations 649—656 were read.

The following communication was read:

Office of the Commissioners of Fairmount Park, No. 224 S. Fifth Street, Philadelphia, March 12th, 1870.

At a meeting of the Commissioners of the Park, held this day, the following preamble and resolutions were adopted:

WHEREAS, The American Philosophical Society has made a communication to this Commission, proposing that the name of André François Michaux, who travelled long in this country, and described our Oaks and forest trees, in a work of great merit and splendor, should have his name, and that of his father (who had, by like travel and study, rendered service to science), honored in the Fairmount Park, in a manner to be a memorial to their devotions, and to promote the objects which had occupied their lives, and has proposed, after the death of the widow of André François Michaux, to devote the interest or income of six thousand dollars bequeathed by him to said Society, to be expended in execution of the trust of his will in the said Park, for the purpose following. Therefore,

Resolved, That there shall be a grove of Oaks in the Fairmount Park forever to bear the name of "The Michaux Grove," in which, if practicable, shall grow two oaks of every kind that will endure the climate.

Resolved, That any surplus of revenue received by the Commission from the Michaux Fund, after satisfying the requirements of the preceding resolution, shall be devoted to the cultivation of Oaks of every variety capable of cultivation in our climate, in the Park nursery, which Oaks, to the extent of two of each kind cultivated, be hereafter distributed to other Public Parks in the United States, under proper regulations to be hereafter prescribed.

Attest, David F. Foley, Sec. Park Commission.

On motion of Mr. Price, it was then

Resolved, That this Society do agree to the terms contained in the preamble and resolutions of the Faiımount Park Commissioners, adopted on the 12th day of March, 1870, in the expectation and confidence that the planting of the Michaux Grove of Oaks may be soon commenced, so that the Grove shall early become one of the attractions of the Park.

And the Society was adjourned.

COMPARISON OF MECHANICAL EQUIVALENTS.

By Pliny Earle Chase.

Read January 7, 1870.

The comparison of different mechanical equivalents will open a new field for investigation, which may prove to be fertile in valuable results. For example, recent determinations, by the different methods of Thomsen and Farmer, fix the mechanical equivalent of light, in a wax candle burning 126½ grains per hour, at 13.1 foot-pounds per minute, the equivalent of 1 grain being 6.213 foot-pounds. According to Dulong, the heat evolved, during the combustion of 1 grain of olive oil in oxygen, is sufficient to heat 9862 grains of water 1° C. According to Favre and Silbermann, 1 grain of oil of turpentine, burned in oxygen, would heat 10,852 grains of water 1° C.

It may therefore be presumed that the total heat given out by the combustion of 1 grain of wax, is about sufficient to raise 10,000 grains of water 1° C., or 18,000 gr. 1° F. This represents a mechanical equivalence of $(18{,}000 \times 772 \div 7000 =)$ 1985.143 foot-pounds, which is 319.5 times as great as the corresponding equivalent of the light given out during the combustion.

Tyndall, in his lecture on Radiation, states that the visible rays of the electric light contain about one-tenth of the total radiated heat. The relative luminous intensity of an electric lamp would therefore appear to be about 32 times as great as that of the wax candle. This ratio so nearly resembles that of solar to terrestrial superficial attraction, and the connection of electric and magnetic currents with solar radiation is so evident, that additional experiments, to furnish materials for a great variety of similar comparisons, seem desirable. While it is possible that the resemblance, in the present instance, may be accidental, the numerous harmonies between the manifestations of cosmical and moecular forces, render it at least equally possible that it may have a weighty significance.

MONTHLY VARIATIONS OF RAINFALL AT PHILADELPHIA.

By Pliny Earle Chase.

Read Feb. 4, 1870.

The following Tables may be of service in the study of secular rainfall. The Normals, in Table II. were computed from the observations of seven successive years, in the same manner as those in my previous discussions.

I. Monthly Rainfall at Philadelphia, for Forty-five Years.

	Jan.	*Feb.*	*Mar.*	*Apl.*	*May.*	*June.*	*Jul.*	*Aug.*	*Sep.*	*Oct.*	*Nov.*	*Dec.*
1825	.84	3.26	4.63	.83	1.72	3.59	2.06	3.70	2.61	1.25	1.36	3.72
1826	1.11	2.13	5.80	3.87	.19	4.65	3.68	2.75	2.00	5.83	1.85	1.28
1827	2.86	3.55	1.23	2.83	2.50	2.09	2.97	5.75	.79	5.91	4.76	3.26
1828	2.05	2.75	3.35	3.82	3.49	2.69	5.33	1.51	4.62	1 39	6.71	.26
1829	5.37	3.75	2.87	4.99	2.68	3.44	4.35	4.61	2.01	2.30	3.97	1.51
1830	1.63	2.06	4.11	1.82	3.75	5.99	4.07	3.87	2.93	4.31	5.35	5 18
1831	6.02	2.44	3.17	5.20	1.07	3.56	4.17	5.39	5.33	4.51	1.88	1.20
1832	4.58	2.66	1.90	2.98	5.40	1.55	2.62	5.69	1.40	3.41	2.59	5.09
1833	3.97	1.24	2.22	.70	5.88	5.28	4.15	3.39	3.82	10.05	2.18	5.67
1834	2.49	2.22	2.02	2.83	3.52	3.99	4.35	.62	3.57	3.29	3.01	2.33
1835	2.75	1.81	3.83	4.33	1.99	6.27	6.55	2.05	2.63	1.22	3.19	2.68
1836	7.62	2.99	1.75	3.47	2.28	7.31	2.91	1.97	1.82	3.59	3.34	3.61
1837	2.50	3.58	3.76	2.83	4.85	2.83	5.89	4.06	2 28	.66	3.23	2.53
1838	2.20	2.19	3.17	3.59	3.58	6 60	2.38	2.78	9.52	4.90	3.35	1.04
1839	5.04	3.42	1.50	1.51	6.07	3.92	2.52	4.64	2.92	2.83	3.10	6.26
1840	1.84	3.01	2.63	6.83	2.69	5.95	4.54	5.55	2.50	5.73	2.49	3.65
1841	7.84	1.39	5.82	6.46	3.27	3.11	3.28	9.10	1.90	3.20	4.22	5.92
1842	1.36	4.26	2.84	5.31	5.86	3.19	11.80	3.79	1.27	1.71	3.49	3.66
1843	1.44	2.54	4.41	4.72	2.04	1.69	4.54	9.25	4.86	3.22	4.15	4.04
1844	4.05	1.45	4.43	1.35	3.09	3.35	5.28	2.40	4.03	5.02	2.95	2.75
1845	3.76	4.74	2.42	2.58	1.60	3.72	2.76	7.30	2.16	2.53	2.50	3.96
1846	4.63	3.33	4.60	2.11	3.44	3.30	4.60	4.27	.25	2.44	7.97	3.44
1847	4.73	4.57	4.70	.59	1.57	3.30	2 76	3.18	8.07	3.00	2.84	5.78
1848	2.03	1.44	2.76	1.54	4.90	4.43	3.28	1.71	1.81	3.74	2.34	5.01
1849	.73	2.61	5 47	1.75	3.99	2.20	2.93	6.97	1.40	5.59	2.60	5.84
1850	4.77	2.87	4.75	2.66	6.50	2.03	5.97	8.33	7.73	1.09	3.32	4.51
1851	1.23	3.11	3.47	4.56	4.82	3.44	2.52	2.56	1.13	3.02	3.36	2.27
1852	2.01	2.71	4.27	6.44	3.03	4.03	4.06	4.40	1.29	2.27	6.05	5.17
1853	1.85	4.44	2.46	3.83	5.17	1.10	6.30	3.09	4.46	3.47	2.32	2.17
1854	2.33	4.20	1.62	7.75	6.93	2.39	3.02	.84	3.80	1.55	2.83	2.91
1855	2.34	2.35	1.68	2.05	2.96	7.95	6.40	2.79	4.00	4.11	2.04	5.42
1856	4.54	1.24	2.23	3.51	2.60	1.99	1.51	6.00	4.01	1.30	2.07	2.94
1857	3.53	.79	1.83	6.79	5.55	7.50	3.91	7.59	1.11	2.69	1.45	5.55
1858	2.59	2.29	1.09	4.64	5.01	4.50	1.35	4.94	1.49	1.84	5.61	4.50
1859	6.67	3.66	6.98	5.61	2.25	6.01	4.07	4.74	7.68	3.13	3.82	3.49
1860	3.22	2.75	1.42	3.80	3.82	2.88	.99	8.40	2.85	4.52	6.13	3.31
1861	5.24	2.07	3.92	3.71	6.64	3.88	2.56	3.14	4.40	3.80	4.87	2.09
1862	4.79	4.64	3.55	4.16	2.31	6.97	2.46	.93	3.98	4.77	4.79	1.65
1863	4.72	4.68	5.88	7.01	4.51	4.25	6.01	1.45	.88	2.46	2.70	4.63
1864	1.70	.55	5.17	3.80	8.68	2.35	3.77	1.92	7.16	1.82	3.93	5.14
1835	3.61	5.82	4.71	2.83	7.21	4.75	2.97	3.77	7.96	3.05	3.96	5.61
1866	3.15	6.61	2.15	2.93	4.68	2.96	2.52	2.18	8.70	4.14	1.76	3.47
1867	1.70	3.89	5.46	1.81	7.32	11.02	2.39	15.82	1.72	4.32	2.94	2.73
1868	3.62	2.52	3.36	5.44	7.00	4.37	3.51	2.67	8.91	1.74	5.28	3.60
1839	4.28	4.66	5.30	2.12	4.24	5.58	2.89	1.28	3.25	6.32	3.73	5.91

II. Monthly Normals of Rainfall at Philadelphia, for 40 Years.

	Jan.	*Feb.*	*Mar.*	*Apl.*	*May.*	*June.*	*Jul.*	*Aug.*	*Sep.*	*Oct.*	*Nov.*	*Dec.*
1828	2.94	3.06	3.06	3.66	2.73	3.25	4.21	3.66	2.69	3.41	4.86	1.88
1829	3.47	2.95	3.18	3.74	2.96	3.74	4.34	3 87	3.03	3.18	4.75	2.26
1830	3.91	2.69	3.24	3.65	3.01	4.01	4.12	4.36	3.28	3.64	4.03	2.91
1831	4.28	2.41	2.95	3.39	3.39	3.79	3.81	4.71	3.36	4.44	3.20	3.50
1832	4.28	2.17	2.53	2.90	4.07	3.64	3.71	4.36	3.26	5·22	2.67	3.97
1833	3.86	2.00	2.36	2.56	4.31	4.07	4.04	3.33	3.17	5.35	2.61	4.01
1834	3.62	2.03	2.50	2.81	3.76	4.89	4.55	2.33	3.05	4.39	2.84	3.56
1835	3.94	2.34	2.72	3.28	3.13	5.50	4.78	2.07	2.83	3.12	3.09	3.09
1836	4.19	2.70	2.87	3.41	3.18	5.56	4.56	2.48	3.05	2.52	3.23	2.86
1837	3.87	2.92	2.89	3.24	3.75	5.26	4.07	3.10	3.98	2.72	3.26	2 83
1838	3.51	2.94	2.78	3.28	4.23	5.04	3.57	3.79	4.66	3.30	3.20	3.20
1839	3.64	2.86	2.80	3.93	4.25	4.89	3.50	4.74	4.16	3.83	3.15	3.95
1840	3.99	2.77	3.22	4.96	4.01	4.49	4.26	5.79	3.02	3.90	3.25	4.53
1841	3.91	2.75	3 77	5.52	3.89	3.80	5.64	6.42	2.41	3.47	3.50	4.58
1842	3.28	2.80	4.01	5.10	3.74	3.11	6.53	6.41	2.66	3.12	3.66	4.23
1843	2.91	2.81	3.98	4.01	3.29	2.84	6.14	6.02	3.16	3.23	3.61	3.80
1844	3.23	2.95	3.85	2.93	2.78	3.01	5.00	5.57	3.19	3.39	3.67	3.58
1845	3.84	3.36	3.80	2.22	2.54	3.30	4.10	5.09	2.93	3.18	4.08	3.75
1846	4.05	3.58	3.92	1.78	2.67	3.46	3.65	4.43	3.11	2.96	4.34	4.25
1847	3.61	3.30	4.07	1.51	3.11	3.47	3.42	3.91	3.50	3.26	3.89	4.83
1848	2.88	2.81	4.21	1.59	3.71	3.29	3.44	4.26	3.58	3.61	3.16	5.13
1849	2.49	2.61	4.37	2.15	4.30	2.96	3.72	5.22	3.57	3.52	2.94	4.94
1850	2.42	2.74	4.34	3.12	4.78	2.84	3.97	5.51	3.51	3.02	3.30	4.37
1851	2.28	2.99	4.00	4.22	4-77	2.93	4.09	4.77	3.12	2.66	3.78	3.84
1852	2.06	3.33	3.42	5.00	4.65	2.92	4.31	3.71	2.89	2.62	3.87	3.52
1853	2.08	3.58	2.74	5.21	4.82	2.99	4.58	2.92	3.25	2.67	3.39	3.41
1854	2.41	3.31	2.16	4.90	4.76	3.61	4.54	2.78	3.70	2.67	2.74	3.57
1855	2.92	2.53	1.92	4.45	4.29	4.45	4.09	3.64	3.64	2.58	2.31	3.94
1856	3.41	1.81	1.94	4.49	4.04	5.00	3.45	4.99	3.12	2.42	2.34	4.27
1857	3.72	1.70	2.22	4.94	4.17	5.26	2.93	5.80	2.84	2.36	2.94	4.41
1858	4.05	2.17	2.84	5.13	4.14	5.22	2.66	5.88	3.30	2.63	3.86	4.23
1859	4.41	2.66	3.40	4.83	3.99	4.82	2.47	5.71	4.06	3.19	4.64	3.72
1860	4.62	2.92	3.55	4.41	4.11	4.48	2.36	5.16	4.27	3.74	4.99	3.08
1861	4.66	3.19	3.68	4.35	4.35	4.59	2.61	3.86	3.92	3.94	4.84	2.74
1862	4 45	3.47	4.20	4.66	4.65	4.74	3.31	2.46	3.67	3.64	4.34	3.04
1863	3.92	3.53	4.75	4.94	5.41	4.41	3.89	1.93	4.22	3.08	3.84	3.89
1864	3.33	3.74	4.78	4.57	6.33	4.01	3.81	2.41	5.59	2.81	3.53	4.57
1865	3.00	4.36	4.34	3.61	6.64	4.33	3.26	3.81	6.64	3.09	3.26	4.55
1866	2.87	4.74	4.02	3.02	6.48	5.39	2.84	5.73	6.55	3.50	3.12	4.02
1867	2.93	4.42	4.08	3.11	6.33	6.24	2.80	6.61	5.87	3.70	3.41	3.73

Table I. indicates the following probabilities:

1. Of a *change* of weather (from a preceding wet month, or season, to a dry one, or *vice versa*).

In September, $\frac{3}{5}$ In Autumn, $\frac{8}{15}$
" November, $\frac{5}{9}$
" January, $\frac{6}{11}$
" April, $\frac{8}{15}$

2. Of a *continuance* of the weather of the preceding month or season.

In January, $\frac{5}{9}$ In Winter, $\frac{9}{14}$
" February, $\frac{6}{11}$ " Summer, $\frac{3}{5}$
" October, $\frac{8}{15}$ " Spring, $\frac{8}{15}$
" December, $\frac{8}{15}$

The indicated probability, nearly $\frac{5}{9}$, that a rainy February will be followed by a dry Summer (June to October, inclusive), and *vice versa*, is very curious.

Stated Meeting, April 1st, 1870.

Present, eleven members.

Prof. Cresson, Vice-President, in the Chair.

Letters accepting membership were received from Carl Fr. Naumann, dated Leipsic, 13th February, 1870; George Ritter Von Frauenfeld, Wien, 5th March, 1870; Prof. Dr. F. V. Hochstetter, Wien, 2d March, 1870; Louis Gruner, Prof. Min. École des Mines, Paris, 6th March, and Edward Everett Hale, dated Boston, March 21, 1870.

Donations for the Library were received from the London Astronomical Society; M. Theodore Wechniaakof, of Paris; the Boston S. N. H.; the Cambridge Museum of Comparative Zoology; Mr. J. H. Trumbull, of Hartford, Dr. S. D. Gross, of Philadelphia, the Franklin Institute, the Episcopal Hospital, and the Editors of Nature.

Prof. Cope exhibited fossil fishes in black shale from Dr. Hayden's collections of 1869; from Railroad cuttings, in the Green River Country, Rocky Mountains, belonging to the salt water family of the Clupeidæ, and the brackish water family of the Cyprinodontidæ, for two of which he proposed the names, *Lithichthys pusillus* and *Cyprinodon levatus.* These make the first appearance in America, of genera known to be fossil in the rocks of Mount Lebanon. (See Proceedings below.)

Dr. Hayden described the large collections which he made in that region, and deposited at Washington. The shales are charged with bituminous matter, and exhibit multitudes of small fish, insects, freshwater-plant stems, nuts, and among other things, a true feather, as determined by Mr. Marsh, of New Haven; probably not a bird's feather, but belonging to some form of Archæopteryx.

A discussion took place respecting the law of storms as set forth in a recent memoir by M. Prestel.

Pending nominations Nos. 649 to 656, and new nominations Nos. 657, 658, were read.

And the Society was adjourned.

GRAMMAR OF THE CHOCTAW LANGUAGE.

PREPARED BY THE REVEREND CYRUS BYINGTON, AND EDITED BY DR. BRINTON.

Read before the American Philosophical Society, Feb. 4, 1870.

INTRODUCTION.

The Choctaw, or properly Chahta nation, numbers at present about 17,000 souls, 4,500 of whom are Chickasaws. When first known to Europeans these allied peoples occupied the territory on the left bank of the Mississippi, almost from the Ohio river to the Gulf. They belong to the great CHAHTA-MUSKOKEE family, which, in early days, controlled the whole country from the Mississippi to the Atlantic, and from the Gulf shore to the Apalachians.

The Choctaws have always been quick to adopt the instruction of their civilized neighbors, and at present have about seventy schools with nearly two thousand pupils on their reservation.[1] During the French occupation of Louisiana, in the early part of the last century, efforts were made by the Roman Catholic missionaries to convert them, but without success.[2] In 1818, Protestant missionaries were sent among them, who effected a permanent impression upon them, and were mainly instrumental in bringing about their present highly creditable condition. Their evil habits were reformed, they were instructed in agriculture, and their language was reduced to writing. In the latter, the alphabet suggested by the Hon. John Pickering, in his essay "On a uniform orthography of the languages of the Indians of North America," was employed. The first book printed was a spelling book, by the American Tract Society, in 1825. Since that time, besides a large number of tracts, almanacs, hymn books, and educational works, the whole of the New Testament and most of the Old Testament have been printed in the language, by the American Bible Society, New York city, after faithful translations by the Rev. Cyrus Byington and the Rev. A. Wright, assisted by educated natives.[3] These can readily be obtained, and will be found of great service in elucidating the grammatical structure of the language, as it is for the first time explained in the present work by the hands of the REV. CYRUS BYINGTON.

This eminent scholar and missionary, whose name is inseparably connected with the later history of the Choctaw nation, was born at Stockbridge, Berkshire county, Massachusetts, March 11, 1793. He

[1] Report of the Commissioner of Indian Affairs, for 1869, p. 37.

[2] Shea, History of Catholic Missions in the United States, p. 441.

[3] In comparing the translation of the Four Gospels, second edition, 1845 (Boston, printed for the A. B. C. F. M.), with the second edition of the New Testament by the American Bible Society (New York, 1854), I find a number of slight differences, especially in the use of the neutral vowel v.

was one of nine children, and his parents were in humble circumstances, but industrious and respected. His father was at one time a tanner, and subsequently a small farmer. Necessarily, therefore, his early education was limited.

When a well grown lad he was taken into the family of Mr. Joseph Woodbridge, of his native town, from whom he received some instruction in Latin and Greek, and with whom he afterward read law. In 1814 he was admitted to the bar, and practiced a few years with success in Stockbridge and Sheffield, Mass.

His father though a moral was not a religious man, and it seems to have been only after he reached manhood that Mr. Byington became, as he expressed it, "a subject of divine grace." He then resolved to forsake the bar and devote himself to missionary life. With this object in view he entered the theological school at Andover, Mass., where he studied Hebrew and theology, and was licensed to preach, September, 1819. At this time he hoped to go to the Armenians in Turkey. But Providence had prepared for him another and an even more laborious field.

For about a year he preached in various churches in Massachusetts, awaiting some opportunity for missionary labor. Toward the close of the summer of 1819, a company of twenty or twenty-five persons left Hampshire county, Mass., under the direction of the American Board of Missions, to go by land to the Choctaw nation, then resident in Mississippi. They passed through Stockbridge, in September, and were provided with a letter from the Board, asking Mr. Byington to take charge of them, and pilot them to their destination. He was ready at a few hours' notice.

The company journeyed by land to Pittsburgh, where they procured flat boats, and floated down the Ohio and Mississippi to a point near the mouth of the Yalobusha river, whence a land journey of two hundred miles brought them to their destination.

Thus commenced Mr. Byington's missionary life among the Choctaws. It continued for nearly fifty years, and resulted, with the blessing of Providence and the assistance of some devoted co-workers in the Nation, especially the Rev. A. Wright and the Rev. Cyrus Kingsbury, in redeeming the nation from drunkenness, ignorance and immorality, to sobriety, godliness, and civilization. There are no lives which in the eyes of the philanthropist are more worthy of admiration, or more deserving of record than those of such men, who not only rescue thousands of individuals from spiritual and physical degradation, but preserve with enlightened care the only memorials of whole nations.

For throughout his missionary life Mr. Byington appreciated the value which a knowledge of the language and traditions of the Choctaws would have to scholars. From his arrival among them, therefore, he devoted assiduous labor to their language with a view to comprehend its extremely difficult construction, and to render it available for the missionary and philological student. The first draft of his Grammar was completed in 1834. It was written and re-written, until at the time of his death, which occurred at Belprè, Ohio, December 31st, 1868, he was at work upon the seventh revisal. This had proceeded as far as the close of Part I. This much, therefore, of the Grammar is almost precisely as the author left it.

Part II. commencing with the Article-Pronouns, I have arranged from the manuscripts of the fifth and sixth revisals, deposited in the library of the American Philosophical Society at Philadelphia, by the family of the author.

In undertaking this task I have throughout adhered closely to the language and arrangement of the original, even where a different nomenclature and an altered arrangement suggested themselves, as in better accordance with modern philological views. It is, I think, more proper to maintain strict fidelity to the forms chosen by so thorough a Choctaw scholar as the Rev. Mr. Byington, in the explanation of so difficult a tongue, than to run any risk of misrepresenting his views by adopting a more modern phraseology.

Mr. Byington's own views of what he had accomplished deserve recording. In his diary under date March 11, 1864 (his birthday), he writes:

"The last year I revised the Choctaw Grammar, going over the ground twice. The last effort I hope is my best, and will be of use to learners of Choctaw, and to Choctaw scholars in schools, but it needs further revision, and then to be well transcribed. I commit these efforts in my old age to the Lord. I have enjoyed these labours very much. The pleasure of happily resolving difficulties in these studies, and of success in the work, is gratifying, and reviving to the mind."

In 1867 he wrote:

"This work can be much improved hereafter by other hands. It may be compared to the first survey and making of a road in a new country."

In spite of these deficiencies, of which no doubt the author was more distinctly aware than any one else, his Grammar remains one of the most valuable, original, and instructive of any ever written of an American language. It is the result of nigh half a century of concentrated study, and we may well doubt if ever again a person will be found who will combine the time, the opportunities, and the ability to make an equal analysis of the language.

Mr. Byington also prepared a Choctaw dictionary, containing about 15,000 words, which remains in manuscript, in the possession of his family.

In commencing the study of Choctaw, those accustomed only to English and cognate languages will discover many peculiarities. Some of them are as follows :

1. The want of the verb "to be" as a declinable word.

2. The want of personal pronouns in the third persons, singular and plural.

3. The want of a plural form in many nouns, verbs and adjectives.

4. The irregular manner in which the plural is made.

5. The want of a passive voice in some verbs, and its irregular formation.

6. The order of words in a clause or sentence.

7. The use of pre-positive particles, or prefixes.

8. The use of post-positive particles, or suffixes.

9. The use of fragmentary pronouns, simple and compound.

10. The repetition of pronouns.

11. The numerous ground-forms of the verbs, arising from internal changes in the primary root.

12. The negative forms of verbs, adjectives, and fragmentary pronouns.

13. The causative forms of verbs.

14. The internal changes in the causative forms.

15. The uniformity of grammatical forms and structure.

16. The extent to which the rough aspirate h supplies the want of the verb of existence.

17. The difficulties in resolving and translating the article-pronouns.

PART FIRST.

ORTHOGRAPHY.

1. THE ALPHABET.

Consonants, vowels, diphthongs, nasals, and aspirates are used.

Letters.	*Names and values.*
A a	a or ah, a broad, as in father.
V v	ă short, as a in vial, or u in sun.
B b	be
Ch ch	che
E e	a long, as in made, or e in there.
F f	fe
H h	he
Hl hl	hle

I i	e as i in marine, and short as i in pin.
K k	ke
L l	le
M m	me
N n	ne
O o	o as in note.
P p	pe
S s	se
Sh sh	she
U u	oo as in took, or u as in full.
W w	we
Y y	ye.

Nasals: a̱, o̱, u̱, i̱.

2. REMARKS ON THE ALPHABET.

The vowel v has heretofore been called ŭ short. But the Choctaws give it the sound of ă short, and when lengthened it passes into ā long; as, vbi, to kill; abi, to kill.

Hl, hl, is an aspirated l, when at the beginning of a syllable; when it closes a syllable, it is lh; as, hlibata, a buckskin thong; tulhko, buckskin leather.

H, h, has two sounds, one a smooth aspirate, as in hina, a road; the other rough, as in tahli, to finish.

K, k, has two sounds, one sharp, as in oka, water; the other rough, as in the article-pronoun okvt, oke. In order to express the sound fully, the latter might be spelled okhvt, okhe.

The vowels have the continental sounds.

The diphthongs are: ai, pronounced as i in pine; and au, as ow in now.

3. THE NASALS.

These are not represented by independent letters, but by a line drawn under the vowels, thus: a̱, i̱, o̱, u̱, pronounced ang, ing, ong, ung, with slight variations depending upon the next succeeding consonant.

v nasalized, passes into a̱.
e " " " i̱.
ai " " " a̱y, as fala̱iya, to be long, fala̱ya, being long.
au " " " a̱w, as lau̱a, to be many, la̱wa, being many.

The nasal sounds increase the distinctive power of the words in which they occur. For instance, the article-pronouns **a** definite and **o** distinctive are made more definite and distinctive by the nasal mark. This is also true of adverbs of affirmation and negation; verbs and adverbs take the nasals as intensives; a̱, yes it is; ha̱, no it is not; keyu̱, no it is not; chito, large; chi̱to, being large, the large one. The nasal sound implies emphasis, and distinctiveness by comparison.

4. SOUNDS WANTING.

The consonants c, d, g, j, q, r, v, x, and z, are absent in Choctaw. Double consonants, such as br, dr, tl, bt, nt, st, are of difficult articulation to the natives. When such sounds occur in proper names, as in the Bible, they substitute others, as follows: for c soft they use s, as Cyrus, Sailas; for c hard, k, as Canaan, Kenan; for ch hard, k, as Enoch, Enak; for d, l, as David, Lewi; or else t, as Daniel, Taniel or Tanili; for g soft and for j, ch, as Gentile, Chentail, Jew, Chu; for g, ko or ku, as queen, kuwin, or kowin; for r, l, as Rachel, Lechel, but at the end of a syllable it is dropped, as Peter, Peta; for v, f or w, as Levi, Lefai, David, Lewi; for x, ks, as Exodus, Eksotus; for z, s, as Zaccheus, Sakevs. When two consonants come together, a short vowel is sometimes inserted, or one is prefixed: as, wheat, wohet; Andrew, Antilu; bridle, bilitel; Stephen, Istifin; Reid, Olit.

5. CONTRACTIONS.

Contractions by the elision of vowels or consonants are frequent in both simple and compound words and phrases. A few examples are given:

chuka a̱y ont antah, for onvt antah, he goes to and stays at the house.
anont a̱ya, for anolit a̱yah, he goes along and tells it.
bot vbi, for bolit vbih, he beats and kills.
chukachvfa, for chuka achvfa, a family.
chukfushe, for chukfi ushi, a lamb.
issakshup, for issi hakshup, a deer skin.
siaknip, for sa haknip, my body.

6. CONSONANT CHANGES.

The following change of the consonants may take place: ch may change to sh: ochiah, she draws water; oshtiah, she goes to draw water; tanchi, corn, tashishi, corn-fodder. Sh may change to t, as in the article-pronoun osh, ot. K and t, and l and m, are interchangeable in a few words: as ikhana to ithana, to know; oktvni to ottvni, to appear; omba to oma, to rain; yukpa changes to yuppa, to be pleased.

7. VOWEL CHANGES.

ā shortened becomes v, as chumpa, to buy, chumpvt iah, he goes to buy.

ē shortened becomes i, as emah, imah, he gives.

ō shortened becomes u, as tok, tuk, it was, hommah it is red, hummah it is reddish.

v lengthened becomes a.

ĭ lengthened becomes e, as pisah, pesah, he sees.

ŭ lengthened becomes o.

o in holissoh becomes i in hollisichih, he writes.

a in momah becomes i in mominchih.

8. NASAL CHANGES.

Exact rules for these changes are not easily given. The nasals a̱, i̱, o̱, u̱, stand before the consonants f, h, hl, k, n, s, sh, w, and y; as i̱ fuli, his switch; i̱ hollisso, his book; i̱ kana, his friend; i̱ wak, his cow; i̱ yuka, his prisoner. The nasal marks are changed to the letter m before the diphthongs, the vowels, and the consonants b, m, and p; and to the letter n before ch, lh, l, and t; but to these rules there are exceptions; as, imi shilombish, his spirit; i̱ ponaklo, to inquire of him; nan anoli, an informer; nan illi, death. The position of the organs of speech preparatory to the utterance of the succeeding letter causes a change in the nasal sound; as, i̱ wak, his cow; im issuba, his horse; in chuka, his house.

9. DOUBLED CONSONANTS.

Consonants are doubled in the intensive form of verbs and adjectives; as,

alota, to be full.	vllota, to be quite full.
anoa, to be reported.	vnnoa, to be commonly reported.
anumpa, to be spoken.	vnnumpa, to be much spoken.
himak, now.	himmak, hereafter, after all.
pila, thither.	pilla, away there.
kvnia, gone.	kvnnia, really gone.

When the consonant y is doubled, the first one is transformed into i; as,

hoyo, to look for.	hoiya, to look for earnestly.
ayukpa, to be glad of.	aiyukpa, to be very glad of.
ayohmi, to do so there.	aiyohmi, to do so really.

10. SYLLABIFICATION.

Syllables usually terminate in a vowel sound, but may end with a consonant. When two simple consonants occur in the same word, the first ends one syllable and the second commences the succeeding one; as, bvnna, to want; tohbi, to be white. The double consonants ch, sh, hl, and lh, are inseparable. The long vowels have their full sound in all accented syllables, except the vowel i̱, which is occasionally short, as in si̱psi, a poplar, i̱lh, to die. In words of two or more syllables the accented syllable takes a consonant, which is heard in both syllables; as, hina, a word, pronounced hinna. In some words the consonant is doubled; as, illi, to die; putta, all. In a few instances the mark ′ has been used to indicate emphasis and the imperative mood; as, Luke X. 37, i̱ nukha̱klo tok a′, he that showed mercy on him.

11. ACCENT.

In words of two or more syllables the penult is accented; as, kan′chi, to sell; ano′li, to relate. In words of four or more syllables there is a secondary accent on the second syllable before the penult; as, po′hlomo′li, to double them up; anum′pohon′li, to keep talking. There is another accent which falls on the final syllable of such words as in English are followed by marks of punctuation, from the comma to the period. It is called the pause accent. Consonants take the accent merely, while final vowels take the rough aspirate h suffixed.

12. DIVISION OF WORDS.

All simple words are written separately. There are, however, words compounded with prefixes, suffixes, and inseparable pronouns, which are written as one. But to avoid confusion, whenever it is possible, the elements of each clause are written and printed separately.

13. ARRANGEMENT OF WORDS IN A SENTENCE.

1. The connective.
2. The subject and its modifications.
3. The object and its modifications.
4. The verb or predicate, with its modifications.
5. Time when comes both before and after the subject.

Time how long is similarly placed, and also at the close of the sentence; Luke I. 24; IV. 25.

6. Instrument and means, with modifications, precede the verb.
7. Adjectives follow nouns.
8. Adverbs follow verbs, adjectives, and adverbs.
9. Infinitives precede the word on which they depend.
10. The place where, comes next after the time when.
11. The imperative follows the noun which is its object; Luke I. 3, 9.
12. The predicate is often at or near the close of the sentence. See Mat. V. 1—12 verses.

PART SECOND.

GRAMMATICAL FORMS AND INFLECTIONS.

PARTS OF SPEECH.

There are in Choctaw nine sorts of words, or parts of speech, namely:

1. Article-pronouns, or post-positive particles.
2. Pronouns, or substitutes.
3. Verbs.
4. Prepositions, or pre-positive particles.
5. Nouns, or names.
6. Adjectives, or attributes.
7. Adverbs, or modifiers.
8. Conjunctions, or connectives.
9. Interjections, or exclamations.

CHAPTER I.

THE ARTICLE-PRONOUNS.

§ 1. This is the most difficult part of Choctaw Grammar. The want of separate words corresponding to the English articles, of the personal pronouns in the third persons singular and plural, the relative pronouns single and double, and the copulas, is much felt by Americans in studying this language. The article-pronouns are used to supply these wants in a great variety of ways. They do not always admit of a translation. They often merely indicate the case of a word or clause. An accurate and full explanation of them is not attempted. Only a few leading remarks and rules are presented.

§ 2. The use of the article-pronouns is for definite and distinctive specification, limitation, emphasis, and prominence, and to show the connection and relation which one word, paragraph, or clause bears to another.

§ 3. They are placed after nouns and pronouns with their attributes, after verbs, adverbs, and their attributes, after prepositions and conjunctions. They are definite, distinctive, and contradistinctive, subjective, objective, and copulative. A part of speech can take more than one at a time.

§ 4. They may be translated by (1) the articles a, an, the, (2) the adjective pronouns one, ones, some, (3) the personal pronouns he, she, it, they, in the nominative case, and him, her, it, them, in the oblique case, (4) the relatives who, which, what, that, in the nominative case, and whom, which, what, that in the oblique case, (5) by the double relatives he who, she who, that which, and they who, (6) and by the one who, the ones who, and the ones whom. Often they are not to be translated in English.

§ 5. The primary or ground forms of the article-pronouns are **a** definite, and **o** distinctive. They are used (1) as articles, (2) as personal pronouns in the third persons singular and plural, (3) as relative pronouns, single and double, in both numbers, (4) as adjective pronouns, (5) as copulas.

§ 6. **a** is definite, and when used as an article is much like the English article *the*, though it is also translated by a, or an. **o** is distinctive, and corresponds to the indefinite *a* or *an* in English, or to the adjective pronouns one, ones, some. **a** implies certain knowledge, while **o** ignores other objects and does not make certain the objects it specifies otherwise than that they belong to one species or kind. **o** is emphatic. Both are used for specification, emphasis, and case.[1]

§ 7. In the oblique case nouns are sometimes found without either of them. And when they are used, they may be rendered by either of the articles, or as mentioned above.

§ 8. The article-pronouns have (1) variations, and (2) modifications.

§ 9. **a** DEFINITE.

a may be varied by becoming v, e, or i.

It is modified by suffixing various letters, which alter its signification, thus:

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[1] *Definite and Distinctive.* — These two forms of speech run through the whole language, and modify not only article-pronouns, nouns, verbs, and conjunctions, but even clauses and sentences. Mr. Byington explains the double plural of the personal pronoun of the first person, common to nearly all American languages, and generally known as the exclusive plural (excluding the second person) and inclusive plural (including the second person, with or without the third person), the former as definite, the latter as distinctive. These plurals, he says, "correspond to **a** definite and **o** distinctive;" and of the separable personal pronouns, vno and sia, he says, "the difference be tween them is similar to that between **a** and **o**." The distinctive expresses in its broadest sense the signification of the word or clause, but lends an emphasis which *distinguishes* it from any word or clause of allied purport; the definite *defines* or limits the signification to some specific, known word, individual, or act. Vno, I, distinctive, begins a sentence, the speaker being as yet vague; but as soon as the speaker is defined by a verb, adjective, or other qualifying word, the pronoun changes to sia, I, definite. Vhli, definite, edge, limit, to be the edge or limit of anything, to bound it; this signification is extended in the distinctive form ahli, to be the whole of anything, hence to be true, truth.

It adds t, to form the nominative case, at, vt, et, it;

a nasal sound, to form the oblique case, a̱, i̱;

h, to form an affirmative (predicate definite), ah, it is the;

h, and varies to e, to form an affirmative (predicate absolute), eh, it is;

k, to form a determinate definite, ak, the, that; and kvt, ket, kit;

sh, to form a renewed mention definite, ash, vsh, the said, the same;

mo, to form a renewed mention distinctive, amo, vmo, the ones.

It prefixes m in mvt, ma, mak, to express a simultaneous, or concomitant object or act, the too; *e. g.* Luke XVI. 25, Svso ma! Son! (*i. e.* thou, too, my son).

§ 10. **O** DISTINCTIVE.

O is modified in a similar manner.

It adds sh, t, or cha, to form the nominative, osh, ot, ocha;

a nasal to form the oblique case, o̱, ona;

h, to form an affirmative (predicate distinctive), oh, that is so;

k, to form a determinate distinctive, ok, that one is so;

sh, to form a renewed mention distinctive, osh, the said ones;

mo, to form a renewed mention concomitant, omo, the said ones, too;

kb, to form an optative, okb, oh, that it were so;

km, to form a conditional, okm, if it were so;

keh, to form an affirmative contradistinctive, okeh, it is so and not otherwise;

t, cha, and na, to form connectives.

§ 11. The definite and the distinctive are both used separately after one subject, and then the definite follows the noun, and the distinctive its modification. Thus John III. 1, Hatak vt Falisi yosh, a man who was a Pharisee; Luke X. 39, itibapishi hvt Meli hohchifo hosh, a sister whose name was Mary. The distinctive may also be used first, and the definite follow the modification; Luke XI. 27, ikfoka yvt yummak osh, the womb that.

§ 12. These two article-pronouns and their modifications combine with each other to form the third class, the CONTRADISTINCTIVES.

§ 13. THE CONTRADISTINCTIVES.

The definite **a** in combination with the distinctive **O**:

at, et, vt, take o to form a contradistinctive a, to, eto, uto, nom. case.

a̱ in the oblique case changes to an and takes o, ano, vno.

ak takes o to make the determinate contradistinctive, ako.

mak takes o to make a simultaneous or successive contradistinctive, mako.

mvt in the nominative case takes o to form a contradistinctive, mvto.

ma̱ in the oblique case becomes man, and takes o, mano.

ak becomes ok in ak ok, for intensity of specification.

mak takes ok in mak ok, for the same reason.

a takes mo to form a definite and indeclinable renewed mention in recent past time, as Luke XVI. 13, achvfa kamo, the one.

The distinctive **o** in combination with the definite **a**:

ok takes vt in okvt, nom. case, contradistinctive.

ok takes a in oka, oblique case.

ok takes ah in okah, a distinctive and definite predicate.

ok takes eh in okeh, a distinctive and absolute predicate.

ok takes ato, vta, in okvta, nom. and okanto.

ok takes ano or vno in okvno, oblique case.

ok takes ak in okak, to double the definitive force of the pronoun.

ok ak takes the pronoun o in okakosh, okako, as a strong definite and concessive, Mark XV. 31.

o takes mo in omo, renewed mention in the remote past tense, indeclinable.

§ 14. The following table presents the values and significations of the article-pronouns and their modifying particles, in a brief and comprehensive manner:

a, v, e, i, definite, implying knowledge of the thing, act or individual named; as, wak a, the cow, not a or some cow.

o, distinctive, generic, implying kind and ignoring other objects, but not rendering the thing, act, or individual certain. It does not specify particular objects, but merely distinguishes them; as, wak o, a cow, not a horse.

ch, connective, and.

h, predicative or affirmative, the sign of existence.

k, determinate or demonstrative, that, the.

kb, optative, wishing it were so, oh that; definite; the distinctive form is okb.

km, suppositive, conditional, or contingent, if, when, provided; definite; the distinctive form is okm.

m, successive, simultaneous, compellative, when, then, also, too, oh.

mo, renewed mention distinctive, the same, the said; omo, remotely past; amo, recently past.

sh, renewed mention definite of recent past time.

shkeh, definite affirmation, it is.

okeh, distinctive affirmation, it is so and not otherwise.

t, connective, continuative, definite; a copula, and.

y, euphonic.

a̱, o̱, i̱, nasals, objectives and copulas.

In order that these modifications may be more perfectly understood, some further explanations of the most important of them are added.

§ 15. **h** predicative, or affirmative. The verb of existence, to be, does not occur in Choctaw, and this particle supplies its place. It is suffixed to nouns, pronouns, infinitives, adjectives, adverbs, prepositions, conjunctions, and article-pronouns, which end in a vowel, to form a proposition;

when they end in a consonant, the consonant receives an accent called the substantive verb accent. Examples:

vlla, a child.	vllah, it is a child.
vno, I.	vnoh, it is I.
takchi, to tie.	takchih, he ties.
kvllo, strong.	kvlloh, he is strong.
fehna, very.	fehnah, it is very.
anukaka, within.	anukakah, it is within.
minti, come.	mintih, it is come.
mihma, and.	mihmah, and it is.
a, the.	ah, it is the.
o, a, one.	oh, it is a, it is one.
he, will, shall.	heh, it will be, it shall be.
hatak, man.	hatak′, it is a man.
chukvsh, heart.	chukvsh′, it is the heart.
tuk, tok, was, has en.	tuk′, tok′, it was, it has been.

This particle is not subject to any change for person, number, or gender. Its place is at the end of a proposition. In such expressions as kullo fehnah, he is very strong, the h is removed from kulloh, he is strong, to the end of the sentence. When used with a verb and article-pronoun, it is in printing often prefixed to the latter, instead of being suffixed to the former, where it properly belongs; as, achi hokeh, for achih okeh, he there says.

§ 16. **k** determinate. This particle limits with precision the word to which it is joined,—just that much, no more, no less, and no other. Like h, it is a suffix, although it is often written as a prefix of the following word. Thus, ilvppvt achukma kvt yummak o i shahli hokeh, this in goodness is better than that, should be ilvppvt achukmak vt yummak o i shahlih oke. The particle k is also used as a prefix to a vowel in the past and future tenses of verbs in the negative forms, where it has reference to the verb, in order to limit it in this form; as, ik kvllo ke tuk, which should be written, ik kvllok etuk. In renewed mention in remote past time, k is changed to ch, as chash, chamo, for kash, kamo; and in some instances h and k are interchangeable, as nachi yim mikvt or nachi yim mihvt, thy faith.

§ 17. **m** successive, simultaneous, compellative. This is a prefix, never a suffix, of **a**. It may be translated after nouns by, the also, the too; and after verbs by when, then, when then, then when. Examples: iyi ma, the feet too; vmoshi mvto, as for my uncle, he too; aki mvno, as for my father, him also. As a compellative it is prefixed to ah; miko mah, a king. It is prefixed to ak to make a definite expression that something is just now gone before, or will next follow, or is now passing; as, ia lih mak okeh, I am going now.

§ 18. The form **shkeh.** The absolute article-pronoun termination shkeh is definite, and follows verbs, adjectives, and adverbs in the present and future tenses, and the pronouns sia, chia, I, thou, etc.

ia lish keh, I go, absolutely, present tense, I am going, I am off.

ia lash keh, I shall go, I will go, let me go, let me off.

The distinctive form is seen in ia li hok eh, I go instead of doing something else; ia lish, I go, and k that, eh, it is; ia la chi shk eh, go I will and that it is; ia lashke, indefinite and remote future for ia la heshke.

§ 19. The conditional forms **km** definite, and **okm** distinctive.

The definite conditional is formed from k determinate and suffix of a word, and m a successive and prefix of a, kma. Luke XII. 53; ia lih, I go; ia lik, a determinate act; ia lik ma, when I go then.

The distinctive conditional is made by the pronoun o before k in okm; ia li hokma, if I go, suppose I go; km and okm take the definite **a** with its modifications.

§ 20. The optative forms **kb** definite and **okb** distinctive. These particles form the optative mood, by prefixing the infinitive of the verb.

§ 21. Y is used as a prefix to **a** and **o**. It is euphonic after the vowels a, i, o, and before a and o; vlla yvt, vlla yosh, ushi yvt, in place of vlla vt vlla osh, vshi vt.

§ 22. The definite article-pronoun of comparison or contrast. This is used to specify objects either as inferior or superior to others when placed in contrast, corresponding to the phrases "how much more," "how much less," especially with definite and pointed emphasis. The simple form is het in the nominative, and hi̱ in the oblique case. But these are not in use. The compound forms only are used.

Nom. case, ak het, mak het, okak het.
Oblique case, ak hi̱, mak hi̱, okak hi̱.

Contradistinctive form.

Nom. case, ak heto, mak heto, okak heto.
Oblique case, ak heno, mak heno, okak heno.

Conditional form.

Nom. case,	k mak het	Oblique case,	k mak hi̱
	ok mak het		ok mak hi̱
	k mak heto		k mak heno
	ok mak heto.		ok mak heno.

Examples of the use of these pronouns where a contrast is expressed may be found in John III. 20, hokakheto, Mat. XXIII. 26, yokakheto, 1 John V. 9, 2 Cor. III. 8, 9, Luke X. 35, John VIII. 4.

§ 22. GENERAL TABLE OF DECLENSIONS OF THE ARTICLE-PRONOUNS.

The definite:
Nom. case, at, vt, et, it.
Oblique case, a̱, i̱, i.

The distinctive:
Nom. case, osh, ot, ocha.
Oblique case, o, o̱, ona.

The contradistinctive:
Nom. case, ato, vto, eto, heto, anto, atoha.
Oblique case, ano, vno, eno, heno, ano, anoha.

Or in one table:
Nom. case, at, vt, et, it, het; osh, ot, ocha; ato, vto, eto, heto; anto, atoha.
Oblique case, a, a̱, i, i̱, hi; o, o̱, ona; ano, vno, eno, heno; ano, anoha.

§ 24. TRANSLATION OF THE ARTICLE-PRONOUNS, AND THEIR MODIFICATIONS.

a definite. When **a** immediately follows a noun it may generally be translated by the article, or else omitted. When any verb is understood in connection with a noun, **a** should be translated by a relative pronoun; as, Atvm ak osh hatak moma i̱ tikba hatok, Adam he was of all men the first of them he was; Adam the one who of all men was the first. When a modifying word or words follow the noun, the particle comes last; as, miko vt mintih, the king comes; miko a̱ pisah, the king he sees (regem videt); miko chito vt mintih, the great king comes; miko chito a̱ pisah, he sees the great king. The particle follows pronouns and designates their cases, vno vt, I; vno a̱, me.

§ 25. **o** distinctive. When it follows nouns it denotes them as unknown; nvni chaha yo, a mountain; the particular mountain is not known, but it is made a distinctive object, a mountain and not a plain, or other place. The difference between **a** and **o** may be seen in Mat. XVII. 1, and 9, nvnih chaha yo, a mountain; nvnih chaha ya, the mountain. It has an emphatic and prominent meaning in such sentences as Gal. IV. 2, Pal sia hosh, I, Paul; Acts VIII. 20, Chihowa yosh nan ima ya̱, the gift of God; Acts V. 4, hatak o̱, men. Like **a**, it is rendered by the personal pronouns in both cases and numbers, he, she, it, they, him, her, it, them, and by the relative and double pronouns. It has a contradistinctive sense in such expressions as Mat. XXV. 3, bila yano, as for the oil, in distinction from the lamps. It is used after verbs, and with some conjunctions, to render a distinct reason for an action; as, Luke XI. 37, ont chukowa cha, impa chi̱ hosh binili tok, he came in and sat down for to eat. It has a oncessive sense when combined with the particles ok ak; as, yohmic hokak o, although it is so.

Sometimes the article-pronouns are used to translate the articles a and the, and sometimes they are used in Choctaw where the articles do not occur in English. Some examples from Mark I. will illustrate this. The beginning, vmmonak vt; the gospel, vbanumpa; the son of Jehovah, Chihowa ushi; the way, ataya ya̱; the river of Jordan, Chatan okhina yako̱; John, Chanvt; Jordan, Chatan ako; Jesus, Chisvs vt; a girdle, vskofvchi yo̱; water, oka yo̱; the water, oka ya̱; a voice, anumpa hvt; the angels, enchel vhleha hosh; the sea, ok hota; the ship, peni ash; fishers of men, hatak hokli yo̱; the unclean spirit, shilombish okpulo ash osh; the unclean spirits, shilombish okpulo hak.

Matth. XV. 38: Mihma okla impa tuk vt, ohoyo vlla aiena hokvto a̱sha ho̱, hatak 4000 ushta tok; And they that did eat were 4000 men, beside women and children. Here vt makes those who ate definite, while ho̱ makes the women and children distinctive and objective.

Acts IX. 6. nanta hak o̱ katiohmi la hi a̱? What wilt thou have me do? is definite; but, Acts XXII. 10: nanta ko̱ katiohmi la chi̱ ho? is distinctive.

§ 26. TABLE OF TRANSLATIONS OF THE ARTICLE-PRONOUNS.

1. Nominative case, as articles;

1. Definite, at vt, et, it, a, the.
2. Distinctive, osh, ot, ocha. a, an, the one.

2. Nom. case, as personal pronouns;

1. Definite, at, vt, et, it, he, she, it, they.
2. Distinctive, osh, ot, ocha, he, she, it, they.

3. Nom. case, as relative pronouns;

Definite, at, vt, et, it, who, which, what, that.

4. Nom. case, as double pronouns;

1. Definite, at, vt, et, it, he who, she who, that which, they who.
2. Distinctive, osh, ot, ocha, the one who, some who, the ones who, any one, some one, some who.

5. Renewed mention;

1. Definite, ash, the, the said, the aforesaid.
2. Distinctive, ok, ak, osh, the one, any one who.

6. Contradistinctive;

1. Distinctive, compound, ato, vto, eto, he as for, she as for, it as for, they as for (he as for him, etc).
2. Definite compound, okvto, they which, such as they. See Luke VII. 25, XII. 4.

7. Definite distinctives;

ak osh, he the one who, she the one who, it the one which, they the ones who, they who and not others.

8. Distinctive definite;

ok vt, he, she, it, they particularly.

9. Renewed mention distinctive;

ash, osh, the said he, the said she, the said they. Luke VII. 20, hatak ash ot.

10. Conditional;

1. Definite, kmvt, if the, when the, if he, if she.
2. Distinctive, okmvt, if it were he then, etc.
3. Contradistinctive, okmvto, if then as for him, etc.

11. Oblique case, as articles;

1. Definite, a̲, i̲, a, an, the.
2. Distinctive, o̲, ona, a, the, any, some.

12. Oblique case, as personal pronouns;

1. Definite, a̲, i̲, him, her, it, them.
2. Distinctive, o̲, ona, him, her, it, them.

13. Relative pronouns;

Definite, a̲, i̲, whom, which, what.

14. Double pronouns;

1. Definite, a̲, i̲, him whom, her whom, those whom.
2. Distinctive, o̲, ona, the one whom.

15. Renewed mention;

ash, the said. Luke VII. 19, Chan ash ot.

16. Definite and distinctive;

ok ak o, the one whom, any one whom.

17. Contradistinctives;

ano, vno, eno, as for him, her, it, them.

kvno, mvno, okvno.

18. Definite distinctive;

ak o, the one whom, he whom, those whom and not others. ak ok, Luke VIII. 12.

19. Distinctive definite;

aka, him, her, them.

20. Renewed mention distinctive;

ash o, the said.

21. Conditional;

1. Definite, kma, if him, if her, if it, if them. Luke XII. 53.
2. Distinctive, okma, if so.
1. Definite, kmvno, if him, etc., what then.
2. Distinctive, okmvno, if so what then.

21. Comparative forms;

1. Nom. ak het, particularly he, she, it, you, I, or they.
2. Oblique, ak hi, particularly him, her, it, you, me, or them.

22. Predicative form;

1. Definite, ah, eh, he is, she is, it is, they are.
2. Distinctive, oh.
1. Definite and final, shkeh, it is.
2. Distinctive and final, okeh, it is so and in no other way.

23. Ancient and sonorous forms;

ocha, hocha, yocha.	ona, hona, yona.
katoha.	kanoha.
okakanto.	okakano.
okakocha.	akakona.

These were formerly used by the orators at the public assemblies, but are now almost obsolete.[1]

The compound forms often admit of both the articles, the pronouns, and the relatives, in their translation; alam okash, he the one who; nukhaklo vkleha yokvto, the last word being composed of y euphonic, o distinctive, k demonstrative, a definite (varied to v), t connective, and o final, and is in form a contra-distinctive, "the merciful, they who are so, as for them, they."

§ 27. Position of the article-pronouns. The article and personal pronouns generally follow nouns and their attributes. The relatives follow pronouns, verbs and their attributes; vno vt, I who, ia li tuk vt, I who went I, Svso ilvppvt illi tuk osh, falamvt okchaya hoke, Luke XV. 24.

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[1] In former times there was a well known solemn style which abounded in sonorous words. One part of a sentence was nicely balanced by another, and in delivery a chanting or metrical intonation was used. At the close of each paragraph the orator would invite the people to listen, who would in turn indicate approval by crying out yvmmah! It is that! (or "that's so"); and vlphesa! It is right! The most frequent peculiarity of the style was the lengthened pronominal suffixes, as for instance, Nanta hocha? What is it? Nana hona, something. (*Byington* MSS).

The article-pronouns are moveable, and may be transferred from the logical to the grammatical subject, in order that they may retain their character as suffixes.

In the tenses, the article-pronouns may either precede the particle by which the tense is indicated, as, a tok, etok, itok, achi, or follow it, as, a-tuk a, a tok a̱, a chik a̱, a tuk o̱, a tok o̱ (literally, a, he; tok, past tense particle, did; o̱, it; he did it); anta la chi̱ hatuk oke, Luke XIX. 5, I must abide; hlvpi sabvnnah a tuk, salt I wanted it was, it was salt that I wanted, h predicative, a a relative pronoun.

§ 28. Change of case. A peculiarity in the use of the article-pronoun with nouns is that the nominative case changes to the oblique case when another subject is introduced. For example, Matthew XIII. 4, Atuk osh hokchi ma na nihi kanimi kvt hina lapalika yo̱ kaha tok; atuk o̱ hushi puta kvt ant vpvt tahli tok. Here osh, nom. he (the sower), is changed to ma, oblique, before na nihi kanimi kvt, another subject (some of the seed); and this latter nominative becomes atuk o̱, oblique, before the next subject, hushi puta kvt, (the fowls).

§ 29. USE OF THE ARTICLE-PRONOUN WITH NOUNS.

In connection with nouns, the article-pronouns indicate case, and may thus be regarded as forming a sort of declension. For example:

hatak, man, men.

Nom. case.	Oblique case.
hatak okvt, the man, as a man.	hatak amo, the said, the same man.
hatak okvto, the man, as for the man.	hatak oka, as a man, a man.
hatak okmvto, when the men they.	hatak okvno, the men they.
hatak ash osh, men the said.	hatak okmvno, if men then.

peni, a boat, boats.

peni vt, the boat, a boat.
peni o, a boat, some boat.
peni mvt, the boat also, a boat too, or also.
peni vto, peni anto, as for the boat, contradistinctive.
peni mvto, as for the boat, also, then.
peni amo, the said boat.
peni osh, a boat, one boat, the boats, some boats.
peni a tuk, peni ya tok, the boat which was.
peni a chi, the boat which will be.
peni a hinla, the boat which can be.

Example: Luke XVII. 32, Lat tekchi a tok a̱ hvsh ithaiyanashke, she who was the wife of Lot, her remember.

§ 30. TABULAR LIST OF ARTICLE-PRONOUNS.[1]

Definite forms.		Distinctive forms.	
Subjective.	Objective.	Subjective.	Objective.
at, vt, et, it, ish	a̱, i̱	osh	o
vto, ato	ano, vno	okvt	oka̱

[1] *Subjective and Objective.*—These expressions are used by Mr. Byington rather in their logical than their grammatical sense, and must be so understood in this Table. The list here given is evidently not complete, but it is accurately copied from his latest revision.

Definite forms.		Distinctive forms.	
Subjective.	Objective.	Subjective.	Objective.
mvt	ma	okmvt	okma
mvto	mvno	okbat	okbeh
	ak, mak,	okbato	okbano
kmvt	kma	omo	omo
kmvto	kmak		
kbat	kba		
cha	na		
amo	amo		
lish	li		

Neither subjective nor objective.

h	ok
eh	ok ak
akok	okm
mak	okmak
km	okvmo, okamo
	ochosh.

Finals, or verb substantive forms.

h, eh,	
shkeh	hokeh
ah	oh

CHAPTER II.

PRONOUNS.

§ 1. The pronouns are divided into two classes, separable and inseparable. Separable pronouns are independent words. Inseparable pronouns are fragmentary words, and are all prefixed to other words, except li, I, which is suffixed.

I. SEPARABLE PRONOUNS.

§ 2. These are of four classes, 1, distinctive personal; 2, definite personal; 3, possessive; 4, personal-and-possessive.

1. The distinctive, or emphatic personal.

Simple form.	With h predicative.
vno, I, me, mine.	vnoh, it is I, it is mine.
chishno, thou, thee, thine.	chishnoh, it is thou, thine.
pishno, we, us, our (def).	pishnoh, it is we, ours.
hvppishno, we, us, our (dis).	hvpishnoh, it is we, ours.
hvchishno, you, yours.	hvchishnoh, it is you, yours.

§ 3. These pronouns are used in the nominative, oblique, and possessive cases for all genders, without change of form. Their case is shown by the article-pronouns, which they take for specification, emphasis, and case.

They are prominent, generally standing at the beginning of a sentence without an antecedent, and are repeated by the inseparable pronouns which follow in the same clause or sentence. They are nasalized with some of the article-pronouns; as, vno vto, vnonto, as for me; vno ak osh, I the one who, but vnąk osh, I being the one who.

Note.—The first person plural has two forms. The first is the definite or exclusive plural, and does not include all who are present, but only a fixed number. The second is the distinctive or inclusive plural, and embraces the speaker and all who are present, but ignores all others. All personal and possessive pronouns have this double plural.[1]

2. The definite Personal.

Simple form.	With h predicative.
sia, I, me.	siah, I am.
chia, thou, thee.	chiah, thou art.
pia, we, (def.) us.	piah, we are.
hvpia, we, (dis.) us.	hvpiah, we are.
hvchia, you.	hvchiah, you are.

These pronouns generally have an antecedent, either a noun, or the distinctive personal pronoun, or both. They may be in the nominative or oblique case, which is denoted by the article-pronoun which follows them.

§ 4. The personal pronouns in the third person, singular and plural, are wanting. They are supplied by a gesture, or by other pronouns; as, ilvppa, this; yvmma, that; ilap, he, she, it, his, her, its; mih, he, she, it, they, the same, the said; okla, people. When no pronoun is expressed, the third person is understood.

§ 5. Examples of the use of the definite and distinctive personal pronouns: Acts X. 26, vno ak kia hatak sia akinli hoke, *I* am also a man; Mat. XIV. 27, vno ash sia hoke, it is *I;* Luke XVIII. 13, nan ashvchi sia hoka, for I am a sinner; Exodus XX. 2, vno ak osh Chin Chitokaka Chihowah sia hosh Echip yakni a——chi kokchi li tuk oke, I am the Lord thy God which have brought the out of the land of Egypt, vno I distinctive, sia I definite.

[1] I have here retained Mr. Byington's definition, but I have no doubt the Choctaw double plural is similar to that of other American tongues. The first plural, definite or exclusive, excludes the second person; the second, distinctive or inclusive plural, includes the second person, and may or may not, include the third person. Thus the Indians in speaking to the whites, would say pishno, we (excluding the hearers), but to those of their own nation, hvpishno (including the hearers). The terms exclusive and inclusive to designate this distinction were, I think, first introduced by Father Holguin, in his *Grammatica y Arte Nveva de la Lengva Qquichua* (Ciudad de los Reyes, 1607), and he calls attention to the fact that when used with verbs, the distinction refers to the action of the verb: "mas no se toma con verbos, por razon del pronombre, como aqui [where the pronouns are independent], sino por la significacion del verbo, si es en todos o no ygual, o si se excluyen de la accion del verbo, o de su significacion, aquellos con quien se habla" (fol. 12 recto). In the *Grammar of the Dakota Language* p. 9, the Rev. Mr. Riggs defines the inclusive as a dual (*I and thou*), the correctness of which I doubt, as it may also mean *I and you*, or *We and you*. Equally erroneous is Mr. Du Ponceau's comparison of the exclusive plural with *nous autres*, in French (*Langues Sauvages de l'Amerique du Nord*, p. 155), because *nous autres* does not necessarily exclude the hearers.

6. The possessive.

Simple form.	With h predicative.
vmmi, mine.	vmmih, it is mine.
chimmi, thine.	chimmih. it is thine.
immi, his, hers.	immih, it is his, hers.
pimmi, ours (def).	pimmih, it is ours.
hvpimmi, ours (dis).	hvpimmih, it is ours.
hvchimmi, yours.	hvchimmih, it is yours.
immi, theirs.	immih, it is theirs.

The reciprocal forms of this pronoun are: ittimmi, each other's; ittimmih, they are each other's, singular and plural.

§ 7. Personal-and-possessive pronouns.

Simple form.		With h predicative.	
Definite, ilap,	he, she, it, and	ilapah	it is his, hers, its, theirs, etc.
ilapa	his, hers, its, his own,	ilapah	
Distinctive, ilapo	they, theirs, their own.	ilapoh	

The first and second persons are formed by prefixing inseparable personal pronouns; thus:

salap, I myself, me myself.
chilap, thou thyself, thee thyself.
pilap, we, us, ourselves (def).
hvpilap, we, us, ourselves (dis).
hvchilap, you yourselves.

And to these again the inseparable possessive pronouns may be suffixed; thus:

Def. ilapi̱, ilapim, ilapin, his own, her own, their own.
Dis. ilapoi̱, ilapoim, ilapoin, his own, etc.

Examples: Mark I. 34, ilapa okla ithana hatuk o̱, because they knew *him;* Mat. X. 32, vno ak kia ilapa, I also *him;* John XIII. 3, ilap ak o̱ ibbak a̱, his hands.

§ 8. The separable pronouns are the same for all genders, as are also all other pronouns, nouns, and verbs. They take the article-pronouns for the purpose of specification, emphasis and case. They can all take the intensive pronoun inli, self; *e. g.:* vno inli, I myself too; sia hak inli, ilap ak inli, etc.

II INSEPARABLE PRONOUNS.

§ 9. These are of seven classes, 1, subjective-personal, 2, objective-personal, 3, objective-possessive, 4, reflexive, 5, reciprocal personal, 6, reciprocral possessive, 7, the marriage or sacred pronoun. They are always prefixed (except li, I,) to the words with which they are in concord, and are never used alone.

§ 10 The subjective-personal.

Affirmative form.	Negative form.
li (a suffix,) I.	ak, I not.
ish, is, thou.	chik, thou not.

Affirmative form.	Negative form.
e, il, we (def).	ik, he, she, it not.
eho, iloh, we (dis).	ke, kil, we not.
hvsh, hvs, you.	heloh, kiloh, we not.
	hvchik, you not.
	ik, they not.

E and eho stand before consonants, il and iloh before vowels. The third persons are wanting in the affirmative form. Li is the only one of the subjective personals that takes the article-pronouns.

§ 11. These pronouns are used in the nominative case with transitive, intransitive, neuter, and passive verbs. When used with neuter and passive verbs they imply an active state, signification, being, or condition. Examples:

Transitive verbs,	tackchi, to tie.
	takchih, he ties it (h predicative).
	takchihlh, I tie it.
	ish takchih, thou tiest it.
Intransitive verbs,	nowa, to walk.
	nowa lih, I walk.
Neuter verbs,	nusi, to sleep.
	nuse lih, I sleep.
Passive verbs,	holitopa, to be honored.
	holitopalih, I get honor.

When these pronouns are used with neuter and passive verbs, the subject of the proposition is active.

These pronouns are rendered as possessives by changing the verbs to nouns; as, apehlichi, to rule there; apelichi lih, I rule there; apelichi li, my kingdom; ish apelichi, thy kingdom; it aiashvchi, our sins; itti bapishi li Sal mah, my brother Saul (from itti bapishi, to suck the breast together).

§ 12. The objective personal.

Affirmative form.	Negative form.
s, sa, sv, sai, si, I, me, my.	iks, ik sa, ik sv, ik sai, ik so, not me.
chi, ch, thou, thee, thy.	ik chi, ik ch, not thee.
wanting	ik, not him, not her.
pi, p, we, us our (def).	ik pi, ik p, not us.
hvpi, hvp, we us our (dis).	ik hvpi, ik hvp, not us.
hvchi, hvch, you, your.	ik hvchi, ik hvch, not you.
wanting	ik, not them.

§ 13. These forms are used where by the pronoun no action is implied. They are not in the nominative case, although in common conversation they are thus translated. They should be treated as in the oblique case. They are used as subjective, objective, or possessive pronouns, and are prefixed to transitive, passive, and neuter verbs, to those nouns which pertain to one's person, to the various members, and to near family relatives. Examples:

Transitive verbs:	chi pesah, he sees thee.
	hvchi hakloh, he hears you.

Passive verbs:	chi tallakchih, bound thee it is.
Neuter verbs:	chi abekah, thee sick be.
	chi achukmah, thee good be.
	sa yonhah, me fever be.
Names of members, and relatives:	sa nushkoboh, my head, me head, it is.
	sa chukvsh', it is my heart.
	svsoh, it is my son.
	satekchih, it is my wife.
	svpvfv, my dog, it is my family dog.
	sabaiyih, it is my nephew.
	subbitek', it is my niece.

The h predicative, or its accent ', will be observed at the end of these sentences.

§ 14. The objective possessive.

Affirmative form.

a, am, vm, vmi, an, sa, sam, sum, sumi, san,	my, of me, to me, for me, from me, &c.
chi, chim, chimi, chin,	of thee, etc.
i, im, imi, in,	of him, her, it.
pi, pim, pimi, pin,	of our (def).
hvpi, hvpim, hvpimi, hvpin,	of our (dis).
hvchi, hvchim, hvchimi, hvchin,	of your.
i, im, imi, in.	of their.

Negative form.

ik sa, iksam, iksvm, ik san,	not of me, not to me, not for me.
ik chi, ikchim, ikchin,	not of the, etc.
ik i, ik im, ikin,	not of him, her, it, etc.
ik pi, ikpim, ikpin,	not of us.
ik hvpi, ikhvpim, ikhvpin,	not of us.
ik hochi, ikhvchim, ikhvchin,	not of you.
ik i, ikim, ikin,	not of them.

§ 15. This class of pronouns is used where there is an acquisition and possession, but not an implied ownership as a part of the thing spoken of.[1] Thus; a shapo, my hat (French, *chapeau*); vmissuba, my horse; an chuka, my house, are things acquired and possessed; but sanushkobo, my head; svbbak, my hand; are integral parts of my person. A few nouns relating to the person take the possessive pronouns; as, vmiskonata foni, my collar-bone; vm uksak foni, my ankle bone.

§ 16. These pronouns are prefixed to nouns and verbs, transitive, intransitive, passive, and neuter. Before nouns they may be translated, of him, of her, in the singular, and of them in the plural; as, Chan in chuka, John of him house, John's house; Chan micha Chemis in chuka, John and James's house, or houses, for them, of them, etc.

Before transitive and intransitive verbs they may be rendered by to, for,

[1] An analogous difference occurs in construction in the Algonkin dialects: "Les êtres qui tiennent leur manière d'être du Créateur, prennent la marque du possessif. Les êtres qui tiennent leur manière d'être de l'homme ne le prennent pas." *Etudes Philologiques sur quelques Langues Sauvages de l'Amerique*, p. 44.

from, or of him, of her, of them; as, in chumpah, he buys for or from him, her, or them; i kanchih, he sells to him, or for him, or them; im ia lih, I go for him, imonah, she goes to him; pim vlah, he comes to us, or for us.

Before passive and neuter verbs they may be translated by of him, for him, to him; or, by I, thou, he. Examples:

Passive verbs,	intvllakchih, she is bound for him.
	i boa, it is beaten for him.
	im patafah, it is plowed for him.
Neuter verbs,	i kulloh, he is hard to him.
	im achukmah, he, she, it is good to him.
	im puttah, they are all for him, all his.
	in tonlah, it lies for him.
	im ashah, they sit for him.
	im ahobah, it seems to him.

§ 17. The reflexive.

This is ille, ill, he himself, she herself, etc. It is used where the subject and object are the same. Example:

ille takchi, to tie himself or herself.

Affirmative forms.

ille takchih lih,	I tie myself.
ish ille takchih,	thou tiest thyself.
ille takchih,	he ties himself, she, it, etc.
il ille takchih,	we tie ourselves (def).
iloh ille takchih,	we tie ourselves (dis).
hvsh ille takchih,	you tie yourselves.
ille takchih,	they tie themselves.

Negative forms.

ak ille takchoh,	I do not tie myself.
chik ille takchoh,	thou dost not tie thyself.
ik ille takchoh,	he, she, does not tie himself, herself.
kil ille takchoh, kiloh ille takchoh, }	we do not tie ourselves.
hvchik ille takchoh,	you do not tie yourselves.
ik ille takchoh,	they do not tie themselves.

§ 18. The reciprocal-personal.

This is itti, itt; the former before a consonant, the latter before a vowel. They are used where the subject and object both being either in the nominative or oblique case mutually act on each other; as, itti takchih, to tie each other together. Examples:

itti takchilih,	I tie him together with me.
ish itti takchih,	thou tiest him together with thyself.
itti takchih,	he, she, it, they tie each other together.
il itti takchih,	we tie each other together, (def).
iloh itti takchih,	(dis).
hvsh itti takchih,	you tie each other together.
itti halvllih,	they pull each other.

§ 19. Reciprocal possessive.

This is itti, ittim, ittin, of, to, for, from each other; as, itti halvlli, they pull from or against each other. Both these and the preceding class, unite with the subjective personal inseparable pronouns.

§ 20. The marriage or sacred pronoun.

This is ho before consonants, oh before vowels. It is used in the first, second, and third persons singular, and the second and third persons plural, as a substitute for son-in-law, father-in-law, mother-in-law, their brothers, sisters, and cousins. It has no variation to express number, case, or gender. It is limited in use to the persons whose relationship is created by marriage; except the husband and wife. It is going out of use, as well as the ancient usages about marriage, especially that which required the mother-in-law and son-in-law to avoid each other. The use of this pronoun may be compared to the emphatic *he* or *she*, with which the master or mistress of the house is sometimes referred to in English; as, when *he* comes back, meaning father, or husband. The father says to his son-in-law, vmissuba ik hopeso, has he not seen my horse? oh ia lih, I went with him; ho mintilih, I come with him, or her; oh ant ik sapeso ka hinlah? will he not come to see me?

§ 21. Combinations of the six classes of inseparable pronouns with the verb pisa, or pesa, to see.

1. The subjective and objective personal.

Affirmative form.		Negative form.
chi pesa lih,	I see thee,	ak chi pesoh,
pisa lih,	I see him, her, or it,	ak pesoh,
hvchi pesa lih,	I see you,	ak hvchi pesoh,
pisa lih,	I see them,	ak pesoh,
issa pesah,	thou seest me,	chik sa pesoh,
ish pisah,	thou seest him, her, it,	chik pesoh,
ish pi pesah,	thou seest us,	chik pi pesoh,
ish pisah,	thou seest them,	chik pesoh;
sa pesah,	he sees me,	ik sa pesoh,
chi pesah,	he sees thee,	ik chi pesoh,
pisah,	he sees him, her, it,	ik pesoh,
pi pesah,	he sees us,	ik pi pesoh,
hvchi pesah,	he or she sees thee,	ik hvchi pesoh,
pisah,	he or she sees them,	ik pesoh,
e chi pesah,	we see thee,	ke chi peso,
e pisah,	we see him, her, it,	ke pesoh,
eho pisah,	we see ourselves (dis.),	ke ho pesoh,
e hvchi pesah,	we see you,	ke hvchi pesoh,
e hohvchi pisah,	we (all present) see you,	ke hohvchi pesoh,
e pisah,	we see them,	ke pesoh,
hvs sa pesah,	ye see me,	hvchik sa pesoh,
hvsh pisah,	ye see him, her, it,	hvchik pesoh,
hvsh pi pesah,	ye see us,	hvchik pi pesoh,

Affirmative form.		Negative form.
hvsh pisah,	ye see them,	hvchik pesoh,
sa pesah,	they see me,	ik sa pesoh,
chi pesah,	they see thee,	ik chi pesoh,
pisah,	they see him, her, it,	ik pesoh,
pi pesah,	they see us,	ik pi pesoh,
hvchi pesah,	they see you,	ik hvchi pesoh,
pisah,	they see them,	ik pesoh.

2. Subjective personal and reflexive.

Affirmative.		Negative.
ille pis alib,	I see myself,	ak ille pesoh,
ish ille pisah,	thou seest thyself,	chik ille pesoh,
ille pisah,	he, etc., sees himself,	ik ille pesoh,
il ille pisah,	we see ourselves (def.),	kil ille pesoh,
eloh ille pisah,	we see ourselves (dis.),	kiloh, ille pesoh,
hvsh ille pisah,	you see yourselves,	hvck ille pesoh,
ille pisah,	they see themselves,	ik ille pesoh.

Ille occasionally takes a locative and drops e; as, illahobachi, to make like to himself.

3. Subjective, objective, and reciprocal-personal.

Affirmative.		Negative.
chitti pesa lih,	I see thee and thou seest me,	ak chitti pesoh,
itti pesa lih,	I see him and he sees me,	ak itti pesoh,
hvsh itti pesa lih,	I see you and you see me,	ak hvchitti pesoh,
itti pesa lih,	I see them, etc.,	ak itti pesoh,
is svtti pesah,	thou seest me and I see thee,	chik svtti pesoh,
ish itti pesah,	thou seest him and he sees thee,	chik itti pesoh,
ish pitti pesah,	thou seest us and we see thee,	chik pitti pesoh,
ish itti pesah,	thou seest them and they see thee,	chik itti pesoh,
svtti pesah,	he sees me and I see him,	ik svtti pesoh,
chitti pesah,	he sees thee and thou seest him,	ik chitti pesoh,
itti pesah,	he sees him, her, and she, he, sees him,	ik itti pesoh,
pitti pesah,	he sees us and we see him,	ik pitti pesoh,
hvchitti pesah,	he sees you and you see him,	ik hvchitti pesoh,
itti pesah,	he sees them and they see him,	ik itti pesoh,
e chitti pesah,	we see thee and thou seest us,	ke chitti pesoh,
il itti pesah,	we see him and he sees us,	kil itti pesoh,
iloh itti pesah,	we see one another,	kiloh itti pesoh,
e hvchitti pesah,	we see you and you see us,	ke hvchitti pesoh,
il itti pesah,	we see them and they see us,	kil itti pesoh,
hvs sitti pesah,	you see me and I see you,	hvchik svtti pesoh,
hvsh itti pesah,	you see him and he sees you,	hvchik itti pesoh,
hvsh pitti pesah,	you see us and we see you,	hvchik pitti pesoh,
hvsh itti pesah,	you see them and they see you,	hvchik itti pesoh,
svtti pesah,	they see me and I see them,	ik svtti pesoh,

Affirmative.		Negative.
chitti pesah,	they see thee and thou seest them,	ik chitti pesoh,
itti pesah,	they see him and he sees them,	ik itti pesoh,
pitti pesah,	they see us and we see them,	ik pitti pesoh,
hvchitti pesah,	they see you and ye see them,	hvchik itti pesoh,
itti pesah,	they see one another,	ik itti pesoh.

4. The possessive-objective, in combination with the subjective-personal and objective personal.

Affirmative.		Negative.
chi̱ pisa lih,	I see for thee, of thine, &c.,	ak chi̱ pesoh lih,
i̱ pisa lih,	I see for him, her,	ak i̱ pesoh lih,
hvchi̱ pisa lih,	I see for you,	akhvchi̱ pesoh lih,
i̱ pisa lih,	I see for them,	aki̱ pesoh lih,
is ą pisah,	thou seest for me, of mine,	chik ą pesoh,
ishi̱ pisah,	for him,	chik i̱ pesoh,
ish pi̱ pisah,	for us,	chik pi̱ pesoh,
ish i̱ pisah,	for than,	chik i̱ pesoh,
ą pisah,	he sees for me, or of mine,	ik ą pesoh,
chi̱ pisah,	for thee,	ik chi̱ pesoh,
i̱ pisah,	for him,	ik i̱ pesoh,
pi̱ pisah,	for us,	ik pi̱ pesoh,
hvchi̱ pisah,	for you,	hvchi̱k pesoh,
i̱ pisah,	for them,	ik i̱ pesoh,
e chi pisah,	we see for thee, of thine,	ke chi̱ pesoh,
il i pisah,	him,	kil i̱ pesoh,
iloh i pisah,	ourselves,	kiloh i̱ pesoh,
e hvchi pisah,	ourselves,	ke hvchi̱ pesoh,
eho hvchi pisah,	you,	ke hohvchi̱ pesoh,
il i pisah,	them,	kil i̱ pesoh,
hvs ą pisah,	you see for me, of mine,	hvchik ą pesoh,
hvshi i̱ pisah,	him,	hvchik i̱ pesoh,
hvshpi̱ pisah,	us,	hvchik pi̱ pesoh,
hvsh i̱ pisah,	them,	hvchik i̱ pesoh.

The third plural, is the same as the third singular.

The possessive is sometimes found before the reflexives ille and ill, and sometimes after them; as, im ill anoli, to confess oneself to him; illi̱ nutakvchi, to humble oneself before him; im ille haiakvchi lih, I shew myself to him.

Combinations with the reciprocal pronouns are formed in the following manners:

chitti̱ pisa lih,	I see for you (or of yours)with you.
itti̱ pisa lih,	him, her, them.
hvchitti̱ pisa lih,	you, etc.
svtti̱ pisah,	he sees for me together with me.
echitti̱ pisah,	we see for thee together with thee.
hvs sitti pisah,	you see for me together with me, etc.

When two possessives are prefixed to a verb, one is subjective and one objective; as,

vm i̱ nukhąkloh,	he pities him for me.
chim i̱ nukhąkloh,	thee.
im i̱ nukhąkloh,	him, her, or them.
pim i̱ nukhąkloh,	us.
hvpim i̱ nukhąkloh,	us.
hvchim i̱ nukhąkloh,	you.

The negative is ik sum i̱, ik chim i̱, ik im i̱, etc.

The following form is a combination of the subjective personal, possessive, and reciprocal possessive:

ish im itti̱ nukha̱kloh,	you have pity on each other for him.
il im itti̱ nukha̱kloh,	we have pity on each other for him.
hvsh im itti̱ nukha̱kloh,	" " "

§ 22. Relative pronouns. The article-pronouns supply the place of the relative pronouns, which are not found in Choctaw. This use of the article-pronouns will be seen in the following examples:

Nom. case.		Oblique case.	
Alvm vt,	Adam he who,	Alvm ą,	Adam him, whom.
If vt,	Eve she, who,	If ą,	Eve her, whom.
lukfi vt,	clay it,	lukfi ą,	clay it.
Alvm ak osh,	Adam, he who,	Alvm ako̱,	Adam, him whom.
If ak osh,	Eve, she who,	If ak o̱,	Eve, her whom.

§ 23. Interrogative and responsive pronouns. The interrogative pronouns kvta, nanta, katima, who?, which?, what?, have two forms, one for interrogation, the other for response. They both take the article-pronouns, like the other separable pronouns, to indicate case. Examples:

interrog.	kvta hosh ik bi? Who made it? (osh or hosh is the subjective or nominative suffix).
respons.	kvna hosh ik bi tuk. Some one made it.
interrog.	nanta hosh minti? What is coming?
respons.	nana hosh mintih. Something is coming.
interrog.	katimak osh achukma? Which of them is good?
respons.	kanima kia achukmah. Any one of them is good.
interrog.	katimampo hosh ia chi̱ ho̱? Which (of the two) will go?
respons.	kanimampo hosh ia hinlah. Either of them will go.
interrog.	katima hosh bvnna? Which of them (all) want it?
respons.	kanimik vt bvnnah. Several of them want it.

Oblique case. kvta ho ish pisa̱ tuk o̱? Whom did you see?
nanta ho chibunnah? What do you want?
katimak o̱ ish chumpa tuk o̱? Which did you buy?

A definite interrogative ends in an aspirate, as, chi bvnnah? Do you want it? A distinctive interrogative ends in a nasal, as, chi bunną? These pronouns may also be subjective, as, nanta hosh yohma wah, nothing could do it; nanta hakosh yohma wa, no one could do it.

§ 24. Demonstrative pronouns. These are used to supply the want of a personal pronoun in the third person singular and plural. They are:

ilvppa, this, these, he, she, it, they (near).
yvmma, that, those, he, she, it, they (remote).

Their plural is sometimes formed by adding the word putta, all. They take the article-pronouns, and are declined by it. Examples: Gen. XIV. 20, yvmmak ak, who; Gen. IV. 2, yvmmak okvt, which; Luke XVI. 27, yvmmak oka, him; Luke XVI. 28, yvmmak mvt, they also; 29, yvmmak o, them.

§ 25. There are other words used as pronouns, some if not all of which can be also used as verbs and adjectives. They are:

chvfa, one, a certain one, the one, the other.
achofona, any.
achvfaiyuka, each one.
achafoa, some, a few.
aiyuka, each, every.
bika, each, same, both, fellow, Mark IX. 33.
inla, other, another.
inli, self, itself.
itatuklo, both, two together.
luna, many.
kanimona, some, several, from kanimi to amount to, and ona some.
kanimusi, a few.
mih, he, she, it, the same, the identical one, they.
mika, each.
moma, all.
okla, a people, they; used to form the plural of nouns.
okluha, all, the entire crowd, number, or quantity.
puta, all, each and every one; used to form the plural of nouns.
vhleha, all collectively, of persons only.

DECLENSION OF THE PERSONAL PRONOUNS.

1st personal singular.

Nom., I,	sia; vno; li.
Oblique, me,	s, sa, sv, sai, si; vno.
Possessive, mine,	sa, sam, svm, svmi, san; vmmi; vno.

1st person plural.

	Definite form.	Distinctive form.
Nom., we,	pia; pishno; e, il.	hipia; hvpishno; eho, iloh.
Oblique, us,	pi, p; pishno.	hvpi, hvp; hvpishno.
Poss., our, ours,	pi, pim, pimi, pin; pimmi.	hvpi, hvpim, hvpimi, hvpin; hvpimmi.

2nd person singular.

Nom., thou,	chia; chishno.
Oblique, thee,	chi, ch; chishno.
Poss., thy, thine,	chi, chim, chimi, chin; chimmi.

2nd person plural.

Nom., you,	hvchia; hvchishno.
Oblique, you,	hvch, hvchi; hvchishno.
Possessive, your, yours,	hvchi, hvchim, hvchimi, hvchin; hvchimmi.

CHAPTER III.

VERBS.

§ 1. There are six classes of verbs in Choctaw, the transitive, intransitive, passive, possessive, attributive, and personal.

§ 2. The passive verb is made by an internal change of the transitive; but this rarely takes place except in verbs where the transitive effects a visible change in the object acted on. Thus, takchi, to tie; tvllakchi, to be tied; sa tvllakchi, I am bound; but pisa, to see; sa pisa, he sees me, not I am seen. The passive is formed so variously that rules are not attempted. The following examples will illustrate this: hofahli, to abash, passive, hofahya; okpvni, to abuse, pas. okpvlo; atokoli, to aim, pas. atokoa; atokoli, to appoint, pas. ulhtoka; okchali, to awake, pas. okcha, siteli, to bind, pas. sita; hopi, to bury, pas. hollohpi; akvlli, to cobble, pas. ulhvta; ikbi, to build, toba, to be built; hukmi, to burn, holukmi, to be burned; chanli, to chop, chaya, to be chopped; bohli, to beat, boa, to be beaten; bvshli, to carve, bvsha, to be carved. Some passives are made by prefixing lh, a locative and intensive particle from vlhi, it may be, to the active; as, tohno, to hire, ilhotno, to be hired; ipeta, to feed, ilhpita, to be fed; apoa, to give in marriage, passive, vlhpoba; abeha, to enter a place, passive, vlhbiha.

§ 3. The possessive verb is formed by prefixing the inseparable possessive pronouns to other verbs. Thus, ihikiah, he has him standing; imantah, he has him staying; intalaiah, he has it standing (like water in a vessel); imachukmah, he has good, there is good for him; intobah, he has it made; imokpuloh, he has evil, he is evil.

§ 4. The attributive verbs affirm attributes or qualities, and are often used as adjectives and adverbs; as, kullo, to be strong; sa kulloh, I am strong; achukma, to be good; sa achukmah, I am good. The possessive pronouns are affixed to these verbs, as vm achukmah, I have a good one; a falaiah, I have a long one, or it is long for me.

§ 5. The personal verbs take the objective inseparable pronouns; as, sa lakshah, I perspire; svllih, I die; sanusih, I sleep; saiokchayah, I live; sa hoitah, I vomit. When the act is involuntary, sometimes a change in the form of the verb occurs; as, hoeta lih, I vomit it up; hotilhko lih, I cough; habishko lih, I sneeze; fiopa lih, I breathe.

§ 6. All verbs end in the infinitive in i, a, or o. They all have an affirmative and negative form in all moods and tenses. This is made by means of the negative prefix ik, and by changing the terminal vowel to o when it is i or a; when it is o, it undergoes no change. Thus, anta, to stay; ik anto, not to stay; minti, to come; ik minto, not to come; ik ishko, not to drink.

Both forms take the inseparable pronouns as prefixes, and the article-pronouns as suffixes, but both classes of pronouns are written separately, as far as may be. Thus, chi pisa lik vt, thee see I who, I who see thee.

§ 7. The modes. There are six modes, the infinitive, indicative, potential, subjunctive, optative, and imperative.

§ 8. THE INFINITIVE MODE.

This is the root or ground form of the verb, from which the other modes are formed by suffixes. It can be used as a noun, or in an adverbial sense, takchi, to tie, a tier, the act of tying; hvllot takchi, to tie strongly. It takes the inseparable pronouns and the prepositions as prefixes, and the article-pronouns, and particles of tense as suffixes. Examples: chi takchi, to tie thee; chin takchi, to tie for thee; ille takchi, to tie himself; itti takchi, to tie each other; iti̱ takchi, to tie them to each other; a takchi, to tie at; on takchi, to tie on; isht takchi, to tie with; ant takchi, to come and tie; ont takchi, to go and tie; et takchi, to tie hither; pit takchi, to tie thither; takchi a̱, to tie him to the; takchi ma, to tie simultaneously; takchi ho̱, to tie distinctive; takchi tuk, takchi tok, to have tied; takcha chi̱, takcha he, to tie in the future; takcha chin tuk, to be about to have tied; takchi tuk achi̱, to have been about to tie.

The English infinitive is sometimes translated by the indicative: as Mat. V. 17, okpvni la hi osh a̱ya li tuk keyu; amba aia̱hlichila̱ he mak a tok, I am not come to destroy but to fulfil; sometimes the English indicative is translated by the infinitive; as Mat. XI. 30, vm ikonla abana ya̱ il abanali ka im vlhpiesa, to put on himself my yoke is easy for him.

The negative form is made by the prefix ik, and the change of the last vowel to o, and corresponds to the English prefixes dis, un, in, etc.; as, iktakcho, not to tie, to untie; haklo, to hear, ikhaklo, not to hear.

§ 9. Modifications of the verb. There are numerous modifications of the ground form or infinitive mode of verbs, each of which forms a new infinitive from which other modifications may arise. Some of the modifications are by internal changes, others by adding a particle. They are:

1. The definite form, takchi, to tie.

2. The distinctive form, ta̱kchi, to be tying the while; implying continuance, prominence, and comparison.

3. The intensive form. This is made in various ways:

1. By an increase of emphasis on the accented syllable of a word; as, tóokbah, to be *so* bad; tákchi to *tie*.

2. By lengthening the vowel sound in the accented syllable; as, chito, to be large, cheto, to be quite large; patvssa, to be flat, patassa, to be quite flat.

3. By inserting a syllable; as, taiyakchi, to tie; chieto, to be decidedly large.

4. By prefixing the diphthong ai to words beginning with a vowel; as, ahli, to be true, aiahli, to be really true; sometimes i is prefixed, as iiksho, to be none indeed.

5. By prefixing **a** to words beginning with a consonant; as bilia, to be forever, abilia, to be forevermore.

6. By doubling a consonant in the accented syllable; as, alota, to be full; allota, to be brimful; kvnia, to be gone, kvnnia, to be gone off.

7. By inserting a consonant in the final syllable; as, chukva, to go in, chukowa, to go in boldly; ihoa, to call him, i howa.

8. By prefixing ai and inserting another vowel; as, ulhpisa to be right, aiulhpiesa, to be just right.

9. By uniting two verbs; as, ishkottahli, to drink all up; vbitkanchi, to massacre.

4. The frequentative or iterative form; tahakchi, to keep tying.

5. The instantaneous or quick form, by the insertion of h in the accented syllable; as, tahkchi, to tie quickly; vbi, to kill; ahbi, to kill quickly; also the form ahahbi; kvnia, to go away, hvninihya, to vanish.

6. The form for a sudden and single act; as shalvlli, to slide, shalakli, to slip; halvlli, to hold, halakli, to catch hold of.

7. The diminitive form in neuter and attributive verbs; as, chito, to be large, chihto, to be largish; hopaki, to be far off, hopahki, to be rather far off; lakna, to be yellow, lahakna, to be yellowish.

8. The repetitive form, to continue an action in one place and one manner; as, binili, to sit, binininli, to rise up and sit down again; tonoli, to roll, tonononli, to roll back and forth.

9. The causal forms, 1, by suffixing chi; as, takchichi, to make him tie; ikbichi, to make him do or make, Mat. V. 32; 2, by suffixing chechi; as, ishko, to drink, ishkochechi, to make to drink, to drench; 3, by suffixing chi and prefixing a, locative; as, atakchichi, to tie it to something; 4, by suffixing li; as, achukmali, to make good; lvshpali, to make hot, to heat. Of these suffixes, chi denotes the causing of the action signified by the primitive verb; as, kvllochi, to harden, from kvllo, to be hard; kolichi, to cause to break, from koli, to break; chechi suffixed to a verb denotes the causing by its own subject of the performance of the action signified by the verb by another subject on an object expressed or understood; as, vno vt vlla ya ikhish a ishkochechi li tuk, I the child him the medicine it did cause him to drink; nafoka ya fohkvchechi lih, I made him put his clothes on himself; chi with a, locative, signifies that two different things are acted upon together, as Mat. XIII. 25, onush ash haiyukpulo yo ant a hokchichi cha, kvnia tok, he came and sowed tares among the wheat, not wheat with wheat but tares with wheat; akakushi yo shuka nipi a aiauvshlichih, she fries (causes to fry) eggs with pork.

The suffix kachi, kechi, kvchi, is added to many verbs slightly altering their sense; as, winali, to shake, winakvchi, to be shaken; basasua, to have stripes, bassasu kvchi, to be striped like a rattlesnake; malvtha, to lighten, malvthakvchi, to flash once; bichota, to bend, bichotakvchi, to bend and spring once.

Note.—Verbs may have all the above forms, but the number of verbs found in all these forms are small.

Example, takchi, to tie, infinitives.

Active:

Definite	takchi, to tie.
Distinctive	ta̱kchi, to be tying.
Intensive	taiyakchi, to tie firmly.
Frequentative	taha̱kchi, to keep tying.
Speedy	tahkchi, to tie instantly.

Passive:

Definite	tvllakchi, to be tied.
Distinctive	ta̱llakchi, to be the one being tied.
Intensive	talaiyakchi, to be tied fast, or at length.
Frequentative	talaiyaha̱kchi, to be often tied.
Speedy	talahkchi, to be instantly tied.

§ 10. INDICATIVE MODE.

This is formed from the infinitive by prefixing and suffixing the personal pronouns, and suffixing the tense particles for past and future time.

1. Present tense, indefinite, with subjective personal pronouns.

takchih,	he, she, or it ties, or they tie, him, her, it, or them.
ish takchih,	thou tiest him, her, it, or them.
takchi lih.	I tie, etc.
hvsh takchih,	ye tie, etc.
e takchih,	we tie, etc. (def).
eho takchih,	we tie, etc. (dis).

2. Pres. tense, definite, with subj. pers. pronouns.

takchishkeh,	third sing. and pl.

To this the pronouns are added as in the indefinite.

3. Pres. tense, distinctive, with subj. pers. pronouns.

takchih okeh,	third sing. and pl.

To this the pronouns are added as above.

4. Pres. tense, with objective pers. pronouns.

chi takchi lih,	I tie thee.
takchi lih,	I tie him, her, it, or them.
hvchi takchi lih,	I tie you.

5. Pres. tense, with possessive pronouns.

in takchi lih,	I tie for him, her, it, them.
chin takchi lih,	I tie for thee.
hvchin takchi lih,	I tie for you.
in takchih,	he ties for him, her, it, them.
chin takchih,	" for thee.
an takchih,	" for me.
hvchin takchih,	" for you.
pin takchih,	" for us.
hvpin takchi,	" for us.

Past tenses. There are two past tenses, signified by the particles tuk and tok; tuk is used for the immediate and definite past, tok for the remote and indefinite past. They may be combined to form the relative or pluperfect past; as, tuk a tuk, tuk a tok, tok a tuk. The particle **a** in these expressions is an article-pronoun, and should be rendered thus: he, she, it was.

Past tense definite.

takchi tuk,	he, she, it, they tied, did tie, have tied.
ish takchi tuk,	thou "
takchi li tuk,	I.
hvsh takche tuk,	you.
e takche tuk,	we.
eho takche tuk,	we, etc.

Past tense distinctive.

This is formed by the article-pronoun, okeh.

takchi tuk okeh, he, etc., tied, did tie, has tied.

Another form of the past tense is made by a nasal sound in the fina vowel, as, takchi̱, chamo̱.

Future tense.

There are two forms of the future, made by the addition of chi̱ for the immediate, and he, or hi, for the remote and indefinite future. The distinctive future is made by suffixing okeh to chi̱ and he; as, chi̱ okeh, hi okeh.

The suffix ashkeh is used for the definite, absolute, or imperative future.

The past and future are combined to form a relative future; as, tuk a chi, tuk a he, tuk ashke, was to tie; also chin tuk, chin tok, he tuk, hitok, will have, shall have, would have, should have.

§ 11. POTENTIAL MODE.

This is formed from the infinitive by suffixing the articles hinla, may, can, and pulla, must, will.

Present tense (but with reference to future time).

Indefinite	takcha hinlah,	he, etc., may or can tie.
Definite	takcha hinlvshhe,	he, etc., may or can tie.
Distinctive	takcha hinla hokeh,	he, etc., may or can tie.
Indefinite	takchi pullah,	he, etc., must or will tie.
Definite	takchi pullvschkeh,	he, etc., must or will tie.
Distinctive	takchi pulla hokeh,	he, etc., must or will tie.

The past tenses are formed like those in the indicative mode, the tense signs being suffixed to hinla and pulla; as, takchi la hinla tuk, I may or might have tied.

§ 12. SUBJUNCTIVE MODE.

This is formed from the infinitive by suffixing km for the definite and okm for the distinctive. The m takes the definite article-pronoun **a** in all its forms.

Note.—km, if, when, whether, is compounded of k, a suffix, definitive of the idea contained in the verb; as, takchik, he ties, at that, in that, or just that; and of m, simultaneous or successive, affirming or supposing something in relation to the idea limited or bounded by k, then, when, at the same time or place; takchi km, when he ties then.

This suffix can be added to the other modes in all their tenses; as, infinitive, takchi kma, if to tie him, when to tie him; indicative, takchi kmah, if or when he ties him; potential, takcha hinla kmah, if he can tie him.

Present tense.

takchikmvt,	definite subjective,	if he, etc., tie, then he.
takchikmah,	definite objective,	"
takchihokmvt,	distinctive subjective,	"
takchihokmah,	distinctive objective,	"

The past and future tenses are inflected with the personal pronouns as in the indicative, except the forms which end in eh. These are always final, and admit of no suffix nor inflections.

In the past tenses, tuk and tok, the k in kmvt, kmah, etc., is dropped, that in the tense particle taking its place. In the remote future, he, the distinctive form is not he okmah, but hokmah.

The distinctive form okm expresses a condition or supposition with more emphasis, and implies a greater degree of uncertainty than km; as, infinitive, takchi hokma, to tie him, if so; indicative, takchi li hokmah, I tie him, if so it be; takchi la hinla hokmah, I tie him if it can be so.

Examples: Romans XII. 20, chin tvnvp vt hohchvfo hokma; if thine enemy hunger; John XVI. 7, vno vt ia li keyu hokmvno, if I go not away; same verse, amba ia li hokmvto, but if I do go away; Mat. IX. 12, amba abeka yok mak oh chatuk oke, but they (distinctive) who are sick; Luke XVI. 30, im ona hokmvno, if one went unto them, then; Mat. XI. 15, haksobish vt i̱ hinlikmvt, if he have ears, definite; John XIX. 12, ish i̱ hotofi hokmv, if thou lettest him go, distinctive; Phillip II. 1, a̱sha hokma, if there be, a suppositive form; I. Cor. XIII. 8, nan ithana yokmá, whether there be knowledge, a suspensive form.

§ 13. OPTATIVE MODE.

This is formed from the infinitive by suffixing kb definite and okb distinctive. The particle b takes the article-pronoun **a** in its definite and contradistinctive forms, babato, babano, and **o** distinctive and emphatic as a prefix, in distinctives and contradistinctives.

takchikbat,	definite subjective,	oh ! that he, etc., would tie it, then he.
takchikba̱h,	definite objective,	"
takchikbato,	contradistinctive subjective,	"
takchikbano,	contradistinctive objective,	"
takchihokbat,	distinctive subjective,	oh ! that he, etc., would tie, even he, then he.
takchihokbah,	distinctive objective,	"
takchihokbato,	contradistinctive subjective,	"
takchihokbano,	contradistinctive objective,	"

Examples:

Subjective form: shukbo chumpak bato, oh! that he would buy a blanket, (and take it home and wear it, etc).

Objective form: shukbo chumpak bano, oh! that he would buy a blanket, (then others might buy).

Contradistinctive subjective:

shukbo chumpa hokbato, oh! that he would *buy* a blanket, (instead of borrowing one), and do something else, wear it, etc.

Contradistinctive objective:

shukbo chumpa hokbano, oh! that he would *buy* a blanket, then others would come and buy, or do something else.

Luke XIX. 42, nana isht chi ai yukpa he ai ulhpiesa ka ish ithaiyna tokokbato, if thou hadst known, or, oh! that thou hadst known; even thou, then thou, etc. Iali hokbat, I wish I could go and I (do something); iali hokbah, I wish I could go and he (do something).

The persons, tenses, and numbers correspond with those in the indicative mode.

§ 14. IMPERATIVE MODE.

Affirmative:

ik takchih,	let him, her, it, or them tie.
takchih,	tie thou.
ak takchih,	let me tie.
hvsh takchih,	ye tie, tie ye (def).
ho takchi,	ye tie, tie ye (dis).
ohiah,	go ye (dis).
ke takchi,	let us tie (def).
keho takchi,	let us tie (dis).
kiliah,	let us go (def).
kilohiah,	let us go (dis).
takchashkeh,	let him, her, or them tie.

The particle ashkeh is suffixed to the infinitive in the last word to express an imperative in the shape of a wish.

The imperative negative is formed by changing the terminal vowel of the verb into o, and suffixing the particle kia; or particles of negation may be used, such as na, wa, heto, he, keyu.

Examples:

ik takcho kiah,	do not let him tie.
ish takchi nah,	don't you tie him.
ish takcha wah,	you will not tie him.
ish takcha heto,	you shall not tie him.
ish takcho he keyu,	you shall not tie him.

Double negatives may be used, not, not no; as:

ak takcho ki nah;
ak takcho ka wah;
ak tokcha ka he keyuh.

Compare Luke VII. 39, ik akostinincho ka heto, he would not have not known, *i. e.*, he would have known.

§ 15. IRREGULAR VERBS.

The irregular verbs are: vbi, to kill; vmo, to trim, to mow; vla, to arrive; vpa, to eat; ia, to go. The vowel v in these verbs is dropped in a part of the persons in both numbers; thus:

Affirmative form.

vpah,	he, etc., eats, *i. e.*, of one article of food.	vbih, he kills.
ishpah,	thou eatest.	ish bih, thou killest.
vpalih,	I eat.	ube lih, I kill.
hvshpah,	you eat.	hvsh bih, you kill.
epah,	we eat (def).	ebih, we kill.
iloh vpah,	we eat (dis).	iloh vbih, we kill.

Negative form.

ik poh,	he does not eat.		ik boh.
chik poh,	thou		chik boh.
ak poh,	I		ak boh.
hvchik poh,	you		hvchik boh.
ke poh,	we	(def).	ke boh.
kiloh poh,	we	(dis).	kiloh aboh.

In the frequentative form of these verbs, the pronouns in the second person singular and plural are modified thus: ahanla, ihishla, sing., ahashlah, pl.

ia, to go.

Affirmative form.		Negative form.
iah,	he goes,	ik aiyuh.
ish iah,	thou goest,	chik aiyuh.
ialih,	I go,	ak aiyuh.
hvsh iah,	you go,	hvchik aiyuh.
il iah,	we go,	kil aiyuh.
iloh ia,	we go,	kiloh aiyuh.

iksho, to be none, may be a negative form of vsha or asha.

It is conjugated:

ikshoh,	he is not, there is none.
ikchikshoh,	thou art not.
iksakshoh,	I am not, etc.
	and:
ik im ikshoh,	he has not, there is none for him, etc.

Keyu, not to be, has no modifications except h predicative, and the causatives chi and kechi; as, keyuchi, to make it nothing; keyukechi, keyukma, if not, or. Kia, although, is perhaps an imperative form of ia, to go, ikiah, let him or it go. It has no variation except to take h predicative, kiah, although it be.

§ 16. It will be seen that verbs have usually but one form for both singular and plural numbers. Some verbs, however, have a plural, made by an internal change; as, hikah, it flies; helih, they fly; binilih, he sits; binohli, they sit; talahlih, he sets it up; talohlih, he sets them up; kopoli, to bite, plural, kobli; kanchi, to sell, plural, kampila; bohli, to lay down, plural, kapulli; tifi, to pluck up. plural, tehli; malleli, to run, plural, yihlepa. Some verbs have this plural form only; as, ilhkolih, they move off; pehlichi, he rules them; chiyah, they sit. Some have the singular number only; as, issoh, he strikes once.

Some few verbs are dual; as, tihlaiah, they two run; ittonachih, they two go there together.

The inseparable pronouns determine the number of the verb in the first and second persons. The third person singular and plural has no personal pronoun; okla is sometimes used as a singular, dual, and plural pronoun; as, anumpulit okla tok, they two spake.

Note.—By a verb in the plural is meant plurality either in the subject or object; as, wak pelichih, he or they drive cattle, and wak a̱ chuffichi, they drive a cow. Here pelichih is in the plural number, and chuffichi in the singular.

CHAPTER IV.

PREPOSITIONS.

§ 1. There are few words in Choctaw that correspond to the English prepositions. The article-pronouns to some extent supply this want. Some verbs involve a preposition in their meaning; as, ona, to go to; vba, to arrive at; bokyupi, to bathe in the creek; hu̱sa, to fire at. The inseparable possessive pronouns i̱, im, in, involve a preposition, to him, for him, of him, from him, against him; so also do the reciprocal possessives, itti, ittim, ittin, to each other, for each other, etc.

The preposition, to, in the infinitive is contained in the simple form of the verb; takchi, to tie. The preposition of, showing the genitive or possessive case is understood; iti hishi, leaf of a tree. When one of the nouns expresses ownership in the other, the inseparable possessive pronoun is used; as, vlla i̱ holisso, the child its book.

§ 2. As the Choctaw is deficient in single words expressing space and time, it uses in place of them prepositive particles of definite significations. These are:

1. Locatives.

They are: a, before consonants; ai, before vowels, and before y. This means the place for, in which, at which, from which, to which, where, there, then; as, afoha, to rest at or in a place, a time for resting; aminti, to come from; ahikia, to stand in; aianta, to stay at or in; ai impa, to eat at or there; ai illi, to die in a (room, etc.), or at (noon, night, etc.); aianuk filli, to think of; aiahni, to long for; ayukfa, to rejoice at.

o̱, om, on. This is a more definite locative than a, ai, and may be translated by on or upon; as, onbinili, to sit on; ontalali, to ride on; oyihlepa, to rush upon; ontalali, to set on or upon.

2. Distinctives:

Et, anet, here, hither, to this place; et is the simple form, anet the intensive; et is from the verb echi, to reach, hand, or hold this way, to pass in this direction, intensive form anechi. These particles are transitive verbs, and are connected by the letter t with other verbs. Echi has the form of a causative verb, ishtishko a̱ echih, pass the cup hither. Examples: et kanchi, to cast it this way; et anoli, to report hither; et anuk filli, to think this way; awethikia, to stand this way, toward the speaker.

Pit, thither. This is a subjective directive (made so by the t). It is from the verb pila, to send off, or throw, from the speaker to some other point. Examples: pit kanchi, to throw that way; pitanoli, to report it thither; pit anukfilli, to think of thither; pit hikia, to stand or lean that way.

3. Instrumental:

Isht, with. This is derived from the verb ishi, to take, with t distinct tive and continuative. Its literal meaning is often lost in the many uses it has as a prefix. Examples: ishtabeka, to be sick with; ishtanowa, to walk with; ishtan umpuli, to talk of; ishtanuk filli, to think about; isht-holitopa, to take it and be rich.

4. Of motion.

Ant, from a̱yvt, means motion hither, to a place; as, ant anta, to come and stay.

Ont, from onvt, means motion thither to a place; as, ont anta, to go and stay.

5. Social.

Iba, with, in company with, awaya, to go with, awant, to bring with. Examples: ibatoksvli, to work with; ibapisa, to see with, a school-mate; itanowa, to travel together, a fellow-traveler; awantanta, to stay with; awantia to go with, awaya, to marry, fem. *i. e.*, she married him; itawaya, he marries her, or they marry.

6. The war or fire particle:

This is ito, before a consonant; it, before a vowel. This particle implies mutuality of action between the fire and what is put on it, or between those who kindle fires in a hostile manner against each other. Examples: oti, to kindle a fire; itoti, to fire each other; itotia, to go to war; itota̱ya, to wage war by fires. It is used in the New Testament, Mat. VII. 50, tvli a bila luak chito ka̱ pit ito—ashacha he, to cast them into the furnace of fire. This particle ito may help us to understand how wars were formerly waged by fire rather than by weapons, these being very imperfect in construction, while fire was always at hand.

§ 3. These particles have various combinations with each other; as, aio̱, aiom, ai on, ont ai, ant ai, ont isht, ant isht, isht o̱, etc., but as they are written separately, they can be readily understood. Examples: ont ai isht ia, go and of it take and go; isht im ai achukma hokeh, they take and in them have pleasure, it is so; ishtai o̱ holissochi, to write on it therewith.

CHAPTER V.

NOUNS.

§ 1. In Choctaw there is no grammatical difference between common and proper, animate and inanimate, concrete and abstract nouns. They have no internal changes nor inflections to denote number, gender, or case. These accidents are supplied by additional words, or are left unexpressed.

§ 2. Number.—Nouns are presumed to be in that number which is most natural to them. If the number is required to be specified, numerals, numeral adjectives, pronouns, or verbs are subjoined. Examples: wak, a cow, cows; wak achofa, one cow; wak tuklo, two cows; wak lawa, many cows; wak moma, all the cows; wak vmmi, my cow or my cows; hatak vt antah, a man stays; hatak vt a̱shah, men are staying; wak vt tihlaiah, the two cows run.

§ 3. Gender.—A few nouns only have names in the masculine and feminine gender; as, hatak, a man; ohoyo, a woman; nakni, a male; tek, a female. When gender is emphatic, these words, nakni, and tek, are subjoined; as, vlla nakni, a boy; vlla tek, a girl; issinakni, a buck; issi tek, a doe.

§ 4. Case.—All nouns take article-pronouns for specification, emphasis, and case. The subjective relation of a noun to a verb is indicated by the article-pronouns in the nominative case; the objective relation by the article-pronouns in the oblique case. A noun, however, is often used by itself, without the article-pronoun, and may then be either in the nominative or oblique case, the connective alone deciding which, though usually it is oblique. Examples: hatak vt mintih, man he comes; hatak mintiah, man comes, or men come; hatak vt pisah, a man sees, or men see; hatak a̱ pisah, man him (or men them) he sees.

§ 5. The nominative and oblique independent. This occurs when two nouns or pronouns are in a subjective or objective relation to the same verb. In this case the first is emphatic or independent; as, hatak okvto i̱ nitak vt hvshvk ak o̱ chiyuhmi hokeh, man as for, he for him, days they, grass, that which is, like they are, so it is.

hatak	achvfa	hosh	ushi	vt	in	tuklo	tok,
man	a certain	he	sons	they	to him	two	so it was.

In these sentences, hatak okvto and hatak achvfa hosh, are in the nominative case, and nitak vt and ushi vt, are also in the nominative case. So in the oblique case:

hvchishno ma,	isht hvchi̱,	mihacha he,
you indeed,	you,	it shall not be judged to, or you, you shall not be judged.

§ 6. The possessive or genitive sense.

Possession may be shown by simple position; as, iti hishi, tree leaf, the tree's leaf; hatak kvllo, man strength, the man's strength, a man of strength; Chahta okla, the Choctaw nation, miko ibbak, king hand, the king's hand.

Where there is an acquired possession, the inseparable possessive pronouns i, im, in, are inserted between two nouns; as, Chan in chuka, John his house. It is probable that the method of indicating possession by position arose from an elision of this pronoun, as this method is most frequent in names of the human body and its members, of near relatives, in nominative and oblique independent nouns, and generally in such as are obviously integral parts of each other, or by nature closely connected. Examples: miko ibbak, the king (his) hand; miko ushe, the king (his) son; iti vni, a tree (its) fruit; iti hakshup, a tree, its bark; wak pishukchi, a cow (her) milk.

Names of time take the possessive pronoun; as, i̱ nitak, his day or days, which might also be regarded as i̱ dative, to him, for him, as in wak i̱ kanchi, he sells a cow to him or for him.

§ 7. The objective (accusative and ablative) sense.

This is made by article-pronouns subjoined to nouns; as, hatak a̱, man him, man whom, man that. In forming the ablative of time, place, cause, the verb, not the noun, takes the preposition; as, hatak vt a̱ hikiah, the man stands in a place; isht ikbih, he makes it with. The vocative can be indicated by the particle mah; as, miko mah, O king.[1]

§ 8. Classes of nouns.

The nouns are either primitive or derived. The former cannot be traced to any root; such are, oka, water; tvli, a stone; hatak, a man; ibbak, the hand; the latter are derived from verbs, adjectives, other nouns, etc.

§ 9. Derived nouns.

The following examples will show the derivation of nouns:

From transitive verbs:

chanli, to chop, chanli, a chopper, the act of chopping.
bvshli, to saw, a sawyer, the act of sawing.

From intransitive verbs:

nowa, to walk, a walk, the act of walking.
pisa, to see, a seer, a sight.

From passive verbs:

talakchi, to be bound, a bundle.
holitopa, to be honored, honor.
kvnia, to be lost, the loss, the act of losing.

[1] In one portion of his manuscript Mr. Byington propounds the following query: "Cannot all Choctaw nouns be treated as verbs? The root may be considered as in the infinitive mood; as, hatak, to be a man; hatak', it is a man; hatak okmvt, if a man." Prof. H. Steinthal, on the contrary, thinks that the peculiar formation of American tongues makes nouns, but no real verbs. He says of the Aztec: "das Mexikanische in seinem Ansatze zur Wortbildung Nomina gebildet hat, aber keine wahrhaften Verba" (*Charakteristik des Sprachbaues*, s. 218). The author of *Etudes philologiques sur quelques Langues Sauvages de l' Amerique*, p. 38, says: "Les noms algonquins ne se déclinent point, ils se conjuguent." Prof. Steinthal, however, is right. The primitive expressions in these languages are concrete, not abstract,—nouns, therefore, not verbs.

From neuter verbs:
 kvllo, to be strong, strength.
 ahli, to be true, truth.
From verbs with the locative particle a or ai:
 achanli, a chopping place.
 impa, to eat, aiimpa, a table.
 apisa, a looking glass.
 abvsha, a saw-pit, from bvsha, to be sawn.
From verbs with the particle isht instrumental:
 isht bvsha, a saw.
 isht talakchi, a band.
From verbs with the particle na or nanta:
 nakanchi, a seller, from kanchi, to sell.
 nanithana, a pupil, from ithana, to learn.
From verbs with the definitive particle ka or kakah:
 falamaka, the return, from falama, to return.
 chukbika, a corner, from chukbi, to be a corner.
 lapalika, the side, from lapali, to be the side of.
 chitokaka, the Great One, God, from chito, to be great.
From the verb ahpi, to be first in time:
 achafahpi, the first one.
 ishahpi, the first taken.
 tofahpi, to first of summer, the spring.
 hushtolahpi, the first of winter, the autumn.
 vttahpi, the first-born.
With ushi, a son, to make a diminutive:
 bokushi, a brook, lit., son of a creek.
 hinushi, a path, from hina, a road.
 ibbakushi, the fingers, from ibbak, the hand.
 iyushi, the toes, from iyi, the foot.
With vpi, a stalk, stem, trunk of a tree, main channel of a river, etc:
 iyvpi, the leg.
 bissvpi, a briar, bramble.
 hatakvpi humma, a red man, an Indian.
From the union of two nouns:
 bila pvla, lamp-oil.
 hvpi oka, brine, salt water.
 iti hishi, leaf, leaves.
 nishkin okchi, tears.
From the union of three nouns:
 chukfi hishi shapo, a wool hat, sheep-hair-hat.
 wak hakshup shukcha, a saddle-bag, cow-skin-bag.
From a noun and an adjective:
 bota tohbi, flour, white-flour.
 hvpi champvlli, sugar, salt-sweet.

From two nouns and an adjective:
issuba haksobish falaia, a mule, horse-ears-long.
From a noun and a verb:
iti bvshli, a tree-sawyer.
shapo ikbi, a hat-maker.
shulush ikbi, a shoemaker.
From two words connected by an article-pronoun:
kanchit ąya, a peddler, one that sells and goes.
mvllit kvnia, a runaway, one that runs and is gone.
From two nouns and a verb:
bila pvla ikbi, a lamp maker.
lukfi ampo ikbi, a potter.[1]
Other combinations are also in use.

10. Abstract nouns.

These are usually formed from neuter verbs; as, kvllo, to be strong, strength; achukma, to be good, goodness; ahli (distinctive form of vhli, edge, end, point, limit), to be true, truth.

The translators of the New Testament rarely, however, use these words alone, but combine others with them.

For example:
nayimmi, faith, I. Cor. XIII. 13.
nannihullo, love.
nanisht i̱ hullo, love.
nanithana, knowledge, 2 Pet. 1, 5.
ishtaivlbi, redemption.
isht aholitopa, glory, Mat. VI. 13.

Often circumlocutions are used; as,
nan-isht hvsh il a nanaiya, your peace, lit., the thing by which you have peace in yourselves, Luke X. 6.

The suffix nana or nan gives an intensive signification; as,
nani̱hullochi, accursed thing, Joshua VII. 13.

§ 11. Proper nouns, and terms of relationship.

These take the article-pronouns, and are construed like common nouns. Some proper nouns are simple, others compound. Chahta, Mvskoki, Chalaki, Wishashi, Shawvno, are simple, uncompounded names. Bulbancha, the Choctaw name of New Orleans, is compounded of bvlbaha ąsha, where there is bvlbaha, unintelligible talking in different languages, as in Babel of old.

Apalachicola,	apelvchi okla,	helping people, allies.
Pensacola,	pąshokla,	hairy people.
Pascagoula,	pvskokla,	bread people.
Tombigbee,	itomikbi,	box makers.
Bok humma,		Red river.

Boktuklo, river two, applied to a creek the channel of which is divided by an island.

[1] A number of words have been adopted from the English, and a few from French and Spanish. They all suffer some change. Thus, katus, a cat; shapo, chapeau; wak, vaca (Sp.); enchil, angel.

The terms of relationship are numerous, and differ materially in application from those used in the English tongue; as will be seen in the following list:

I. Kinship by blood.

1. In the male line.

vmafo, my grandfather, the father of my father or of my mother, their fathers, brothers, and male cousins.

aki, my father, his brothers, his male cousins, his uncles and nephews, their brothers and male cousins.

vmoshi, my maternal uncle, his brothers and male cousins.

akni, the eldest among brothers, and male cousins.

ushi, a son, *svso*, my son, son of the father, father's brothers, male cousins, son of the mother, her sisters and female cousins, son of the father's sister (said by this father's son).

sabaiyi, my nephew, a son of my sister or her female cousin.

sapok nakni, my male grandchild, my sister's male grandchildren, my brother's children (said by an aunt).

ittibapishi, brother, literally those who suck together, a general name for brothers and male cousins.

vmmvnni, my elder brother or cousin.

sa nak fish, my younger brother or cousin.

i *nak fi*, her brother, spoken by a woman.

2. In the female line.

vppokni, my grandmother, her sisters, female cousins and their mothers.

hvshke, my mother, her sisters, and female cousins.

ahukni, my aunt, her sisters and female cousins.

akni, the eldest child among sisters and female cousins.

vshetik, or *svsotek*, my daughter, the daughter of my sisters or female cousins, the child of my father's sister, her sister or her cousin.

sapoktek, my granddaughter, my sister's grandchildren, the female child of a brother's sister.

itte bapishi, sisters, female cousins, common gender.

vmmvnni, my eldest sister or cousin.

sanak fish, my younger sister or cousin.

antek, my sister or female cousin, said by a man.

II. Kinship by marriage.

hatak, husband, literally, her man.

tekchi, wife, *im ohoyo*, his woman.

svppochi, my father-in-law, said by the man.

svppochi, *ohoyo*, my mother-in-law, said by the man.

vmvfa, my father-in-law, said by the woman.

vppokni, my mother-in-law, said by the woman.

sayup, my son-in-law.

sapok, my daughter-in-law.

vmalakusi, my brother-in-law, brother of my wife.

vmalak, my brother-in-law, husband of my sister.

vmafo, my uncle, the husband of my aunt.

vmalakusi ohoyo, my sister-in-law, sister of my wife.

sahaiya, my sister-in-law, wife of my brother, also wife of my uncle, or of my nephew.

uppo, my sister-in-law.

sapok, my sister-in-law.

vshke, the wife of my father's brother.

haloka, a family name for son-in-law, father-in-law, and mother-in law.

While formerly the kinsmen (*iksa*) and the peoples (*okla*) had specific names, the family had none.[1] The names of individuals were significant of some trait or quality. Some of the masculine names mean Come and kill, Stand and kill, Kill all, Kill and go; some of the feminine names signify Giver, Bringer, She who loops up her hair, Take water and give him. In times of war brave men received titles, such as Red bird, Red knife, Red owl, etc.

The individual name is sacred, and is never used in common conversation; the name of relationship, my brother, my cousin, is used instead. The wife speaks of her husband as *vlla i̱ki*, the children's father.

The ancient law of marriage was that no man could choose a wife in his own *iksa*. Hence the matter of clan relationship became one of great importance, and upon it the terms of relationship in general were based. In common salutations, the husband addressed his wife's clan as vm okla mah, my people, but his own clan as vm ai okla mah, inserting the locative particle ai, with an emphatic sense.

Parents usually refer to their offspring as vlla, the child, or children.

There are no words, such as great-grand-father, great-grand-son, etc., to express relationship in the same line beyond grandfather and grandson. All ancestors and descendants more remote than these are called indiscriminately by these terms.

§ 12. Termination of nouns.

Nouns may end with the vowels a, i, o, u, and with the consonants f, h, k, l, n, p, s, and sh; fakit, a turkey, the only noun ending in t, is probably a borrowed word. Those which end with a consonant take the article-pronouns which begin with a vowel sound; as, at, vt, osh, ot, ocha, a̱, o̱, ona, or with the euphonic y; as, yvt, yosh, yocha, ya̱.

CHAPTER VI.

ADJECTIVES.

§ 1. The words used as adjectives, or attributes of nouns, are in reality verbs. All the classes of verbs are used to modify nouns, but the attributive neuter verb is that most frequently employed. When subjoined to

[1] The Choctaws were formally divided into two iksa, and three "fires" or districts. The latter were: okla falaia, the long people; ahepvt okla, potatoe-eating people; okla hannali, six peoples. The iksa lived promiscuously throughout the nation and their establishment was attributed to sacred authority. This information I owe to Col. P. P. Pitchlynn, a thorough native Choctaw scholar, who has kindly read the proof of Mr. Byington's Grammar with me.

nouns as adjectives, the verbs drop the inseparable and article-pronouns which belong to verbs alone, but continue to be modified by the internal changes of the verb.

§ 2. The adjective follows the noun it qualifies, and the article-pronouns subjoined to nouns are removed and placed after the adjective. Thus, hatak vt mintih, a man is coming; hatak achukma yvt mintih, a good man is coming. The adjective agrees with its noun in number and case.

§ 3. Affirmative and negative forms.

Adjectives are changed from the affirmative to the negative forms as verbs are. Thus, hatak kvllo, a strong man; hatak ikhvllo, a man not strong; ąhli, true; ikahlo, not true. A noun with its adjective may be conjugated like a verb through the modes and tenses in the affirmative and negative forms.

§ 4. Number.

Adjectives have a singular and plural number. The plural is formep from the singular by internal changes, and by the addition of other words. Examples:

Singular.		Plural.
achukma,	good,	hochukma.
chito,	large,	hochito.
falaia,	long,	hofaloha.
falvsa,	long and slender,	falvspoa.
pvtha,	wide,	hopvtka.
ibakchufanli,	tapering,	ibakchufashli.
ibakhatanli,	bald faced,	ibakhatashli.
ibakpishanli,	round and pointed,	ibakpashashli.
ibaktaṣanli,	starved in the face,	ibaktasashli.
yushkotoli,	short,	yushkotushli.
yushbonoli,	curly haired,	yushbonushli.
yushtololi,	short,	yushtolushli.
okchvmali,	green,	okchvmashli.

§ 5. Comparison.

The degrees of comparison are much more numerous than in English. They are expressed either by internal changes, or by the addition of other words. Example: achukma, good.

Descending graduation.

achukma ik ono,	not good enough.
achukma ik lawo,	less good.
achukma momaką ik lawo,	less good than all.
achukma iklawokit taha,	completely less good than all.

Positive degrees.

achukma,	good.
achokma,	goodish.
achuhkma,	good emphatically.

achoyukma,	good in an increased degree.
achukma,	good distinctly compared with others.
achohukma,	good and growing better.

Comparative degree.

achukma i shahli,	better.

Superlative degree.

achukma moma i shahli,	best.
achukma kvt i shaht tahli,	best, he completes it, subjective.
achukma kvt i shaht taha,	best, it is completed, objective.

The last two expressions are attempts to translate the English superlative, and are not natural to the language. They are rarely heard.

Diminutives.

iskitini,	small,	iskitvnisi,	smallish.
okpulo,	bad,	okpulosi,	baddish.
kanomi,	few,	kanomusi,	fewish.

Sometimes it is expressed by a kind of lisp; as for ikchito, not large, say iksito.

§ 6. Numerals.

These are all parsed like verbs, but are here called adjectives, in accordance with custom.

	Cardinal.	Ordinal.
1.	achvfa.	tikba.
2.	tuklo.	atukla, or hittukla.
3.	tukchina.	atuchina, or hittuchina.
4.	ushta.	aiushta, or isht aiushta.
5.	tahlapi.	ishttahlapi.
6.	hannali.	isht hannali.
7.	untuklo.	isht untulo.
8.	untuchina.	isht untuchina.
9.	chakali.	isht chakali.
19.	pokoli.	isht pokoli.
11.	auahchvfa.	
12.	auahtuklo.	
13.	auahtuchina.	
14.	auahushta.	
15.	auahtahlapi.	
16.	auahhannali.	
17.	auahuntuklo.	
18.	auahuntuchina.	
19.	auah chakali.	
20.	pokoli tuklo.	
30.	pokoli tuchina.	
100.	tahlepa achvfa.	
1000.	tahlepa sipokni.	

The word auah means with, akucha, out of, over. There are no words for portions less than one half.

CHAPTER VII.

ADVERBS.

§ 1. Adverbs in Choctaw are verbs as well as adverbs. They are either primitive or derived. The former are single words, such as beka, always; bano, only; illa, merely; tokba, very much; ạhli, certainly; pulla, surely.

§ 2. Derived adverbs are formed in various ways. When two verbs have a connective between them, the first of them may serve merely to qualify the second and must then be rendered adverbially, though both may be parsed as verbs; as, achukmalit hvsh hoyashke, do ye search diligently, Mat. II. 8.

Adverbs of place are formed from the demonstrative pronouns ilvppa, here; yvmma, there. These take some of the article-pronouns; ilvppakinli, right here; yvmmakinli, right there.

Adverbs of number are derived from the numerals; as, ushta ha, four times; ai ushtaha, at the fourth time.

Adverbs of time past are derived from the definite article-pronoun ash, renewed mention; as, mish ash, day before yesterday; hopakik ash, long since, long ago.

Adverbs modify each other; fehna chohmi, somewhat very; fehna pulla, surely very. The degree of modification is varied after the manner of adjectives, by emphasis, by prolonging the sound of a word, or by inserting a syllable; as, fehna, fiena; cheki, chehki; chiki, chehika.

Diminutives are formed by adding si; as, olatomasi from olatoma, this way, on this side of; bili̱kasi from bili̱ka, close by.

§ 3. Interrogatives. These are definite and distinctive. The distinctive calls for a definite answer; katima ish ia hoh cho? where are you going? anchuka ia lih, I am going to my house.

In speaking an interrogative tone is used, and to increase the strength of the interrogation the final syllable ends with a nasal sound; antạ? is he staying? minti̱? is he coming? As there is no predicate in such interrogations, the verbal h final is dropped. There is a milder interrogative where the nasal sound is dropped, and the h predicative is suffixed; as, yohmik ah? is it thus? yobatuh ah? could it be? Interrogatives with the nasal are distinctive; without the nasal they are definite.

An interrogative in the negative demands an affirmative reply; as, yvmmak keyu? is it not that?—it is that.

The principal interrogative adverbs are katima? or mvto? where? nanta? what? katiohmi? how? cho? an interrogative particle. Examples:

Katima ishia hạ?	Where did you go? (definite.)
Katima ishia ho̱?	Where did you go? (distinctive.)

§ 4. Adverbs take the article-pronouns, and some inseparable pronouns; as, sa tikba, before me (in place); an tikba, before me (in time). When they follow verbs, the article-pronouns of the verbs are removed, and placed after the adverbs.

§ 5. Examples of Choctaw adverbs.

Yes, yea,	yau, a̱h, i̱, ome.
Nay, not, no,	keyu, aha̱h, ha̱, heto, awa, (haia, Chikasaw).
Much,	laua, fehna, apakna.
Little,	kanomusi, iskitine, chvbi̱hasi.
Once,	himona, himonaha.
Twice,	hitukla, hituklaha.
Thrice,	hituchina, hituchinaha.
First,	vmmona, tickba.
Secondly,	ont atukla.
Thirdly,	ont atuchina.
Now,	himak, himo.
Then,	yvmma.
To-day,	himak nitak.
To-morrow,	onna.
Yesterday,	pilashash.
Upward,	vba pila, vbema, vba imma.
Downward,	oka pila, akema, ak imma, aket.
Beyond,	mish sha.
Soon,	cheki.
Enough,	vllpesa.
Perhaps,	chishba, yobaka.
Truly,	a̱hli (from vhli, the limit).
Hither,	anet.
This side of,	ola.
Toward,	pila.
Merely,	peh.

CHAPTER VIII.

CONJUNCTIONS.

§ 1. Conjunctions connect words, sentences, clauses and paragraphs, and commence and close sentences. They are definite and distinctive.

Definite conjunctions usually end with t, vt, or a; as, mihmvt, mihma, and. The distinctives end with osh or o̱; as, mihi osh, mihio̱. Some are both definite and distinctive; as, okvt, oka, where ok, a demonstrative distinctive, is combined with vt and a definite.

§ 2. They take some of the article-pronouns to exhibit the nominative and oblique cases; as, mihmvt, nom. case, and he, mihma, oblique case, and him; mih is used as a personal pronoun in the third person singular. Mihmvt is literally "he then he;" mihma, "he then him;" mihmvt contains the verb of existence (h predicative) and the subjective copula; mihma likewise contains the verb of existence, and solves the subjective copula, and thus it acts on the subject—the subjective copula being solved, a new subject with its copula takes its place. This conjunction may be translated by any of the personal pronouns in the third person.

§ 3. The conjunction in the nominative case connects two or more subjects to one verb; as, Acts II. 8—11, where mikmvt and micha connect the names of several nations with eho haiyak loshke.

When there is one subject and two or more predicates, the subject is connected with all the predicates; as, Luke XV. 13, where the connective is suffixed to the predicates as a copula.

But when another subject and predicate following the first are connected with it, the conjunction is in the oblique case. This change of case gives notice of the succeeding subject and predicate; as, Mat. I. 2: Eblaham vt Aisak a tobachi tok; atuko Aisak vt Chekob a tobachi tok; here, atuko is in the oblique case, and connects the two prepositions, and shows two different subjects. If it were atuk osh instead of atuko it would make Abraham a subject of the second preposition. The genealogy of the Saviour in Luke III., illustrates the same usage. The conjunction mihma is there used, "and he," the subject of the next verb. This change in the conjunction does not change the subject to the object. It gives notice of another subject, and connects them both by mihma. The copula is *solved*, and the way opened for another subject to take it. Thus, in Luke XVII. 10: achvfa kok osh Falisi okma, achvfa kvto publikan a tok; okma is in the oblique case. These instances exhibit the difference between a conjunction in the nominative and oblique cases.

§ 4. Conjunctions are divided into the following classes:

1. Copulatives; definite subjective, and, then, t, cha, micha, mihmvt, mikmvt, yohmi cha, yumohmi cha, yohmi mvt, yumohmi mvt.
   definite objective, na, mina, mihma, mikma.
   distinctive, mih ho, mih hosh.
2. Distinctives; or, if not, unless, except, but, keyukmvt, keyu hokmvt, amba, ikshokmvt, keyukma.
3. Concessives; although, nevertheless, be it so, admit it. They concede something which has been said. They are kia and amba. The distinctive article-pronouns osh, o, and oh, often precede kia, as akohkia, okako kia.
4. Adversatives; but, yet, notwithstanding, amba, kia; atuk ak o, but, Luke XIX. 14.
5. Causals; therefore, for, because, as, so as, okvt, yohmi hosh, yohmi kokvt, yomohmi hosh, yomohmih hoh, yomohmi hokah.
6. Illatives; therefore, wherefore, on account of, yomohmi hokvt, yomohmi hokah.
7. Finals; because, for, hokvt, hokah, yohmi hokvt, yohmi hokah.
8. Conditionals; if, lest, when, then, provided, kmvt, kma (def.), okmvt, okma, (dis).

9. Suspensives; whether, whether or, kmá (def.), okmá, (dis.), ish tohbichikmá; ish lusachikmá, whether white or black, Mat. V. 36.

Examples of conjunctions:

Again,	anonti, anowa, himmakma, himakona.
Also,	aiena, itatuklo, mvt, ma, akinli.
Although,	kia, okakǫ, okakosh.
And,	cha, na, micha, mina, mihmvt, mihma, mikmvt, mikma.
Because,	hokvt, hoka, hatukosh.
Besides,	aiena, micha, mikmvt, mikma.
But,	amba, kia.
Except,	keyukma, akcho.
Since,	hatukosh, hatukǫ.
Therefore,	yvmohmikmvt, yvmohmiką, yvmohmihokvt.
Unless,	keyukmvt, keyuhokmvt.

CHAPTER IX.

INTERJECTIONS.

§ 1. The Interjections may be divided into two classes, the subjective and the objective.

§ 2. The subjective interjections.

These are produced by a sudden ebullition of feeling and merely manifest the state of the speaker's mind, as akshukeh! oh! on account of pain from water or cold; akshupeh! oh! when the pain is from fire; ulleh! for any severe pain; ikikeh! when in distress of mind or body.

§ 3. The objective interjections.

These are employed to excite the attention of the party addressed; intah!, ok!, okintah!, well! now! used for defiance or banter; yak eh! look here!, yak okeh, thanks to you; yokokeh, in lamentation; omeh! omishkeh! to call attention, Give ear! There are interjections for times of sport, of mourning, of war, victory and defeat. Some are common to both sexes, some used by only one.

§ 4. Interjections chiefly used by men.

Ahąh,	no! stop! take heed!
Pullashkeh,	God forbid!
Auohmeh,	ah indeed!
Hahah,	oh!
Han,	oh! what!
Humpheh,	oh! in anger, defiance, or pain.
Ok,	well! now! as, I dare you!
Okintah,	well, come on, I dare you.
Omeh,	to invite the attention of hearers.
Omishkeh,	the same in more solemn style.
Yakoh! yakih!,	a shout by the warner to the ball-players.

Interjections chiefly used by women.

Aiena,	alas, wo is me.
Aiyenaheh,	alas, wo, uttered at funerals.
Ehwah,	fie ! begone, in reproach or disgust.
Aiheh,	oho ! half in fun and half in earnest.
Wehkah,	quit ! don't !
Kaihoh,	oh ! in fear.

Interjections common to both sexes.

Ok hoh,	no ! no ! quit ! in anger.
Akshukeh,	oh dear ! it hurts me !
Okshupeh,	oh ! it burns !
Ehah,	woe, woe !
Hai,	in disappointment.
Hok,	oh !
Hush,	alas !
Hushha,	alas !
Ikkikeh,	alas ! pity !
Intah,	well, now, come, enough !
Issah,	quit ! be off ! stop !
Mah,	look there now, sign of vocative.
Makhalokah,	"let it be so to him," in contempt.
Mishia,	begone !
Okkvnno,	indeed !
Okokkoh,	oh dear ! alas !

Stated Meeting, April 15, 1870.

Present, ten members.

Mr. Fraley, Vice-President, in the Chair.

Donations were announced from the Acclimatisation Society of Paris; the Editors of Nature; the Commissioners of Emigration of the State of New York; Prof. Röhrig, of the Cornell University; the Essex Institute; Dr. Newberry; the Phila. Acad. Nat. Sciences; Journal of Med. Sciences, and Franklin Institute, and the U. S. Secretary of the Treasury.

Prof. Cope exhibited and described vertebræ and other parts of a new species of *Bottosaurus*, found in the upper beds of the Cretaceous Green Sand of Burlington Co., N. J., and showed how it differed from *B. Harlani.*

Prof. Hayden exhibited photographs of fossil fishes, from the Green River locality described at the last meeting, and described a new process of picture printing, from which a great improvement in the representations of natural objects may be expected; he also showed sketches of Gelogical sections of the Rocky Mountain rocks.

Dr. Brinton described the peculiar mode adopted by Mr. Charency for interpreting some curious inscriptions newly discovered at Pelenque.

The Society then proceeded to ballot for members, nominations Nos. 651, 652, 654 and 655, being postponed for the present.

When the ballot boxes were examined by the presiding officer, the following persons were declared duly elected members of the Society:

Major R. S. Williamson, U. S. Engineers.
Hon. J. D. Cox, of Washington, D. C.
Prof. Charles H. Hitchcock, of New York City.
Mr. Edmund Quincy, of Dedham, Mass.

And the Society was adjourned.

Stated Meeting, May 6, 1870.

Present, twenty-five members.

Letters accepting membership were received from Mr. J. D. Cox, dated Department of the Interior, Washington, April 26; Mr. Edmund Quincy, dated Dedham, Mass., April 20; and Mr. C. H. Hitchcock, dated Hanover, N. H., April 29, 1870.

Photographs of Prof. F. L. O. Röhrig, Cornell University, Ithaca, N. Y., and Dr. Horn, of Philadelphia, were received for the album.

Letters acknowledging the receipt of Proceedings and announcing transmissions, were read.

Donations for the Library were received from the Royal Academies and Societies at St. Petersburgh, Munich, Göttingen, Copenhagen and Edinburgh; the Society at Marburg; the Geological Society at Berlin; Geographical Society at Paris, and Astronomical Society at London; the Institutes at Salem, Philadelphia, and Baltimore; the New Jersey and Pennsylvania Historical Societies; the State Geologist of New Jersey; Dr. Ruschenberger, Hon. W. D. Kelley, Mr. C. H. Hunt, Genl. Abbott, and the Public School Commissioners in St. Louis.

The death of a late member of the Society, Mr. Franklin Peale, of Philadelphia, on Thursday morning, May 5, aged 74, was announced by Mr. Robert Patterson, who, on motion of Mr. Fraley, was appointed to prepare an obituary notice of the deceased.

The Secretary communicated, as from the author, the second part of a Memoir on the Geological Position, Characters and Equivalencies of the Marshall Group, by Prof. Alex. Winchell, Part I. of which was published in the Proceedings, No. 81.

The Secretary gave the following account of beads from Indian graves on the Susquehanna River, now in the possession of Prof. S. S. Haldeman, of Columbia, Pa.

A bead found in an Indian grave near Bainbridge, Lancaster Co., Pa., in making the Pennsylvania Canal, about the year 1832. The bead is spherical, but made out of a section of a cylinder, or group of four concentric cylinders, the outer one blue, the middle one red, between these a thin one of white, and the fourth also white, forming an innermost thin lining to the red and a coating to the siphuncle or string-hole through the centre. The end section of the three inner cylinders is star-shaped, or, more properly, corrugated very regularly in 13 waves, like a watch pinion of 13 cogs. The white shining through the blue produces a banded appearance of the surface of the bead, the bands being alternately deep blue and light blue. No doubt the blue cylinder was corrugated on the outside surface, also, and then pressed or rolled smooth. The diameter of the bead across the string-hole is $\frac{5}{16}$ in., and its length $\frac{1}{4}$ inch. Its general appearance can be known from that of the objects figured on Plate, p. 114, Proceedings Amer. Philos. Soc., Dec. 5, 1862, especially Fig. 3.

With this bead others were found, made of segments of blue glass cylinders about $\frac{1}{10}$ inch diameter, and about half an inch long; others of Venetian red color, of the same diameter, but an inch or an inch and a half long. See similar figures in Schoolcraft. Also, a string of very small copper beads, above $\frac{1}{16}$ of an inch large, every way, made of bits of flat copper wire coiled to receive a string.

Dr. Allen presented for publication in the Transactions, a paper "On some of the effects of age as observed in the osseous system," with three plates, which was referred to a committee consisting of Dr. Ruschenberger, Dr. Leidy and Prof. Lesley.

Prof. Cope presented a paper entitled, "Observations on the Fishes of the Tertiary Shales of Green River, Wyoming," collected by Dr. Hayden. (See Proceedings, page 380.)

Dr. Hayden presented for publication three papers, descriptive of certain elaborately drawn and colored sections of rocks exposed in the cuttings of the Union Pacific Railroad. (See Proceedings, about page 419.)

Professor Cope exhibited and discussed a new Dycynodont cranium from the Trias of South Africa, and compared it with some evidently Dycynodont tusks from the Triassic rocks of the Phœnixville tunnel, on the Reading Railroad, thirty miles northwest of Philadelphia, which he exhibited to sustain his remarks. (See Proceedings, about page 418.)

Mr. James returned to the custody of the Society, the MSS. of Pursh's Botanical Journal, loaned to him for publication in 1869; and, with the MSS., presented to the Library of the Society a copy of the published Journal, with MSS. notes of his own interleaved.

Mr. James returned, also, certain mosses, loaned to him from the Muhlenberg Herbarium, for comparison.

Pending nominations Nos. 651 to 659 were read, and the Society was adjourned.

Provost C. J. Stillé then read an obituary notice of the late Mr. Horace Binney, Jun. (See Proceedings, page 371.)

OBITUARY NOTICE OF HORACE BINNEY, Jr.,

Read before the American Philosophical Society,

By Charles J. Stillé.

It is not often that the judgment of a man's life and character by the world agrees with that of his intimate friends. By the world, success in life is too often measured by results which strike most forcibly the popular imagination ;—it means a large fortune, a brilliant professional reputation, opportunities eagerly sought and adroitly taken advantage of, for gaining prominent public positions. To his friends on the other hand, a man may be most endeared and best remembered by qualities of which the world knows nothing, or at best knows them only as they are seen in the perfect symmetry of his life. Happy is the memory of him who, dying, forces the world to forsake for once the false standards by which it commonly judges character, and extorts from it an involuntary homage to what is real and true in human life. I think that the career of our late friend and colleague, Mr. Binney, is an illustration of this rare coincidence between the opinion of the world, and that of a man's inner circle of friends. Here was a man who won none of the great prizes of life as the world counts them, who was not a successful politician, who never aspired to high official position, or gained great professional reputation, who had none of the arts which please the multitude, who was simply a man of warm sympathies, and generous culture, striving to do his duty in the fear of God in that station of life in which his lot had been cast, a simple-hearted, modest Christian gentleman,—and yet when he dies, a voice comes to us made up of many voices, proclaiming that his conception of life was a just one, and that such a life is worthy of our affectionate commemoration.

Horace Binney, Junior, was born in Philadelphia, on the 21st of January, 1809. He was the eldest son of the Honorable Horace Binney, and one of the many blessings of his life was, that during the whole of it he felt himself supported by the wise counsel, the sure guidance, and the lofty example of such a Father. The influence of Fathers upon their children is, I fear, declining in this age and country, but in this case the deep yet discriminating affection of the Father for the son, and the profound filial reverence of that son towards the Father, forms a picture as attractive and suggestive, as unhappily in our experience it is rare. Such a relationship between two such men continued for threescore years, could not be without an important influence on both. By the younger, at least, it was felt as a power which he never referred to, except to speak of it with gratitude, as having happily controlled the whole course of his life.

As a boy, Mr. Binney was of a serious and thoughtful turn. His love of study, and his exquisite moral sense were developed simultaneously, and they soon became blended in that perfect harmony which formed the great charm of his character in his maturer years. He was somewhat shy and retiring in his disposition, and possibly a constitution never very robust, may have unfitted him for those boyish sports for the keenest enjoyment of which high animal spirits are essential. His studies began in the school of Mr. James Ross, and under the training of that most accomplished teacher he gained great proficiency in the Greek and Latin Classics. In this school, among his friends and associates, were the late Professor Henry Reed, Charles Chauncey, a young man of great promise, cut off in early manhood, and the Rev. Dr. Hare—and they remained his friends until death divided them. "He was remarkable among his school-mates" says the last survivor of these companions, "for the qualities which distinguished him in after life. He was to an unusual degree just, regular and industrious. I have no remembrance of his having ever missed a lesson or incurred a censure."

Mr. Binney entered the Freshman class in Yale College, in the autumn of 1824, in his sixteenth year. Although he was with one exception, the youngest member of a class nearly one hundred strong, his attainments in the classics were far beyond those required by the College rules for admission. This proficiency gave him of course a great advantage at the start, and was no doubt one cause of his high standing in his class. I well remember years afterwards at Yale a tradition, that Mr. Binney's class was one of the most brilliant which had ever passed through that College, and in this class he carried off the highest honors. Those who know what is meant at Yale by that distinction, can best estimate not merely the attainments, but the force of character required in a boy of twenty years of age to reach it. His friends at College, like his friends at school, seem to have been chosen from those whose subsequent career proves his early discriminating judgment of character. I need mention only the names of two of our most eminent colleagues, Mr. Justice Strong, and Dr. Barnard, President of Columbia College, who were his class-mates, and his life-long friends, in illustration of what I have said.

Perhaps however, the most powerful influence in moulding his character at this period of his life, came from a source outside the College. During the four years of his residence there, not a day passed in which a letter was not written by the Father to the son, or by the son to the Father. Such a correspondence could never have been maintained without that profound mutual confidence in each other which was a striking characteristic of both. It had too the inestimable advantage of making the Father and the son better known to each other, and one of its results was, that the Father who had been the most careful and judicious of parents while his boy was at College, regarded him from the time he left it to the day of his death, as a younger brother rather than a son.

It is not to be supposed that because Mr. Binney attained the highest College honors, he had no time or inclination for studies beyond the ordinary *curriculum*. Although a firm believer to the last, in the simply disciplinary value of a thorough study of the Classics and the Mathematics, he never had the folly to suppose that four of the most precious years of his life were to be given merely to training his intellect, without storing his mind with knowledge, or cultivating his taste. His study of languages, and especially of Greek, led him into a far wider field than that embraced by an accurate knowledge of their grammar and their idioms. His proficiency was such that he was able to do that which few young men at College ever do, to regard the ancient languages principally as the vehicles of the literature of the people who spoke them. He was thus led to study in the best way, the civilization of the free states of antiquity. No one had a finer appreciation of what modern culture owes to Greek models. He himself was thoroughly imbued with their spirit, and their influence was conspicuous in liberalising his views and directing his studies all through life.

There can be, I suppose, little doubt that Mr. Binney's strong religious nature inclined him after he left College to adopt as a profession, that of the Sacred Ministry. That he acted wisely in not following this inclination, no one who now looks back upon his career can doubt. Mr. Binney's life as a layman was a living epistle of all virtues, a daily exhibition in the midst of no ordinary trials and duties, of purity, goodness, faith and truth, and it is not to be doubted that the silent influence of such a life upon those around him was as powerful and as healthful as if he had been the most brilliant professional teacher of those Divine truths, the fruits of which were so conspicuous in his daily walk and conversation. There is no warrant for the statement which has been made, that he wished to devote himself to the Ministry, and that he was persuaded by his Father to study Law. His Father, no doubt wished and recommended it, but his intervention was confined to pointing out the priceless value of the life of a truly religious layman in the world, and more particularly that among such religious men in England, were to be found several of her most eminent Judges and Lawyers. No one, indeed, who knows how solemn a thing duty always was with Mr. Binney, and how absolute was the confidence which his Father reposed in him, can doubt that the decision when arrived at, was the result of his own free and deliberate choice.

Mr. Binney's career as a Lawyer was not a striking or brilliant one. He studied his profession, as he did everything he undertook, thoroughly and conscientiously, and his well-trained mind, and habits of industry, made him a master of the great principles of the science. But he was never intended for a professional *athlete*. He had none of the abundant self-assertion, the eager watching of opportunity for advancement, or the disposition to regard litigation as a game, the chief interest of which lies in the chances of success of those who conduct it, which are so characteristic of one class of Lawyers, while he had not those extraordinary gifts which make the fame of the truly great Lawyer, like that of the great Historian, one of the rarest of intellectual distinctions. He was however without doubt, one of those who do most to secure for the Profession the confidence of the Public. His nature abhorred all the arts of low cunning and chicanery, or rather with a certain noble simplicity, he seemed scarcely aware of their existence, and he lived in a moral atmosphere so pure, that it inspired every one who approached him with implicit trust and confidence. Hence in that large class of cases (much larger than is commonly supposed), in which the moral qualities of the man are quite as important to the interests of the client as the professional skill of the lawyer, he found abundant occupation. He was eminently a safe counsellor, accurate and thorough, and perfect master of any case which had been confided to him. I have been assured by one of the most eminent living Jurists, that there are at least two cases in our Reports in which Mr. Binney's printed arguments have always seemed to him models of Professional skill, showing on his part perfect familiarity with some of the most intricate and difficult questions of the Law.

Mr. Binney's extreme modesty, and his utter aversion to display or ostentation of any kind, confined his reputation as a scholar chiefly within the limits of those who knew him well. To his friends he seemed always a man of genuine scholarly instincts, loving the familiar intercourse of the wise, the true, and the good of all ages, as a means of enriching and invigorating his own nature. His memory abounded with passages from his favorite Latin authors, and he studied Greek literature, and especially the Greek Scriptures in a thoroughly critical spirit. I have often heard him refer to certain expressions in the original, the peculiar significance of which he thought had been lost in the translation. He talked often of St. Paul as one of the finest specimens of Greek culture, and nothing could be more instructive than to listen to his analysis of the speech before Agrippa, and of its points of resemblance to the most celebrated productions of the Greek orators. He referred frequently to the connexion between Greek culture, and the spread of Christianity, and to the providential combination for that purpose at the time of its Advent, of the Jewish or Monotheistic idea of the Deity, of the Greek conception of the dignity of man, and of the universal Roman sway. He was fond of the study of history, but its chief interest to him, was as a record of the dealings of God with his creatures, and of the influence of the Church as a divinely organized institution in the world. His familiarity with ancient literature and ancient history never tempted him as it has done so many scholars in our day, to make it the basis of a destructive criticism which would leave us no Divine revelation, and no personal God. If he abstained, it was not from indifference, nor from a fear of the consequences, but because no man ever had a clearer intellectual perception than himself, of the boundaries between the domain of faith and that of reason.

The classical spirit with which Mr. Binney was imbued, formed the basis of all his canons of taste and criticism. He had learned at least one thing from the Greeks which so many are apt to forget, and that was the value of simplicity and truth in style. He had a great dislike for everything that was exaggerated, abnormal, or simply pretentious. Like Plato, he sought the beautiful by striving to find the true, and any picture in which truth and reality were sacrificed to effect failed to make the intended impression upon him. He thought that the ancient Poets and Dramatists pourtrayed most truly human emotions and passions, because their descriptions were at least consistent and natural, and because they did not present to us as real human beings, those literary monsters of modern times,—"the names linked with one virtue and a thousand crimes." He had the keenest perception of what was of real value, either in the form or in the substance of the writings of others. He especially disliked that mode of presenting or discussing a subject which was simply rhetorical, passionate, or sensational. Such a style offended equally his moral, and his æsthetic principles. It was not true because it was one-sided, and there was no beauty to him in anything which was not true. I have always regarded Mr. Binney as one of the best illustrations I have ever met with, of the practical value of classical studies, and I may mention here that during his long service as a Trustee of the Protestant Episcopal Academy,—extending over a period of nearly forty years,—and as a Trustee of the University, he was unceasing in his efforts to uphold their dignity, and in insisting upon their value in every scheme of liberal culture.[1]

[1] The following anecdote will illustrate Mr. Binney's familiarity with Greek style.

Mr. Richard Henry Wilde, once a member of Congress from Georgia, and an accomplished scholar, had written some beautiful verses beginning, "My life is like the summer rose, &c.," which being published in the newspapers, became widely known. Some time after, Mr. Wilde was surprised to find in a Georgia newspaper, a Greek Ode purporting to have been written by Alcæus, an early Eolian poet of somewhat obscure fame, and it was claimed that Mr. Wilde's verses were simply a translation of this Ode, the ideas in both being almost identical. As Mr. Wilde had never heard of Alcæus, he was much puzzled to account for this resemblance of the two poems. At the suggestion of a friend, the Greek Ode was sent to Mr. Binney for examination and criticism. He at once, much to the relief of Mr. Wilde, pronounced it a forgery, pointing out wherein its style differed from that of classical Greek. It turned out afterwards that the Ode in question had been written by an Oxford scholar on a wager that no one in that University was sufficiently familiar with the style of the early Greek poets, to detect the counterfeit. To carry out this scheme, he had translated Mr. Wilde's verses into Greek.

It is not to be inferred from what has been said, that Mr. Binney led the life of a secluded student, for he felt the deepest interest in the great movements which were going on around him, yet it is also true that he had no ambition to occupy a prominent position in public life. The arts of the politician were abhorrent to every instinct of his nature, and he felt, as we all do, that by these arts success is chiefly gained in a public career. He was one of that class, who, observing quietly the current of human affairs, are not disposed to make vain efforts to check its course until it threatens to sap the foundations of society, and those who have hitherto guided it lie panic-stricken and helpless. Such men form the true reserve force of a nation; never seen, almost never thought of in days when all is smooth and prosperous, they are the only guides who are trusted in the crisis of danger. Mr. Binney was a typical man of this class. He was forced into public life when earnest men sought to purify our Municipal Government, or when the suppression of riot and bloodshed in his native city, required him to assume the singularly uncongenial duties of a Captain of a Volunteer Company.

In his religious opinions, Mr. Binney was a conservative Churchman. He had deeply studied the organization and claims of the Christian Church, and was strongly convinced of the rightfulness of its authority as a Divine agency in this world. With a most devout and earnest spirit, he strove through this means to uphold a high standard of Christian life and duty. He revered the memory of the Saints and Martyrs of that Church. The virtues which distinguished them—child-like faith, humility, self denial, and an earnest love of the weak and the lowly—were those which found in him the fullest recognition and sympathy. His moral instincts and his mental culture were here also in perfect harmony, and his enthusiasm for Saintly George Herbert, and his familiarity with Keble's Christian Year, which he could repeat from beginning to end, were due, not merely to his appreciation of the literary merits of those Poets, but also to their praise of those virtues which it had been his life-long concern to cultivate.

Mr. Binney's peculiar views concerning the Church and its functions, modified his opinions upon many important questions, especially in regard to those great movements of moral reform by which the present age is so strongly characterized. With an ardent desire that men should grow purer and happier, his sober and serious judgment made him very slow in adopting any one of the plausible schemes by which it was proposed to accomplish that desirable object. He was no humanitarian. He had very little hope for the future of the race outside the influence of Christian faith and duty. He saw too much of the disturbing passions of mankind to believe that true progress could be made in any other way. In all his work for his fellow-men he was guided by a principle far deeper and more enduring than a vague sentiment of philanthropy, and that was, obedience to a duty divinely commanded. Hence his zeal had all the characteristics of duty,—courage, constancy and self-denial—and none of the weaknesses attendant upon mere passionate impulse.

How completely Mr. Binney's whole life was the outgrowth of this principle of duty was shown by his conduct during the war. He had no favorite theories to establish, no passions to gratify by the subjugation of the Southern people. Moreover, he was one of those who, while he deplored most deeply the evils of slavery, felt himself bound by the force of positive law to abstain from interfering with it where it existed. Yet when a gigantic conspiracy to overturn the government of the country revealed itself, he regarded it with almost judicial calmness, and he prepared to resist it, as he would have performed any other high duty with all the manly earnestness of his nature. Shocked and indignant, no doubt, he was:

> "Neque enim siluisse licebat,
> Cum passos, mœrens indigna, Columbia crines
> Et pectus lacerum et stillantia lumina monstrat."

Yet he never lost his balance: he went about his work with a sober enthusiasm which was deep-rooted in conscientious conviction. He never doubted or wavered, nor weakly desponded, but keeping his eye steadily on the end in view, he gave himself and all that he had to the support of the government. Nothing was more suggestive than the sight of this quiet, undemonstrative gentleman, in active sympathy with the country in danger. Of all the many schemes devised here to give popular aid to the authorities during the war, he was a most zealous promoter. He was one of the founders of the Union League of this City, an agency in the successful prosecution of the war, the value of which I do not think it easy to over-estimate. He was never unduly excited by our successes, or depressed by our reverses, and I do not think that I ever saw him more moved during the war, than when on a public occasion here, he expressed his satisfaction that he was at last permitted to give free play to his convictions concerning slavery, and to aid with a clear conscience in its destruction.

Mr. Binney's services during the war were not confined, as is well known, to a hearty support of the policy of the government. His active sympathy soon embraced those who were called upon to defend the country at the risk of their lives. He sought every opportunity to promote their health, comfort and efficiency. He helped to build up that great monument of American civilization, the United States Sanitary Commission, and he is entitled to a full share of whatever honor may be due to those who organized and carried on the grandest and most efficient system of voluntary relief to the sick and wounded of an Army known in History since wars began on earth.

He was elected on the thirtieth of July, 1861, by the gentlemen appointed by the President of the United States, a "Commission of Inquiry and Advice in respect of the Sanitary Interests of the United States Forces," a member of that body. His duties in this position were all engrossing. To do properly the work which the Commission had undertaken to do, which was nothing less than an attempt to supplement by the full measure of popular sympathy the deficiencies of the government service in the care of the suffering of the Army, required something more than mere devotion and zeal. If the whole project was not to end by increasing the very evils it sought to remedy, there was need of the utmost judgment, prudence and intelligence on the part of those who managed its affairs, in order to secure the harmonious co-operation of the army officials. In shaping and directing the policy of the Commission to this end, Mr. Binney was always conspicuous. On many occasions during its sessions in Washington, I was impressed with his sound and well-considered views, not merely in regard to the general objects of the Commission, but as to the best methods of securing them. His judgment was always so sure and calm, his counsel so wise and patriotic, that he soon gained the fullest confidence of his colleagues, many of whom were among the foremost men in the country.

But Mr. Binney's care for the sick and the suffering of the Army during the war, did not end with this general supervision of the means to be taken to improve their condition. One of the methods adopted by the Sanitary Commission to organize popular sympathy on the widest basis, was the establishment of branch or tributary associations in different parts of the country. In pursuance of this plan, Mr. Binney was instructed to organize in December, 1861, such an association in this City. By his zeal and personal influence, he gathered round him many of our prominent citizens, who desired to aid in this great scheme of Army relief. Of this body, called the "Philadelphia Associates," Mr. Binney was Chairman during the war, and by means of its labors, more than a million and a half of dollars were contributed in aid of the purposes for which the Commission was established. It is impossible, it seems to me, to recall the vast proportions which this work assumed without admiration, wonder and gratitude. Under Mr. Binney's wise and earnest leadership, it collected vast supplies from the homes of the country, and distributed them to the suffering of the Army, it supplemented the needs of the Military Hospitals, local and general,—it was foremost in relieving the miseries of battle-fields; it established a Hospital Directory, by means of which the condition of the suffering soldier, in any Military Hospital, might become speedily known to his friends, and it maintained a Bureau for the purpose of collecting the soldiers, claims on the government without charge to him. To carry on this great scheme, it secured large contributions from our citizens, and as its crowning work, it organized the Great Central Fair in 1864—an enduring memorial, not merely of the patriotism and mercy of the people of Philadelphia, but also a wonderful proof of their perfect trust that their vast benefactions would be wisely administered by Mr. Binney, and the gentlemen associated with him.

It has sometimes been said that the war and its duties, brought into active excercise qualities in many men which had lain dormant all their lives, and of the existence of which they themselves had hardly been conscious. But in Mr. Binney's case, the war only offered an opportunity for an exhibition on a wider sphere of virtues, which had been his essential characteristics through life. He had courage, for instance,—not mere coolness in the midst of danger, although he possessed that to an eminent degree,—but a much loftier quality, which the French call the courage of one's opinions. His convictions were intensely strong, and when once formed, no power on earth would move him. Out of every conviction grew a duty, which soon brought forth fruit in an appropriate act. No one who knew Mr. Binney, could doubt his perfect readiness to maintain opinions so formed, with the courage and constancy of a martyr. And yet there was at all times in him, such true modesty, and a manner so unassuming, and almost shrinking, that to many the real strength of his nature lay hidden. His largeness of view, and his innate sense of courtesy, preserved him from the slightest taint of arrogance when he differed from others. Certainly, no opinions were held by Mr. Binney more strongly or clearly, than those concerning the nature and the functions of the Church, and yet I have seen him in the most intimate personal relations with representatives of almost every type of thought on this subject, except his own, at all times most zealously co-operating with them in the performance of duties demanded by a common Christianity.

As Mr. Binney was earnest and constant in his devotion to any cause the success of which he had at heart, so he was enthusiastic in his attachment to those whom he honored with his friendship. This is a trait of his character which I think is little understood. Few suspected what a fount of generous affection and tenderness lay hidden under that quiet and undemonstrative exterior. When he once trusted a man, he seemed to give himself up wholly to him. The only instances which I can recall, in which his usually calm judgment was disturbed, arose from this intense desire to serve his friends. On one occasion I had urged him to support for an important position a gentleman in whose success I felt a deep interest. After listening patiently to what I had to say, he suddenly exclaimed: "*Do not press me, do you know that Dr.* ——— (the opposing candidate), *once saved my life?*" Then again, he was led to feel that one of his friends had done some service to the country by his writings at a critical period of the war. From that hour his heart warmed towards that friend: he gave him his fullest confidence, he spoke in the most unmeasured terms of the value of his services, and whatever influence he could command, was thenceforth exerted to secure for him posts of trust and honor. And this is the man, with a heart as simple as a child's, and as tender as a woman's, who was thought cold and formal by those who did not know him.

Mr. Binney never fully recovered from the effects of an illness through which he passed about ten years ago. Within a few weeks of his death, a disease of the heart was rapidly developed, and he was snatched away from his family and friends with startling suddeness, on the third of February, 1870. He left a widow, the daughter of the late William Johnson, Esquire, of New York, the eminent Reporter, and the intimate friend of Chancellor Kent, and seven children.

His life seems to me to have been in its symmetrical beauty almost an ideal one. It was nurtured and strengthened by the two great principles out of which all true excellence springs, Trust in God, and Devotion to Duty:

"Thus it flowed
From its mysterious urn a sacred stream,
In whose calm depths the beautiful and pure
Alone are mirror'd; which, though shapes of ill
May hover round its surface, glides in light,
And takes no shadow from them."

OBSERVATIONS ON THE FISHES OF THE TERTIARY SHALES OF GREEN RIVER, WYOMING TERRITORY.

By Prof. E. D. Cope.

Physoclysti.

Asineops, Cope, gen. nov.

Fam. squamipennes. Branchiostegal radii, seven; ventral radii I. 6–7. Opercular and other cranial bones unarmed; scales cycloid. Spinous and cartilaginous dorsal fins continuous; caudal rounded; anal with two spines. Lateral line distinct, not interrupted. Operculum with regularly convex posterior border. Teeth coarsely villiform, without canines. Both spinous and soft portions of dorsal and anal fins moderately scaly.

This well marked genus is established on the remains of fifteen individuals, in various states of preservation, so that the characters undistinguishable in one, can be discovered in another. Thus the lateral line is preserved in one only, and the teeth in another. In none can I be entirely sure that I see the vomer.

The scales are preserved in many specimens, and I cannot find a ctenoid margin in any, nor any radiating sculpture, but delicate concentric ridges continued round the central point proximally, distally forming parabolic curves, the less median not completed but interrupted by the margin of the scale. Near the margin all the ridges become gently zig-zagged.

There is no depression between the two portions of the dorsal fin, though the cartilagius portion is the more elevated. Laid backwards, the latter is in line with the extremity of the anal, and both extend beyond the basis of the caudal.

The close affinities of this genus are difficult to determine with entire satisfaction. In its smooth cranial bones and united dorsals it is like the genera Apsilus Cuv. Val. of the Atlantic, and Micropterus Lac. of the fresh waters of North America. Its numerous ventral radii, agreeing with those of the Berycidæ (or Agassiz' section Holocentri in Poiss. Fossiles) separate it entirely from the above genera. The absence of the emargination of the operculum, also distinguishes it from Micropterus. Its affinities are, however, entirely remote from the Berycidæ. The genus to which it stands in nearest relationship, is Pygæus, of Agassiz, which he refers to the Chætodontidæ, and which, if so referred, will intervene between the typical forms of the family, and the aberrant Toxotes. The only character by which I distinguish it from Pygæus, is the presence of one or two additional ventral radii, the number in the latter genus being I. 5. Nine species of that genus are described in the Poissons Fossiles all from Monte Bolca, and the existence of the present near ally, suggests a determination of the age of the Green River beds, which the other species do not furnish. This would be upper Eocene.

ASINEOPS SQUAMIFRONS, Cope, sp. nov.

General form is sub-oblong, the greatest depth just behind the head, and contained two and a half times in the length exclusive of caudal fin. Radii D. VIII, 14; A. II, 9; C. 14; V.I, 7; P. ?11 ?13. Scales 5—?30—10, vertical line counted a little behind the ventral fins. The line of the extremities of the second dorsal and anal fins, marks the basal third of the caudal fin. The dorsal spines are sub-cylindric, slightly curved, and of nearly equal length; the length equals the depth of the body at the middle of the second dorsal fin.

The external series of villiform teeth are stout of their kind, conic, and a little incurved. I cannot see the pharyngeal bones or teeth.

The number of vertebræ which extends between the caudal fin and the superior margin of the operculum, where one or more are concealed, is twenty-five, of which fifteen are of the caudal portion (in two I can only count fourteen).

The mouth is directed obliquely downwards and is rather large; the mandible, when closed, does not project beyond the premaxillary border. The maxillary, where preserved, is narrow distally, and does not project beyond the posterior line of the orbit. The latter is rather small, and though not well defined in any specimen, is not more than one-eighth the length of the head, and 1.5 to, 1.75 times inside of muzzle. The margins of all the opercular bones are entire and smooth. The interoperculum is narrow, and lies obliquely upwards, narrowing the operculum. The greatest width of the latter is more than two-thirds its depth. The pelvic supports of the ventral fins are slender, and about half the length of the fin. The pectoral fins are not elongate.

The scales extend over the top of the head to or beyond the orbits. They also extend out on the ramus of the under jaw. Those of the fins are quite small; they extend to a considerable distance on the unpaired and on the caudal fins.

	M.
Total length of the largest specimen	0.19
Do. No. 2, smaller example (with caudal)	0.12
Length of head of do.	0.044
Depth of do. posteriorly about	0.036
Length base spinous dorsal	0.0265
" posterior " ray	0.017
" operculum	0.0125
" maxillary bone about	0.0145
Depth No. 3, at base 1st dorsal	0.045
" " " " anal, 1st ray	0.0325
Length basis anal=basis caudal	0.0162
" caudal fin	0.034

Tertiary strata of Green River, Wyoming; Dr. F. V. Hayden, Coll. Mus. Smithsonian.

CLUPEA HUMILIS, Leidy.

Proc. Acad. Nat'l Sciences, 1856, 256.

Vertebræ 34. Depth $2\frac{1}{2}$ to $2\frac{2}{3}$ lines in length exclus caudal fin ($2\frac{1}{4}$ times, Leidy). Scales large; l. transverse 11–12.

A very abundant species in the shales.

CLUPEA PUSILLA, Cope.

Greatest depth contained four times in the total length, or 3.5 times to basis of caudal fin. Length of head 3.2 to basis caudal;—this measurement may require revision, as the end of the muzzle is slightly injured. Orbit large, contained twice in length of head behind it. Middle of dorsal near the middle of length, and about over the origins of the ventrals. D. II. 11, V. 7. Pectorals extending half way to ventrals. Vertebræ 29–30, dorsals 19–20. Ventral keeled ribs 18. Anal fin lost. Caudal peduncle slender, caudal fin deeply furcate. Length M. 044; greatest depth M. 011.

The present species is about half the size of the last, and of considerably less proportionate depth.

CYPRINODON LEVATUS, Cope.

Anterior margin anal fin commencing a little behind opposite the posterior margin of the dorsal. Vertebræ 10. 14. I. Radii D. 8, A. II. 8, V. 8. Caudal fin deeply furcate; first anal ray strong.

General form elongate, the greatest depth contained three times in the length between the scapular arch and the basis of the caudal fin. Scales preserved, small; seven longitudinal series above, and seven below the vertebral column, probably two rows concealed by it. The caudal peduncle is rather contracted for the genus. Length from scapular arch to extremity of caudal M. 0335; depth at origin dorsal fin M. 008.

There are portions of five individuals on the slab of slate, but none present a clear cranium. This slab represents that portion of the stratum which is highly carbonaceous, portions of it thrown into the fire burn freely. Dr. Hayden, who has brought numerous specimens from this locality, informs me that the laminæ exhibit great numbers of these little fishes. No doubt the carbonaceous character of the shales is due to the decomposition of their bodies. The character of the species, as well as nature of the deposit, and mode of preservation, remind one strongly of the Cyprinodon meyeri, of Agassiz, from the neighborhood of Frankfort a. M. That species differs especially in presenting 18 Anal radii.

Some of the specimens above described were obtained and preserved for scientific study, by David B. Collier, formally United States District Attorney for the Territory of Wyoming.

From a Tertiary deposit on the upper waters of Green River, Wyoming Territory, from a laminated calcareous rock similar in color and appearance to the clay beds of Mount Lebanon and Mount Bolca. The first indication of the existence of this deposit was brought by Dr. Jno. Evans, who obtained from it a Clupeoid, which was described by Dr. Leidy, as *Clupea humilis* (Proc. Acad. Nat. Sci., Phila., 1856, p. 256). One of the blocks contains the remains of two small shoals of the fry, probably of Clupea humilis, which were caught suddenly by a slide or fall of calcareous mud, and entombed for the observation of future students. They must have been taken unwares, since they lie with their heads all in one direction as they swam in close bodies. One or two may have had a moment's warning of the catastrophe, as they have turned a little aside, but they are the exceptions. The fry are from one-half to three-quarters of an inch long and upwards.

True herring, or those with teeth, are chiefly marine, but they run into fresh waters and deposit their spawn in the Spring of the year, and then return to salt waters. The young run down to the sea in Autumn and remain there till old enough to spawn. The size of the fry of the Rocky Mountain herring indicates that they had not long left the spawning ground, while the abundance of adults suggests they were not far from salt water, their native element. To believe, then, that the locality from which the specimens were taken was neither far from fresh, nor far from salt waters, is reasonable; and this points to a tide, or brackish inlet or river. Lastly, the species of Cyprinodon inhabit also, tide and brackish waters. Most of the species of the family, as well as of the genus, are inhabitants of fresh water; but they generally, especially the Cyprinodons proper, prefer still and muddy localities, and often occur in water really salt. This habitat distinguishes them especially from Cyprinidae (Minnows and Suckers) and Pike.

The material which composes the shales indicates quiet water, and not such as is usually selected by herring for spawning in; while the abundance of adult Clupeas indicate the proximity of salt water.

This is far from a satisfactory demonstration of the nature of the water which deposited this mass of shales, but is the best that can be obtained with such a meagre representation of species.

As to geological age, the indications are rather more satisfactory. The genus Clupea ranges from the upper Eocene upwards, being abundant in the slates of Lebanon and Monta Bolca, while Cyprinodon has been found in neither, but first appears in the Middle or Lower Miocene in Europe. The Asineops resemble very closely, and I believe essentially, the Pygeaus of Agassiz, of Eocene age, from Monta Bolca. The peculiarities presented by the genus found by Dr. Hayden, are of such small significance as to lead me to doubt the beds in question being of later than Eocene age; though the evidence rests chiefly on this single, new and peculiar genus.

The position of these fishes, 7000 feet above the level of the sea, furnishes another illustration of the extent of elevations of regions once connected with the ocean, and the comparatively late period of Geologic time at which, in this case, this elevation took place.

Supplementary Notice of a new Chimærid from New Jersey.
Leptomylus cookii, Cope.

Indicated by a right inferior maxillary bone, of one-fourth the size of that indicating the *Leptomylus densus.* In general form the ramus resembles that of Ischyodus divaricatus, the posterior portion being curved outwards from the symphyseal. The latter region is much compressed and moderately prolonged, the inner face quite concave; posteriorly the outer face is also slightly concave. There is a single external crest, which is obtuse, and descends gradually to the plane of the beak, and presents no dentinal area. A single small oval area represents the internal, so large in Ischyodus. It lies along the inner margin. This margin is much thickened, and rolled over inwards; symphyseal face very narrow. The extremity of the beak is broken away, and the section shows that there is no inferior plate-like column, which produces the terminal area in most species of Ischyodus, but a round column, which issues on the upper surface of the beak, behind the apex.

	Lines.
Depth at posterior margin outer crest	25.4
" " anterior base " "	15.
" " end terminal column	6.8
Width of inner area	2.
" at " "	10.6
" " middle of beak	5.4

The apical dentinal column of this species distinguishes it from the L. densus, Cope, where no such column exists. It may be noted that at the posterior fractured section of the jaw, the apical column is seen, while internal dental area is not, the latter occupying only a pocket, not a column.

This species approximates Ischyodus solidulus in the apical column, which has the same form in both. The two dentinal faces the latter possesses, are those of true Ischyodus.

From the upper marl bed of the Cretaceous of New Jersey, from near Mt. Holly. Dedicated to Prof. Geo. H. Cook, under whose auspices the palæontological interests of the State survey have been extended.

Stated Meeting, May 20, 1870.

Present, ten members.

MR. FRALEY, Vice-President, in the Chair.

A letter accepting membership was received from Maj. R. E. Williamson, dated San Francisco, May 10th, 1870.

A letter respecting the Byington MSS. was received from Prof. Jos. Henry, Sec'y Smithsonian Institute, Washington, D. C., May 16th.

Donations for the Library were received from the Academies at Turin, Berlin and Boston; the Annales des Mines, and Nature; the R. Astronomical Society: Essex Institute; Boston Public Library; Silliman's Journal; American Museum of Natural History in New York, and Dr. Wm. Duncan, of Savannah.

The death of Dr. Jas. Y. Simpson, of Edinburgh, was announced by the Secretary.

ON THE GEOLOGICAL AGE AND EQUIVALENTS OF THE MARSHALL GROUP.

BY PROF. A. WINCHELL,

DIRECTOR OF THE GEOLOGICAL SURVEY OF MICHIGAN..

PART II.[112]

IV. PRESENT STATE OF OUR PALEONTOLOGICAL KNOWLEDGE.

I come now to the most important and most interesting branch of this investigation. In order that others may be placed in full possession of all

[112] For Part I of this paper, see Proceedings American Philosophical Society, vol xi., p, 57 (March 5, 1869). Both Parts of the paper were presented to the Chicago meeting of the American Association for the Advancement of Science, August 11, 1868. It was not offered for publication in the Proceedings in consequence of its length. It was reported, however, in the Chicago newspapers, and the chief points were briefly stated in the *American Naturalist* for October, 1868, p. 445. Part I. was published in these "Proceedings" without alteration; and Part II., as here presented, is unchanged, except in the omission of some detailed lists of fossils, and in the addition of a few remarks based on late discoveries in Tennessee and Pennsylvania, and which have been made public in these Proceedings, vol. xi., p. 245, etc.

the data upon which my forthcoming conclusions are to rest, I introduce here a complete list of the fossils of the Marshall Group, and its supposed equivalents in other States. As introductory to this, however, and as tending to exclude from consideration the series of shales which I have designated the Huron group, I offer a few remarks upon the paleontology of these strata as far as investigated.

The following is a complete catalogue of the fossils thus far determined:

Orthoceras Barquianum. Win.
Spirifera subattenuata, Hall.
" medialis, Hall.
" Huronensis, Win.
" pharovicina, Win.
" insolita, Win.
Retzia polypleura, Win.
Merista Houghtoni, Win.
Pleurotomaria Huronensis, Win.
Goniatites Whitei, Win.
Rhynchonella Huronensis, Win.
Orthis Vanuxemi, Hall.
" crenistria? Phil.
" Iowensis? Hall.
Chonetes setigera? Hall.
Cardinia complanata, Win.
Leptodomus clavatus, Win.
Solen priscus, Win.
Orthoceras gracilius, Win.

Four of the foregoing species I have identified, more or less doubtfully, with species from the Hamilton group. These are *Spirifera subattenuata*, *S. medialis*, *Orthis Vanuxemi*, and *O. Iowensis*. A species very similar to *O. Vanuxemi* exists, however, in the Waverly series of Ohio, and in strata of the same age in Illinois and Missouri. *Chonetes setigera* (*?*) of the list, ranges in New York from the Marcellus shale to the Genesee. *Leptodomus clavatus* closely resembles a *Grammysia*, a genus ranging from the Corniferous to the Chemung. The equivalencies of these rocks are not very precisely indicated from the paleontological data. That the formation is newer than the Genesee shale is demonstrated by its observed superposition. The paleontological evidence indicates, at least, that the fauna is older than that of the Marshall group; and this is all that is necessary. If this group of rocks is proven by stratigraphical superposition to be newer than the Genesee, it belongs either to the horizon of the Portage and Chemung, or to that of the Marshall. If its stratigraphical position, its lithological characters and its fossil remains indicate equally that it is not to be embraced in the same group with the Marshall, no alternative remains. *The Huron group, above the Black Shale, must correspond to the Portage and Chemung, or to some portion of them.*

The question is now narrowed down to this:—Having discovered a representative of the Portage and Chemung groups in the Huron shales and their equivalents, in Michigan and Ohio, ought we to unite with these shales the Marshall sandstones and their equivalents, and thus embrace these also in the zone of the Portage and Chemung?

I have furnished lithological and stratigraphical indications that this ought not to be done. Let us examine the paleontological evidence.

CATALOGUE OF THE KNOWN FOSSILS OF THE MARSHALL GROUP AND ITS SUPPOSED EQUIVALENTS IN THE UNITED STATES.[113]

Names.	References.	Mich. N.	Mich. S.	Ohio.	Ind.	Ill.	Iowa.	Mo.	Other States.
Spirophyton crassum, Hall	xvi. Rep. N. Y. Reg., 83		*	*				*	
Dictyophyton Newberryi, Hall	xvi. Rep. N. Y. Reg., 87			*					
" Redfieldi, Hall	xvi. Rep. N. Y. Reg., 88			*					
Lepidodendron corrugatum, Daw.	Qr. Jour. Geol. Soc. xviii. Pl. xii., fig. 10.			*					
" sp ?		*							
Sigillaria sp ?	Proc. A. P. Soc., xii., 260			*					
Syringodendron gracile, Daw.	Qr. Jour. Geol. Soc., xviii. Pl. xii., fig. 12.			*					
Lycopodites gracilis, Shum. sp.	Mo. Rep. II., 208, Pl. A, 11							*	
Rhachiopteris striata, Daw.	Qr. Jour. Geol. Soc., xviii.			*					
Cyclopteris ? Marshallensis, Win.	MS.		*						
Nullipora obtexta, White	Bos. Proc., ix., 33						*		
Lophophyllum calceola, W. & W.	Bos. Proc., viii., 305						*		
Zaphrentis elliptica, White	Bos. Proc., ix., 31						*		
" acutus, W. & W.	Bos. Proc., viii., 306						*	*	
" Ida, Win.	Phil. Pr., July, 1865, p. 111			*	*				Tenn
Sphenopoterium enorme, M. & W.	Phil. Pr., Oct., 1860, p. 448				*	*		*	
Conopterium effusum, Win.	Phil. Pr., July 1865, p. 111							*	
Syringopora Harveyi, White	Bos. Proc., ix., 32						*		
Alveolites vermicularis, McCoy	Brit. Cal. Fos., 1st Fasc. 69 Mo. Rep. viii., 218							*	
Favosites divergens, W. & W.	Bos. Proc., viii., 306						*		
" (?) mancus, Win.	Phil. Pr., July, 1865, p. 112				*				
Leptopora typa, Win.	Phil. Pr., Jan., 1863, p. 3						*		
Trematopora (?) vesiculosa, Win.	Phil. Pr., Jan., 1863, p. 3			*			*		
" (?) fragilis, Win.	Phil. Pr., Jan., 1863, p. 3						*		
Synbathocrinus Oweni, Hall	xiii. Rep. N. Y. Reg., 111				*				
Pentremites Rœmeri, Shum.	Mo. Rep., II., 186							*	
" sp ?				*					
? Onychocrinus exculptus, Ly. & Cas.	Amer. Jour. [2] xxix., 78				*				
Platycrinus graphicus, Hall	Pamph. 11 Nov. 1863; xvii Reg. Rep., 54			*					Ky.
" contritus, Hall	" " " " 54			*					
" sp ?								*	
Actinocrinus Indianensis, Ly. & Cas.	Am. Jour. Sci. [2] xxix., 75				*				
" pistilliformis, M. & W.	Phil. Pr., Aug. 1865; Ill. Rep., III., 151					*			
" Coreyi, Ly. & Cas.	Am. Jour. Sci. [2] xxix., 76				*				
" Helice, Hall	Pamph. 11 Nov. 1863; xvii. Reg. Rep., 53			*					
" viminalis, Hall	" " " " 54			*					
" Daphne, Hall	" " " " 52			*					
" sp ?								*	
Bursacrinus Meekianus, Shum.	Mo. Rep., II., 188					*		*	
Cyathocrinus decadactylus, Ly. & Cas	Am. Jour. Sci. [2] xxix., 73				*				
" hexadactylus, Ly. & Cas.	" " " 74				*				
Poteriocrinus crineus, Hall	Pamph. 11 Nov. 1863; xvii. Reg. Rep., 56			*					
" Pleias, Hall	" " " " 57			*					
" Corycia, Hall	" " " " 57			*					
Forbesiocrinus communis, Hall	" " " " 55			*					N. Y.
" lobatus, *var.* tardus, Hall	" " " " 56			*					
" Kellogi, Hall	" " " " 56			*					
Scaphiocrinus (Poteriocrinus) Ægina Hall	" " " " 57			*					
" " Lyriope, Hall	" " " " 58			*					
" subcarinatus, Hall	" " " " 58			*					
" subtortuosus, Hall	" " " " 59			*					
Zeacrinus paternus, Hall	" " " " 59			*					
" Merope, Hall	" " " " 60			*					
Lepidechinus rarispinus, Hall	xx. Rep. N. Y. Reg., 295			*					Pa.

113 This Catalogue is little more than a list of references to the original descriptions. There is undoubtedly a large amount of synonymy involved, but extended investigation will be required to eliminate it satisfactorily. The Catalogue, in its present form, will be found useful, it is hoped, to all occupied with researches in rocks of this age.

Names.	References.	Mich. N.	Mich. S.	Ohio.	Ind.	Ill.	Iowa.	Mo.	Other States.
Fenestella rhombifera, Phil.	Mo. Rep., 218							*	
" sp?								*	
Lingula membranacea, Win.	Phil. Proc., Jan. 1863, p.3						*		Pa.
" Melie, Hall	xvi. Rep. N. Y. Reg., 24			*					
" Cuyahoga, Hall	" " " 24		*	*					
" ? subspatulata, M. & W.	Ill. Rep., III., 437			*					Tenn
Discina capax, White	Bos. Proc., ix., 30, (1862)			*			*		
=*D. Newberryi*, Hall	xvi. Rep. N. Y. Reg., 30, (1863.)								
" Gallaheri, Win.	Phil. Pr. July, 1865, p. 112		*	*					Pa.
" patellaris, Win.	" Jan., 1863, p. 4						*		
" Saffordi, Win.	Tenn. Rep., 1869, p.443; Proc. A. P. Soc., xii., 248								Tenn
Producta arcuata, Hall	Iowa Rep., 518			*			*		
" concentrica, Hall	x. Rep. N. Y. Reg., 180	*	*	*	*		*		Tenn
" Cora, d'Orb.	Pal. Voy. en Amer. mer. 55			*					
" Cooperensis, Swal.	St. Louis Trans., I., 640			*			*	*	
" crenulata, Shum.	Mo. Rep., 218							*	
" curtirostra, Win.	Phil. Proc. July, 1865, p. 114						*		
" dolorosa, Win.	" " " 114			*					
" duplicostata, Win.	" " " 113		*	*					
" gracilis, Win.	" " " 112			*					
" lævicostata, White	Bos. Jour., vii., 230						*		
" minuta, Shum.	Mo. Rep., 218							*	
" morbilliana, Win.	Phil. Proc., July 1865, p. 113			*			*		
" Murchisoniana, de Kon.	Genus Prod. Pl. xvi., 3; Mo. Rep., 218					*		*	
" Newberryi, Hall ? = *P. semireticulata*, Flem.	x. Rep. N. Y. Reg., 180			*					
" parvula, Win.	Phil. Proc., Jan. 1863, p. 4						*		
" pyxidata, Hall	Iowa Rep. Part II. p. 498					*		*	
" semireticulata, (Flem.) de Kon.	Monogr. Gen. Prod., 183		*	*		*	*		Pa.
" Shumardiana, Hall	Iowa Rep. Part II. p. 498			*				*	
" subaculeata, Murch.	Bull Geol. Soc., xi., 255							*	
Strophalosia ? nummularis, Win.	Phil. Proc., Jan. 1863, p. 4						*		
Chonetes Fischeri, Nor. & Prat.	Phil. Jour., III., 25						*		Tenn
" geniculata, White	Bos. Proc., ix., 29			?	?		*	*	
" Illinoisensis, Worthen	St. Louis Trans., I., 571	*		*	*		*		
= *C. Logani*, Hall, (not Nor. & Prat.)	Iowa Rep. Part II., p. 598								
" Logani, Nor. & Prat.	Phil. Jour., III., 30. Pl. II., fig. 12			*			*		
" mesoloba, Nor. & Prat.	Phil. Jour., III., 27			*					
" Michiganensis, Stevens	Am. Jour. Sci. [2] xxv. 262		*						
" multicosta, Win.	Phil. Proc., Jan. 1863, p. 5						*		Tenn
" ornata, Shum.	Mo. Rep., II., 202							*	
" pulchella, Win.	Phil. Proc., Sept. 1862, 410		*	*					Pa.
" Shumardiana, de Kon.	Monogr. 1re. part. p. 192								Ky.
Strophomena rhomboidalis, Wahl.	Act. Soc. Upsal., III, 65			*		*	*	*	
? Strophodonta arctostriata, Hall	N.Y. Rep. IVth Dist., 266			*					N. Y.
Hemipronites inæqualis, Hall, sp.	Iowa Geol. Rep., II., 490			*			*		Pa.
" inflatus, W. & W.	Bos. Proc., viii., 293			*			*		
" lens, White	Bos. Proc., ix., 28			*		*		*	
" ? umbraculum, (V. B.)	Anim. Foss., 222			*			*	*	Pa.
Orthis flava, Win.	Phil. Proc., July 1865, p. 117						*		
" Michelini, L'Evéillé, sp.	Mem. Geol. Soc., France, II., 39			*		*		*	Pa.
" Missouriensis, Swal.	St. Louis Trans., I., 639							*	
" occasus, Hall	xiii. Rep. N.Y. Reg., p. 111				*				
" resupinata, Phil.	Pal. Foss., Cornwall, 67					*		*	
" subelliptica, W. & W.	Bos. Proc., viii., 292			*			*		
" Swallovi, ? Hall	Iowa Rep. Part II., 597						*		
" Thiemei, White	Bos. Jour., vii., 231						*		
? " Vanuxemi, Hall	x. Rep. N. Y. Reg., 135			*			*		
Spirifera biplicata, Hall	Iowa Rep., 519			?		*	*		
" camerata, Morton	Am. Jour. Sci. [1] xxix. 150			*					
" Carteri, Hall = *S. Vernonensis*, Swal.	x. Rep. N. Y. Reg. 170 (1858)			*		*	*		Pa.
" centronota, Win.	Phil. Proc., July 1865, p. 118			*					
" Cooperensis, Swal.	St. Louis Trans., I., 643; Ill. Rep., II., 155				*			*	

Names.	References.	Mich. N.	Mich. S.	Ohio.	Ind.	Ill.	Iowa.	Mo.	Other States.
Spirifera Cooperensis, Swal.									
= *S. semiplicatus*, Hall	xiii. Rep. N. Y. Reg., 111								
? “ cuspidata, Sow. (not Hall)	Min. Conch., III., 42							*	
“ extenuata, Hall	Iowa Rep., 520		*	*			*		
“ Grimesi, Hall	Iowa Rep., 604					*			
“ hirta, W. & W.	Bos. Proc., viii., 293						*		Tenn
“ latior, Swal.	St. Louis Trans., II., 86							*	
“ lineata, Phil.	Geol. Yorks., II., 219							*	
“ Marionensis, Shum.	Mo. Rep., II., 203			*				*	
? = *S. Vernonensis*, Swal.									
“ Missouriensis, Swal.	St. Louis Trans., I,, 643							*	
? “ mucronata, Con.	Ann. Rep. N.Y. 1841, p.54							*	
	Hall: N.Y.Rep.IVth Dist								
“ Osagensis, Swal.	St. Louis Trans., I., 641							*	
? = *S. Carteri*, Hall									
“ peculiaris, Shum.	Mo. Rep., II., 202					*	*	*	
“ Sillana, Win.	Phil.Proc.,July 1865,p.119			*					
? “ striata, Sow.	Min. Conch., III., 125							*	
“ subrotundata, Hall	Iowa Rep. Part II., 521			*			*		
“ Taneyensis, Swal.	St. Louis Trans., I., 645							*	
“ texta, Hall	x. Rep. N.Y. Reg., 169				?				
“ Waverlyensis, Win.	Proc. A. P. Soc., xii., 251			*					
“ (Cyrtia) Hannibalensis, Swal.	St. Louis Trans., I., 648							*	
Cyrtia acutirostris, Shum.	Mo. Rep., II., 204							*	
“ sp?				*					
Syringothyris typa, Win.	Phil. Proc., Jan.1863, p. 7			*		?	*		Pa.
“ Halli, Win.	Phil. Proc., Jan. 1863, p. 8		*				*	*	
“ capax, Hall, sp.	Iowa Rep. Part II., 520						*		
Spiriferina binacuta, Win.	Phil.Proc.,July 1865,p.120						*		
“ Clarkesvillensis, Win.	Phil.Proc.,July 1855,p.119							*	
“ solidirostris, White	Bos. Jour., vii., 232			*			*		
Spirigera biloba, Win.	Phil.Proc.,July 1855,p.119				*				
“ corpulenta, Win.	Phil. Proc., Jan. 1863, p. 6						*		
“ crassicardinalis, Swal.	Bos. Jour., vii., 229						*		
“ Hannibalensis, Swal.	St. Louis Trans., I., 649			*		*	*		
“ Missouriensis, Win.	Phil.Proc.,July 1865,p.117			*				*	
“ Ohiensis, Win.	“ “ “ 118			*					
“ Prouti, Swal.	St. Louis Trans., I., 649					*		*	
Nucleospira Barrisi, White	Bos. Jour., vii., 227						*		
Retzia Osagensis, Swal.	St. Louis Trans., I., 653							*	
“ (?) Popeana, Swal.	St. Louis Trans., I., 654							*	
“ sexplicata, W. & W.	Bos. Proc.. viii., 294						*		
“ (Acambona?) altirostris, White	Bos. Proc., ix., 28						*		
Atrypa sp?	Mo. Rep., 218							*	
Ambocœlia sp?				*					
“ (Spirifera?) minuta, White	Bos. Proc., ix., 26					*		*	
Pentamerus Salinensis, Swal.	St. Louis Trans., I., 652							*	
“ lenticularis, W. & W.	Bos. Proc., viii., 295						*		
Rhynchonella Barquensis, Win.	Phil. Proc.,Sep.1862, p.408	*							
“ camerifera, Win.	“ “ “ 408	*							
“ caput-testudinis, White	Bos. Proc., ix., 23						*		
“ Cooperensis, Shum.	Mo. Rep., II., 204						*	*	
“ gregaria. Shum.								*	
“ heteropsis, Win.	Phil.Proc.,July 1865,p.121			*			*		
“ Hubbardi, Win.	“ Sep. 1862, p. 407	*	*	*					
“ Marshallensis, Win.	“ “ “ 408		*	*					
“ Missouriensis, Shum.	Mo. Rep,, II.. 204; Ill. Rep.,II.153; Ib., III. 450			*	*	*	*	*	
“ obscuroplicata, Shum.	Mo. Rep., 218							*	
“ occidentalis, Shum.	“ 218							*	
“ opposita, W. & W.	Bos. Proc., viii., 294						*		
“ persinuata, Win.	Phil.Proc.,July 1865,p.121						*		
“ pustulosa, White	Bos. Jour., vii., 226			*			*		
“ Sageriana, Win.	Phil. Proc.,Sep. 1862,p.407		*	*					Tenn
“ subcircularis. Win.	“ “ “ 408		*						
“ ? tetraptyx. Win.	“ July 1865, 120				*				
“ unica, Win.	“ “ “ 122						*		
“ Whitei, Win.	“ Sep. 1862, 407		*						
“ (Retzia?) micropleura, Win.	“ July 1865, 122		*						
“ (Eatonia) obsolescens, Hall	xiii. Rep. N. Y. Reg., 111				*				
Centronella Allei, Win.	Phil.Proc.,July 1865,p.123			*		*	*		
“ Flora, Win.	Pr.Am. Phil. Soc., xii.,254			*					

Names.	References.	Mich. N.	Mich. S.	Ohio.	Ind.	Ill.	Iowa.	Mo.	Other States.
Centronella Julia, Win.	Phil. Proc., Sep. 1862, p. 405	*							
Terebratula Burlingtonensis, White	Bos. Jour., vii., 228						*		
? " fusiformis, Murch. & V.	Geol. Russ., p. 65							*	
Ostrea patercula, Win.	Phil. Proc., July 1865, p. 124						*		
Pterinea cardinata, Win.	Phil. Proc., Sep. 1862, p. 412	*							
" crenistriata, Win.	" July 1865, p. 124		*						
=*Cardiopsis crenistriata*, Win	" Sep. 1862, p. 417								
" spinalata, Win.	" July 1865, p. 124			*			*		
" strigosa, W. & W.	Bos. Proc., ix., 31						*		
" ? undulata, M. & W.	Ill. Rep., III., 456					*	*		
" Whitei, Win.	Phil. Proc., Jan. 1863			*			*		
Aviculopecten Caroli, Win.	" " " p. 9			*			*		
" circulus, Shum., sp.	Mo. Rep., II., 206							*	
? " duplicatus, Hall	N. Y. Rep., 264							*	N. Y
" gradocostatus, White	Bos. Proc., ix., 31						*		
" Newarkensis, Win.	Proc. A. P. Soc., Jan. 1870, xii., 255			*					
" nodocostatus, W. & W.	Bos. Proc., viii., 296						*		
" occidentalis, Win.	Phil. Proc., Jan. 1863, p. 9			*			*		
" tenuicostatus, Win.	" " " 10		*	*	*		*		
Pernopecten limæformis, Win.	" July 1865, p. 126			*			*		
=*Aviculopecten limæformis*, W. & W.	Bos. Proc., viii., 295								
" limatus, Win.	Phil. Proc., July 1865, p. 126			*			*		
" Shumardanus, Win.	" " " 126;						*		
	Ill. Rep., III., 453						*		
" ? (Amusium) Cooperensis,								*	
Shum.	Mo. Rep., II., 206			*			*	*	
Microdon reservatus, Hall	Prelim. Notice, part 2, p. 33			*					
Posidonomya ambigua, Win.	Phil. Proc., Jan. 1863, p. 10						*		
" mesambonata, Win.	" Sep. 1862, p. 420		*						
" Romingeri, Win.	" " " 420		*						
" Whiteana, Win.	" " " 420		*						
Dexiobia Whitei, Win.	" Jan. 1863, p. 11						*		
=*Cardiomorpha ovata*, Hall	Iowa Rep., part 2, p. 522								
+*C. parvirostris*, White	Bos. Proc., ix., p. 31								
" Halli, Win.	Phil. Proc., Jan. 1863, p. 11						*		
Pinna (?) Marshallensis, Win.	" Juiy 1865, p. 126		*						
Mytilus elongatus, Shum	Mo. Rep., 218							*	
" fibristriatus, W. & W.	Bos. Proc., viii., 296						*		
=*Mytilarca fibristriata*, Hall	Prelim. Notice, part 2, p. 24								
" occidentalis, W. & W.	Bos. Proc., viii., 297						*		
=*Mytilarca occidentalis*, Hall	Prelim. Notice, part 2, p. 24								
" Whitfieldanus, Win.	Phil. Proc., Sep. 1862, p. 413	*	*				*		
=*Mytilarca fibristriata*, Hall	Prelim. Notice, part 2, p. 24								
Myalina imbricaria, Win.	Phil. Proc., Sep. 1862, p. 412		*						
" Iowensis, Win.	" July 1865, p. 127						*		
" Michiganensis, Win.	" Sep. 1862, p. 411		*						
" pteriniæformis, Win.	" " " 412	*							
" rara,[114] Win.	Proc. A. P. Soc. (hoc loco)		*						
=*M. aviculoides*, Win.	Phil. Proc. Sep. 1862, p. 412								
Orthonota phaselia, Win.	" Jan. 1863, p. 12						*		
" rectidorsalis, Win.	" Sep. 1862, p. 412		*						
" ventricosa, W. & W.	Bos. Proc., viii., 297						*		
Sanguinolites amygdalinus, Win.	Phil. Proc., Jan. 1863, p. 13						*		
=*Modiomorpha (?) amygdalina*, Hall	Prelim. Notice, part 2, p. 78								
" Æolus, Hall	" " 46			*					
" borealis, Win.	Phil. Proc., Sep. 1862, p. 415	*	*						
" concentrica, Win.	" July 1865, p. 128		*						
=*Cardinia concentrica*, Win.	" Sep. 1862, p. 413								
" cylindricus, Win.	" Jan. 1863, p. 13						*		
" ? flavius, Hall	Prelim. Notice, part 2, p. 47			*					
" Iowensis, Win.	Phil. Proc., Jan. 1863, p. 14						*		
" ? jejunus, Win.	" " 15						*		
" Marshallensis, Win.	" Sep. 1862, p. 415		*	*					
" naiadiformis, Win.	Proc. A. P. Soc., xii., 255		*	*					
" strigatus, Win.	Phil. Proc., July 1865, p. 127	*							
" sulciferus, Win.	" Jan. 1863, p. 14						*		
" unioniformis, Win.	" Sep. 1862, p. 414		*						
" valvulus, Hall	Prelim. Notice, part 2, p. 46			*					

114 The original name (*M. aviculoides*) is preoccupied by Meek & Hayden, for a Permian species.

Names.	References.	Mich. N.	Mich. S.	Ohio.	Ind.	Ill.	Iowa.	Mo.	Other States.
Sanguinolites (Cypricardia ?) Chouteauensis, Swal. sp.	St. Louis Trans., I., 96							*	
" " rigida, W. & W. sp.	Bos. Proc., viii., 300			*			*		
" " rhombea, Hall	N. Y. Rep., p. 291								N. Y.
" " securis, Win.	Proc. A. P. Soc., xii., 255			*					
" (Cypricardia) ventricosa, Hall. sp.	xiii. Rep. N. Y. Reg., 110				*				
Allorisma Hannibalensis, Shum.	Mo. Rep. II., 206		*	*			*	*	N. Y.
= *Grammysia Hannibalensis*, Hall	Prelim. Notice, pt. 2, p. 62								
Edmondia æquimarginalis, Win.	Phil. Proc., Sep. 1862, p. 413		*	*			*		N. Y.
" binumbonata, Win.	" " 414		*						
" Burlingtonensis, W. & W.	Bos. Proc., viii., 301			*			*		
" contracta, Win.	Phil. Proc., July 1865, p. 110						*		N. Y.
= *Cypricardia contracta*, Hall	N. Y. Rep. IVth Dist. p. 292								
= *Edmondia? bicarinata*, Win	Phil. Proc., Jan. 1863, p. 13								
= *Sanguinolites rigida*, Hall	Prelim. Notice, part 2, p. 44, (1870)								
" elliptica, Win.	Phil. Proc., Jan. 1863, p. 13						*		
" Marionensis, Swal.	St. Louis Trans., I., 654							*	
" nitida, Win.	Phil. Proc., Jan. 1863, p. 12						*		
" nuptialis, Win.	" " 12						*		
" strigillata, Win.	" " 12						*		
Modiomorpha hyalea, Hall	Prelim. Notice, part 2, p. 79			*					
Cardiomorpha Julia, Win.	Phil. Proc., Sep. 1862, p. 416		*						
" modiolaris, Win.	" " 416		*						
" sulcata, de Kon.	Anim. Foss., 109							*	
" triangularis, Swal.	St. Louis Trans., I., 655							*	
" trigonalis, Win.	Phil. Proc., Jan. 1863. p. 15						*		
? = *C. rhomboidea*, Hall	Iowa Rep., part 2, p. 523								
Pholadella Newberryi, Hall	Prelim. Notice, part 2, p. 65			*					
Arca arguta, de Kon.	Anim. Foss., p. 116							*	
" Missouriensis, Shum.	Mo. Rep., 218							*	
" modesta, Win.	Phil. Proc., Jan. 1863, p. 15			*			*		
" sp ?	Mo. Rep., 218							*	
Macrodon cochlearis, Win.	Phil. Proc., Jan. 1863, p. 16						*		
" ovatus, Hall	Prelim. Notice, part 2, p. 15			*					
" parvus, W. & W.	Bos. Proc., viii., 299						*		
Ctenodonta bellaluta, Win.	Phil. Proc., July 1865, p. 128							?	N. Y.
= *Nucula bellatula* Hall	N. Y. Rep. IVth Dist., p. 196								
" hians, Win.	Phil. Proc., July 1865, p. 128				*				
= *Nucula hians*, Hall	xiii. Rep. N. Y. Reg., p. 110								
" Houghtoni, Win.	Phil. Proc., July 1865, p. 128		*						
= *Nucula Houghtoni*, Stev.	Am. Jour. Sci. [2] xxv., 262								
" Hubbardi, Win.	Phil. Proc. Sep. 1862, p. 417; July 1865, p. 128		*	*					
? = *Nuculites sulcatina*, Con.	Phil. Jour., viii., p. 250								
" Iowensis, Win.	Phil. Proc., July 1865, p. 128		*				*		
= *Nucula Iowensis*, W. & W.	{ Bos. Proc., viii., 298; Win. Phil. Proc., Sept. 1862, p. 418								
" microdonta, Win.	Phil. Proc., Jan. 1863, p. 16						*		
" sectoralis, Win.	" Sep. 1862, p. 418	*	*	*					
? = *Nuculites mactroides*, Con	Phil. Jour., vii., p. 249								
" Stella, Win.	Phil. Proc., Jan. 1863, p. 419	*	*	*					
Nuculana (Leda) bellistriata, Stevens, sp.	Am. Jour. Sci. [2] xxv., 261; Win. Phil. Proc., Sep. 1862, p. 419		*						Tenn
" " Barrisi. W. & W., sp.	Bos. Proc., viii., 298			*			*		
= *Palæaneilo Barrisi*, Hall	Prelim. Notice, part 2, p. 11								
" (Leda) dens-mammillata, Stevens, sp.	Am. Jour. Sci. [2] xxv., 261		*						
" " nuculæformis, Stevens, sp.	" " " 261		*						
" " pandoræformis, Stevens, sp.	" " " 261		*						
" " saccata, Win.	Phil. Proc., Jan. 1863, p. 16						*		
Palæaneilo attenuata, Hall	Prelim. Notice, part 2, p. 12			*					
Conocardium bovipedale, Win.	Phil. Proc., Sep. 1862, p. 419		*						
" Napoleonense, Win.	" " 419		*						
" pulchellum, W. & W.	Bos. Proc., viii., 299			*			*		
" Romingeri, Win.	MS.		*						
Isocardia ? Jennæ, Win.	Phil. Proc., Jan. 1863, p. 17						*		

Names.	References.	Mich. N.	Mich. S.	Ohio.	Ind.	Ill.	Iowa.	Mo.	Other States.
Cardiopsis jejuna, Win.	Phil.Proc.,Sep. 1862,p.417		*						
" megambonata, Win,	" " 417	*					*		
" radiata, M. & W.	" Oct. 1860: Ill. Rep., II., 157				*	*			
=*Megambonia Lyoni*, Hall	xiii. Rep. N.Y.Reg. p. 110								
Cypricardella quadrata, W. & W.	Bos. Proc., viii., 300						*		
" Barquensis, Win.	MS.	*							
Cardinia occidentalis, Swal.	St. Louis Trans., I., 655							*	
Sanguinolaria leptogaster, Win.	Phil.Proc., Jan. 1863,p. 18						*		
" rostrata, Win.	" July 1865, p.129		*						
" sectoralis, Win.	" Sep. 1862, p. 422		*						
" septentrionalis, Win.	" " 421		*						
" similis, Win.	" " 421		*						
Anatina Leda, Hall	xiii. Rep. N.Y. Reg. p.110				*				
Solen Missouriensis, Swal.	St. Louis Trans., I., 655							?	
" quadrangulars, Win.	Phil.Proc.,Sep. 1862,p.422		*	*					Tenn
" scalpriformis, Win.	" " 422		*						Tenn
Conularia Byblis, White	Bos. Proc., ix., 22						*		
" multicostata, M. & W.	Phil.Proc.,Dec. 1865,p.252			*					
" Newberryi, Win.	" Jan. 1865, p. 130			*					
" Whitei, M. & W.	" Dec. 1865, p.253			*					
" sp ?	Mo. Rep., 218							*	
Bellerophon Barquensis, Win.	Phil. Proc., Sep. 1862, 427	*							
" bilabiatus, W. & W.	Bos. Proc., viii., 304			*			*	*	
" cyrtolites, Hall	xiii. Rep.N.Y. Reg., 107: Win. Phil. Proc.,Sep.1862 p. 426; Ill. Rep. II., 160		*	*	*		*		
" galericulatus, Win.	Phil.Proc.,Sep. 1862,p.426		*						
" lineolatus, Hall	xiii. Rep. N. Y. Reg., 107		*		*				
" Michiganensis, Win.	Phil.Proc.,Sep. 1862,p.427		*						
" nautiloides. Win.	" " " 427		*						
" panneus, White	Bos. Proc., ix., 21						*		
" perelegans, W. & W.	" viii., 304						*		
" rugosisculis, Win.	Phil.Proc.,Sep. 1862,p.425		*						
" scriptiferus, White	Bos. Proc., ix., 21						*		
" vinculatus, W. & W.	" viii., 304						*		
" Whittleseyi, Win.	Phil.Proc.July 1865, p.130			*					
Porcellia crassinoda, W. & W.	Bos. Proc., viii., 303						*		
" nodosa, Hall	Iowa Rep. Sup.to Vol. I,p. 4; Ill. Rep., III., 458					*			
" obliquinoda, White	Bos. Proc., ix., 21						*		
" rectinoda, Win.	Phil.Proc.,Jan. 1863, p.18						*		
Pugiunculus? (Theca) aculeatus,Hall	xiii. Rep. N. Y. Reg., 107		*		*				
Dentalium grandævum, Win.	Phil. Proc.,Jan. 1863,p.18						*		
" (?) Barquense, Win.	" Sep. 1862, p. 425	*							
Metoptoma undata, Win.	" July 1865, p. 131						*		
Platyceras æquilaterale, Hall	Iowa Rep., Supp.					*			
" bivolve, W. & W.	Bos. Proc., viii., 302			*			*		
" corniforme, Win.	Phil.Proc.,Jan. 1863, p.18						*		
" haliotoides, M. & W.	" 1866, p. 264; Ill. Rep., III., 458			*					
" Herzeri, Win.	Proc.A.P.Soc.,Jan., 1870, p. 256			*					
" paralium, W. & W.	Bos. Proc., viii., 302			*			*	*	
" vomerium, Win.	Phil.Proc.,Jan. 1863, p.19			*			*		
" (Orthonychia) subplicatum, M. & W.	" 1866, p. 265; Ill. Rep., III., 457			*					
Pleurotomaria exigua, Win.	" Sep. 1862, p. 424		*						
" Hickmanensis, Win.	Proc.A. P. Soc.,xii.,p. 257								Tenn
" humilis, Win.	Phil.Proc.,Sep. 1862,p.424		*						
" Mississippiensis,W.&W.	Bos. Proc., viii., 302						*		
" (?) mitigata, Hall	xiii. Rep N. Y. Reg., 108				*				
" quinquesulcata, Win.	Phil.Proc..July 1865,p.131						*		
" rota, Win.	" Jan. 1863, p. 19						*		
" Stella, Win.	" Sep. 1862, p. 424		*						
" tectoria, Win.	" Jan. 1863, p. 19						*		
" vadosa, Hall	xiii. Rep. N.Y. Reg., 108 Win. Phil. Proc., Sep. 1862, p. 423		*	*	*				
" Whitei, Win.	Phil.Proc. Sep. 1862,p.423		*						
Murchisonia (Pleurotomaria ?) limitaris, Hall	xiii. Rep. N.Y. Reg. p.108				*				

Names,	References.	Mich. N.	Mich. S.	Ohio.	Ind.	Ill.	Iowa.	Mo.	Other States.
Murchisonia neglecta, Win.	Phil.Proc.,Jan. 1863, p.20						*		
" prolixa, W. & W.	Bos. Proc., viii., p. 303			*			*		
" quadricincta, Win.	Phil.Proc.,Jan. 1863, p.19			*			*		
" (?) Shumardiana, Win.	" " 20						*		
" sp?	Proc. A. P. Soc., xii., 260								Pa. N. Y.
Straparollus Ammon, W. & W.	Bos. Proc., viii., 301						*		
=*E. depressus*, Hall, sp. (not *E. depressus*, Sby.)	N. Y. Rep. IVth Dist., p. 291								
" Barrisi, Win.	Phil.Proc.,Jan. 1863, p.20						*		
" cyclostomus, Hall, sp.	Iowa Rep., Part 2, p. 516						*		
" lens, Hall, sp.	xiii. Rep. N. Y. Reg. 109; Ill. Rep., II., 159				*	*		*	
" macromphalus, Win.	Phil.Proc.,Jan. 1863, p.20						*		
" obtusus, Hall, sp.	Iowa Rep., p. 523			*			*		
" spirorbis, Hall, sp.	xiii.Rep. N. Y. Reg. p. 107				*			*	
" sp?	Mo. Rep., 218								
Phanerotinus paradoxus, Win.	Phil.Proc., Jan.1863, p.21						*		
Holopea conica, Win.	" " 21						*		
" subconica, Win.	" " 21						*		
Machrochilus pinguis, Win.	" " 21						*		
Loxonema oligospira, Win.	" " 22						*		
" turritiformis, Hall	xiii. Rep. N. Y. Reg., 109				*			*	
Chemnitzia tenuilineata, Shum.	Mo. Rep., II., p. 20								
Holopella mira, Win.	Phil.Proc.,Jan. 1863, p.22						*		
Naticopsis depressus, Win.	" " 22						*		
? Orthoceras arcuatellum, Sandb.	Verstein. 165, Taf. xix. 2; Amer. Jour. Sci., [2], xxxiii., 355		*						
" Chemungense, Swal.	St. Louis Trans., I., 660							*	
" clinocameratum, Win.	Am. Jour. Sci. [2] xxxiii., 356	*							
" heterocinctum, Win.	Phil.Proc.,Jan. 1863, p.23						*		
" Indianense, Hall	xiii. Rep. N. Y. Reg., 107; Win. Am. Jour. Sci. [2], xxxiii., 354		*	*	*		*		
" Lathropianum, Win.	Am. Jour. Sci. [2] xxxiii. 357		*						
" Marshallense, Win.	" " " 356		*						
" multicinctum, Win.	Phil.Proc.,Sep. 1862, p.421		*						
" occidentale, Win.	Am. Jour. Sci. [2] xxxiii. 356		*						
" reticulatum, Phil.	Geol. Yorks., II., 238; Win. Am. Jour. Sci. [2], xxxiii, 357		*						
" robustum, Win.	Am. Jour. Sci. [2], xxxiii. 356		*						
" vittatum (?) Sandb.	Verstein. 165, Taf. xx., 9; Win. Am. Jour. Sci. [2] xxxiii, 355		*						
" Whitei, Win.	Phil. Proc.,Jan. 1863, p.22						*		
" sp.	Mo. Rep., 218							*	
Gomphoceras sp?				*					
" "	Mo. Rep., 218							*	
" "	" 218							*	
Nautilus (Trematodiscus), altidorsalis, Win.	Phil. Proc., 1862, p. 429		*						
" " digonus, M. & W.	" Oct. 1860, p.470; Ill. Rep., II., 163				*	*		*	
" " discoidalis, Win.	Am. Jour. Sci. [2], xxxiii. 360		*		?				
" " ingentior, Win.	" " " 361		*						
" " Meekianus, Win.	" " " 360		*						
" " planidorsalis, Win.	" " " 358		*						
" " striatulus, Win.	" " " 358		*						
" " strigatus, Win.	Phil. Proc., 1862, p. 426		*						
" " subsulcatus, Phil.	Geol. Yorks., II., 233; Win: Am. Jour. Sci. xxxiii., 361		*						
" " trigonus, Win.	Am. Jour. Sci. [2], xxxiii. 358		*						

Names.	References.	Mich. N.	Mich. S.	Ohio.	Ind.	Ill.	Iowa.	Mo.	Other States.
Nautilus (Trematodiscus) trisulcatus, M. & W.	Phil.Proc. Oct. 1860,p.470; Ib. Jan. 1861; Ill. Rep., II., 162			*	*				
" (Gyroceras?) gracile, Hall,sp	xiii. Rep. N. Y. Reg., 105				*				
" sp?	Mo. Rep., 218							*	
Phragmoceras expansum, Win.	Phil. Proc.,Jan. 1863, p.23						*		
Cyrtoceras Rockfordense, Win.	" July 1865,p.132				*				
=*N. (Cryptoceras) Rockfordense*, M. & W.	" " 275								
=*Gyroceras Rockfordense*, M. & W.	Ill. Rep., III., 459								
? " tesselatum, de Kon.	Anim. Foss., 529	*							
" unicorne, Win.	Phil. Proc.,Jan. 1863,p.23						*		
" sp?								*	
Gyroceras Burlingtonense, Owen	Rep. Wis., &c., p. 581						*		
Goniatites Allei, Win.	Am. Jour. Sci. [2] xxxiii., 363; Sketches of Creation, p. 116, fig. 50		*						
" Andrewsi, Win.	Proc. Am. Phil. Soc. xii. 259			*					
" Holmesi, Swal.	St. Louis Trans., I., 659							*	
" Houghtoni, Win.	Am. Jour. Sci. [2] xxxiii, 363		*						
" Ixion, Hall	xiii. Rep. N. Y. Reg., 100				*				
? =*G. rotatorius*, de Kon.									
" Lyoni, M. & W.	Phil.Proc. Oct. 1860, p.471			*	*				
=*G. Hyas*, Hall	xiii. Rep. N. Y. Reg., 102								
" Marshallensis, Win.	Am. Jour. Sci. [2] xxxiii. 362	*	*	*					
" Morganensis, Swal.	St. Louis Trans., I., 659							*	
" Ohiensis, Win.	Proc. A.P. Soc., xii., 259			*					
" opimus, W. & W.	Bos. Proc. viii., 305						*		
" Osagensis, Swal.	St. Louis Trans., I., 659							*	
" Oweni, Hall	xiii. Rep. N. Y. Reg., 100	*			*				
" propinquus, Win.	Am.Jour.Sci., [2] xxxiii., 365	*							
" pygmæus, Win.	" " " 366		*						
" Romingeri. Win.	Phil.Proc.,Sep. 1862,p.427		*						
" Shumardianus, Win.	Am.Jour. Sci. [2] xxxiii., 363	*		*					
Proetus (Phillipsia?) auriculatus, Hall	xv. Rep. N. Y. Reg., 107			*					
" " ellipticus, M. & W.	Phil.Proc.Dec. 1865,p.267; Ill. Rep., III., 460					*			
" " Missouriensis, Shum.	Mo. Rep., II., 196			*				*	
" " Swallovi, Shum.	" " 196							*	
Phillipsia Doris, Win.	Phil.Proc.July 1865,p. 133			*	*				
=*Proetus Doris*, Hall	xiii. Rep. N.Y. Reg., 112								
" insignis, Win.	Phil. Proc. Jan. 1863,p.24						*		
? " Maramecensis, Shum.	Mo. Rep., II., 199 Win. Phil. Proc., Jan. 1863, p. 24			*			*		
" Rockfordensis, Win.	Phil.Proc. July 1865,p.133				*				
" Tennesseensis, Win.	Tenn. Rep. 1869, p. 445; Proc. A. P. Soc., xii., 259								Tenn
" sp?	Mo. Rep., 218							*	
Cythere crassimarginata, Win.	Phil. Proc. Sep. 1862,p.429		*	*					
Helodus biformis, Newb. & Wor.	Ill. Rep., II., 77						*		
" placenta, Newb. & Wor.	" " 80						*		
Gyracanthus Alleni, Newb.				*					
Orodus multicarinatus, N. & W.	" " 62				*				
Pleurodictyum problematicum, Goldf.	Win.: Proc. A. P. Soc., xii., 260			*					

Note.—In the foregoing table, "Bos. Jour." = Journal Boston Soc. Nat. Hist.; "Bos. Proc." = Proceedings of same; "Ill. Rep.," "Iowa Rep.," "Mo. Rep.," "N. Y. Rep.," "Tenn. Rep.," = Geological Reports of Illinois, Iowa, Missouri, New York IVth District, and Tennessee, respectively; "Mich. N." and "Mich. S." = Northern and Southern outcrops of Marshall group; "Pamph." = Pamphlet issued Nov. 1863, republished in xvii. Reg. Rep., p. 50; "Phil. Jour." = Journal Academy of Natural Sciences, Philadelphia; "Phil. Proc." = Proceedings of same; "Prelim. Notice" = Preliminary Notice, &c., Preparatory for the Palæontology of N. Y.; "Rep. N. Y. Reg." = Appendix to Annual Report Regents of University, State N. Y., on condition of State Cabinet; St. Louis Trans." =Transactions Acad. Sciences, St. Louis.

From the foregoing catalogue, it appears that the total number of determined species, from rocks of the period under consideration, is, at present, 416. These are distributed in groups as follows:

Plants,	9	Porcellia,	4
Corals (Polypi),	13	Gasteropoda,	48
Crinoidea, &c.,	27	Cephalopoda,	46
Fenestella,	1	Trilobites,	9
Brachiopoda,	124	Ostracoids,	1
Lamellibranchiata,	116	Fishes,	4
Bellerophon,	13	Pleurodictyum,	1
Total,			416

The number of species known, but not identified, is 20.

The identified species have been collected in eleven detached districts or States, which have yielded, severally, the following numbers:

1.	Northern Michigan	23
2.	Southern Michigan	93
3.	Ohio	139
4.	Indiana	45
5.	Illinois	27
6.	Iowa	160
7.	Missouri	77
8.	Kentucky	2
9.	Tennessee	13
10.	New York	9
11.	Pennsylvania	9
	Total identifications	597

From this it appears there have been 181 identifications of species in two or more of the above regions. A further analysis of the geographical distribution of these species will set in a strong light the palæontological affinities of the several regions.

It might be admitted at once that the outcrop at Pt. aux Barques ("Northern Michigan") is of the same geological age as the typical formation in Southern Michigan; but as Messrs. Houghton and Hubbard[115] have separated the two series of outcrops as different formations, I desire to introduce the palæontological discussion, by setting at rest all controversy respecting the synchronism of the strata in the two Michigan districts. The following species occur in both regions:

Producta concentrica,
Rhynchonella Hubbardi,
Mytilus Whitfieldanus,
Sanguinolites borealis,
Ctenodonta sectoralis,
" Stella,
Goniatites Marshallensis.

With 30 per cent. of the known species of the Pt. aux Barques sandstones identifiable with fossils from the Marshall sandstones, and with a

[115] See Part I. of this paper, p. 59.

stratigraphical and lithological conformity in the two series of sandstones (besides *Goniatites Oweni*, common to Northern Michigan and Indiana, *Chonetes Illinoisensis*, common to Northern Michigan, Ohio, Indiana and Iowa; *Cardiopsis megambonata*, common to Northern Michigan and Iowa, and *Goniatites Shumardanus*, common to Northern Michigan and Ohio), I think their geological equivalency can never hereafter be called in question.

In conducting the palæontological branch of the discussion of equivalencies among the western districts, it would be appropriate to cite here the lists of species identified in two or more of these districts. As this, however, would considerably extend the limits of this paper, and these lists are readily deducible from the "Catalogue" given, I present only the summaries. In doing this, I shall count the two Michigan districts as one, and shall also omit Kentucky, since I feel some uncertainty about the geological position of the two species recorded from that State.

Species	common to	Michigan and	Ohio,	27
"	"	"	Indiana,	9
"	"	"	Illinois,	1
"	"	"	Iowa,	13
"	"	"	Missouri,	3
"	"	"	Tennessee,	4
"	"	Ohio and	Indiana,	12
"	"	"	Illinois,	10
"	"	"	Iowa,	51
"	"	"	Missouri,	16
"	"	"	Tennessee,	4
"	"	Indiana and	Illinois,	5
"	"	"	Iowa,	7
"	"	"	Missouri,	5
"	"	"	Tennessee,	2
"	"	Illinois and	Iowa,	10
"	"	"	Missouri,	14
"	"	Iowa and	Missouri,	13
"	"	"	Tennessee,	5
"	"	three States,		32
"	"	four "		10
"	"	five "		2

Should we unite *Producta Shumardana* and *P. pyxidata* with *P. concentrica*, the latter species would be known in seven different Western States, besides the Pt. aux Barques region.

With such an extended network of identifications, and with long lists of representative species which I forbear to cite, I believe it will be admitted that the several formations brought under comparison must have been accumulated in one geological period. Let it now be distinctly stated what are the formations which are thus synchronized. They are as follows :

1. The Marshall Group of Michigan.

2. The Gritstone and Waverly series of Ohio, down to the Chocolate Shales.

3. The Goniatite Limestone of southern Indiana, and its equivalent sandstone in northern Indiana.

4. The Kinderhook Group of Illinois.

5. The Yellow Sandstone series of Iowa, at least down to the bluish sandy shales.

6. The series known in Missouri as the Chouteau Limestone, the Vermicular Sandstone and Shale, and the Lithographic Limestone.

7. The Silico-bituminous Shales at the base of the Silicious Group of Tennessee.

For the sake of brevity and convenience I shall hereafter employ the term Marshall Group as the general designation for this formation in the Western States.

Let us next consider what are the paleontological relations subsisting between the Marshall Group and the Chemung and Portage and older formations of New York.

Professor Hall [116]has described from Summit County, Ohio, a crinoid under the name of *Forbesiocrinus communis*, which, he states, cannot be distinguished from a single specimen from the Chemung of Chatauque County, N. Y. At the same time he states that this species combines some of the characters of two types occurring in the Carboniferous Limestone. Another species, *Forbesiocrinus lobatus*, presents characters which he regards as constituting a variety (*Var. tardus*) of a species from the Hamilton Group[117]. A third species from the same locality, he regards as closely related to *Poteriocrinus diffusus*, of the Hamilton Group, though distinctly differing. At the same time Professor Hall notes no less than seven species from this locality which exhibit distinct affinities with species from the Burlington Limestone. We have in this assemblage of crinoids, therefore, two species identified with species from rocks which I regard as older than the Marshall, while nine species, including the two identified, sustain intimate relations with the fauna of the Carboniferous system, which Professor Hall assumes to be entirely above the zone of the Chemung.

The only other species from the Marshall Group which stand referred to strata as old as the Chemung are the following:

1. *Strophomena arctostriata* Hall, from Hobbieville, N. Y.,—doubtfully recognized at Cuyahoga Falls, Ohio.

2. *Orthis Vanuxemi*, Hall, which if not identical with *O. Michelini* L'Evéillé, a carboniferous species, is so closely related as to show that the type of *O. Michelini* began to exist during the Hamilton period. A species perhaps identical, has been described from Iowa as *O. Swallowi*, Hall; and *O. flava*, Win. from the same locality, belongs to the same group of forms.

[116] xvii, Rep. N. Y. Regents, p. 50.

[117] The analogue of this is *F. Giddingi*, of the Carboniferous Limestone. Hall, xv. Rep. N. Y. Reg. 124.

3. *Orthis resupinata* de Kon. ranges from the Devonian into the Carboniferous system both in Europe and America.

4. *Orthis Thiemei*, White, from Iowa, is reported by Professor Hall as identified in the Chemung of New York.

5. *Chonetes Logani* Nor, and Prat, is also reported by Professor Hall occurring in the Tully Limestone. I have heretofore expressed my dissent from this identification.[118] I pronounced the New York species distinct before being informed of its geological position or locality. It presents a series of concentric rugosities or wrinkles which extend both across the ribs and the intervals between the ribs, while in *C. Logani* the rugosities are feebler, and are confined to the crests of the ribs.

6. *Strophomena rhomboidalis*, Wahl, has a range even greater than that of *O. resupinata*.

7. *Spirifera mucronata* Con., found in the Chemung of Steuben County, N. Y., was doubtfully identified in Missouri. Not having seen the Missouri specimens, I would be strongly inclined to suspect that they belong rather to *S. extenuata*, or some related species.

8. *Ctenodonta bellatula*, Hall, sp. of the Hamilton group of New York, has also been doubtfully identified in Missouri.

A few additional species had been provisionally reported identical with Chemung forms, but as already stated, a direct comparison of the species suspected to be identical has induced me to abandon the identification in every instance. We have then no unquestioned identifications with species from rocks as old as the Chemung, except in the case of *Orthis resupinata* and *Strophomena rhomboidalis*, and perhaps *Orthis Thiemei*. It is fair to presume that the forms of *Strophomena rhomboidalis*, occurring as high as the Marshall group, will yet be distinguished from the Silurian forms by appreciable characters, as has been done recently in respect to the forms of *Atrypa reticularis*.[119] The different expression of the Marshall forms has already been remarked. This species, so abundant in the Marshall period, existed in the Lower Silurian, and appears to have attained its culmination in the Upper Silurian. There is an improbability that the same species, after having once undergone a decline, should attain a second culmination in seas swarming with species and types of a much later period.

I think it will be admitted that the palænotological correspondence between the Marshall and the Chemung strata is extremely meagre. We know four hundred and fifteen species from the strata of the Marshall period, of which 138 come from Ohio, a State almost in continuity with the State of New York. We know probably 100 or 150 species from the Chemung of New York; and yet we are able to identify scarcely a single characteristic species with the types of the Marshall group. This state of the facts looks very unfavorable to the attempt to parallelize the Marshall and Chemung.

I proceed now to point out the specific facts bearing upon the relation subsisting between the Marshall fauna and that of formations in Western

[118] Proc. Acad. Nat. Sci. Phil. July, 1865, p 116.

[119] Whitfield: observations on the internal appendages of the genus Atrypa, 1866.

New York, which are newer than the characteristic Chemung. I have already stated that Professor Hall indicates the existence in Western New York, of three conglomerates which he regards as coming in consecutively above the typical Chemung. I have also stated that the consecutive arrangement is not established by any observed superposition. On an examination of the fossils of the so-called carboniferous conglomerate preserved in Professor Hall's magnificent cabinet, I at once identified the following Marshall species :

Straparollus Ammon, White.[120]
Cypricardia contracta, Hall=(Edmondia bicarinata Win.)
Edmondia æquimarginalis, Win.
Allorisma Hannibalensis, Shum.

Straparollus Ammon is from Iowa, though an undistinguishable form occurs in the coal measures of Lasalle, Illinois. *Cypricardia contracta* is also from Burlington, while *Edmondia æquimarginalis* is known in Michigan, Ohio and Iowa, and has a European analogue in *Cardina robusta* of J. de C. Sowerby ; and *Allorisma Hannibalensis* is known in Michigan, Ohio,[121] Iowa and Missouri. The whole number of species in the cabinet from this conglomerate did not amount, if I remember rightly, to more than eight, and here were four of them immediately and conclusively identifiable. Here is a percentage of identifications forty or fifty times as great as we have been able to make with fossils of Chemung age. It seems to me that we are within the limits of truth when we assert that the paleontological evidence points much more strongly to a synchronism between the Marshall group and this conglomerate, than between the Marshall and the Chemung.

When next I turned my attention to an examination of specimens from the reputed Chemung conglomerate, I remarked its lithological similarity to the former. and was able also to recognize among the fossils the following species identified in the other conglomerate :

Edmondia æquimarginalis.
Allorisma Hannibalensis.

Out of a very limited number of fossils in these two conglomerates, here were two completely identical. But for their reputed dissimilarity in age, any paleontologist would feel inclined to pronounce them synchronous. Biding the opportunity to make a re-examination of the grounds upon which Professor Hall has separated these two conglomerates ; and holding paleontological induction as always subordinate to stratigraphical demonstration, I shall provisionally regard as one the two conglomerates under consideration.

The so-called Chemung conglomerate rests upon typical Chemung strata. The outliers of the Catskill group in Western New York also rest, when-

[120] This was described by Hall as *Euomphalus depressus*, but as this name had been preoccupied by Sowerby, the name of White will take precedence.

[121] This and some others of the species identified in this paper from Ohio have very recently been sent rom Licking County by Rev. H. Herzer. P. S.—Others have been sent by Prof. E. Andrews, See. Proc. A. P. Soc. xii, 245.

ever seen, upon Chemung strata, and so do the outliers of the so-called Carboniferous conglomerate. Not only are the three similarly superposed, but they agree in presenting sometimes a conglomeritic character, and sometimes the character of a sandstone with oblique lamination. The carboniferous conglomerate near Panama, in Chatauque County, affords a fine building stone, and is quarried there for that purpose. Finally, I desire to recall the fact that the Marshall sandstone in the vicinity of Pt. aux Barques assumes a decidedly conglomeritic character, and presents the appearance of the conglomerate at Cuyahoga Falls in Ohio, with which the earlier Michigan geologists were inclined to identify it. I ought also to mention the fact that *Cypricardia Catskillensis*, figured and described by Vanuxem,[122] presents close analogies with two species from the Marshall group, *Sanguinolites unioniformis* and *S. naiadiformis*.

For these reasons, I shall, for the present, regard the three conglomerates in Western New York, with the associated strata, as belonging together in the horizon of the Catskill group.

I ought to cite here the results of some investigations which I have more recently made upon a collection of fossils from the sandstones of Venango County, Pennsylvania.[123] At a point near Shafer's, on Oil Creek, the following characteristic fossils of the Marshall group were recognized in April, 1869, and the results communicated to Professor E. Andrews, to whom I was indebted for the specimens.

Lingula membranacea.	Hemipronites umbraculum.
Discina Gallaheri.	Orthis Michelini.
Producta semireticulata.	Spirifera Carteri.
Chonetes pulchella.	Syringothyris typa.
Hemipronites inæqualis.	

This locality was reported by Prof. Andrews to be "200 to 300 feet below the coal." Every identifiable specimen belonged to the Marshall group. Judging from these data, there can be no doubt that this group extends into western Pennsylvania.

At Kinzua, however, not far from Shafer's, at a point thought by Prof. Andrews to be a hundred feet lower, geologically, quite a different fauna presented itself. Not a single Marshall species could be identified; while *Spirifera disjuncta* (Phillips) Hall, and fragments of lamelli branches which seemed to belong to *Avicula longispina* and *acanthoptera* Hall, proclaimed the horizon of the Chemung.

Since the recognition of the Marshall sandstones in northwestern Pennsylvania,[124] it becomes much easier to admit the evidence which I have already adduced in proof of their existence in southwestern New York. The physical character of these sandstones so closely resembles that of the Chemung rocks that the line of demarkation between them had not

[122] Geol. Rep. Dish. N. Y., p. 186.

[123] Proc. Amer. Phil. Soc., Jan. 4*th*, 1870.

[124] Professor Hall, in xx Rep. N. Y, Reg. p. 295, reports also *Lepidechinus rarispinus* from Meadville, Pa., and Licking County, Ohio. He argues from this a parallelism which I will not contest, but the fact establishes no affinity with the Chemung.

heretofore been recognized in that part of the country. Further east, however, where they become lithologically differentiated from the Chemung, they had long since been assigned a distinct position, both in Pennsylvania and New York.

V. The Fauna of the Marshall Group presents a Carboniferous Aspect.

I proceed in the next place to prove, on paleontological grounds, that the Marshall group possesses close affinities with the carboniferous system. These affinities are manifested in the presence of species identical with recognized carboniferous fossils of America and Europe ; in the presence of species which may be regarded as the precursors or analogues of recognized carboniferous fossils, and in the dominance of generic and sub-generic types which attain their culmination during the carboniferous age.

1. Species identified with fossils from the carboniferous rocks of America :

Producta semireticulata Flem.	Coal measures.
" Cora d'Orb.	" "
Chonetes Illinoisensis Wor.	
(=C. Logani Hall).	Burlington Limestone.
" multicosta Win.	" "
" mesoloba N&P.	Coal measures.
Hemipronites umbraculum Von Buch.	" "
Orthis Swallowi Hall,	Burlington Limestone.
Spirifera lineata ? Phil.	Coal measures.
" Grimesi Hall.	Burlington Limestone.
" camerata Morton.	Coal measures.
Nuculana bellistriata Stev. sp.	Coal measures.
Phillipsia Maramecensis ? Shum.	Warsaw Limestone.

2. Species which extend up into the base of the Burlington Limestone at Burlington, Iowa :

Syringopora Harveyi White.	Restricted.
Trematopora ? vesiculosa Win.	"
" fragilis Win.	
Syringothyris typa Win.	Restricted.
Pentamerus lenticularis W&W.	
Aviculopecten Caroli Win.	
Pernopecten limatus Win.	Restricted.
Ctenodonta microdonta Win.	
Platyceras corniforme Win.	
Pleurotomaria rota Win.	
Orthoceras Indianense, Hall.	
" heterocinctum, Win.	

The species marked "restricted" do not occur below the base of the Burlington Limestone at Burlington, but they are included here because the fauna proper of the Burlington Limestone begins above the narrow basal zone containing the Marshall species. *Syringothyris typa*, moreover, is believed to occur in the Kinderhook group of Illinois. [It is now known also from Ohio and Pennsylvania.]

3. Species identified with fossils from the Carboniferous rocks of Europe:

Producta semireticulata Flem.	Spirifera lineata? Phil.
? " Cora d' Orb.	Orthoceras reticulatum Phil.
Hemipronites unbracutum V. Buch.	Nautilus subsulcatus Phil.
Orthis Michelini L'Evé.	Cyrtoceras tesselatum de Kon.
" resupinata de Kon.	

4. Fossils whose analogues recur in the recognized carboniferous rocks of America:

	Analogues.
Platycrinus contritus.	Platycrinus Burlingtonensis.
Actinocrinus Helice.	Actinocrinus unicornis.
" pistilliformis.	{ Actinocrinus pyriformis. { Actinocrinus pistillus.
" viminalis.	" Whitei.
Poteriocrinus Corycia.	Poteriocrinus cauliculus.
Forbesiocrinus lobatus Var. tardus.	Forbesiocrinus Giddingi.
Scaphiocrinus subcarinatus.	Scaphiocrinus carinatus.
" subtortuosus.	{ " tortuosus. } { " carinatus. }
Zeacrinus paternus.	Zeacrinus scoparius.
Lepidechinus rarispinus.	Lepidechinus imbricatus.
Producta arcuata.	Producta semireticulata.
Producta Newberryi.	Producta semireticulata.
" morbilliana.	" Rogersi.
Chonetes multicosta.	Chonetes Logani.
Orthis Vanuxemi?	Orthis Michelini.
" flava.	" "
Spirifera hirta.	Spirifera pseudolineata.
" Cooperensis.	" lineata.
Spiriferina Clarksvillensis.	Spiriferina subtexta.
Spirigera Missouriensis.	Spirigera subtilita.
Pernopecten Shumardanus.	Pecten aviculatus.
Myalina Iowensis.	Myalina angulata.
Edmondia Burlingtonensis.	Edmondia radiata.
Sanguinolites Chouteauensis.	Cypricardia transversa.
Ctenodonta Stella.	Nucula ventricosa.
Conocardium pulchellum.	Conocardium carinatum.
Cypricardella quadrata.	Cypricardella subelliptica.
Bellerophon perelegans.	Bellerophon cancellatus.
Dentalium grandævum.	Dentalium venustum.
Platyceras paralium.	Platyceras acutirostre.
Straparollus Ammon.	Euomphalus Spergenensis
Macrocheilus pinguis.	Macrocheilus primigenius.

5. Fossils whose analogues recur in the Carboniferous rocks of Europe:

Producta arcuata,	Producta semireticulata.
" morbilliana.	" punctata,
Orthis flava.	Orthis Michelini.
Rhynchonella Sageriana.	R. pleurodon Var. Devreuxiana.
Rhynchonella Whitei.	Rhynchonella radialis.
" subcircularis.	" "
" persinuata.	" pleurodon.
" ? tetraptyx.	Spirifer Buchianus. [mis.
" Missouriensis.	Rhynchonella pugnax & renifor-
Pterinea spinalata.	Avicula lunulata.
Pernopecten limæformis.	Pecten dissimilis.
Posidonomya Romingeri.	Posidonomya vetusta.
" mesambonata.	" "
Mytilus Whitfieldanus.	Modiola lingualis.
Myalina Michiganensis.	Myalina virgula.
" imbricaria.	" lamellosa.
Edmondia nitida.	Edmondia unioniformis.
" æquimarginalis.	Cardinia robusta.
" binumbonata.	Edmondia scalaris.
Sanguinolites concentrica.	Cardinia tellinaria.
Cardiomorpha modiolaris.	Cardiomorpha livida.
" Julia.	" Puzosiana.
Arca modesta.	Arca arguta.
Conocardium pulchellum.	Condocardium aliforme.
Bellerophon vinculatus.	Bellerophon bicarenus.
" rugosiusculus.	" decussatus.
" galericulatus.	" Urei.
Pleurotomaria humilis.	Pleurotomaria helicinoides.
Straparollus Ammon.	Euomphalus lævis.
Straparollus macromphalus.	Euomphalus lævis.
Orthoceras Indianense.	Orthoceras cinctum.
" robustum.	" giganteum.
" multicinctum.	" cinctum.
Nautilus trisulcatus.	{ Nautilus sulcatus. " Edwardsianus, &c.
" digonus.	" "
" planidorsalis.	" "
" trigonus &c.	" "
Cyrtoceras Rockfordense.	Cyrtoceras cyclostomum.
Goniatites Oweni.	Goniatites princeps.
" Ixion.	" rotatorius.
" Marshallensis.	" mixolobus &c.
" Lyoni.	" "
" pygmæus.	" striolatus.
" Romingeri.	" rotatorious.

6. Generic and sub-generic types of a carboniferous character. The most important genera possessing a paleontological value in this discussion are the following :

Actinocrinus.	Edmondia.
Producta .	Sanguinolites.
Aviculo pecten.	Cardiomorpha.
Mytilus.	Nautilus.
Myalina.	Phillipsia.

The genus *Actinocrinus* begins its existence in the upper Silurian, but attains only a feeble development until we reach the lower carboniferous. It seems to reach its culmination in the Burlington Limestone. According to a table drawn up by Dr. B. F. Shumard[125] in 1865, this genus is represented by two species in the Niagara group, 2 in the Corniferous ; 6 in the Hamilton ; 3 in the Chemung ; 115 in the Burlington Limestone ; 29 in the Archimedes Limestone, and 2 in the Kaskaskia Limestone. Later investigations render it necessary to change these figures without materially altering their ratios. It is emphatically a Carboniferous genus. Of this genus seven or eight species are known in the Marshall group; and they also belong to those peculiar types which characterize the Carboniferous limestone (Compare for instance *A. pistilliformis*).

The genus *Producta*, in its sub-generic forms, has a similar history. It begins in the lower Devonian and culminates in the Lower Carboniferous. Professor Hall describes 11 species from the Chemung group of New York. I am acquainted with 20 species (including one *Strophalosia* ?), from the Marshall group. De Koninck describes 28 species from the carboniferous rocks of Belgium. D'Orbigny enumerates 63 known species of *Producta*,[126] of which one is Silurian, 4 are Devonian, and 49 are Carboniferous. Bronn enumerates[127] 45 species as certainly discriminated, of which 37 belong certainly to the Mountain Limestone, and only two occur in rocks as old as the Devonian.

Of the genus *Spiriferina* we have three species in the Marshall group. No species have ever been recognized in rocks as old as the Devonian.

The genus *Aviculopecten* is emphatically a Carboniferous type, and was so regarded by McCoy when first proposed. In his descriptions of British Paleozoic Fossils, he enumerates 18 species of the genus, 15 of which belong to the Carboniferous system, and 3 to the Old Red Sandstone. Nine species are reported from the Carboniferous rocks of Illinois. From the Marshall group I am acquainted with 12 species (including 4 species of *Pernopecten* not heretofore separated from *Aviculopecten*). It is true the Chemung contains also several species; but as the type is not known to descend lower, the presence of these species in the Chemung unites

125 A catalogue of the Palaeozoic Fossils of North America I. Echinodermata.
126 Prodrome de Paléontologie.
127 Index Palæontologicus.

with the presence of *Producta* and various forms of land vegetation, in imparting to that group, to this extent, a Carboniferous aspect.[128]

The genus *Mytilus*, of which we know four species in the Marshall group, is decidedly one whose history runs through later geological times. Of 203 species enumerated by D'Orbigny, only 12 are recognized as occurring in rocks older than the Carboniferous, and it is probable that some of these belong to *Modiolopsis* and *Orthonota* or allied genera.

The genus *Myalina* was established by De Koninck exclusively to receive three species from the upper part of the Coal measures of Belgium. McCoy discovered none below the Permian system. In this country the genus is restricted to the limits of the Carboniferous system, attaining its maximum development in the Coal measures. Of this Carboniferous genus the Marshall group affords at least 5 species.

Edmondia, also founded for the reception of Carboniferous forms, has not been certainly traced downwards into the limits of the Devonian system. De Koninck gives two species, both from the Coal measures; Mc Coy, in the work cited, describes 10, all of which occur in the Carboniferous Limestone. The Marshall group has afforded 9 species which have been referred to this genus.

Sanguinolites of McCoy afforded its proposer 14 species, of which 11 occur in the Carboniferous strata, and 3 in rocks of older date. In the Marshall group we recognize 19 species of this genus, including 5 belonging to the type of *Cypricardia*.

The genus *Cardiomorpha* is, in the Old World, confined exclusively to the Carboniferous System, from which De Koninck describes 13 Belgian species, and McCoy 3 British species. We have described 5 species from the Marshall group, and know of none from the Chemung.

Nine species of trilobites have been described from the Marshall group, all of which probably belong to the Carboniferous genus *Phillipsia*, though five of them were referred to *Proëtus* by their original describers. Of the latter five, *Proëtus ellipticus*, M. & W. was thought by the authors to be probably a *Phillipsia*. *Proëtus Swallowi*, Shum. is regarded as the nearest analogue of this, and the latter is hence probably also a *Phillipsia*. This species, moreover, does not present the posterior termination of the great suture required by *Proëtus*. *Proëtus Doris*, Hall, was described from pygidia, and of course its generic relations are not demonstrated. I have since discovered from the same locality, several complete cephalic shields which present the distinctive marks of *Phillipsia*, so far as they have been pointed out. All the Carboniferous trilobites of Europe and America belong to this genus and its sub-genus *Griffithides*. Though Barrande inclines to recognize Phillipsia sparingly in the upper Silurian and Devonian, we are still compelled to regard it as an eminently Carboniferous type.

[128] As has been already intimated several Carboniferous types began their existence as early as the Hamilton and even the Corniferous period. Several of the *Fenestellidæ* from the Hamilton rocks of Michigan were identified by Dr. H. A. Prout with species in the Carboniferous Limestone. His work upon these fossils was incomplete at his death, and has never been published.

Of *Nautili* we are acquainted with 13 species from the Marshall group. Of these, 11 or 12 belong to the section characterized by longitudinal furrows and angulations and an open umbilicus, for which Messrs. Meek and Worthen have proposed the sub-generic name *Trematodiscus*.

Remarks similar to the foregoing could be offered in reference to the geological affinities of various other genera represented in the Marshall group—as *Platycrinus*, *Forbesiocrinus*, *Zeacrinus*, *Pterinea*, *Posidonomya*, *Pinna*, *Macrodon*, *Solen* and certain forms of *Spirifera*, *Bellerophon*, *Orthoceras* and *Goniatites*.

Such are the leading characteristics of the fauna of the Marshall group which indicate its affinities with the Carboniferous system of Europe and America.[129] To sum up: we find 12 species identified with fossils from the Carboniferous rocks of America; 12 species which extend from the Marshall strata upwards into the base of the Burlington Limestone at a point where the two formations rest in juxtaposition; 9 species identified with fossils from the Carboniferous rocks of Europe; 32 species whose analogues recur in the higher Carboniferous rocks of America; 44 species whose analogues recur in the Carboniferous rocks of Europe; 10 generic or subgeneric forms largely represented, which characterize pre-eminently the Carboniferous system, besides numerous other genera and species whose affinities point rather to Carboniferous than to other strata.

Two years ago, (Aug. 1866,) during the meeting of the American Association at Buffalo, a discussion incidentally arose as to the paleontological relations of the Marshall group, in which on the one hand, it was claimed that it presented "a Carboniferous aspect;" while on the other hand the question was asked, "what is meant by a Carboniferous aspect?" and the remark was added: "I don't know what you call a Carboniferous aspect." I turn now to the citation of facts, of which I have just presented a summary, and reply: "That is what I mean by a Carboniferous aspect."

To answer this question in other words, let me quote the language of a distinguished American paleontologist.[130] "We have a right to contend, therefore, for the existence of the Carboniferous system at any point where we can find a continuation of the genera *Pentremites*, *Productus*, *Goniatites*, (*Cyrtoceras*, *Discites*) *Nautilus* and the ganoid fishes.[131] I contend that this is the legitimate conclusion, or else the Carboniferous system is subordinate to the Devonian." That is in principle exactly what I contend for. It was in that school, too, that I received my teaching.

VI. The Fauna of the Chemung Group presents a Devonian Aspect.

In the further prosecution of this discussion it would be appropriate to

[129] The strata of the Marshall group probably correspond to the "yellow sandstone" of Ireland and the Westphalian schists lying at the base of the Carboniferous system.

[130] Hall: Foster & Whitney's Rep. Lake Sup. Land Dist II, 308.

[131] May we not say that the Devonian is distinguished from the Silurian by the *advent* of these and other types, while the Carboniferous is characterized by their great expansion?—this being indicated by the great multiplication of species, the increased richness of ornamentation, the extravagant development of certain features, and sometimes by unusual bulk. Carboniferous types in the Devonian Age were, in a sense, *prophetic faunas*, or "colonies"—to employ a phrase from Barrande, used in reference to the Primordial Zone of the environs of Prague.

enter upon an examination of the paleontological affinities of the Chemung group, with which it has been thought this Carboniferous assemblage of strata can be synchronized. I shall content myself, however, with three remarks. 1. The fauna of the Chemung group embraces numerous generic forms, some for the first time introduced, which were destined to undergo their full expansion and find their closest analogues in the Carboniferous Age. 2. It embraces some generic and many specific forms which lingered from early Devonian times, and which do not pass the upper limits of this group. 3. The balance of affinities is universally admitted to be with the Devonian system, so that the attempt to establish that proposition would be superfluous.

VII. Can the Marshall and Chemung be Synchronized?

Ever since Cuvier first enunciated the doctrine of successive faunas in the past history of the world, geologists have held that paleontological characters stand next in importance and reliability to observed superposition in the determination of the synchronism or sequence of formations. Pictet[132] lays down the following principles for our guidance in the use of fossils:

"1. In all countries which have been studied to the present time, the geological faunas succeed each other in the same order."

"2. Contemporaneous formations, or those formed at the same epoch, contain identical fossils."

"3. Reciprocally, formations which contain identical fossils are contemporaneous."

Professor Agassiz,[133] in writing of the "succession of animals and plants in geological time," says: "I cannot refrain from expressing my wonder at the puerility of the discussions in which some geologists allow themselves still to indulge, in the face of such a vast amount of well-digested facts as our science now possesses. They have hardly yet learned to see that there exists a definite order in the succession of these innumerable extinct beings, &c."

"One result stands now unquestioned; the existence during each geological era of an assemblage of animals and plants differing essentially for each period. And by period I mean those minor sub-divisions in the successive sets or beds of rocks which constitute the stratified crust of our globe, the number of which is daily increasing as our investigations become more extensive and more precise."[134]

Professor Hall,[135] in attempting to establish the distinctness of the two groups, Portage and Chemung, uses these words: "When we apply the test of organic remains, we find an equally, or even more strongly marked difference in the two groups; and, upon this alone, a distinction between the two should be made." In reporting upon the result of his examination

[132] Paléontologie, I. p 100.
[133] Contributions to the Natural History of the U. S., vol. 1, p. 93.
[134] Ib. p. 96.
[135] Geolog. Rep. IVth Dist. N. Y., p. 229.

of western formations in 1841, he states:[136] "This examination westward also afforded a good opportunity of testing the value of fossil characters, when applied to the same strata extending over wide tracts of country, and the results will be seen, as we proceed, to have been mostly satisfactory." On another occasion he used the following words:[137] "Every step in this research tends to convince us that the succession of strata, when clearly shown, furnishes conclusive proofs of the existence of a regular sequence among the earlier organisms;" Finally, in 1850, he employed this explicit and pertinent language:[138] "In distant and disconnected localities we are compelled to base our opinions of the equivalency of beds upon the organic remains which they contain."

Such citations could be made almost without limit, but it scarcely seems necessary to proceed. Every paleontological research proceeds upon the assumption of the truths of the fundamental principles which these extracts enunciate. On paleontological grounds Professor Hall undertook the identification of the western formations; on such grounds he asserted the Spergen Hill limestone to belong to the age of the Warsaw limestone; on such grounds Mr. Billings identified the Lower Helderberg group in Maine; on such grounds Barrande divides his Promodial Zone into distinct stages which he attempts to identify in other parts of the world; on such grounds Barrande confidently asserted, without even having placed foot upon American soil, that certain Trilobites described by Professor Hall from the town of Georgia, in Vermont, belonged to a much lower, stratigraphical position than had been assigned to them; and thus, while sitting in his study at Paris, confidently and successfully rectified the mistakes of field geologists in America working amongst the hills of northern New England.

It is evident that if we proceed according to the established principles of paleontological science, we shall be obliged to deny the contemporaneous origin of the rocks of the Marshall and Chemung groups. We shall be induced to leave the Chemung within the limits of the Devonian system where it has been placed by the nearly unanimous judgment of paleontologists; and to admit the Marshall group within the boundaries of the Carboniferous system according to the present nearly unanimous judgment of western geologists;[139] according to the opinions of the eminent European geologists who have investigated the question, and according also to views which were at one time shadowed forth by the present principal opponent of such views. De Verneuil[140] in alluding to certain representatives of the Marshall group, says: "As it [the Devonian system in New York] is principally composed of Schists and argillaceous sandstones which, as we have said, are lost and disappear in the West, it thence results that in the States of Ohio, Indiana and Kentucky, it is reduced to

[136] Trans. Asssoc. Amer. Geol. p. 268.
[137] Paleont. N. Y., vol. I. Introd. p. xxxiii.
[138] Foster and Whitney's Rep. Lake Sup. Land Dis. II. p. 286.
[139] See the references made in the 2d section of this paper.
[140] See Amer. Jour. Soc. [2] v. 370.

the Black Schists which represent the Genesee Slate, and to a calcareous band which represents at once the Corniferous and Onondaga limestones and the Hamilton group of the State of New York."

In his comments upon this paper of de Verneuil, from which I just quoted, Professor Hall himself says:[141] "We know that *between* the Chemung group and the great Carboniferous Limestone of the West and southwest, there is an extensive formation of yellow sandstones and green shales and sandstones"—and, for the sake of enforcing a view which he then held, that even the Chemung strata ought to go into the Carboniferous system, he adds, "charged with fossils having a close analogy with those of the groups below." Still further in his tabular arrangement appended to his elaborate discussion on the "Parellelism of the Paleozoic Deposits of the United States and Europe,[142] he places the "Yellow sandstones and green shales of Ohio," not only above the Chemung, but above the shales and sandstones of the Catskill mountains."

In the presence of such facts and such testimony as have been cited, it becomes a question of curious interest upon what grounds the geological equivalency of the Chemung and Marshall can still be maintained. In a paper presented before the National Academy last summer (1867) at Hartford, and repeated before the American Association at Burlington, it was held that the Devonian fauna of the Chemung in its western extension becomes replaced by the Carboniferous fauna of the Marshall simply through the influence of *local conditions*. Geographical variations were pointed out in the nature of the deposits and the accompanying faunas, of the Trenton, Hudson River, Niagara and Hamilton groups, and it was maintained that the paleontological contrast between the Chemung and the Marshall is something of the same kind, and possessing no different significance. These views at Hartford, were endorsed by the high authority of Professor Agassiz.

The same views had been previously recorded by Professor Hall in the Fourth Volume of the Paleontology of New York,[143] as follows: "We have every reason to believe that, in those sedimentary formations between the Hamilton group and the Coal measures in the east, and between the same group and the Burlington (Carboniferous) limestone in the west, the Devonian aspect of the fauna, on the one hand, and the Carboniferous aspect on the other, are due, in a great degree, to geographical and physical conditions, and not to difference of age or chronological sequence of the beds containing the fossils."

Again, in a pamphlet "Notice"[144] of this volume, in alluding to the contrast between the faunas of the Chemung and Marshall groups, he uses these remarkable words:—"*The distinction between Devonian and Carboniferous faunas is based as often upon geographical as chronological relations.*"

141 Amer. Jour. Sci. [2] v. 368, Note.

142 Foster and Whitney Rep. L. Sup. Land Dis. II, Chap. xviii.

143 pp. 252–257. See Notice of this volume, Trans. Amer. Phil. Soc., May, 1866, p. 246; also, Pamphlet, 1867.

144 Notice of IVth volume Pal. N. Y., 1867, p. 5.

It seems to me that the doctrine asserting the influence of geographical and other physical conditions, is being carried entirely too far. That the organic beings which populated the earth in past ages must have been distributed in each period, in faunas geographically restricted, under laws identical with those which now determine the distribution of animals and plants, is a doctrine which every reflecting paleontologist has either asserted or implied.[145] It would be puerile, indeed, to attempt to draw a stratigraphical induction from paleontological data, without keeping in view the known laws of faunal circumscription. But it is a new and an unprecedented procedure for a geologist to attribute to physical conditions the characteristics which the common consent of all paleontologists has assigned to faunas which lived in different ages of the world. This is to recede to the platform of De Maillet and Lamarck; it is to yield the determination of the organic facies of a geological period to the chances of physical conditions, instead of the domination of an intelligent method of sequence and adaptation; it is to surrender the grand procession of organic forms through past time, to the moulding and determinative influence of the secular changes of the physical world; it is to turn our backs upon positions which have been so ably and so successfully defended by our great adopted naturalist; it is to drown the key-note of the celebrated "Essay on Classification" in the discord of transmutationism and materialism.

The following extract is from the celebrated paper of de Verneuil, to which allusion has so often been made:[146] "We have endeavored to prove that the first traces of organic life in countries the most remote, appear under forms nearly alike, at the base of the Silurian System; and that the same types, often the same species, are successively, and in parallel order, developed through the entire series of the paleozoic beds. If we have not succeeded in lifting the vail which still hides from us the cause of this grand phenomenon, perhaps, at least, our observations have demonstrated the insufficiency of those causes by which certain authors seek to explain it. They prove, in effect, that *the phenomenon itself is independent of the influences which the depths of seas exercise upon the distribution of animals;* for if, in certain countries, the Silurian deposits prove a deep sea, they have, on the contrary, in the State of New York, a littoral character. They prove, in fine, that, in its general character, it is equally independent of the upheavings which have affected the surface of the globe; for, from the eastern frontier of Russia even to Missouri—distant from, or near the lines of dislocation—in the horizontal beds as well as those which are disturbed, the law according to which it is accomplished appears to be uniform." "We do not pretend to say that the differences of depth in the seas had not already an influence upon the distribution of animals; it is to this circumstance, on the contrary, that we attribute the more or less local faunæ which we often discover in the paleozoic formation. *But these local faunæ always afford some species which connect them with the*

145 See, with multitudes of others, the works of Lyell, Sharpe, Salter, de Verneuil, d'Orbigny, Pictet, and especially of Barrande and Agassiz.

146 See Amer. Jour. Sci. [2], vii. 51.

epoch to which they belong. They are the exceptions, which do not derange the general symmetry."

Let us now examine, for a moment, the circumstances which afford a shadow of plausibility to the extraordinary dogma of the parallelism of the Chemung and Marshall groups. It is alleged first, that the fauna of the Chemung assumes gradually a less Devonian and more Carboniferous aspect, when traced westward within the limits of the State of New York, and that it is possible that the characters of the Marshall group would be reached in the prolongation of the Chemung through the Western States. This allegation must be considered in the light of the fact, that a great thickness and geographical extent of strata in eastern New York, which were, a few years since, regarded as belonging to the Catskill group, are now pronounced by Professor Hall and Col. Jewett to be really a part of the Chemung; and that strata which were formerly regarded as Chemung belong really to the Hamilton. Restoring to the Hamilton that which is its own, it cannot be otherwise than that the Chemung strata of eastern New York should present a more modern aspect than was once supposed. But let it be granted that even yet the Chemung presents a more Carboniferous aspect in western than eastern New York, it is not yet a Carboniferous fauna; it retains numerous Devonian types; it does not embrace a trio of species, if it does a single one, which reappear in central and eastern Ohio. All this is unprecedented in formations of the same age, at points but one or two hundred miles removed from each other.

In the next place, some local difference in the nature of the sediments is admitted to exist. The rocks of the Marshall group, both in Ohio and Michigan, embrace a bed which is somewhat calcareous; in southern Indiana they are known only by an aluminous limestone; in Illinois and Missouri they are, to a considerable extent, calcareous and argillaceous. On the other hand, it is notorious that the great mass of the Marshall group consists of olive, reddish and yellowish sandstones, and shaly sandstones, which can scarcely be distinguished from the strata of the Chemung. The rocks are identical, and so far as we have the means of judging, the physical conditions under which the sediments were accumulated, must have been extremely similar. We discern none of those changed conditions which are always present on the occurrence of a local fauna. And yet the two faunas are more distinct than those of the Portage and Hamilton—vastly more distinct than those of the Hudson River and Trenton groups. Such pretensions are not set up in reference to any other formation. *Lingula prima*, of the Potsdam group, is recognized in the coarse sandstones of New York and Minnesota, and the fine aluminous shales of Alabama. The western prolongation of the Hudson River group is stocked with the same *Rhynchonella increbescens*, *Orthis lynx*, *Strophomena alternata* and *Chætetes lycoperdon*, as the typical strata of eastern New York. The various physical conditions under which we find the Niagara group, present us uniformly with *Canyocrinus ornatus*, *Halysites catenularia*, *Favosites Gothlandica*, *Athyris nitida*, *Spirifera radiata*,

&c. So the Corniferous limestone holds several species which never fail to declare its identity; and the Hamilton group is traced by persistent and unmistakeable paleontological characters over an area two thousand miles in breadth—from eastern New York to the Rocky Mountains, and from Central Kentucky to the valley of Mackenzie's river. It is incredible that the fauna of the Chemung sandstones, without visible change in physical conditions, should have undergone a total transmutation in a distance less than 200 miles. Were the lithological characters of the Chemung and Marshall remarkably distinct, we should expect a marked variation in the faunas, even if contemporaneous. But we should still have detected a few identical species, and a strong correspondence in dominant ideas—as the Edmondias, Aviculopectens and Producti, of the Chouteau limestone, are identical with the same genera and species of the Marshall sandstone. In some portion of the hundreds of thousands of square miles over which the Marshall strata have been extended, would have existed physical conditions sufficiently similar to those of New York, to have permitted the introduction of a few of the types which are dominant at the East.

The facts which I have already pointed out demonstrate that there *was* a time when the fauna of Ohio and Michigan had a representation in New York and Pennsylvania. Fossils even from Iowa and Missouri—fossils from fine, and even from calcareous strata—have been identified in western New York, identified, too, in conglomeritic deposits. It is even true, as de Verneuil asserts, that there is a law, however inscrutable, which stamps a common and recognizable impress upon faunas of the same age, however diverse the physical conditions under which they subsist.

The doctrine of faunal collocations of organic beings is founded in Nature, and has been made a specialty by one whose name commands universal respect. We must apply this doctrine to the distribution of extinct animals. It seems to me, however, there is a possibility of using this doctrine as "a hobby," and of carrying it to unwarranted limits. Thinking has its fashions no less than architecture and dress. Another fashion of our times is to reunite varieties and species of organic remains, which have been discriminated often with much study and great utility. It is the fashion just now to concede a wide range to the variability of species. Both these fashions tend to a relaxation of the rigor of the limits which we had set to the influence of external agencies. It seems to me that the true philosophy leads to the practice of a judicious conservatism in reference to the long-accepted canons of paleontological science.

For these reasons I cannot, at present, consent to the parallelizing of the Chemung and Marshall groups.

VIII. Parallelism of the Catskill and Marshall.

If the Chemung be not the eastern representative of the Marshall, where, it may be asked, does that representative exist? It would be no reply to the argument which I have presented, if no representation of the Marshall were yet discovered east of Ohio. The case would not be without parallel. The St. Peter's Sandstone, the Galena Limestone, the Mountain Limestone, the Laramie Limestone, are all without distinct representation at the east. The Medina Sandstone, the Oriskany Sandstone, the Schoharie Grit, and the Marcellus Shale, are without distinct representation at the west. But it seems to me that, for the Marshall group, we have discovered a probable representative in the Catskill group of New York. The lithological and paleontological facts which favor this identification have already been pointed out. If this identification be correct, it will appear that the Catskill group is not to be regarded as thinning and partially disappearing, in central and western New York, in consequence of an original lack of sediments, but in consequence of subsequent denudation upon a scale of vast magnitude.

But it may be pronounced a fatal objection to this method of paralellizing, that the Catskill is regarded by the New York geologists, and by others, as the American representative of the Old Red Sandstone, which is generally admitted to be Devonian. In reply to this, I offer two suggestions. First, it is not the universal opinion of European geologists that the Old Red Sandstone, as restricted to Scottish deposits along the flanks of the Grampians, and upon the southern borders of the Moray Firth, is properly classed with Devonian strata. The North Devon strata, to which the term Old Red Sandstone has been extended, are thought by some to hold a lower position. The Scottish Old Red Sandstone may be, in part, at least, of Carboniferous age. Secondly, the identification of the Catskill with the Old Red, rests upon the similarity of a few scales of fishes, especially of a supposed *Holoptychius*. But fish remains are quite abundant in the Marshall group, and some of them of types similar to those of the Old Red. Dr. Newberry has described three species from Illinois. Moreover, the Molluscous fauna presents numerous affiliations with the fauna of the Old Red, as delineated in Murchison's Silurian System; and this resemblance, in fact, was the first circumstance which turned my attention to the equivalency proposed in this paper. Among Marshall fossils which I have noted as having near analogues in the Old Red of Scotland, are the following:

	Analogues.
Ctenodonta Iowensis, W. & W.	Cucullæa antiqua, Sow.
Isocardia ? Jennæ, Win.	Goniophora cymbæformis.
Murchisonia quadricincta, Win.	Turritella obsoleta.
Holopella mira, Win.	" gregaria.

Finally, it may be observed, that, whether the Catskill be synchronized with the Old Red or not, it holds a position above all the typical Devonian rocks of Europe and America. Professor Hall[147] long ago stated that "after the change which takes place at the termination of the Hudson River group, there is, perhaps, nowhere else in the Paleozoic series so complete a change in the lithological and Paleozoic features of the strata as at the termination of the Chemung group. Over a considerable extent

[147] Amer. Jour. Sci., [2] v. 367, Note.

in New York and Pennsylvania, the Chemung group is succeeded by a coarse sandstone or conglomerate, which lies at the base of the Red sandstone. This change is equally great with that which took place at the production of the Oneida conglomerate, and the mass forms a distinct topographical feature in the southern part of New York, and in parts of Pennsylvania. At the same time, all the peculiar organic forms of the Chemung group have become extinct. * * * When we undertake to mark the limits between systems, at points where it is difficult to decide them either from lithological or organic characters, (as in the separation of Devonian and Silurian,) it seems to us very proper to give more importance to such a remarkable line of separation as that indicated at the base of the red sandstone. * * * The relations between the red sandstone and the Carboniferous system appear to be scarcely known at all; or whether there may, or not, be a more intimate relation between this mass and the succeeding gray sandstones, has never been shown."

M. deVerneuil,[148] while admitting it incontestible that the Catskill group "is upon the same horizon as the Old Red Sandstone of Scotland and Wales," concludes, with emphasis, that the study of the New York strata has resulted in "proving that the Old Red Sandstone, in America, is more recent than the schists and limestones which represent the deposits of the Eifel, the Hartz and of Devonshire."

In accordance with the views set forth in the foregoing paper, I append the following table of geological equivalents. The Table, as originally presented to the American Association, was published in the "Geology of Tennessee," pp. 364–5. As here given, it is slightly modified, in the Tennessee column, to adapt it to late discoveries already announced. In the Michigan column, I have merged the "Black shale" with the "Huron group," in accordance with views long entertained (see especially, Proc. Am. Phil. Soc., No. 81). That this shale occupies a position beneath the Hamilton will not, I think, be longer maintained. Whether it be wholly Genesee, or wholly Portage, or the representative of both, it is certainly a lower constituent of a group of argillaceous strata, which is one mass, physically, and which, in 1861, I was induced to designate as the "Huron Group," in consequence of its extensive outcropping around the shores of Lake Huron, between Detroit and Pt. aux Barques.

Cashaqua shale.		*Green Shal.*	*(Base of Waverly Series.)*							
Genesee shale,	Hamilton shale.	*Black Shal. (perhaps Portage in part.)*	Black Shale.	Black Shale.	Black Shale?			Black Shale.	Black Shale.	
Hamilton Gr.	Hamilton Gr.	Hamilton Gr.	Hamilton Gr.	Hamilton Gr.	Hamilton Gr.	Hamilton Gr.	Hamilton Gr.	Hamilton Gr.	(Wanting)	Orthoceras-schiefer; Spiriferen sandstein, (*Nassau.*)

148 See Amer. Jour. Sci., [2] v., pp. 367, 369.

Table of Geological Equivalents.

NEW YORK.	ONTARIO.	MICHIGAN.	OHIO.	INDIANA.	ILLINOIS.	IOWA.	MISSOURI.	KENTUCKY.	TENNESSEE.	EUROPE.
(Wanting?)	(Wanting)	Parma Congl.	Conglom'ate.	Conglom'ate.	Conglom'ate.	?	?	Conglom'ate.	Conglom'ate.	MillstoneGrit
(Wanting)	(Wanting)	(Wanting)	False Coal Meas.	?	False Coal Meas.	?	?	False Coal Meas.	False Coal Meas.	?
(Wanting)	(Wanting)	Carboniferous Limest. Michigan Salt Gr.	(Wanting)	(Wanting)	KaskaskiaLi.	Kaskaskia L.	?	Kaskaskia L.	Kaskaskia L.	Mountain Limest.
(cont.)	(cont.)	(cont.)	(cont.)	St. Louis Lim.	St. Louis Lim.	St. Louis Lim.	St. Louis Lim.	St. Louis Lim.	Silicious Group. St. Louis L.	(cont.)
(cont.)	(cont.)	(cont.)	(cont.)	Warsaw Lim.	Warsaw Lim.	Warsaw Lim.	Warsaw Lim.	?	Silicious Group. Warsaw L.	(cont.)
(cont.)	(cont.)	(cont.)	(cont.)	Keokuk Limestone. *Gray Lim. Brown Sh. Knobstones*	Keokuk Lim.	Keokuk Lim.	Keokuk Lim.	Keokuk Lim. *Knobstones*	Silicious Group. Keokuk L.	(cont.)
(cont.)	(cont.)	(cont.)	(cont.)	?	Burlington L.	Burlington L.	Burlington L.	?	Silicious Group. ?	(cont.)
Upper part of Catskill Gr. *including "Carboniferous" Conglomerate and "Chemung" conglomer'te*	(Wanting?)	Marshall Group.	Waverly Series. *in part.*	Rockford Limest. and Williamsport Gritstone.	Kinderhook Group.	Yellow Sandstone Series.	Chouteau Limestone, Vermicular Sandst. and Shale, Lithographic Limestone.	(*Probably dark silici'us shale not yet observed.*)	Silicious Group. Silicious Shales.	Old Red Sand. (*Scotland.*) Yellow Sand. (*Ireland.*) Westphalian Schists.
Chemung Gr. Portage Gr.	"Portage Shales."	Huron Group *Micaceous Schists and Flags. Argillaceous Shale.*	Chocolate Shale Series,	(Wanting)	(Wanting)	*Perhaps Lower part of Yellow Sandstone series.*	Bluish Shale	Argillaceous Beds.	(Wanting)	Cypridinen-schiefer.

IX. The Name.

Should the equivalencies of the rocks under consideration be finally adjusted in the manner which I have indicated, it will be important to select a designation for the group in accordance with the recognized canons of geological nomenclature. In that case, it will scarcely be permissible to employ the term "Catskill Group," since the principal mass of the rocks which are made the type of that group is now known to belong to the Chemung; and the name would be a misnomer. A similar objection rests against the use of the term "Waverly." This term, as I have already intimated, has been used in different senses; and by all parties, from Professor Briggs down, has been employed to embrace, at least in central and southern Ohio (the typical region), either the entire series of strata between the Conglomerate and the "Black Shale," or, at least, the *lower portion* of that series. It is necessary to apply a term to the exclusion of the "Chocolate Series" of Ohio, underlying the fossiliferous sandstones of the Waverly series. The first geographical designation which was employed in this restricted sense was "Marshall Group," first employed and published by me in December, 1860, and afterwards introduced in my Geological Report, advance copies of which were distributed in August, 1861.

APPENDIX.

References to Publications on the Geology of the Rocks under Consideration.

1836. Hildreth: Amer. Jour. Sci. and Arts, xxix., pp. 133, 136; Pl. 1, 26, 28.
1838. Houghton: First Ann. Rep. Geol. Surv. Mich., p. 3.
" Briggs: First Ann. Rep. Geol. Surv. Ohio, p. 79.
" Foster: Second Ann. Rep. Geol. Surv. Ohio, p. 105.
1839. Houghton: Second Ann. Rep. Geol. Surv. Mich., p. 28.
1840. Hubbard: Mich. Geol. Rep., p. 87.
1841. Hubbard: Mich. Geol. Rep., p. 132, &c.
1842. Hall: Am. Jour. Sci. and Arts, xlii., p. 51.
" Hall: Jour. Bos. Soc. Nat. Hist., v., p. 1.
" Conrad: Jour. Acad. Nat. Sci., Phil.; viii., 249.
" Hall: Trans. Assoc. Amer. Geol., p. 269.
" Vanuxem: Final Rep. Geol. N. Y. IIId Dist.
1843. Hall: Final Rep. IVth Dist. N. Y.
1846. Hall: Paleont. N. Y., vol. I., Introd., p. 16.
1847. Yandell and Shumard: Contributions to the Geology of Ky., p. 16.
" De Verneuil: Bull. Soc. Geol. France, ser. II., Tome iv, p. 648 (Am. Jour. Sci. [2] v., 176, 350; and vii. 45, 218.)
1848. Sharpe: Quar. Jour. Geol. Soc. Lond., vol. iv, 151.
1848-9. Murray: Canad. Geol. Rep., p. 24.

1850. Hall: Foster & Whitney's Rep. L. Sup. L. Dist., II., p. 285.
1850–1. Murray: Canad. Geol. Rep., p. 29.
1851. Christy: Proc. Amer. Assoc, v. 76.
" Whittlesey. Ib., 207.
1852. Owen (D.D.): Geol. Rep. Wis., Min.. and Ind., pp. 92, 95, and Map.
1853. Marcou: Geol. Map of U. S., Explanation and Text, p. 33.
1855. Swallow: Mo. Geol. Rep., I., 101.
" Marcou: Geol. Karte der Verin. Staaten, Peterm. Mittheil, p. 149.
" Shumard (B. F.): Mo. Geol. Rep., II., 137, 185.
" Meek: Mo. Geol. Rep., II., 218.
" Norwood & Pratten: Jour. Acad. Nat. Sci. Phil. [2] III., 254.
1856. Owen (D. D.): Ky. Geol. Rep., I., 89.
" Safford: Geol. Reconn. Tenn., 158.
" Murray: Can. Geol. Rep., 1853–6, p. 129.
1858. Stevens: Am. Jour. Sci., [2] xxv., 262.
" Marcou: Geology of North America, &c., Zurich.
" Hall: Io. Geol. Rep. [I] 88, and [II] 517.
" Owen (D. D.): Geol. Recon. Ark., I., 87, &c., 135.
1859. Newberry: Ohio Agricultural Rep. 1859, Pamphlet on the Rock Oils of Ohio, p. 6.
1860. White: Jour. Bos. Soc. N. Hist., vii., 209, Sep.
" Lyon: Trans. St. Louis Acad. Nat. Sci., I., 620.
" Worthen: Ib., 571.
" Swallow: Ib., 635.
" Meek and Worthen: Proc. Acad. Nat. Sci. Phil.; Sep., p. 447.
" Winchell: Detroit Tribune, Dec. 11 (Summary of Results of Mich. Surv.)
" Winchell: Chicago Tribune, Dec. (Lecture before Chicago Academy of Sciences, on Excursion to Ann Arbor.)
1861. Winchell: Mich. Geol. Rep., Aug. (Advance sheets.)
" Meek and Worthen: Amer. Jour. Sci. [2] xxxii.; 167 (Sep).
" Hall: xiii. Rep. N. Y. Reg., 96.
1862. White and Whitfield: Proc. Bos. Soc.; viii., 289 (Feb).
" White: Proc. Bos. Soc., ix., 8 (Apr).
" Swallow: Trans. St. Louis Acad. Sci., II., 81 (Apr).
" Winchell: Amer. Jour. Sci. [2] xxxiii., 352 (May).
" Winchell: Proc. Acad. Nat. Sci. Phil., Sep., 405.
" Hall: Canadian Nat., vii., 377 (Nov).
" Hall: xv. Rep. N. Y. Regents, 107 (Nov).
" Jewett: xv. Rep. N. Y. Regents, 198; and Amer. Jour. Sci., [2], xxxiv., 418.
" Hall: xv. Rep. N. Y. Regents, 81.
" Dawson: Quar. Jour. Geol. Soc. Lond., xviii.
" Owen (R.): Ind. Geol. Rep., 92, 108, &c.
1863. Winchell: Proc. Acad. Nat. Sci., Phil., Jan., p. 3.
" Winchell: Amer. Jour. Sci. [2] xxxv., 61.
" Logan: Geol. Can., 387, 404.
" Hall: Pamphlet; Republished in xvii. Rep. N. Y. Reg., 1865, p. 50.

1864. Hall: xvi. Rep. N. Y. Regents, pp. 92, 107, Note.
" Winchell: The Oil Region of Michigan (Repub. Amer. Jour. Sci., May, 1865, xxxix., 350).
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" Meek: Proc. Acad. Nat. Sci., Phil., Dec., 275.
" Meek and Worthen: Ib., 245.
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" Hall: Proc. Amer. Phil. Soc., 246 (in advance of Pal. N. Y., vol. iv).
" Logan: Atlas to accompany Geology of Canada, 1863.
1867. Davidson (Thos.): Geological Magazine; vol. iv., July.
" Carpenter (W. B.): Annals and Magazine of Natural History, July.
" Meek: Amer. Jour. Sci. [2] xliii., 407.
" Hall: Notice of Volume IV., Paleontology of New York.
1868. Hall: xx. Report N.Y. Regents, p. 295, pl. ix., fig. 10.
" Winchell: Proc. Amer. Assoc., Abstract in Chicago papers, Aug. 12, and "American Naturalist," Oct., p. 445.
" Meek and Worthen: Geol. Survey of Illinois, vol. III., p. 450; and also the Geology of the Counties.
1869. Safford: Geology of Tennessee, pp. 341, 439.
" Winchell: In Geol. of Tenn., pp. 364–5, 442–6.
" Winchell: Proc. Amer. Phil. Soc., xi., pp. 57–83.
" Newberry: Proc. Amer. Assoc. Salem Meeting, Relations of Ohio Geology to that of adjoining States.
1870. Hall: Preliminary Notice, &c., Preparatory for Palæntology of New York (received Jan).
" Winchell: Proc. Amer. Phil. Soc., xii., pp. 245–261 (read Jan. 4th).
" Newberry: Geological Survey of Ohio, its Progress in 1869. An Address before the Legislature (received 15 April).

ERRATA

IN PART I. OF THIS PAPER.

Page 57. Contents, v. for "analogies," read "analogues."
57. " ix., for "Their names," read "The Name."
64. Sixth line from top, for "*Gryroceras*," read "*Gyroceras*."
66. Tenth line from top, for "Hudson," read "Huron."
69. Note "70," line 3, for "authority," read "authorities."
72. Seventh line from top, for "correction," read "conviction."
72. Note "83," line 3. for "he previously," read "he had previously."
78. Note "104," line 2, for "geological," read "geographical."
80. Note "108," line 3, for "announcement," read "announcements."
82. Twenty-seventh line from top, for "phenomenon," read "phenomena."

Several minor errors will, perhaps, be apparent to the reader.

Remarks by Edward D. Cope, at Meeting May 6th, 1870.

Prof. E. D. Cope exhibited the nearly perfect cranium of a Dicynodont Reptile from the Cape Colony, South Africa, which he regarded as different from those described by Owen and Huxley.

The application of the cutting edges of the mandible to those of the upper jaw, was nearly horizontal instead of vertical, as in some marine Chelonia, on which account he regarded it as representing a genus distinct from Ptychognathus, with which it was otherwise identical. This was named Lystrosaurus.

It was nearest the Ptychognathus latifrons, Owen, but differed in having narrowed, sublongitudinal orbits, with immense protuberances in front of them, a very narrow front anterior to, or below these, with two parallel wide sulci on each side, and a much wider occiput and interorbital region. The middle of the cutting margin of the premaxillary was prolonged into a short beak. The front from the orbital protuberances, and the direction of the tusks, both nearly vertical. The following measurements are given:

	In.	Lines.
Length cranium (greatest),	7	9
Width occiput,	8	
" intertemporal space,	1	10.5
" interorbital "	3	7
" between supraorbital protuberances,	4	8
" anterior to orbits,	2	3
" across middle of alveolæ of tusks,	3	
" " internasal space,	1	8
" " temporal fossa,	3	1.5
Length of "	2	1.5
" from hindmost part of skull to orbit,	3	3
" from fore part of orbit to border of premaxillary,	4	9
Long diameter of orbit,	2	3
" " nostril,		11

The species was named *Lystrosaurus frontosus*. The specimen belonged to the private collection of Dr. E. R. Beadle of this city.

Portions of several large teeth or tusks enclosed in the Triassic shales and sandstones of Phœnixville, Pa., were exhibited, probably belonging to Dicynodont reptiles. They represented specimens of much larger size than that of the L. frontosus.

Sections of Strata belonging to the "Bear River Group," near Bear River City, Wyoming Territory.

By F. V. Hayden, M. D.

Read May 6, 1870.

During my explorations along the line of the Union Pacific Railroad, last autumn, my attention was attracted by two of the most remarkable artificial cuts or excavations that I have ever seen in the West. They are located about a mile west of Bear River City, or nearly 950 miles west of Omaha. No such exhibitions of the strata can be found in the country, formed by natural causes. Usually the rocks of the modern formations are composed of such soft materials that they have readily decomposed on the surface, covering it with a considerable thickness of debris, thus concealing, in many instances, not only the true character of the underlying rocks, but also many of the details of the stratification.

At my request, Mr. H. R. Durkee, an excellent civil engineer, residing at Bear River City, made a careful survey of the cuts, and noted the character of each layer, with its thickness in feet and inches. Some of the layers are so crowded with fresh water shells that they seem almost made up of them. A list of them is given in Mr. Meek's Catalogue.

Upon the surrounding hills, among the debris rock from these beds, the fossil shells are so abundant that they may be gathered by the bushel, like nuts in autumn, in a fine state of preservation. The strata are all regarded as of lower Tertiary age, and belong to what I have denominated the Bear River Group. All the beds in this vicinity are very much disturbed, holding a nearly vertical position, or inclining at a high angle. I desire to call the attention of scientific men to these sections as they travel along this portion of the road, and for that reason I regard them of some value. I shall hereafter work up the geology of this district more in detail, and simply wish to make a record of these facts at the present time.

Commencing at the Eastern Extremity of the Cut.

No.	Description.	Feet.	In.
1.	Clay, Greyish, Black, contains fragments of sandstone,	10	
2.	Limestone, Blue,	2	
3.	Clay, Greyish-black,		6
4.	Clay, Brown, hard, and in large fragments,	1	
5.	Clay, Black, " " small "	1	
6.	Limestone, Blue, Fossiliferous,	1	6
7.	Clay, Greyish-black,	1	2
8.	Sandstone, Fragmentary,		2
9.	Clay shale, Grey,	1	
10.	Clay, Greyish-black, very compact,	1	
11.	Clay shale, Black,		10
12.	Marl, shells in fragments,		8
13.	Clay shale, Black,		6
14.	Limestone, much shattered, and in angular pieces,	2	

No.	Description.	Feet.	In.
15.	Clay shale, Black,		10
16.	Limestone, angular fragments,		6
17.	Clay shale, Brown,		
18.	Limestone, slightly fossiliferous,	1	6
19.	Gypseous Earth, contains crystals of Selenite,		3
20.	White Marl, shells fragmentary,	1	
21.	Limestone, very fossiliferous,		6
22.	Clay shale, Black,	1	4
23.	Limestone, very fossiliferous,		2
24.	Clay shale, Brown,	2	6
25.	Sandstone, Fragmentary,	4	
26.	Clay shale, Grey-black,	2	
27.	Gypseous earth, layer of crystals of Selenite on E. side,		6
28.	Clay shale, contains streak of coal and Gypseous earth,	2	6
29.	Gypseous earth, contains streaks of brown bituminous shale,		8
30.	Clay shale, Brown, very hard,	1	6
31.	" Black, Bituminous,		5
32.	Marl, Grey,		2
33.	Limestone,		10
34.	Clay, full of fossils,		3
35.	Clay shale, Grey,	1	
36.	" Blue,		3
37.	Sand. Yellow,		2
38.	Clay shale, Grey,	1	
39.	" " Bituminous,		8
40.	Limestone, Fossiliferous,		6
41.	Clay shale and marl, Fossiliferous, less foss. on W. side,	1	6
42.	Bituminous shale, contains streaks black coal,		4
43.	Clay shale, Blue,		6
44.	Gypseous Earth,		1½
45.	Clay shale, Blue,		1
46.	Marl,		4
47.	Clay shale, Blue,	1	
48.	Marl, Yellowish-white,		3
49.	Sandstone, Fossiliferous,		9
50.	Clay shale, Blue,	1	2
51.	Sandstone, Fragmentary,		8
52.	Clay shale, Blue and Yellow,		6
53.	Limestone, very fossiliferous,		6
54.	Clay, full of fossils,		2
55.	Bands, Black, bituminous shale and marl,	2	6
66.	Marl,		5
57.	Slaty shale, Black,		6
58.	Limestone, very fossiliferous,		3

No.	Description.	Feet.	In.
59.	Slaty shale, Grey,		10
60.	Shale, full of fossils,	1	
61.	Clay shale, Black,		8
62.	" Yellowish-brown,		6
63.	" Blue,		6
64.	Coal and yellow shale in streaks,		10
65.	Limestone, very fossiliferous,	1	
66.	Marl,	1	
67.	Limestone, slightly foss., fossils fragmentary,	1	6
68.	Nodular clay and shells, streaks bituminous shale on W. side,		10
69.	Marl, Yellow, hard,		4
70.	Marl, Black, soft,		5
71.	Clay shale, Black bituminous,	1	6
72.	Gypseous earth, yellow and white,		2½
73.	Marl, hard,		4
74.	" soft,		8
75.	Clay shale, Grey,	1	
76.	Clay and shale in bands,	1	
77.	Marl,	2	
78.	Gypseous earth, Yellow,		1
79.	Marl,	2	6
80.	Clay shale, Black and Blue, in bands,	4	
81.	Clay, stony, Grey,	2	
82.	Gypseous earth, Yellow,		3
83.	Limestone, fossiliferous, fossils small,	1	8
84.	Gypseous earth, white,		2
85.	Clay, stony, Bluish-gray,	2	6
86.	Clay shale, Black,		10
87.	Limestone fossiliferous,		8
88.	Clay shale, Black,		3
89.	Limestone,		4
90.	Marly clay, Black,		2
91.	Marl, Light grey,		2½
92.	Clay shale, "		4
93.	" Black,		4
94.	" Grey,		6
95.	" Black,		2
96.	Gypseous earth, Yellow,		2
97.	Clay shale, Black,		4
98.	Gypseous earth, Yellow,		3½
99.	Limestone,	1	6
100.	Clay shale, Blue,	1	
101.	Limestone.		8
102.	Clay shale, Blue,		8
103.	Limestone,	1	8

No.	Description.	Feet.	In.
104.	Marl, Grey,		6
105.	Shale, Black,		2
106.	Sandstone,		$3\frac{1}{2}$
107.	Marl,		3
108.	Shale, Black,		4
109.	Marl,	2	
110.	Shale, Bituminous,		1
111.	Marl,		2
112.	Limestone,		8
113,	Marl,		5
114.	Limestone,		6
115.	Marl,	1	
116.	Shale, Black,	1	
117.	Coal and Shale,		2
118.	Limestone,		11
118.	Marl,		6
120.	Limestone,		10
121.	Marl,	1	6
122.	Clay shale, variegated (Purple, Yellow, &c.)		9
123.	Limestone, slightly fossiliferous,		3
124.	Gypseous earth,		6
125.	Limestone, slightly fossiliferous,		4
136.	Marl, Bluish-black, hard,		2
127.	Coal,		$\frac{1}{4}$
128.	Gypseous earth,		3
129.	Coal,		$\frac{1}{4}$
130.	Limestone,	1	
131.	Marl and coal,		2
132.	Limestone,		7
133.	Shale, Bituminous, Black,		10
134.	Marl, hard,		4
135.	Shale, Black,		1
136.	Marl.	2	
137.	Shale,		1
138.	Limestone, very fossiliferous,		4
139.	Clay shale, Blue, full of fossils,	1	
140.	Shale, Bituminous, Yellow and Black,		3
141.	Limestone,	2	6
142.	Shale, Slaty, Black,		6
143.	" Brown, full of fossils,		3
144.	" Blue,		7
145.	Marl,		$3\frac{1}{2}$
146.	Gypseous earth,		1
147.	Limestone, compact, streaks of marl and coal, which run out,	3	6
148.	Shale, Slaty,	1	2

No.	Description.	Feet.	In.
149.	Bituminous shale and Brown coal,		8
150.	Limestone,	1	
151.	Clay shale, contains scales of white Gypseous earth,	1	10
152.	Marl, hard,		3
153.	Shale, fossiliferous,	2	
154.	Clay, hard, fossiliferous,		8
155.	Clay shale, Black,		1½
156.	Clay, hard, fossiliferous,		4
157.	Marl, Grey,		6
158.	" Black,		2
159.	Gypseous earth, White,		8
160.	Clay, hard,		8
161.	Marl,		1
162.	Coal, Brown,		6
163.	Clay,		2
164.	Limestone,	3	
165.	Gypseous earth and shale,	2	
166.	Limestone,	1	6
167.	Sandstone, Yellow,		2
168.	Limestone,	1	
169.	Gypseous earth and shale,		8
170.	Limestone,	1	
171.	Clay shale,	3	
172.	Bituminous shale,		4
173.	Limestone,	2	

From No. 173 to western end of cut (which is made up of the reversed strata, but not in regular order, some seem to be pinched out).

ORDER OF STRATA EXPOSED IN RAILROAD CUT NO. 2.

(FROM EAST TO WEST.)

No.		Feet.
1.	Drift, steel colored,	15
2.	Sandstone, White,	12
3.	" Yellow, containing fragments, No. 2,	1.5
4.	Shale, arenaceous, Brown,	9.5
5.	Sandstone, coarse, yellow, in layers,	1
6.	" fine, " in thin layers,	1.5
7.	" coarse, containing irregular streaks of brown shale, which contains coal in fragments,	2.5
8.	" fine, white,	18
9.	" brown, contains brown marks resembling bark and branches,	.25
10.	" Steel grey, contains streaks of No. 9,	40
11.	Shale, Black, and sandstone, steel grey,	1
12.	Sandstone, Fine, white,	4
13.	" in thin layers of variegated colors,	6
14.	" in broad " "	21

No.		Feet.
15.	Sandstone, steel grey,	12
16.	" in thin layers of variegated colors,	5
17.	" steel grey, in layers (contains streaks of coarser yellow in layers),	35
18.	Shale, Brown,	2
19.	Sandstone, Yellow,	6
20.	Shale, Brown,	1
21.	Sandstone, Steel grey,	40
22.	" White,	6
23.	Sandstone, Grey,	4
24.	Shale, earthy, Black,	1
25.	Gypseous earth, Yellow,	.5
26.	Shale, Black,	.5
27.	Sandstone, contains shells in fragments,	15
28.	Shale, Brown,	1
29.	Clay, marly,	1.5
30.	Sandstone, Yellow,	30
31.	Shales and clays, earthy,	25
32.	Shale, Brown,	6
33.	Sandstone and Gypseous earth,	20
34.	Shale, Bituminous,	1
35.	Gypseous earth,	3
36.	Sandstone, yellow,	10
37.	" white,	8
38.	Marl, contains shells,	6
39.	Gypseous earth,	2
To end of Cut, Shale, clay, and arenaceous Gypseous earth,		60

Length of cut, 440 feet.

A Preliminary List of Fossils, collected by Dr. Hayden in Colorado, New Mexico and California, with Brief Descriptions of a few of the New Species.

By F. B. Meek.

Read before the American Philosophical Society, May 6, 1870.

Silurian Species.

Camp Creek Cañon, Colorado City.

1. *Orthis Coloradoensis*, Meek.

A small, compressed, nearly equivalve, subsemicircul species, much widest on the hinge line, which is sometimes abruptly produced into lateral auricles. Dorsal valve less convex than the other, and having a shallow, rather wide, mesial sinus, rapidly narrowing to the beak, which does not project beyond the hinge line. Ventral valve depressed convex, with cardinal area rather low, flat, inclined backward, and sharply defined to the lateral extremities; beak not incurved. Surface of both valves ornamented with sharply defined, slightly curved, unequal radiating plications, and finer unequal striæ, which, on the central regions of the valves, are more or less gathered into five or six fascicles, the middle one of which corresponds to the sinus in the other valve.

In its surface markings and sinuous dorsal valve, this species is much like a form from the upper Lingula-flags of Wales, referred by Mr. Davidson, doubtfully, to *O. lenticularis*, Wahlenberg. It is much more extended on the hinge line, however, and has the radiating costæ and striæ more strongly defined on the central region, and more nearly obsolete on each side. From its affinities, it seems to be a Lower Silurian species, but as no other fossils were found with it, its exact age may be somewhat doubtful. It is unlike any Devonian or Carboniferous form known to me.

Crater's Falls.

2. *Merista?* (undetermined).
3. *Ophileta complanata*, Vanuxem, or a very closely allied species.
4. *Bucanella nana*, Meek.

Very small, and much like *Bucania trilobatus*, Hall, but much smaller, with proportionally larger umbilicus, and its three or four volutions increasing less rapidly in breadth, both transversely and in the direction of the plane of the shell; while its middle lobe is proportionally narrower, and embraced by each succeeding turn.

As these little shells want the remarkable expansion of the aperture characterising *Bucania*, and show no traces of the mesial dorsal band, corresponding to a dorsal sinus in the lip; as in *Bellerophon*, they seem to me to belong to an undescribed genus, for which I would propose the name *Bucanella*.

5. *Pleurotomaria?* or *Raphistoma*. Merely indeterminable lenticular casts.
6. *Endoceras*. Small undt. sp.

CARBONIFEROUS SPECIES.

Moleen Station.

1. *Fusulina cylindrica*, Fischer?
2. *Syringopora* (undetermined).
3. *Campophyllum*, like *C. torquium*, Owen, sp. From the Upper Coal Measure, along the Missouri, at Rock Bluff, and near there in Nebraska and Iowa.
4. *Chaetetes* (undt. massive sp).
5. *Productus Nebrascensis*, Owen.
6. *Spirifer* (*Martinia*) like *S. planoconvexus*, Shumard.
7. *Bellerophon?*; a rude cast; may be a *Nautilus* or *Goniatite*, as it is not in a condition to show septa, if any exist.

Sangre de Christo Pass, South Colorado.

8. *Productus semireticulatus*, Mart. (sp.)
9. *Productus punctatus*, Martin, sp.
10. *Athyris subtilita*, Hall (sp).

Pecos Church, New Mexico.

11. Fragments crinoid columns.
12. " *Spiriferina.*
13. *Spirifer cameratus,* Morton (fragments).
14. *Productus.* Fragments, like *P. semiretuculatus.*

Near Pecos R. N. M., Aug. 6, 1869.

15. *Fenestella and Polypora.* Fragments.
16. *Athyris subtilita,* Hall?
17. *Aviculopecten* (undt).
18. *Aviculopecten occidentalis.* Shumard.
19. *Aviculopecten carbonarius,* Stevens?
20. *Myalina Swallovi,* McChesney.
21. *Myalina subquadrata,* Shumard.
22. *Myalina perattenuata,* M. & H.
23. *Pleurophorus?* (undetermined).

Ten miles South of Kosylowiski, New Mexico.

24. *Fenestella* (undt).
25. *Athyris subtilita,* Hall.
26. *Spiriferina Kentuckensis,* Shumard.
27. *Myalina Swallowi,* McChesney.
28. *Myalina* (undetermined).
29. *Avicula* (fragments).
30. *Pleurophorus angulatus,* M. & W.
31. *Pleurotomaria ?* (large cast).

Mora Creek, New Mexico.

32. Crinoid columns.
33. *Productus nodosus,* Newberry.
34. *Athyris subtilita,* Hall, sp.
35. *Spiriferina Kentuckensis,* Shumard.
36. *Spirifer Rocky-montana,* Marcou.
37. *Spirifer comeratus,* Morton.

Mora River, (1*st ser. Carb.*)

38. *Polypora, Fenestella, &c.*
39. *Synocladia* (*Septopora*) *Cestriensis,* Prout, sp.(=*S. biserialis.* Swallow.)
40. *Productus semireticulatus,* Mart. (may be, in part, *var.* of *P. costatus*),
41. *Productus nodosus,* Newb.
42. *Athyris subtilita,* Hall (sp).
43. *Spiriferina Kentuckensis,* Shumard.
44. *Spirifer cameratus,* Morton.
45. *Orthoceras* (fragment).

Hot Springs, Salinas Creek, (Sept. 3d).

46. *Campophyllum?*
47. Crinoid columns.
48. *Chætetes,* undetermined; both massive and ramose.
49. *Productus longispinus,* Sow. (var. *Wabashensis,* N. & P.)
50. *Productus nodosus,* Newb.

Santa Fe, New Mexico.

51. *Hemipronites crassus*, M. & H.
52. *Productus longispinus*, Sow.
53. *Productus semireticulatus*, Martin, sp.
54. *Productus nodosus*, Newb.
55. *Productus*, (undetermined, 2 or more sp.)
56. *Productus Nebrascensis*, Owen.
57. *Orthis* (undetermined).
58. *Chonetes* (undetermined).
59. *Athyris subtilita*, Hall (sp).
60. *Spirifer cameratus*, Morton.
61. *Spirifer Rocky-montana*, Marcou.
62. *Spiriferina Kentuckensis*, Shumard.

Morav. City, Weben Mt.

63. *Productus semireticulatus*, Martin, sp.

Salt Lake.

64. *Campophyllum.* Mere fragments in hard, bluish-gray limestone.

NOTE.—It is worthy of note that, although some of the species mentioned in the foregoing list of Carboniferous fossils, are forms known to be common to the Lower Carboniferous and the Coal Measures of the Western States, they are *all*, with one or two exceptions, so far as they have been identified, forms common in the Coal-measures of Illinois, Iowa, Kansas and Nebraska; while *not a single one of them* is identical with any of the species *peculiar* to the Carboniferous limestone series below the horizon of the Millstone-grit in the Western States, though about 14 of them seem to be peculiar to the Coal-measures there.

JURASSIC SPECIES.

Salinas Creek.—Hot Springs.

1. *Cardinia?* (undetermined).
2. *Pholadomya* (undt).

(1–2) Very poor specimens, not showing hinge. Look like some Jurassic forms, but only referred provisionally to that epoch.

Between Sacramento and Summit Station.

3. Undt. bivalve.
4. " univalves, 2 forms.
5. *Ammonites Nevadensis*, Gabb.

These fragments belong to the group of discoid Liasic species, with keeled and bisulcated periphery, and numerous very slender whorls, all exposed on each side, and crossed by nearly or quite straight, simple, smooth, regularly arranged costæ. They belong to one or the other of Mr. Hyatt's genera—*Discoceras*, *Arnioceras*, or *Ophioceras*. Very probably of Liasic age.

Weber Cañon.

6. *Bivalves.* Mere undeterminable casts, in a matrix like that of beds in the west, of Jurassic age.

Camo. (C. L. Morcham.)

7. *Belemnites densus*, M. & H.

Cretaceous Species.

Fountain Creek, Colorado City, Colorado.

1.	*Inoceramus* (undt. sp.)	Cret. No. 4
2.	*Baculites compressus*, Say.	"
3.	*Baculites ovatus*, Say.	"
4.	*Scaphites Cheyennensis*, Owen.	"
5.	*Scaphites nodosus*, Owen.	"
6.	*Scaphites Conradi*, Morton.[1]	" 5
7.	*Ammonites placenta*, De Kay.[2]	" 4
8.	*Inoceramus problematicus*, Schlot. (sp.)	" 3
9.	*Ostrea congesta*, Conrad.	"
10.	*Inoceramus* (undt. large gibbous distorted sp.)	"
11.	*Ammonites* (undt.)	" 2 or 3

Miser Station, U. P. R. R., Oct. 19th.

12. *Inoceramus* (undt.) Cret. No. 4.
13. *Baculites ovatus*, Say. "

Near Canon City.

14. *Bivalve* (undt. sp.) Cret. No. 4
15. *Baculties ovatus*, Say. "

Medicine Bow Station.

16. *Inoceramus* (undt). Large sp. No. 4 Cret.

Mission Station, N. P. R. R.

17. *Inoceramus* (undt. sp). Cret. No. 4.
18. *Ammonites* (undt).
19. *Caprina* (undt).

Between Denver and Cheyenne.

20. *Inoceramus* (large undt. sp).

Six miles east of Como Station, U. P. R. R.

21. *Inoceramus* (undt. sp).

Valley of Fountain Creek, Colorado.

22. *Anisomyon* (undt. sp). No. 4 Cret.

Red. Between Hard Scrabble and St. Charles.

23. *Inoceramus problematicus*, Schlot. (sp). Cret No. 3.
24. *Ostrea congesta*, Conrad. " "

Medicine Bow River.

25. *Inoceramus fragilis*, Hall and Meek. No. 2 Cret.
26. *Scaphites Warrenana*, M. & W. " "
27. *Ammonties serrato-carinatus*, Meek. Cret. No. 2.

Shell attaining a rather large size ; discoid, with periphery provided with a very narrow, prominent, serrated mesial keel, including the siphuncle. Volutions increasing rather gradually in size, somewhat com-

[1] I propose for the group of *Scaphites*, of which this may be regarded as the type, the subgeneric name, *Discoscaphites*.

[2] This may be regarded as the type of a group, for which I propose the name *Placentocerus*.

pressed laterally, and a little excavated, without being distinctly channeled on each side of the ventral keel; inner ones but slightly embraced by each succeeding turn, and consequently well exposed in the wide umbilicus. Surface ornamented with numerous unequal costæ, some of the larger of which bear a small, somewhat pinched node near the umbilicus, and two closely approximated small nodes around the ventro-lateral margins, where they all curve very strongly forward as they pass upon the periphery; spaces between each two of the large nodose costæ, occupied by from one to about three smaller ones. Septa unknown.

Although undoubtedly a Cretaceous species, this shell would rather nearly resemble *A. spinulatus*, Brug., from the Lias, as illustrated by d'Orbigny, if that species had from one to three smaller costæ between each two of its ribs, and its serrated keel more prominent. Our shell also differs in the presence of a small node near the umbilicus, on each of the larger costæ. It is not a true *Ammonite*, according to the latest classification of the *Ammonitidæ*.

Fort Bascom.

28. *Gryphæa navia*, Conrad. Cret. No. 2 or 3.

Dodson's Ranche.

29. *Inoceramus problematicus*, Schloth. (sp.) Cret. No. 2.
30. *Cucullæa*, and other undt. bivalves. " "
31. *Anchura*, undt. " "

Como—(C. L. Morchom).

32. *Baculites ovatus*, Say.

Near Coalville, in high hill, and near base of same.

33. *Ostrea* (undt. sp.)
34. *Modiola Pedernalis*, Rœmn.
35. *Nuculana.*
36. *Pleurotomaria* ? ?

TERTIARY SPECIES.

Associated with Coal-bed, Bear River City.

1. *Ostrea soleniscus*, Meek.

Attaining a length of near one foot, and very narrow, or not more than from one to two inches in breadth; almost perfectly straight, excepting the immediate beaks, which usually curve a little to the left; sides nearly straight and parallel. Upper valve flat; lower moderately concave, and like a little trough. Surface of both valves without radiating striæ or costæ, or strong concentric markings. May be Cretaceous.

Limestone-hill, Bear River.

2. *Unio vetustus*, Meek.
3. *Unio belliplicatus*, Meek.

Differs from the last in having the posterior dorsal region marked with about six to eight strong, regular, oblique plications, which begin very small and crowded, just in front of the beaks, and radiate backward and downward nearly to the posterior and postero-basal margins.

4. *Corbula* (*Azara*) *pyriformis*, Meek.
5. " " " var. *concentrica*, Meek.
6. " " *Engelmanni*, Meek.
7. *Cyrena* (*Corbicula*) *Durkeei*, Meek.

Shell attaining a moderately large size ; subtrigonal in outline, thick and strong, gibbous in the central and umbonal regions, and cuneate postero-ventrally ; posterior side sloping above, and narrowly rounded below ; beaks rather elevated, pointed, and curving inward and forward, so as nearly to touch each other ; posterior dorsal region much inflected from the beaks down the slope nearly to the extremity of the valves, so as to give the posterior umbonal slopes a prominently rounded appearance. Surface with moderately distinct marks of growth.

Very closely allied to *C. antiqua*, Ferr., and *C. Forbesi*, Desh., from Lignite Lower Eocene beds of the Paris Basin, but differs from both in the details of the hinge, its lateral teeth being nearly or quite smooth, and like the cardinal teeth, differing in other respects.

Named in honor of Mr. H. R. Durkee, who sent large collections of the species to the Smithsonian Institution, from Wyoming.

8. *Tiara humerosa*, Meek.

Elk Station, Cent. Pac. R. R., beyond Salt Lake.

9. *Sphærium* (two or more species, in highly bituminous shale).

Fort Bridger; Wyoming (McCarter).

Unio Haydeni, Meek.
Melania (*Goniobasis?*) *Simpsoni*, Meek.
Viviparus (two or more undt. species).
Planorbis spectabiles, Meek.
Cypris (undt.) In Oolitic ? matrix.

DESCRIPTIONS OF FOSSIL FISHES, FROM THE UPPER COAL MEASURES OF NEBRASKA.

By Orestes St. John.

Read by Dr. F. V. Hayden, before the American Philosophical Society, May 6, 1870.

Genus CLADODUS, Agassiz.

Cladodus mortifer, N. and W.

Reference.—Newberry and Worthen, Geol. Illinois, Vol. II, p. 22; Pl. I, fig. 5.

In the collection there are fragments of three individuals of the above species—two showing the base with portions of the crown, and one preserving about a third of the lower portion of the median cusp of a very large specimen. There can be no doubt that the teeth before me are referable to the above species; but as they exhibit characters not shown in the imperfect specimen figured and described by Messrs. Newberry and Worthen, a short description of the Nebraska teeth is here appended.

Description.—The base of the tooth is semi-elliptical in outline, obtusely angular behind, with low protuberances rising at the angles upon the superior inner margin, the outer margin interrupted by a broad, shallow sinus, at either angle of which, immediately beneath the smaller lateral denticles, an obtuse node projects downward, similar to those upon the upper opposite side of the root, the presence of which would seem to have been designed to lend additional strength to the muscular attachment of the tooth upon its cartilaginous support; median cone cervical, regularly tapering, recurved, inequally compressed, with acute lateral edges; striæ sharp, interrupted, separated by wide plane spaces, less numerous upon the strongly compressed anterior face, and confined to the lower half of the cusp; lateral denticles two upon either side, strong, with sharp cutting edges, and strong sharp striæ or ridges.

Breadth of base twice its length, and equal to the entire height of the tooth.

This species, so far as we at present know, is restricted to the Upper Coal Measures. The single type specimen from which the species was originally described, was found in the Upper Coal strata near Springfield, Illinois; and in the prosecution of the geological survey of Iowa, Dr. White has brought to light the same species from the Upper Coal Measures of the southwestern portion of the State. I have also found this species in the same formation at Manhattan, Kansas.

Compared with other species, the present one is probably more closely related to *C. mirabilis*, Agassiz, from the mountain limestone, Ireland, than with any other with which I am acquainted. It differs, however, in being less robust, and more symmetrical in its general proportions.

Formation and Locality:—Upper Coal Measures, bed 6, Nebraska City section, Nebraska.

Genus DIPLODUS, Agassiz.

Diplodus compressus, Newb.

Reference.—Newberry, Geol. Illinois, Vol. II, p. 60; Pl. IV, fig. 2.

The single specimen *Diplodus* in the collection is probably referable to the form described by Dr. Newberry, under the name *D. compressus.*

Description.—The tooth is of medium size; base slightly narrower than long, broadly rounded in front, and terminating in an obtuse point behind, under surface slightly raised in the middle, anterior extremity produced into a large obtuse tubercle projecting slightly outward and downward, with a flattened, sharply defined, obovate pad-like projection upon the upper surface of the posterior extremity, marked upon either side by a shallow groove terminating above in a little pit, and which is entirely separated from the bases of the crown cusps,—in this latter respect, as Dr. Newberry has remarked, offering marked contrast to *D. gibbosus*, Agassiz, from the mountain limestone of Europe; cusps three, median one rudimentary, slender, compressed, with finely crenulated lateral edges, base well defined from the general surface and terminating in a slight protuberance in the osseous root in front; the apices of the lateral cusps are broken away in the specimen before me; they are strongly compressed, smooth, with sharp, beautifully annulated cutting edges, unequally divergent; left one—viewed from before—most inclined from a vertical line and broadest at base; transverse section of both lenticular.

In the collection of the State Geological Survey there is a tooth from the Upper Coal Measures of southwestern Iowa, which is doubtless specifically identical with the Nebraska specimen, though possessing some slight differences. In the Iowa specimen the base has, as in the above described tooth, a lozenge-shaped outline, its posterior extremity is more abruptly truncated, and the pad-like elevation surmounting its surface is ellipitical with its longer axis transverse to the root—in other respects the same as the Nebraska tooth; viewed in front, the right lateral cone is the strongest and most inclined laterally, and the bases on the anterior face are swelled out, producing an angular ridge or buttress, which, however, is lost both in the crown above and in the root below. These two individuals are the only ones I have had opportunity to examine, and comparing them with the excellent description and figures of *D. latus*, Newb., I cannot doubt but that they are distinct from that species. The present species is described from the Coal Measures of Ohio and southwestern Indiana, the latter locality holding a stratigraphical position probably below the Nebraska horizon.

Form. and Loc.—Upper Coal Measures.

Genus PETALODUS, Agassiz.

Petalodus destructor, N. and W.

Reference.—Newberry and Worthen, Geol. Illinois, Vol. II, p. 35; Pl. II, figs. 1-3.

The collection contains a large, almost perfect specimen of the above species, which presents the following characters:

Description.—The crown is sharp, compressed, gradually thickening toward the base; crest more or less gently arched from the lateral extremities, obtusely acuminate at the apex, and distinctly striated for the space of a line or less, below which the striæ are lost in the dense enamel-like coating which covers both faces of the crown; posterior face of crown rhombic, outline of base similar to that of crest, and bordered by five strongly marked imbricating folds, which are conspicuously arched downwards in the middle and more or less deflected at the lateral extremities; anterior face broadly rhomboidal, basal fold consisting of four or five obscurely marked imbrications, gently curved downwards in the middle and again at the lateral extremities; the upper edges of the imbricating folds are minutely crenulated; root broad, compressed at the edges, rapidly tapering from the lateral shoulders, and terminating in a blunt rounded point. Upon much worn surfaces the crown is finely punctate.

	Inches.
Length, nearly	2
Greatest breadth of crown, about	1.60
Height of anterior face of crown,	.95
Height of posterior face,	1.28
Breadth of root across the lateral shoulders, about	1.1

This species bears a striking resemblance to *Petalodus acuminatus*, Agassiz, from the mountain limestone of Europe; but, at the same time, it possesses characters which readily distinguish it from that species. The present species differs mainly in the more tapering root, the coronal band upon the inner face is more strongly curved downwards in the middle, and the crown is relatively higher. This species was originally described from the Upper Coal Measures of central Illinois. I have seen a fine specimen of the same species in the collections of the Museum at Cambridge, from similar horizons in southwestern Indiana, and also from the Upper Coal Measures of central Iowa.

Form. and Loc.—Upper Coal Measures.

Genus PERIPRISTIS, Agassiz (ms).

Gen. char.—Teeth small or of medium size, possessing the general characteristics of the Petalodonts. Crown compressed, acuminate, serrate, more or less curved laterally; extremities on the inner face connected by a raised transverse shoulder, in which the crown terminates below and which gives rise to a more or less profound coronal cavity. Root well developed, entire, as in *Petalodus*. The surfaces of the crown and coronal cavity are covered by a dense and highly polished layer of ganoine, which forms an imbricated band at the base.

The above generic designation was suggested by Prof. Agassiz, for the reception of a group of peculiar teeth, of which we have at least two representative species—that of *P. semicircularis* being regarded as the type. These forms certainly possess features which are widely at variance to the typical species of the genus *Ctenoptychius*, as represented by *C. apicalis*, Agassiz; and in their description of the following species, Messrs. Newberry and Worthen have also referred to the remarkable characters which distinguish it from the typical species of *Ctenoptychius*. The central coronal cavity and the prominent transverse ridge in which the root is terminated above on the posterior aspect, are peculiarities which do not appear in any of the numerous other genera comprised in the groups of Petalodonts.

The genus is Carboniferous, ranging from the Subcarboniferous to the Upper Coal Measures inclusive.

Peripristis semicircularis.

Ref. and Syn.—*Ctenoptychius semicircularis*, Newberry and Worthen, Geol. Illinois, Vol. II, p. 72; Pl. IV, Figs. 18, 18a, 18b.

Description.—Tooth small, broadly obovate in outline, crown much compressed and strongly curved laterally, giving the crest a semicircular outline viewed from above; cutting edge divided into seven to nine denticulations, the median lobe strongest, lateral ones gradually decreasing in size toward the lateral extremities, where they are scarcely relieved from the edge; the calcigerous tubes slightly diverge on nearing the edge, producing a minute radiated striation of the denticulations like that observed in the even crest of *Petalodus*, and when the crown is much worn the surface is finely punctate; outer face of crown very low in proportion to its breadth, base sharply beveled, coronal band narrow, imbrications very obscure or obsolete, gently descending in the middle and slightly curved downward at the lateral extremities; upon the posterior face the base of the crown is defined by a conspicuous transverse ridge, which unites the lateral extremities, and gives origin to a deep central coronal cavity; the enamel-like coating lines the walls of the cavity, and spreading over the gently and regularly downward arched transverse shoulder, it forms a thin coronal band with one or two faint imbrications upon its external inflexed border. The root is nearly as wide and much thicker than the crown, tapering rapidly and rounded at its extremity; anterior side convex or ridged, posterior face slightly concave transversely, both surfaces more or roughened.

	Inches.
Greatest length,	.77
Greatest breadth at the lateral angles of the crown,	.72
Height of crown upon its anterior face,	.32
Depth of the coronal cavity from the apex of the median denticulation, about	.45
And from the transverse shoulder, about	.20

The collection contains a perfect individual of the above described species, from Bellvue, Nebraska, imbedded in a matrix of limestone, but exhibiting the entire posterior aspect of the tooth without a blemish; and I owe to the kindness of Mr. J. Sterling Morton, of Nebraska City, another equally perfect specimen, obtained from a shaft excavation near the City, which shows the anterior face of the tooth. I think there can be no question as to their specific identity with the form described by Messrs. Newberry and Worthen, from the Upper Coal Measures of Illinois.

I am acquainted with but a single other form to which this species seems to be closely related, and that is from the mountain limestone of Yorkshire, England. Specimens of the latter species are in the extensive collections of the Museum of Comparative Zoölogy at Cambridge. The English specimens are, however, markedly specifically distinct from the American; they are less curved laterally, and possess some sharp, thick serrations on either side of the median cusp; the crown is relatively higher, and the coronal band on the outer face is more deeply arched downward in the middle, is wider and more distinctly imbricated; the coronal cavity of the inner face is shallower, and the transverse shoulder less prominent. I am not aware that the English species is described.

Form. and Loc.—Upper Coal Measures.

Genus CHOMATODUS, Agassiz.

Chomatodus arcuatus, n. sp.

A fragment of limestone from Bennet's mill, near Nebraska City, preserves the impression of a tooth of the genus Chomatodus, which seems to be distinct from all the species of this genus heretofore described from the Coal Measures and Subcarboniferous. The impression presents almost the entire figure of the anterior face, from which the following description is given:

Description.—Tooth large, laterally elongated, moderately thick (?), extremities rounded; crown slightly arching from the lateral angles and curved laterally, anterior face slightly convex vertically and rounded at the crest, which was probably more or less obtuse; the anterior face of the crown was apparently undulated along its crest, the obscure sulci may have reached half the distance from the crest toward the base, and at the median line a very shallow depression, about as high as it is wide at the base, reaches upward about two-thirds the height of the crown, and seem to interrupt the continuity of the basal folds, which, however, may not be persistent or of specific importance; basal band narrow, linear, with two or three imbricated folds, and parallel with the base of the root; surface coarsely punctate. Root nearly as wide as the crown, its anterior face deeply channeled by an angular transverse furrow, with a low ridge traversing the lower portion from one extremity to the other, below which it is beveled to the outer basal edge.

	Inches.
Greatest breadth, about	1.60
Height,	.50
Greatest height of anterior crown face,	.22

In outline the above species bears a somewhat marked resemblance to *C. loriformis*, N. and W., from the Keokuk limestone; but it differs from that form in having the anterior face of the crown relatively higher, its crest undulated and less parallel, and its bow-shaped outline viewed from above, as well as in the more vertical concavity of the outer aspect of the root. It is not improbable that the basal angle of the posterior crown face was quite prominent, and the vertical concavity of that face of the crown must have been considerable, judging from the arched character of the opposite face, and in this respect somewhat resembling *C. cinctus*, Agassiz, though the present species is not acuminate, the coronal band not nearly as wide as in that species, and the tooth is not as thick and massive.

Form. and Loc.—Upper Coal Measures, Bennet's mill, near Nebraska City.

Genus XYSTRODUS, Agassiz (MS.)

Xystrodus? occidentalis, n. sp.

The collection affords an interesting little Deltoid tooth, which, I believe, has not been heretofore described. Unfortunately, the specimen is quite imperfect, and, although its specific characters permit of description, its generic affinity remains somewhat in doubt.

Description.—Terminal tooth small, subtrigonal in outline, little narrower than long, but slightly inrolled, flattened or gently depressed above; the straight side is abruptly beveled, and from its edge the crown gently inclines to the opposite oblique margin, which is very slightly raised; the border extremity is thickened, forming a well defined continuous marginal border, which rapidly descends upon the inner side and gently slopes into the shallow depressed space in front; toward the terminal extremity the tooth becomes exceedingly thin, and in the specimen before me the pointed end and outer margin are broken away. The superior surface is coarsely punctate, as is also the straight articular margin. Distance between the angles of the broader extremities .38 inch.

The tooth above described possesses some characters which seem to connect it more closely with *Xystrodus*, Agassiz, (MS.) than with any other genus with which I am acquainted. Its general depressed triturating surface, and but slightly convoluted terminal extremity, are strongly suggestive of this relation. The genus *Xystrodus* was established by Prof. Agassiz, for the reception of *Cochliodus striatus* and two or more other European species from the mountain limestone.

Form. and Loc.—Upper Coal Measures.

DELTODUS? ANGULARIS, N. and W.

Ref.—Newberry and Worthen, Geol. Illinois, Vol. II, p. 97; Pl. IX, Fig. 1.

Description.—Terminal tooth small, obliquely triangular in outline, thick, but slightly inrolled; the broader extremity has a sigmoidal curvature terminating in an acute point at the oblique posterior extremity; straight side forming an angle of about 55° with the oblique margin, abruptly truncated, with a narrow sulcus about the middle of the beveled articular face extending from the inner angle to the pointed end, below which the tooth apparently expands into a thin narrow border similar to that upon the opposite side; the articular margin is bordered by a prominent flattened ridge which occupies about one-third the surface of the crown and gradually narrowing as it approaches the terminal point; a sharp, narrow keel rises from the oblique margin, rapidly converging and decreasing in prominence toward the apical end, and separated from the broad, flattened prominence of the straight margin by an equally broad, deep, angular furrow; along the oblique side the tooth was slightly expanded into a thin marginal border. The crown surface is beautifully granulo-punctate, the broader extremity very faintly marked by longitudinal sigmoid lines of growth, and the broad mesial depression is traversed by very obscure undulations parallel with the oblique keel. Under surface longitudinally undulated, smooth.

Length of tooth along the straight margin, about .52 inch.; greatest distance between the acute and obtuse angles of the broader extremity, .48 inch.

The collection affords but a single example of this handsome form. The specimen before me has a remarkable resemblance to the posterior teeth of *Deltoptychius* Agassiz (MS.), founded upon Cochliodus acutus, of the Irish mountain limestone, but we do not at present possess the materials fully to demonstrate this identity. The Nebraska tooth, however, is evidently identical with the form described by Messrs. Newberry and Worthen, from stratigraphically corresponding horizons in Illinois; and Dr. White has discovered the same, or a very closely allied species, in the Upper Coal Measures of southwestern Iowa.

Form. and Loc.—Upper Coal Measures.

Stated Meeting, May 20, 1870,

Continued from page 385.

The following communication, descriptive of the recent hail storm of the 8th inst., was received from Mr. Hector Orr, of Philadelphia. Mr. Trego, Prof. Cresson, Dr. Coates, and Dr. Horn described the storm as they saw it, and Judge Lowrie compared its features with those of the great hail storm at Pittsburg, which he saw Sep. 30, 1850.

PHILADELPHIA, May 17, 1870.

To the Secretary of the Amer. Phil. Soc.

SIR:—I have not seen any scientific account of the late fierce hail storm of the 8th inst. in print. I noticed the following points of fact connected with it.

The moon entered her first quarter at 10.34′ A. M. that day. Wind from sunrise onward was brisk from N. E. till noon; a light *scud* flying quite low, some two points divergent from the surface current, and a heavy upper stratum of cloud coming nearly from the South. Towards noon the upper clouds showed signs of condensation, and by 2 P. M., the various currents seemed to converge over the city. At this time the sun and moon made nearly equal angles on either side of our meridian, both planets being also well advanced towards the zenith. Rain began to fall about 2.10′, the wind then passing across the pole from N. E. to N. W. For several minutes previous to the fall and at its commencement, the electrical discharges were violent and frequent.

The halting of the clouds directly over head happened within that period of the day in which the sun develops the most heat, and the artificial warmth always present over such a surface as that of the built-up part of Philadelphia, joined to the solar influence, seemed to me sufficient to drive the vapor suddenly upward almost perpendicularly. The concentration, congelation and precipitation, were thus all embraced in a period of thirty minutes.

The demolition of glass shows the wind to have come from the N. W. until the storm reached the line of Sixth street, when it became West, and thus continued to the Delaware. The original breeze entirely spent itself during the fall, for during the last seconds of it the tendency of the stones was slightly from the S. E.—the storm centering itself on the city plot.

Yours, Very Respectfully,

HECTOR ORR.

Dr. Genth communicated a new discovery of rhodium gold in San Domingo, and the results of recent examinations of dirt excavated in Philadelphia, holding silicate jems indicative of the presence of gold.

Dr. Genth stated that, according to Del Rio, an alloy of gold and rhodium is found in Mexico, which contains from 34 to 43 per cent. of the latter metal. This discovery has never been confirmed, and there is perhaps no mineralogist living who ever has seen it. Some experiments which he has lately made with residues from San Domingo gold leave very little doubt as to the existence of this very interesting substance. Prof. Gabb sent a lot of gold from San Domingo to Dr. Horn, from which the latter dissolved the gold by aqua regia, and placed the very minute residue into his hands! This consisted of scales of Iridosmine, a dull, yellowish substance, in microscopic rounded and angular grains, and a silicate which under the microscope appeared to be topaz. One of the yellowish grains, on being flattened out in an agate mortar, assumed metallic lustre and a pale yellow color. It was almost insoluble in aqua regia, but by treating it for several days with a large excess of this solvent, it was finally brought into solution. A trace of chloride of ammonium was added, and the whole evaporated to dryness and sufficiently heated to reduce the gold. Mixed with this were microscopic reddish crystals, which were dissolved in boiling water, filtered, the filtrate evaporated to dryness, and the residue slightly heated, by which it assumed a reddish brown color. On being fused with bisulphate of potash it gave a slightly rose-colored mass, soluble in water, and precipitated yellow by ammonia. From these reactions there seems to be no doubt that the yellowish grains are rhodium-gold.

Dr. Horn states that the gold received from Prof. Gabb came from the South side of the Island, and contained about 95 per cent. of gold. Dr. Genth remarked that some of the gold from the North side is of a peculiar nature; that several years ago a lot had been sold in this city and New York to jewellers, who stated that they could not work it, as it contained a substance unknown to them. It is very probable that this was also rhodium-gold.

Dr. Genth communicated the result of panning sand and gravel of the Delaware River, dug from a cellar at 106 Arch street. After removing quartz and other light substances, a considerable quantity of heavy black sand remained, which contained a little magnetite, but a large quantity of titaniferous iron (menaccanite). These were treated and dissolved with chlorhydric and sulphuric acid, which left the silicates clean enough for further examination. These consisted principally of very brilliant but microscopic zircons, some garnets and a few yellowish green grains of the appearance of chrysolite. The observed mineral generally accompany gold, but not a particle of the latter could be found. This negative result, however, does not prove its absence, because the quantity of the sands washed was not large and they did not come from the bed rock, where they are always far richer.

Prof. Cope exhibited a portion of the dorsal spine of a shark of the genus *Asteracanthus* of Agassiz, from New Jersey, the first on record from the United States.* He regarded it as confirmatory of his theory respecting the existence of beds of Jurassic age in that State, though probably of small extent.

Prof. Cope made some observations on the genus *Labidesthes*, Cope, which he had discovered in the Clinch River, E. Tennessee; he said it was an *Atherinid*, having considerable resemblance to the Cyprinodont genus *Belonesox*, having a prolonged premaxillary beak.

Pending nominations Nos. 651 to 659 were read.

The Committee on the Michaux Legacy reported through Mr. Price, that a site for the Oak Grove had been selected.

The Committee on the Michaux Legacy have the satisfaction to report, that in pursuance of the arrangement made between this Society and the Fairmount Park Commissioners, the latter have lost no time in selecting a site for the Grove, in a central portion of the Park westward of the Schuylkill, on the Landsdowne drive. It was selected with a view to suitableness, in furnishing the kinds of soil required by oaks, both upland and low land; dry and moist. There were found already growing, stately oaks of a century's growth, to form at once an impressive scene of shade and sunlight, to become more dense in foliage as the trees recently planted and soon to be planted, shall grow and expand their shade. There have been planted such additions to the previous varieties as could be had near this city. The annexed report of John C. Cresson, the Chief Engineer of the Fairmount Park, shows that seventeen different kinds of oaks are now in the Michaux Grove; and the Park Commission have authorized the importation from France of all other species that will live in this climate; a resource to us for the grove, largely enriched by the scientific labors and zeal of the Messieurs Michaux, who made known to the world the great variety of oaks that were native to this country.

PHILADELPHIA, May 18th, 1870.

Hon. E. K. Price,

Chairman of Committee on Michaux Legacy.

DEAR SIR:—Under the arrangements made for carrying into effect the Will of the late F. A. Michaux, a grove of oak trees, named the Michaux Grove, has been established in Fairmount Park.

* In the Proceedings of the Acad. Nat. Sci., Phila., No. 1, for Jan.-April, 1870, at page 13, there subsequently appeared the report of a communication on *Asterocanthus ilerius*, made by Dr. Leidy, at a meeting held March 22, 1870.

It now contains one hundred trees of the following species:

Quercus alba.	Quer. fastigiata viridis.	Q. palustris.
Q. bicolor.	Q. Fulhamensis.	Q. phellos.
Q. cerris.	Q. laurifolia.	Q. prinus acuminata.
Q. coccinea.	Q. Leana.	Q. robur.
Q. falcata.	Q. macrocarpa.	Q. tinctoria.
Q. fastigiata.	Q. nigra.	

In pursuance of authority given by the Park Commission, all other species of Oaks that will live in this climate are to be imported from abroad, chiefly from the nurseries of France.

Very Respectfully,

JNO. C. CRESSON,

Chief Engineer.

The following resolution was then passed:

Resolved, That Mr. Durand be respectfully requested to make known to the widow of the late André François Michaux what has been done by this Society, and the City of Philadelphia, through the Fairmount Park Commissioners, towards the carrying out the views of this lover of sylvan culture and benefactor of science, and towards holding his name in honor before the American People and Scientific World.

The resignation of Dr. Wood from the Presidency of the Society, on account of age and ill health, was presented by Prof. Cresson. When, on motion of Dr. Rushenberger, it was

Resolved, That the Secretaries be requested to address a letter to Dr. Wood, requesting him to withdraw his resignation, hoping that he will consent to remain with us as President of the Society.

Mr. Fraley informed the Society that Provost Stillé had been requested to deliver his obituary notice of Mr. Binney, Jun., before an audience of the Union League. On motion of Prof. Cresson, seconded by Dr. Coates, the MSS. was placed at the disposal of the author.

And the Society was adjourned.

Stated Meeting, June 17, 1870.

Present 10 members.

Mr. FRALEY, Vice President, in the Chair.

Photographs for the Album were received from Prof. H. A. Newton, of Yale, and Dr. Jarvis of Dorchester.

A letter announcing the decease of Madame Michaux was read, and on motion, the following resolution was adopted without debate.

Resolved, That M. Carlier be requested to have prepared the proper procuration or Letter of Attorney from this Society to himself, to dispose of the rentes or public loans standing in the name of this Society, being the investment of the Michaux legacy, and to make deposit of the proceeds as the Society may hereafter direct; and also to instruct us as to the manner of executing the procuration.

A letter withdrawing his resignation was received from the President, Dr. Wood.

Donations for the Library were received from the Museum at Beunos Ayres; the Carlo Alberto Observatory; Berlin Academy; London Society of Antiquaries; Essex Institute; B. N. H. S. Edmund Quincy, of Dedham; the Albany State Library; N. Y. Lyceum; Phil. Acad. of N. Sciences; Franklin Institute; Medical News; Mr. Hector Orr; Dr. Brinton; the U. S. War Department, and the Editors of Nature.

Prof. Joseph Henry returned, by request of the late Mrs. Bache, the MSS. correspondence of Prof. A. D. Bache relating to the Society.

Dr. Brinton returned to the custody of the Society Dr. Byington's MSS. Choctaw Grammar.

Prof. Frazer offered for publication in the Transactions a chart exhibiting all the metallurgical processes now employed at Friberg, in Germany, with descriptive text by Persifer Frazer, Jun., which was referred to a Committee consisting of Dr. Genth, Prof. Lesley and Dr. Bridges.

Prof. Cope communicated for publication in the Proccedings a paper entitled: A partial synopsis of the Ichthyology of North Carolina, (see next number of Proceedings) which was referred to the Secretaries.

Dr. Genth made some remarks upon a new meteorite from North Carolina, which he desired to be considered preliminary to a description and full analysis of the same. Prof. Kerr had forwarded photographs of the mass.

Dr. Genth showed also, specimens of metallic lead and metallic iron from Gold tailings on Camp Creek, Montana Territory. The place, circumstances, absence of all meteoric indications, and presence of gold in the lead, support the view that we have here a genuine discovery of lead and iron in a state of nature.

Dr. Genth showed photographs of a new meteoric iron, weighing about twenty pounds, which was found on a small mount in Rockingham Co., N. C.; he made some preliminary remarks on a fragment of the same, which he received from Prof. W. C. Kerr, State Geologist of N. C. The iron is coated with a crust of hydrated sesquioxide of iron. A polished portion of it, after etching with dilute nitric acid, developed the Widmannstaedtean figures, and showed a very remarkable structure of the iron. It is composed of three different kinds of iron; one portion of it is quite homogeneous, and has a very fine granular structure; if, however, the light is reflected in different directions it shows a peculiar glistening, and, very faintly, lines intersecting at angles of about 60° and 120°; this same iron runs into bands of not over 0.5^{mm} diameter, which, at another portion of the iron, intersect at angles of about 60. The space between the bands is filled with an iron presenting a reticulated structure. Disseminated throughout the homogeneous iron are crystals of *rhabdite*, but few only show a regular arrangement. A preliminary analysis gave:

Iron	90.41	per cent.	
Nickel (Cobalt)	8.74	"	
Copper	0.11	"	
Iron	0.27	"	Phosphide insoluble in chlorhydric acid.
Nickel (Cobalt)	0.33	"	
Phosphorus	0.14	"	

traces of a quartz-like mineral.

A sulphide of iron of a pale, brass yellow color, and great hardness—probably *pyrite* is mixed with the iron. Dr. Genth intends to give a fuller account of this interesting meteorite at a future day.

Dr. Genth also showed specimens of *native iron* and *native lead* from the bed-rock of gold-placers, and covered with about six feet of gravel, at Camp Creek, Montana Territory, which have been discovered there by Mr. P. Knabe, who kindly communicated them.

The native iron is found in small, angular fragments, but slightly coated with rust; the largest which he has seen is about 0.5 inch in length. Etching with dilute nitric acid does not develop any Widmannstaedtean figures, but a finely granular structure. Mr. Knabe examined it for nickel and cobalt with negative results. Associated with the iron is native lead, in irregularly shaped rounded and flattened pieces, from the size of a pin's head to about 0.5 inch in diameter. The lead is coated with a crystalline crust of *massicot*, of a sulphur yellow to reddish yellow color; some pieces also show very brilliant but microscopic crystals, which may be *cerussite*. Acetic acid dissolves this massicot, and leaves the metallic lead, which then shows its crystalline structure. A small piece, on dissolving it in nitric acid, left an appreciable quantity of *gold*, but the solution contained no *silver*.

Prof. Cope made some observations on the Reptilia of the Triassic formations of the Atlantic region of the United States. He observed that thirteen species had been described and referred to ten genera. None of these had been referred by their describers to their appropriate orders, and he had undertaken an investigation of them, having for its object such reference, as well as the determination of the closer affinities.

Three of the species he proved to be Dinosauria. He had already assigned Megadactylus and Bathygnathus to this division, and would now add Clepsysaurus, Lea, from evidence derived from an ischium discovered among the original remains. It resembled that of Megadactylus.

Of the remaining ten species, he was satisfied that those referred to Palæosaurus by Emmons, as well as the Compsosaurus and Eurydorus, were founded on posterior teeth of Belodonts. He also said that nothing was to be found in the descriptions of Rhytidodon, Emmons, and Omosaurus, Leidy, to distinguish them from Belodon, to which genus he was inclined to refer the remains which had fallen under his observation. Thus, three species were certainly to be distinguished from the ten, viz: Belodon carolinensis, Emm., (*Rhytidodon*, Emm., *? Centemodon sulcatus*, Lea); Belodon priscus, Leidy, (*Palæosaurus carolinensis*, Emm., *? Compsosaurus priscus*, Leidy, *Clepsysaurus pennsylvanicus* in part, Emmons); Belodon leaii, Emmons, (*Clepsysaurus*, Lea). The above were not asserted to belong to the same genus without doubt, but that evidence to distinguish them was yet wanting. He added a fourth species, discovered by Chas. M. Wheatley, in the Triassic tracks of Phœnixville, Pennsylvania, which was apparently distinct from the above, and of larger size. The remains preserved were dorsal, lumbar and caudal vertebræ, with costal and abdominal ribs; left femur and fibula nearly perfect; portion of pelvis; ungueal and chevron bones, etc. The femur measured thirteen inches in length, and the lumbar vertebræ exhibited slender cylindric diapophyses, which bore ribs to the sacrum. This reptile was named *Belodon lepturus*, and was estimated to have attained a length of about twelve feet.

Eleven of the thirteen species being thus disposed of, there remained the Dicynodon rosmarus, Cope, and *Rhabdopelix longispinis*, Cope. The latter he had formerly suspected to be a Pterosaurian, but he thought it more likely that it would turn out to be a Rhynchocephalian reptile.

He called attention to four remarkable vertebræ from the Cretaceous green sand of New Jersey, which were characterized by the possession of enormous pneumatic foramina. The articular extremities of the extremities were rugose, and with scarcely any dense layer, so that they probably belonged to an immature animal, and were to be referred to the sacral or lumbar regions. If they belonged to the latter, they indicated a coössification similar to that seen in many birds. That they were not dorsals is indicated by the lack of capitular articulations. The pneumatic foramina occupied half of the centrum along its middle, leaving abutments fore and aft, for the support of the neural arch, which was lost in each one. There were no diapophyses. The neural canal presented a deepening and compression at the middle of the centrum, and a rising and expansion near the articulations. Centra much compressed medially, as well as contracted upwards; articular extremity subtriangular, with rounded angles and notch for neural canal one-third its vertical diameter. Cancellous tissue, coarse, but much finer than in Lælaps; the dense layer thin. The total length of the four, is seventeen and a half inches, the shortest measuring four; the other three, four and a half inches in length. The complete number of six would have measured six inches in length.

These vertebræ had been described as the sacrals of a young Hadrosaurus by Leidy (Cretaceous Reptiles, U. S., p. 100), but there are several reasons for dissenting from this conclusion. The pneumatic foramina of the sacral nerves, which, however, in known Reptiles and Birds, issue *between* the neural arches, not beneath them, not only in the sacral, but in the lumbar and other vertebræ. The reasons for questioning their pertinence to Hadrosaurus were, first: the genus Megadactylus presents similar large pneumatic foramina, and they occur in both the caudal and lumbar vertebræ; the lumbar and caudal vertebræ of two species of Hadrosaurus are known, and do not present any pneumatic foramina whatever, which would scarcely be the case were the present vertebræ sacrals of Hadrosaurus. Second: they form too long a series for the known ilium of Hadrosaurus. From the approximation of the facets for the sacral diapophyses in the type specimens of H. foulkei, it would appear that those vertebræ had somewhat the shortened form of the caudals. Yet the present animal appears to be a young one. Third: the structure is in several respects more Megalosaurian than Iguanodontine. Thus the alternate enlargement and contraction of the neural canal is seen in Palæosaurus and Clepsysaurus; the neural arches appear to have alternated above the articulations of the centra. The pneumatic foramina exist in Lælaps, but of reduced dimensions.

In respect to the presence of the foramina just mentioned, there is a resemblance to the Ornithopsis hulkei, recently discovered by Seeley, though here the comparison ends. In that form the cancellous texture of the centrum is extremely open and light, and composed "of enormous honeycomb-like cells of irregular polygonal form—for the most part long in the direction of the length of the centrum, and divided by exceedingly thin and compact films of bone," etc. The structure in the subject of the above description is spongy and light, but much closer. Lælaps offers a much closer resemblance to Ornithopsis in its exceedingly coarse structure; while in Megadactylus, lumbar vertebræ appear to be absolutely hollow.

Had Dr. Seeley been acquainted with these genera, he would probably have referred Ornithopsis to the Goniopod Dinosauria, rather than to the Ornithosauria. Prof. Cope added that he had already (Aug. 1869,) published the view that the bone described previously as a quadratum of Iguanodon, (the type of Seeley's Ornithopsis), was evidently not a cranial bone, and that he had always supposed it to be a vertebra.

The reptile represented by the above vertebræ was named *Pneumato arthrus peloreus;* the possibility of its being found to be *Ornithotarsus* being entertained, though the near resemblance of the bones to those of a tortoise could not be overlooked. The specimens were discovered by Dr. John H. Slack, in Monmouth Co., N. J.

Prof. Cope exhibited also seven Australian skulls and one Maori skull, probably the first seen here.

Pending nominations, Nos. 651 to 659 were read.

And the Society was adjourned.

Stated Meeting, July 15, 1870.

Present, four members.

Dr. Genth in the Chair.

Letters of envoi were received from various correspondents.

Letters of acknowledgement for the receipt of No. 83 were received from the Essex and Smithsonian Institutes, Massachusetts, New York, New Jersey, and Georgia Historical Societies, Cambridge Museum, and New York Lyceum; Nos. 77 to 80, R. Danish Society; 77 and XIII. 2, Zool. Bot. Soc., Vienna; 78—80, Physical Society, Berlin; 76—80, Nassau, N. H. Association.

Donations for the Library were received from the Academies at St. Petersburgh, Berlin, and San Francisco; the Institutes at Salem, Albany, Philadelphia, Baltimore and Washington; the Societies at Königsberg, Vienna (Zool. Bot. and Anthropological), Leipsig (P. Jablon. and R. Saxon), Görlitz, Berlin (Geological, Physical and Horticultural,) Bremen, Wiesbaden, Bonn, Strasbourg, Bordeaux, London (R. Astronomical and Chemical), and Leeds; the Observatories at Munich, Montsouris and Oxford; the Universities at Liège; the Museums at Salisbury and Cambridge, Mass.; the Italian Geological Commission; MM. Manjini and Denra; American Medical Journal; Messrs. Elihu Thompson and A. Gebow; the International Exposition Commission at Washington, and the editors of "NATURE;" and the Chinese Recorder at Foochow.

The death of Sir James Clark, of London, aged 82, was announced by the Secretary:

The committee to which was referred the Chart of Freiberg processes, by Percifer Frazer, Jr., reported in favor of its publication in the Transactions, which was so ordered.

Prof. Cope communicated for the Proceedings, a Register of Meteorological Observations made at Bois Chêne, near Port au Prince, Hayti, by Prof. A. Ackerman, Phys. Sciences National Museum.

Communications respecting the Michaux Legacy, and respecting Mr. Peale's Cabinet of Antiquities, were made to the meeting.

Nominations Nos. 651, 652, 654, 655 were postponed.

The ballot boxes being examined by the presiding officer, the following persons were declared duly elected members of the Society:

Dr. C. W. Boekh, of Christiana, Norway.
Dr. Wm. Pepper, of Philadelphia.
Rd. E. R. Beadle, of Philadelphia.

And the Society was adjourned.

A PARTIAL SYNOPSIS OF THE FISHES OF THE FRESH WATERS OF NORTH CAROLINA.

By Edw. D. Cope. A.M.

Read before the Amer. Philosophical Society, June 7, 1870.

The material on which the present investigation is based was, for the most part, procured by the writer during the autumn of 1869. A journey from the Cumberland Mountains of Tennessee to the ocean, offered opportunity for making collections in the waters of five hydrographic basins, viz. : those of the Cumberland, Tennessee, Catawba, Yadkin and Neuse. The streams of the Tennessee examined were the Clinch and French Broad ; the former in a tributary called Coal Creek, in Anderson Co., Tenn.; the latter at various points, both in the mountainous part of its course, and in the elevated and flat valley of Henderson Co., where it takes its rise. A small seine with fine meshes, kindly lent me by the administration of the Smithsonian Institution, was used in the smaller streams; and fishermen's apparatuses, especially weir traps, furnished most of the species inhabiting the river channels. Passing many of the latter at the time of year when the migratory fishes were descending, the writer was able to examine and procure them in great numbers. The opportunity of seeing fishes in life, it is believed, is no small aid to their proper specific determination.

ACANTHOPTERYGII.

PERCA, Linn.

1. Perca flavescens, Cuv.

Neuse River.

ROCCUS, Gill.

2. Roccus lineatus, Bloch.

Neuse River.

STIZOSTEDIUM, Raf.

3. Stizostedium americanum, C. V.

This is the largest Percoid of the Western waters, occasionally attaining a weight of 35 lbs.: no specimen of more than 10 lb. came under my observation. It loves the most boisterous and rapid streams, ascending them to near their sources, having much the manners, and haunting the same waters as the trout, but of much more voracious habits. Its swiftness enables it to take the black perch (Micopterus fasciatus) with ease, though that fish is, after it, much the most powerful swimmer of the rivers it inhabits. I took two from the stomach of a Lucioperca of eight pounds, one of which weighed 2½ lbs. Suckers are used as bait in taking them by hook ; but the mode in which large specimens are most readily taken is by shooting. When the Lucioperca has gorged himself, he seeks some shallow bayou, and lies in a sluggish state, digesting his meal. Then the gun-fisherman, concealed in a tree close by, makes sure of him. It is the most valued food-fish of the French Broad, the flesh being very tender as well as rich.

Without the opercular armature of the Percae, its chief defence is in its numerous and powerful canine teeth, with which it makes serious wounds on the hands of the unwary fisherman. The common name on the French Broad is "Jack."

4. Stizostedium salmoneum, Raf.

This fine species was described to me as an inhabitant of the French Broad, though I did not see it. As elsewhere, it is called Salmon. A species of this genus occurs also in the Neuse.

ETHEOSTOMA, Raf.

5. Etheostoma nevisense, Cope.

Proc. Amer. Philos. Soc., 1870, p. 261.

Turbulent waters of the Neuse River.

6. Etheostoma maculatum, Girard.

Putnam Bull. Mus. Comp. Zool., Cambridge, No. I. Cope. Proc. Am. Phil. Soc., 1870, 262. *Hadropterus maculatus*, Girard. Proc. A. N. S, Phil., 1859, 100.

Abundant in the rapid waters of Buck Creek, which empties into the Catawba, in Marion Co., N. Ca.

HYPOHOMUS, Cope.

Cottogaster, Cope, Journ. Acad. Nat. Sci., Phila. 1869, 210, not of Putnam.

The name *Cottogaster*, my friend Prof. Putnam informs me, was applied to species of the type of *Boleosoma*. It is, therefore, inapplicable to the *C. aurantiacus*, to which I apply the above generic name. The characters of the genus have been pointed out as above cited. They are those of Etheostoma, excepting the median ventral series of shields, which are here wanting.

7. Hypohomus aurantiacus, Cope.

Jour. Acad. Nat. Sci., Phila., 1868, 211.

One specimen from the French Broad River, in Madison Co., North Carolina, measuring 4 inches 8 lines in length, more than twice the size of the types, and larger than any species of the Etheostomine group, excepting *Percina caprodes*. Color in life bright yellow, with a black lateral band, and a few brown spots on each side of the dorsal fin.

POECILICTHYS, Agass.

8. Poecilichthys vitreus, Cope.

Proceed. Am. Phil. Soc. 1870, 253.

This species is quite translucent in life. The only specimen taken was adult, and exhibited ovaries well filled with well developed ova. Seven green dorsal spots, and eight or nine linear spots on the sides, of the same color.

Walnut Creek, a tributary of the Neuse River.

9. POECILICTHYS FLABELLATUS, Raf.

Cope, Jour. A. N. Sci., Phil., 1868, 213. *Catonotus*, Agass., Putn. Bull. M. C. Zool., I.

Var. Cope, Proc. Am. Phil. Soc., 1870, 263.

From the Catawba River.

10. POECILICHTHYS VULNERATUS, Cope.

Proceed. Am. Phil. Soc., 1870, 266.

A beautiful species from the Warm Springs Creek, Madison Co., N. Ca., a tributary of the French Broad River.

11. POECILICHTHYS RUFILINEATUS, Cope.

Loc. cit., 267.

Abundant in the same localities as the last, and one of the most ornate species of the genus.

12. POECILICHTHYS ZONALIS, Cope.

Jour. Acad. Nat. Sci., Phil., 1868, 212, Tab. xxiv., f. 1.

French Broad River.

BOLEOSOMA, DeKay.

Cope, Proc. A. P. Soc., 1870, 268.

13. BOLEOSOMA EFFULGENS, Girard.

Cope, l. c. *Arlina effulgens*, Girard. Proc. Acad. Nat. Sci., Phil., 1859, 64.

Deep River, Guilford Co., North Carolina, from Samuel C. Collins.

14. BOLEOSOMA MACULATICEPS, Cope.

Proc. A. P. Soc., 1870, 269.

Upper waters of the Catawba River.

HYOSTOMA, Agass.

Cope, Jour. A. N. Sci., Phil., 1868, 214.

15. HYOSTOMA CYMATOGRAMMUM, Abbott.

French Broad River.

MICROPTERUS, Lac.

Grystes, Cuv. Val.

16. MICROPTERUS FASCIATUS, DeKay.

Apparently not found east of the great Water Shed: I only obtained it in the state in the French Broad. Also from the Clinch and the Cumberland.

17. MICROPTERUS NIGRICANS, Cuv.

The green bass is abundant in all the rivers of the State. I have it from the Neuse, Yadkin, Catawba, upper and lower French Broad, and from the Clinch in Tennessee. Specimens from the Neuse and from near Norfolk, Virginia, six in number, differ from those of the other rivers, in having a deeper body, and generally longer and more prominent mandible. The depth enters the length 2.75 times; in the more western forms always 3.25 times; in the former it is greater than the length of the head, in the latter it is considerably less. Other differences are not discoverable and I regard it as a marked variety only.

POMOXYS, Raf., Agass.

18. POMOXYS HEXACANTHUS, C. V.

Neuse River.

Numerous specimens of this species and the *Pomoxys storerius* from Leavenworth, on the Missouri River, from Saml. H. Edge.

CENTRARCHUS, C. V.

19. CENTRARCHUS IRIDEUS, Cuv., Val.

Vol. III., p. 89, Holbrook Ichth. S. Ca., 18, Tab. III., fig. 1.

From the Neuse River. A specimen presenting an additional dorsal and anal ray, as compared with the description of Cuvier and Valenciennes; but Holbrook adds one to the anal spines, thus agreeing with anal formula D. xii., 14, A. viii., 15. Of a brilliant pea green in life, without ocellus on second dorsal, as described by the above authors. Soft dorsal and anal, with narrow, blackish bars. Not probably specifically distinct from specimens in Mus. A. N. Sci., from South Carolina.

AMBLOPLITES, Raf., Agass.

20. AMBLOPLITES RUPESTRIS, Raf.

Centrarchus æneus, Cuv. Val.

Abundant in the French Broad and head of Cumberland; none found east of the Alleghenies.

CHÆNOBRYTTUS, Gill.

This genus, for which I have reserved the above name, is equally allied to *Lepomis* and *Ambloplites*. It agrees with the first in its entire and rather produced operculum, and three anal spines, but differs materially in possessing the additional maxillary bone of the latter, *Centrarchus*, *Pomoxys*, etc. Gill defined it in consequence of its palatine and lingual dentition, characters which exhibit various grades of imperfection to entire extinction in the typical Lepomes. Hence, in my view of fresh water fishes from the Allegheny region of southwest Virginia, I united Lepomis, Bryttus, and Chænobryttus. I now discover the importance of the presence or absence of the additional maxillary bone, which, with the emargination of the operculum previously pointed out, enables me to define the genera more satisfactorily than my predecessors. Thus they may be arranged in four groups.

I. Operculum emarginate ; a supernumerary maxillary bone :—Micropterus, Ambloplites, Pomoxys, Centrarchus, Acantharchus, Enneacanthus (?) Hemioplites.

II. Operculum emarginated ; no supernumerary maxillary :—Mesogonistius.

III. Operculum entire, produced ; an additional bone attached to the maxillary:—Chænobryttus.

IV. Operculum as last ; no supernumerary maxillary : —Lepomis, Pomotis.

21. CHÆNOBRYTTUS GILLII, Cope.

Lepomis gillii, Cope. Jour. Acad. Nat. Sci., 1868, 225.

This species is exceedingly common in all the streams of North Carolina east of the Allegheny Mountains. It does not occur in the French Broad. All the specimens have clouded markings on the sides, which in the young, are broad, distinct olive-brown cross-bands, which embrace pale spots, giving a chain-like pattern. Fins blackish, cross-barred ; four brown bands radiating backwards from orbit. Iris bright red. The species is rarely seen more than five inches long, and prefers rather still waters. It bites the hook very readily, and is called the red-eyed bream on the Catawba.

The *C. mineopas*, Cope, possesses the additional maxillary, and I have no doubt the *C. melanops* (Gill's type), and the *C. charybdis*, Cope, though I have not been able to verify it on the latter.

ENNEACANTHUS, Gill.

Jour. A. N. Sci. Phil, 1868, 218.

22. ENNEACANTHUS GUTTATUS, Morris.

Proceed. Acad. Nat. Sci., Phila., 1858, p. 3.

Abundant in the Neuse River in still water, as in Virginia and New Jersey.

LEPOMIS, Raf.

23. LEPOMIS RUBRICAUDA, Holbr.

This marked species, the southern representative of the *L. appendix* is very common in the hydrographic basins of the Catawba, Yadkin and Neuse. In life the second dorsal and caudal fins are red, and there is a bay spot at the base of each scale forming interrupted stripes. Flap of operculum black, the continuation of a dark shade from the preoperculum, which is bordered above and below by a blueband ; two blue lines on operculum below the latter.

24. LEPOMIS MEGALOTIS, Raf.

L. incisor Cuv. Val.

From the upper waters of the French broad.

There are several species allied to the present, which may be distinguished, as follows:

Scales 4—35—11.

Dorsal spines short, longest equal muzzle and orbit to pupil; mucous cavities small; eye four times in head with long flap, which is black, red bordered below and behind; anal spine reaching base last anal ray.
L. PELTASTES.

Scales 5-7—36-47—2-14.

Spines of dorsal shorter, equalling muzzle and half orbit; third spine of anal not reaching base of last anal ray; ear flap long, blue edged below; pectoral scales large; a spot on second dorsal. L. MEGALOTIS.

Spines etc., as above; pectoral scales small, no spot on second dorsal.
L. c. 41—4. L. NITIDUS.

Spines longer than the above, dorsal equal muzzle and orbit .5 or head; anal reaching base last ray; opercular flap very small not lighter margined; spot on second dorsal.
L. c. 36—9. L. NOTATUS.

Spines longest, more than muzzle and orbit; anal extending beyond last anal ray; ear flap very short, not light margined; spot on second dorsal. L. SPECIOSUS*

Eye .33 of head; scales 7—47; spines long, equal muzzle and orbit; anal ray extending beyond base last anal; opercular flap very small; spot on second dorsal. L. PURPURESCENS.

Lepomis nitidus, Kirtland.

L. megalotis, var. B. Cope Journ. A. N. Sci., Phila., 1865, p. 220.

Common in Coal Creek a tributary of the Clinch River; not seen in North Carolina.

25. LEPOMIS NOTATUS, Agass.

Amer. Journ. Sci. Arts, XVII, 302.

This species is allied to the *L. ardesiacus*, Cope (l. c., p. 222), but its scales are larger, there being but 36—9 on the lateral line, and 13 below it, while there are 45, with 17 below, in the latter. The eye is also larger, entering the head only three times, while it is measured four times by the same in on L. *ardesiacus* of the same size.

The general form is elongate oval, the front of dorsal region steep, the muzzle conic and not obtuse. Eye large and round, its diameter measuring muzzle and half itself, and .2 more than interorbital width: R. D. X. 11, A. III. 10, Depth 2.33 times in length to end of lateral line. Four rows scales on cheek; no palatine teeth. Scales above lateral line, five large series and one small one. Length 3. 5 inches. Color uniform greenish brown, below yellowish; no band. No red on the very small opercular spot. Fins not cross-barred

Very abundant in the upper French Broad River, North Carolina, and the tributaries of the Clinch, East Tennessee.

*LEPOMIS SPECIOSUS, Girard. *L. heros* Girard. *L. longispinis*, Cope, Journ. A. N. Sci., 1868, 220: from Texas.

This is probably Agassiz species as above, but the orange on the opercular flap scarcely extends posterior to the black spot, and is easily lost sight of in spirits.

26. Lepomis purpurescens, Cope.

Species nova.

This is an elevated compressed fish, with very small or rudimental opecular flap, like the L. *notatus*, *L. ardesiacus* and *L. nephelus*. It is similar to the first, and different from the *L. ardesiacus* in its large eye, which enters the head scarcely three times, and the interorbital width .75 times, but agrees with the latter in its small numerous scales. Thus there are six rows of equal scales above the lateral line, and one small one, and 47 on the lateral line and 13 below it; (in the *L. ardesiacus* there are 17 below it.) Depth 2.25 to 2.33 in length (exclus. caudal fin.) The spinous rays of this fish are nearly as long as in the *L. speciosus*. The caudal fin is longer than usual, equalling at least, the head. Length of latter, three times in length of body + head. Six rows scales on the cheek. Length three inches. Mucous cavities small.

Color in life a pale silvery lilac, darkest in four or five vertical shades across the sides, which disappear in alcohol. Fins unicolor except dark shades on middle of anal, and second dorsal and edge of caudal, with a black spot at lower posterior portion of second dorsal.

Abundant in a tributary of the Yadkin River in Roane County, North Carolina.

Lepomis peltastes, Cope.

A deep stout species of small size, distinguished for its large scales, short spines and bright color; mucous caverns small. Eye large, equal muzzle, four times in length of head with long opercular flap, just equal interorbital width. Head with flap 2.5 times in length; depth 2.1 times in same. Caudal fin and peduncle considerably more than one-third the length. Longest dorsal spine equal from end muzzle to middle of pupil; longest anal reaching base last anal ray.

Five rows scales on cheek, three large and two small rows above lateral line; those of middle of sides larger than those on lower part. The profile is regularly descending to end of muzzle; front but little concave. Radii D. X. 11. A. III. 10. Length three inches.

Color above golden brown, sides and belly golden, top of head blackish. Large black opercular spot, red margined below and behind. I dorsal fin blackish, II D. blackish at base orange above, anal similar, caudal blackish, ventrals more or less black. The pectoral fins do not quite reach the base of the anal fin.

This species is from the Huron River, Michigan, whence it was procured through the kindness of my friend Prof. Alexander Winchell, Ann Arbor, Michigan. Its relationships are to the *L. oculatus*, Cope, but in that species the eye is smaller, and the tail and peduncle are .33 of the length. In *L. anagallinus* the mucous caverns are much larger.

POMOTIS, Cuvier.

27. Pomotis maculatus, Mitchill.

Morone Mitchill, *P. vulgaris*, Holbr.

From all the rivers of North Carolina east of the Allegheny Range. Identical with specimens from Pennsylvania and Michigan.

URANIDEA, Dekay.

28. Uranidea carolinæ, Gill.

Proc. Bost. Soc. Nat. His., 1861. 41.

Abundant in the French Broad River in Madison County, North Carolina.

APHREDODIRUS, Lesueur.

29. Aphredodirus sayanus, Gilliam.

Journ. A. N. Sci., Phila., IV, 81, pl. III; Dekay, N. Y. Fauna, Fishes p. 35, pl. xxi., fis. 62.

Abundant in sluggish waters tributary to the Neuse River in Wake County, North Carolina.

LABIDESTHES, Cope.

Fam. *Atherinidæ.* Premaxillary bones prolonged anteriorly into a roof-shaped beak of elongate form, moderately projectile; reaching posteriorly to the line of the orbit: its teeth in several series. Mandible as long as the muzzle. No palatine teeth.

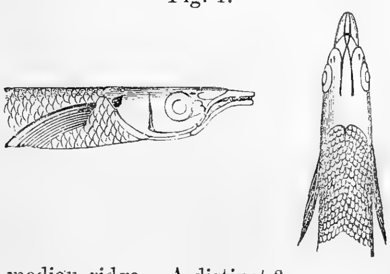
This genus differs from Chirostoma (*Atherinopsis*, Blkr.) in the duck-like muzzle, which is almost exactly like that of the *Belonesox belizanus*, though shorter. Like it, the premaxillaries are not coössified, and are separated on the superior surface by a groove between the median portions. The general characters remind one so of Belonesox, as to strengthen the belief in the close relationship existing between Atheriridæ and Cyprinodontidæ, though the form is Acanthopterygian, and the latter Malacopterygian.

Labidesthes sicculus, Cope.

Chirostoma sicculum, Cope. Proc. Acad. Nat Sci., Phila., 1865, p. 81.

Form slender, the depth contained in the length (without caudal fin) seven times; the length of the head 4.33 times in the same. The eye is large and round, contained 3.6 times in the head, 1.5 times in the length of the muzzle and once in the interorbital space. The top of the head and muzzle are plane, the latter convex transversely, and not exceeded by the extremity of the mandible. Front with a median ridge. A distinct ? mucous pore above each orbit. The teeth

Fig. 1.



are elongate, slender and simple. The premaxillaries are a little projectile; extremity of maxillary acuminate. The first dorsal commences at a point mid-way between the basis of the tail and the anterior margin of the orbit, or opposite the 3–4th anal radii. The second dorsal commences above a point a little in front of the middle of the anal. Radii D. IV. 10; A. I. 22–3; V. I. 5; P. 12. The scales are small, in 14 longitudinal, and 75 transverse series.

In life this fish is translucent, with a silver band on each side, which covers one scale and two halves, and is lead-edged above. The dorsal region and top of head are dusted minutely with black. Operculum and cheek silvery.

	M.
Length,	0.074
Of head,	0.015
Of pectoral fin,	0.011
Base of anal,	0.018
Width head behind,	0.006

This little fish I took in great abundance in Coal Creek, a tributary of the Clinch, in East Tennessee. It was very abundant, and easily caught in rather sluggish water. The stream named passing through a limestone region, is liable to partial desiccation in the Autumn, and in several pools, thus formed, I obtained this species.

In the original description I gave D. V., which should probably be as here stated, D. IV.

MALACOPTERYGII.

FUNDULUS, Lac.

30. Fundulus catenatus, Storer.

Cope, Journ. A. N. Sci., Phil., 1868, Tab. xxiv., fig. 2.
Clinch River, abundant.

HAPLOCHILUS, McClelland.

I refer the following species to this genus, without going into its synonymy, following the arrangement given by Günther in the Catalogue of the British Museum. In consideration of the peculiar views of this author respecting specific and generic characters, I consider this a temporary arrangement, to be rectified by a more thorough analysis of the subject at some future time.*

*_Fundulus nisorius_, Cope, Sp. nov.

Stout; head four times in length to basis caudal; orbit four times in length of head, and twice in inter-orbital width. Depth 3.75 times in length. Anal fin commencing about opposite the middle of the dorsal. Cheek scaly, operculum smooth. Scales of body in. 36 transverse, and 12 longitudinal series. Radii D. 12, A. 10 or 11, extending more than half way from basis of first ray to basis caudal. Length of female, four inches. Color uniform light brown, yellowish below.

Most of the specimens of this species (seven) are females, and in them the oviducts are prolonged in a tube to near the extremity of the first ray of the anal fin. Several have many well developed eggs in the former. Small, faintly cross-banded specimens, perhaps males. do not pre-

31. Haplochilus melanops, Cope.

Sp. nov.

First dorsal ray opposite middle of anal. Scales in. 31 transverse, and 9 longitudinal series. Radii D. 1.6, A. 1.8, V. 6. Head 3.66 times in length, exclusive of caudal fin; eye 3 times in head, 1.6 times in interorbital width. Dorsal and anal fins each short, each measuring less than half the distance from their first ray to the basis of the caudal fin. Caudal narrowed, rounded.

Above, yellowish brown, scales darker edged, a few longitudinal lines on some dorsals; in some specimens, a median brown dorsal line. Dorsal and caudal fins each with a row of black dots across the middle, and one near the margin. Belly golden. Length 1.5 inches, the largest size. A blue-black spot below the eye in most specimens.

Very abundant in still waters of the Neuse basin, Wake Co., N. Ca.

ESOX, Linn.

32. Esox affinis, Holbrook.

Ichth. S. Carolina, 198, Pl. xxviii., fig. 1.

This species is near to but distinct from the *E. reticulatus* of the North. In life it is of a bright light emerald green, with dark reticulations. Common in the Neuse River.

33. Esox ravenelii, Holbrook.

Ichthyology South Carolina, p. 201, Pl. xxvii., fig. 2.

Length from muzzle to pectoral equalling length from pectoral to ventral fin; latter space embracing 37 transverse series of scales. From end muzzle to orbit less than from orbit to opercular border. Br. XIII. D II. 12. Brown above with brown cross-bars; edge of dorsal and caudal fins red.

This species is near *E. americanus*, but has a relatively longer head. Size and color similar. From the Catawba River, N. Ca.

SEMOTILUS, Rafinesque.

Putnam, Cope.

34. Semotilus corporalis, Mitchill.

From the French Broad, Catawba, Yadkin, Deep, and Neuse Rivers.

CERATICHTHYS, Baird.

Four species of this genus were observed, of which two are new to Zoology. They both belong to

Sect. II., mouth more or less inferior, small; teeth 4–4 or 4. 1.—1. 4; size small.

Depth less than length head; last dorsal ray more than half first; muzzle narrow, beards long; small; C. labrosus.

sent this character. There are no pseudo-branchiae. From Gaboon, W. Africa. P. B. DuChaillu.

It may be stated in this connection that the genus called *Lycocyprinus* by Peters, for Haplochioid fishes with pseudobranchiæ, was previously named Epiplatys by Gill. The type of the latter (E. sexfasciatus, (1862) from Gaboon, is different from the *E. (L.) sexfasciatus* (1864), the type of Peters. The latter may, therefore, take the name of *E. infrafasciatus* (1865), which Günther gave the same species, subsequent to Peters.

Depth equal length head; last dorsal ray less than half first; muzzle broad, beards small; C. HYPSINOTUS.

35. CERATICHTHYS LABROSUS, Cope.

Spec. nov.

This is a peculiar species of slender proportions. The top of the head is gently decurved to a muzzle which scarcely overhangs the thick, projectile upper maxillary arch. The mouth is entirely horizontal, and the extremity of the maxillary bone attains the line of the orbit. The latter enters the length of the head 3.75 times, and is just exceeded by the inter-orbital width. The head enters length to origin caudal from 4 to 4.5 times. Front arched in transverse section. Depth 5.5 times in length. The dorsal line is nearly plane, and the elevation of the first dorsal rays is contained twice in the length from its base to the anterior rim of the pupil: it stands over origin of ventral. Scales large 6—34-5—4. Radii D. 8; A. 8.

	Lines.
Total length	29.5
Of caudal fin	5.1
Of head	5.8

Teeth 4. 1——1. 4.

This fish is silvery from the middle of the sides downwards. In some specimens there are numerous blackish scales above the lateral line, which are arranged so as to form indistinct cross-bars in life; in other specimens the color is quite transparent, indicating two varieties. The latter are frequently a little more slender than the former.

The beards of this species are relatively longer than in any other species of the genus. The prominent lips remind one of Phenacobius. The species is not uncommon on the bottom in clear and rapid creeks which flow into the upper waters of the Catawba River, in Macdowell and Burke Counties, N. Ca.

36. CERATICHTHYS HYPSINOTUS, Cope.

Spec. nov.

This little species has a stout robust form. The head and muzzle are broad and flat; the muzzle is not prominent; the mouth is inferior and horizontal; the maxillary just reaches the line of the orbit. The form is characterized in the genus by the gradual elevation of the dorsal line to the base of the first ray of the dorsal fin, and its rather abrupt descent from that point. The base of this fin is thus oblique and the distal outline is vertical; the posterior ray being less than half as long as the anterior. This produces a characteristic appearance. The head is short and enters the length 3.75 times, equalling the depth. Body compressed. Orbit 3.5 times in length head, and once in inter-orbital space. Lips, especially inferior, thin; beards small. Scales, 4-5——38-41——3. Teeth 4. 1——1. 4. Dorsal fin originating a little in advance of above ventrals; 8. A. smaller than dorsal, 8.

	Lines.
Length	33.6
Caudal fin	6.5
Depth	7
Width head behind orbits	3.5

Color in life silvery, with a double series of black specks along the lateral line, and a lateral band of dusted blackish; a dark line round muzzle between orbits. Membrane of dorsal fin often shaded with blackish.

Common in creeks heading the Catawba R., in Macdowell Co., N. Ca., or tributary to the Yadkin River in Roane Co., in the same State.

37. Ceratichtyhs hyalinus, Cope.

Jour. Acad. Nat. Sci., Phil., 1868, 226.

From the French Broad and Clinch Rivers in North Carolina and Tennessee; not found east of the Alleghenies.

38. Ceratichthys biguttatus, Kirtl.

Trans. Amer. Philos. Soc., 1866, 366.

Found in the rivers of East Tennessee and North Carolina, from the heads of the Cumberland, to, and including, the Neuse.

ARGYREUS, Heckel.

39. Argyreus lunatus, Cope.

Proc. Acad. Nat. Sci., 1864, 278. Jour. Acad. Nat. Sci., 1868, 228, Tab. 23, fig. 3.

Common in the tributaries of the French Broad and Holston Rivers, in North Carolina and Tennessee. The absence of any species of this genus in the rivers of North Carolina east of the Alleghenies is a peculiar feature. They no doubt occur in the Roanoke, as I have taken *A. atronasus* from that river in Virginia.

HYPSILEPIS, Baird.

40. Hypsilepis coccogenis, Cope.

Proceed. Acad. Nat. Sci., 1867, 160.

Common in the French Broad and Clinch Rivers. Not found in the Beech Fork of the head of the Cumberland.

41. Hypsiepis cornutus, Mitch.

Var. *frontalis*, Agass., Cope, l. c., 158.

Abundant in Coal Creek, a tributary of the Clinch River in Tennessee: Var. *cornutus*, Cope, l. c. From the Neuse River.

42. Hypsilepis analostanus, Girard.

Cope, l. c., p. 161.

Found in abundance in the Catawba River, but nowhere in the tributaries of the Tennessee or Cumberland. Found in the Neuse River.

43. Hypsilepis galacturus, Cope.

Loc. cit., 160.

Most common in all the tributaries of the French Broad, Clinch and Cumberland. It does not occur east of the Alleghenies.

Hypsilepis ardens, Cope.

Loc. cit., p. 163.

Abundant in the headwaters of the south fork of the Cumberland River in Tennessee. In my examination of the Virginia streams, I did not find it in any western water, but only in the Roanoke and James Rivers.

HYBOPSIS, Agass.

Cope. Transac. Amer. Philos. Soc., 1866, 379.

Group A.

44. Hybopsis amarus, Girard.

Proceed Acad. Nat. Sci., Phila., 1856, 210. *Hybopsis phaënna*, Cope, l. c. 1864, 279.

Specimens from the Catawba River all have a relatively longer head than typical examples from the Potomac; former 4 times in length to basis caudal fin ; latter 4.5 times. They have also teeth 4.1—1.4, in place of 4.2—2.4 ; the three inferior of the outer row obtuse, without hook, the superior one only with masticatory face. Both varieties may really belong to the H. hudsonius, as indicated in Monograph Cyprinidæ Pennsylvania.

Group B.

Hybopsis longiceps, Cope.

Journal Acad. Nat. Sci., Phila., 1868, 231.

Abundant in the head waters of the Cumberland River, and Coal Creek, a branch of the Clinch River, Tennessee. Originally found in the Roanoke and James Rivers, Virginia.

45. Hybopsis spectrunculus, Cope.

Loc. Cit. 231.

From the tributaries of the French Broad in the high valley of Henderson County, North Carolina.

Group BB.

Teeth + 4. 4 + ; mouth horizontal, lower jaw received beneath upper.

46. Hybobsis niveus, Cope.

Spec. nov.

Char. Head 4.5 in length ; depth 5 times in the same ; eye 3. 3 in head, equal muzzle. Scales $\frac{6}{38\text{–}40}$: anal 1. 8. White, a black spot on dorsal fin behind.

Description. This is a regularly fusiform fish, the dorsal region more arched than the ventral. Head conic, muzzle obtuse, not projecting, mouth nearly terminal; preorbital large, longer than deep. Occipital region arched, its breadth at superior extremity of operculum equal from end muzzle to middle pupil. Muzzle about equal orbit, preorbital bone elongate ; end of maxillary extending to opposite anterior rim of orbit.

Mouth slightly oblique downward, mandible included ; isthmus medium. Fins D. I. 8, A. I. 8 ; the osseous dorsal ray separated from the first cartaliginous by a narrow membrane, and originating above the ventrals. Posterior ray 3-5 length of the anterior.

Length 31.3 lines ; of caudal 5.8 lines ; to basis dorsal 12.9 lines. From basis to apex pectorals 4.1 lines ; same to basis ventrals 13 l.

Color in life very pale, sides and below silvery ; a blackish spot at basis caudal, and a large dark spot at upper posterior part of dorsal fin.

Common in the upper waters of the Catawba River, North Carolina.

GROUP D.

Teeth 4.1—1.4 ; lateral line little decurved ; scales $\frac{(5)-6}{\frac{39:}{3}}$ muzzle short obtuse ; interorbital region wider ; depth 5; head 4 times in length. A. I. 8.
H. CHLOROCEPHALUS.

Teeth 4.2—2.4 ; lateral line much decurved ; scales $\frac{7}{\frac{34-7;}{2}}$ muzzle acuminate, interorbital space narrower ; depth 5.5, head 4 times in length. A. I. 8.
H. CHILITICUS.

47. HYBOPSIS CHLOROCEPHALUS, Cope.

Spec. nov.

This small species is rather stout and has a deep caudal peduncle. The head is broad with large orbit, descending muzzle, and descending mouth, orbit in head three times, diameter exceeding length of muzzle. End of maxillary extending beyond line of orbit ; premaxillary margin barely reaching plane of lower margin of pupil. Interorbital width much more than length of muzzle. Lateral line moderately decurved. Dorsal fin above ventrals, elevated : R. I. 8, A. I. 8.

Length (total) 27 lines ; to origin dorsal 11.9 lines ; to basis caudal 21.6 lines. Everywhere, except on belly and below orbits, thickly dusted with blackish, especially gathered into a lateral band which terminates in a basal caudal spot. Fins unspotted, in life a metallic green line on the vertebral line, and one from the upper angle of each operculum to caudal, visible in several lights ; below the latter, dark crimson ; dorsal and caudal fins, operculum and cheek with end of nose, all crimson. Part of operculum, properculum, postfrontal region and top of head metallic green.

This surpassingly beautiful fish is abundant in the clear waters which it inhabits, viz : the tributaries of the Catawba River.

This species may be compared with H. rubricroceus and H. plumbeolus as its nearest allies. The former has a relatively larger head, and more slender caudal peduncle, A. 1. 9. The latter is much shorter and deeper fish ; its depth enters the length 4.6 times ; the eyes the head only 2.75 times.

48. Hybobsis chiliticus, Cope.

Spec. nov.

This species is an ally of the last; it has a more clupeoid aspect, seen in strongly decurved lateral line and more acuminate muzzle. Head broad behind occiput, convex, interorbital width less than length of muzzle, orbit 3 times in head, exceeding length of muzzle; maxillary extending beyond its anterior rim. Teeth 4.2—2.4. Dorsal small, originating above ventrals, R. 1. 8, A. 1. 8. Line of premaxillary margin opposite middle of pupil.

Length 24.4 lines; to basis dorsal 12.4 l. to basis caudal 24.4 l. Length pectoral from base 5; from same base to do. ventrals 5.7 lines.

In life pure silver white to the dorsal line; the dorsal scales brown edged; a vermillion band through anal fin and one through dorsal; the lips vermillion all round the mouth.

This species is as beautiful as the H. chlorocephalus; if not as rich, its tints are much more transparent. Common in the tributaries of the Yadkin River, in Roane County, North Carolina.

HEMITREMIA, Cope.

Genus novum.

Char. Dentition 5—4, with marked masticatory surface. Alimentary canal short, with the usual two flexures. The lateral line one-half wanting, and generally imperfect. First (osseous) dorsal ray adherent. Premaxillary projectile.

This genus is Hybopsis with teeth 5—4, and undeveloped lateral line. perhaps it will be necessary in future to refer H. heterodon and H. bifrenatus to it.

Hemitremia vittata, Cope.

This is a stout species with very short head and obtuse muzzle. The latter is rounded horizontally from the orbits. The mouth is short and oblique; the end of the maxillary does not reach the orbit. Diameter of orbit equal muzzle, 3.5 in head; 1.33 times in interorbital width. Length head 4.2 times to base caudal; depth 4.5 in same isthmus rather wider. The first dorsal ray originates a little behind above the ventrals; scales $\begin{array}{c}6\\ \hline 38:\\ \hline 4\end{array}$ Radii D. 1. 8; A. E. 7. Length to basis caudal 24.4 lines. Do to basis dorsal 13.2 lines; length pectoral 4.2.

The specimen is alcoholic, and I do not know the colors in life. There is a conspicuous dark shade along the median lateral line, and a pale band above it; above this the whole dorsal region is of a dark color.

This species is from the tributaries of the Holston River, near Knoxville, Tennessee, and was procured by my friend, Prof. Harrison Allen, who submitted the specimen to me for examination.

PHOTOGENIS, Cope.

Proceed. Acad. Nat. Sci., 1867, 163.

49. Photogenis leucops, Cope.

Var. *aaaa*. Depth into length to basis caudal fin 6.5 to 7 times; head in same 4.5 times; scales $\begin{array}{c}6\text{–}7\\ \hline 38\\ \hline 2\end{array}$ abundant in the French Broad River.

Var. *aaaad*. Depth into length 5 times; length head into same 4 times; scales $\begin{array}{c}5\text{–}6\\ \hline 38\\ \hline 3\end{array}$ color silvery, a double row of black specks on lateral line. Very abundant in the head waters of the Catawba River. This fish, when taken from the water, always sustains a rupture of some of the branches of the ophthalmic artery by which blood is suffused beneath the cornea. The altered condition of pressure on transfer to a rare medium, is no doubt the cause.

Also from the Neuse River, near Raleigh.

50. Photogenis telescopus, Cope.

Loc. Cit. 165.

Very abundant in the French Broad River; a variety with large eye in a tributary of the Clinch.

51. Photogenis leuciodus, Cope.

Loc. Cit. 165.

Abundant in the waters of the tributaries of the French Broad River.

52. Photogenis pyrrhomelas, Cope.

Spec. nova.

This species is in most characters related to the Hypsilepides, and it combines remarkably the characters of the H. cornutus, H. analostanus, and H. diplæmia. Thus it has the head of the first, the form, with milky paired, and black spotted dorsal of the second, and the long anal of the third. As the teeth are without masticatory surface, I refer it for the present to this genus.

The extremity of the muzzle descends obliquely to the mouth, which is itself oblique, the end of the maxillary descending to a line from the anterior margin of the orbit. The mandibular and premaxillary margins are in the same vertical line when the mouth is closed. The diameter of the eye ball enters the length of the head 3.6 times, and 1.25 times in interorbital width. Length of head four times in length, depth about the same. The body is therefore rather deep and compressed. Teeth sharp, hooked, 4.1—1.4. Radii D. I. 8, A. I. 10. V. 8. The extremities of the pectorals barely reach the ventrals, and the ventrals attain the anal. Scales $\begin{array}{c}6\\ \hline 31\text{–}6\\ \hline 3\end{array}$; most of them with narrow exposed surfaces, as in typical Hypsilepis. Total length 40 l.; to orbit, 2.8 l.; to origin dorsal fin 16.5 l.; to origin caudal 32.7 l.

In coloration this is again one of the finest of our Cyprinidæ. Specimens taken in autumn were steel blue above, the scales darker edged; the belly silver. The muzzle and upper lip to the end of the maxillary, are vermillion; also, the iris above and below the orbit. The dorsal fin has a large black spot on the posterior half; the fin is anteriorly vermillion. The tail has a rather broad black posterior margin, and a wide vermillion crescent following it into the points of the fin; base of the fin pale. Anal and ventral fins with milky pigment.

Small horny tubercles appear on the upper surface of the head in spring, as in the species of Hypsilepis.

In this case I have assigned this species to its genus in accordance with its technical characters, but it is probable that it will be necessary to change the arrangement at some future time,—when the structure of these fishes is better known.

The P. pyrrhomelas is the most abundant fish in the tributaries of the upper Catawba River, North Carolina.

ALBURNELLUS, Girard.

Several species of this genus were obtained, and may be compared with others already known, as follows:

I. Ventral fins extending beyond dorsal, reaching anal.

Scales 5—36—2; dorsal much elevated. A. 8. A. ALTIPINNIS.

II. Ventrals extending to opposite last dorsal ray; not to anal.

α. Scales above lateral line 5—6.

β. Scales large, lateral line 33.

Orbit large. A. MEGALOPS.

ββ. Scales smaller, l. l. 38—40.

Scales $\frac{5}{3}$; head smaller, body stouter. A. 8, eye smaller. A. AMABILIS.

Scales $\frac{5}{2}$; head larger, body slender. A. 10, eye larger. A. JACULUS.

Scales, etc., as last; eye much larger. A. ARGE.

αα. Scales above l. l. 7.

Scales $\frac{7}{\frac{44}{3}}$; slender. A. 11. A. MATUTINUS.

ααα. Scales above l. l. 9.

Rather stout. A. UMBRATILIS.

III. Ventrals only extending to line of middle of dorsal.

Head 4.5 in length; scales $\frac{6}{\frac{39}{3}}$. A. MICROPTERYX.

53. Alburnellus altipinnis, Cope.

Spec. nov.

This species is much less elongate than such typical forms of the genus as A. jaculus, etc. The head is short, but not wide. Orbit very large, diameter exceeding muzzle, entering length of head 2.75 times, one-third greater than the interorbital width. Head 4.33 times in length to basis of caudal, depth five times in same. Anterior dorsal radii unusually prolonged for the genus, equal just half distance from the base to end of muzzle. D. I. 8. A. I. 9. The pectorals do not quite reach the base of the ventrals. Total length 26 lines; to basis of dorsal 11 lines; to basis caudal 21 lines.

Color white, a broad lateral silver band punctulated with strong black dots. A black band across operculum to orbit, and black spot on preorbital bone. Top of head to origin premaxillaries black shaded.

Two marked bony ridges connected with the system of mucous tubes, diverge from the apices of the premaxillary bones to the epiotic region on each side enclosing an urceolate interspace.

From the Yadkin River, Roane County, North Carolina.

54. Alburnellus matutinus, Cope.

A compact slender species with small scales. Orbit large, contained 3.5 times in length of head, and scarcely larger than length of muzzle, equal also interorbital width. Length of head contained 4.25 times in total less caudal fin, depth six times in same. Length of first dorsal ray just .33 distance from its base to end of muzzle. Pectorals considerably short of ventrals, ventrals short of anal. R. A. I. 11. Twenty-five rows of scales across dorsal line in front of dorsal fin.

Length 32 lines; to basis dorsal 14.4 lines; to basis caudal 26 lines.

Above olivaceous, edges of scales brown shaded; lateral band plumbeous; sides and below silvery, a dark spot at base of caudal fin. End of muzzle and chin bright rufous.

From the Neuse River, in Wake County, North Carolina. The first species of the genus found in Atlantic waters.

55. Alburnellus micropteryx, Cope.

Journal Ac. Nat. Sci., Phila., 1868, 233.

Several specimens of this species were taken in Coal Creek, a tributary of the Clinch River, Tennessee, and preserve exactly the characters by which this species was originally distinguished from A. jaculus m.

CLINOSTOMUS, Girard.

56. Clinostomus affinis, Girard.

Jour. A. Nat. Sci., Phila., 1868, 228.

Very abundant in the waters of the Catawba and Yadkin.

STILBE, Dekay.

57. Stilbe americana, Linn.

Common in still and sluggish water of the Catawba, Yadkin and Neuse Basins.

HYBOGNATHUS, Agass.

The species of this genus are few, and have a wide distribution. Those known to the writer are distinguished as follows:

I. Suborbital bones broad, short; speculum on postfrontal region large. Scales $\frac{6}{4}$; eye small, one-sixth of head, twice in muzzle; A. 8.

H. placitus.

Scales 5-39 $\frac{1}{4}$, eye 4.25 to 4.5, less than length muzzle; head wide, entering length 4.66 times; A. 8. H. NUCHALIS.

II. Suborbital bones long, slender; speculum on postfrontal region little marked.

Scales 6—38—4; head 4.75 times in length, wide; eye large 3 times in head, larger than length muzzle; A. 7.

H. OSMERINUS.*

Scales 5-6——36——3-4; head narrow 4.25 times in length; eye large, diameter exceeding muzzle, 3.3 times in head; A. 8.

H. ARGYRITIS.

58. HYBOGNATHUS ARGYRITIS, Girard.

Proc. Acad. Nat. Sci., Phila., 1856, 182. U. S. Pac. R. R. Surv., vol. X, Tab.

This species was described by Dr. Girard, from specimens obtained by the U. S. Explorations for the Pacific Railroad route, from the Milk and Arkansas Rivers. It appears to be very abundant in the Catawba River, North Carolina. Specimens from it cannot be distinguished from those from the Arkansas in the Museum of the Smithsonian Institution.

CAMPOSTOMA, Agass.

59. CAMPOSTOMA ANOMALUM, Raf.

Rutilus Raf., *Campostoma*, Agass.

From the Cumberland, Clinch and French Broad Rivers, west of the Alleghenies and the Catawba River east of them.

CATOSTOMIDÆ.

Prof. Gill proposed to distinguish this group from the Cyprinidæ as a family (in Proc. Acad. Nat. Sci., Phila., 1861, p. 8), basing the latter on the peculiar characters of the pharyngeal bones and teeth. This course has not been followed by subsequent writers, and the character assigned does not appear to me to warrant the proposed separation. I find, however, that while the premaxillary bone completes the superior arch of the mouth in the Cryprinidæ, in the Catostomidæ, those bones form but a slight portion of the same, the maxillary bones entering into it extensively on each side. This feature is evidently of importance sufficient to define the family, and I therefore adopt it as left by Prof. Gill.

*HYBOGNATHUS OSMERINUS, Cope spec. nov.

The characters of this species are expressed in the above table. It is very near the H. argyritis Gir., but has a materially shorter head and smaller anal fin. The head is relatively wider. The preorbital bone is about as long as deep. The mandible very attenuate, and with a slight symphyseal tubercle. End of maxillary not beyond line of posterior nares. Orbit large. D. I. 8, A. 1.7. (H. regius has II—9 A., according to Girard.) Total length 31.2 lines; of head 5 l.; to basis dorsal 12.5 l.; to basis caudal 12.7 l. Pectorals and ventrals very short; first articulated dorsal ray 6 lines long. A broad silver lateral band; bright olive above it, pale below it: no black spot on basis caudal. Speculum on postfrontal region small and little visible.

This species is abundant in the Raritan River, New Jersey, in early spring ascending the river with the smelt (Osmerus). Discovered by my friend, Dr. Chas. C. Abbott, of Trenton, who is investigating the ichthyology of New Jersey.

PLACOPHARYNX, Cope.

Genus novum.

Allied to *Ptychostomus*, Ag. The pharyngeal teeth much reduced in number, only seven on the proximal half of the bone, cylindric in form, with a broad truncate triturating surface. These play against a broad crescentic chitin-like shield on the posterior roof of the pharyngeal cavity. Three divisions of the vesica natatoria.

With a great superficial resemblance to *Ptychostomus*, the masticatory apparatus is different from that of any Catostomoid form known to me, and combines peculiarities observed in forms of true Cyprinidæ. The chitin-like shield is found in some of the latter; it is represented in *Catostomus*, *Ptychostomus* and *Carpiodes*, by a narrow and very thin pellicle of the same material, frequently interrupted on the middle line.

I know as yet but one species of the genus.

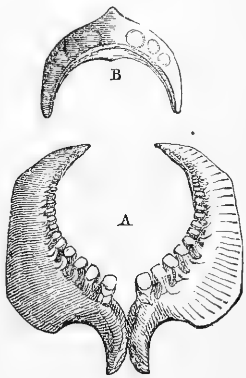
Placopharynx carinatus, Cope.

Species nova.

The physignomy and proportions of this sucker are those of the *Pt. erythrurus* or the "red horse" of the Western Rivers.

The lips are large and plicate, the anterior pendent like that of the *P. collapsus*, the posterior full like that of *Pt. cervinus*. Muzzle vertically truncate. Length of head in that of body four times; depth of body in same 3.66 times; scales 6—41—5. Radii D. XIV, V. 9. A. 7. Free margin of dorsal straight, not elevated anteriorly. Occipital region more elevated medially than in *Pt. erythrurus*, superior ridges well marked, with a special addition characteristic of this species, and of none other with which I am acquainted. This is a median longitudinal frontal ridge, extending from the fontanelle to between the nasal ridges. Only the posterior extremity of this ridge appears in some Ptychostomi. Orbit longitudinally oval, 4.5 times in length of head, twice in interorbital width. Type, fourteen inches in length.

Fig. 2.



Color in alcohol like that of other species, uniform straw or whitish silvery.

The pharyngeal bones of this species are much stouter than those of other species of its own and greater size, *e.g*., *Pt. aureolus* of eighteen inches, where they are comparatively slight. The exteroposterior ala is twice as wide as the body inside the teeth is deep, and but for its short base and narrowed tip would do for that of a Semotilus. But while there are seven broad teeth without heel or cusp on the basal half, there are at least forty on the distal half, they becoming more compressed and finally like those of other allied genera. There are fourteen with truncate extremities. The pharyngeal plate has narrow horns directed upwards and forwards, and is thickened medially. It is placed immediately in advance of the opening of the oesophagus. I have but one specimen of this curious species, which I obtained at Lafayette, on the Wabash River, in Indiana.

CATOSTOMUS, Lesueur.

60. CATOSTOMUS TERES, Mitchill.

Cyprinus teres, Mitch. *Catostomus teres, C. communis* and *C. bostoniensis*, Les.

Common in all the rivers of the State and on both sides of the Allegheny water-shed.

61. CATOSTOMUS NIGRICANS, Les.

C. planiceps, Cuv. Val.

Common in the Clinch, Cumberland and French Broad Rivers.

An especially western species, and abundant, where it occurs.

62. MOXOSTOMA, Rafinesque.

MOXOSTOMA OBLONGUM, Mitch.

Catostomus tuberculatus and *vittatus*, Lesueur. *Labeo oblongus*, Dekay.

In North Carolina, as in Pennsylvania, this species is confined to the sea-board streams. I only found it in the Neuse.

PTYCHOSTOMUS, Agass.

Amer. Journ. Sci., Arts XIX. 88. *Teretulus*, Raf. Cope emend. Journ. Acad. Nat. Sci., Phila., 1868, 235.

The species of this genus are found in the United States, South of New York and East of the Rocky Mountains, including the waters of the great lakes. They are especially numerous in the rivers of North Carolina, which flow into the Atlantic, and constitute one of the peculiarities of that shed of the Allegheny range, as distinguished from the streams of the western slope in Tennessee, where a smaller number of species is found. Wherever Ptychostomi occur they are abundant in individuals.

The development of the lips furnishes important diagnostic indications in this genus. In those most nearly allied to Moxostoma, the inferior lip resembles that of that genus, in being narrower, and deeply incised, emarginate posteriorly forming a figure V with the apex forwards; at the same time the superior lip is very thin, and often narrow. Such species are shorter, and tend to a large development of dorsal fin. Others of this type are more elongate. The more typical forms have a large inferior lip, which is generally produced posteriorly to a square transverse margin. Most of these are more elongate species than the last group. Some species of both are distinguished by their very prominent conic muzzle, and minute inferior mouth, reminding one of the Carpiodes. In one species the surface of the lips is pappillose instead of plicate. In some species the mouth is very projectile, in others scarcely so at all.

Rafinesque proposed a genus *Teretulus* on the characteristic peculiarity of nine ventral radii, belonging to most of the species of this genus. He, however, included species of two other genera. On this account Agassiz, in rearranging the suckers, imposed on it the name standing at the head of this article, regarding the plicate lips as a primary character. I think Rafinesque's name is to be rejected, owing to its ill application ; the more as I find two species in which there are ten ventral radii. I adopt that of Agassiz, though I showed, when describing the Pt. cervinus, that the tricellular natatory bladder is a more distinctive feature. This becomes the more obvious now that I have found a species where the lips are turbercular instead of plicate.

The following scheme will render the identification of the species more simple.

A. Lips pappillose, inferior Λ shaped.

Head elongate, muzzle truncate. P. PAPPILLOSUS.

AA. Lips plicate.

a. Inferior lips infolded, Λ shaped.

β. Oblong species ; head one-fourth the length.

Eye large ; D. XVI ; form compressed. P. VELATUS.

Eye smaller ; D. XV ; compressed. P. COLLAPSUS.

Eye smaller ; D. XII ; subcylindric. P. PIDIENSIS.

ββ. Fusiform species ; head one-fifth the length.

Muzzle conic ; mouth minute inferior. P. COREGONUS.

aa. Inferior lips narrow, crescentic.

Head one-fifth length, muzzle sub-conic. P. ALBUS.

Head long, truncate, $\frac{1}{4}$; fins white. P. THALASSINUS.

aaa. Inferior lips well developed, truncate posteriorly.

β. Compressed species.

γ. Head 4, 4.5 in length.

δ. Dorsal radii XII.

Stout, elevated ; muzzle short, fins crimson. P. ROBUSTUS.

δδ. Dorsal radii XIII.

ε. Ventral radii IX.

Head longer, occipital region flat, muzzle truncate, eye smaller 4.5 ; scales 5—42—4 ; scales white. P. ERYTHRURUS.

Head shorter ; occipital region convex ; muzzle projecting, mouth inferior, eye larger 3.5 in head ; scales black at base. P. MACROLEPIDOTUS.

Head elongate, convex with ridges above occiput ; eye 4.5 in head ; muzzle prominent, mouth inferior ; scales white. P. LACHRYMALIS.

εε. Ventral radii X.

Head 4 times ; muzzle conic. P. DUQUESNEI.

δδδ. Dorsal radii (XVII) XVIII.

"Eye small ; depth 3.25, head 4.3 times in length." P. CARPIO.

$\gamma\gamma$. Head five times in length ; occipital region strongly convex.

δ. Ventral radii IX.

D. XIII. muzzle little prominent, dorsal truncate. P. AUREOLUS.

D. XII. Muzzle projecting ; lips large. P. CRASSILABRIS.

$\delta\delta$. Ventral radii X.

D. XIII. Muzzle projecting, mouth inferior. D. free border deeply incised. P. BREVICEPS.

$\delta\delta\delta$. Ventral radii unknown.

D. XIV. Muzzle produced convex, mouth very small, back elevated. P. CONUS.

$\beta\beta$. Cylindric species.

D.XI, XII. Head one-fifth length ; sides lined. P. CERVINUS.

63. PTYCHOSTOMUS PAPPILLOSUS, Cope.

Species nova.

Body deeper than thick, the dorsal outline not at all elevated. Head elongate not more than one-fourth the length to base of caudal, the orbit small and bordering the frontal plane. Preorbital region most elongate in the genus ; muzzle truncate in profile ; the upper lip hanging free, the lower deeply incised behind so as to be Λ shaped, and with the upper, finely granular, not plicate. The muzzle very projectile, more so than in any species of the genus. The top of the cranium is everywhere plane. Dorsal fin truncate, with XII radii. Scales large, about as in P. COLLAPSUS, Cope, i. e. 6—42—5.

Color everywhere a silvery white, except some blackish shades at the bases of the scales of the dorsal region. The fins, unlike those in most other species, are pure white in life. They obtain one foot in length, and do not exceed one pound in weight.

This species is quite abundant in the Catawba and Yadkin Rivers, in North Carolina, and is highly valued by the inhabitants as an article of food. It is regarded as the best of the Catostomi for this purpose. It is less frequently caught on a hook than some other species, but in the autumn they come on the weirs in considerable numbers; from these I procured many specimens. The fishermen call it the "Shiner." Its characters are very constant, and not likely to be confounded with those of any of the known Ptychostomi.

Ptychostomus velatus, Cope.

Species nova.

This is a stout species, with a short head, large eye, and more than usually elongate dorsal fin. Scales 5-6——42——5 ; head scarcely 4 times in length ; superior plane nearly flat ; orbit 3.75 times in length of head ; 1.5 times in interorbital width. D. XVI. with straight superior margin ; V. IX. Upper lip pendent. Dorsal outline arched to the first dorsal ray greatest depth 3.2 lines in length (exclus. caudal). Total length 11 inches.

The color of this species I cannot give, as I have not seen it in life ; in spirits it is uniform silvery, the dorsal fin dusky.

I know this fish from two specimens which I caught in the Youghiogheny River, in Western Pennsylvania.

64. Ptychostomus collapsus, Cope.

Species nova.

This very abundant fish is in the form of its lips similar to the last. It is stout and short, the head not entering the length (exclus. caudal) quite four times. The dorsal line is somewhat elevated to the first ray of the dorsal fin, the depth entering the length 3.5 times. The eye is smaller than in the *P. velatus*, entering the length of the head 4.75 and 5 times, and the interorbital width 1.75 times. Top of head plane ; muzzle moderately prominent, intermediate between P. erythrurus and Pt. conus in this respect, being more compressed than in the last. Mouth small, little projectile, superior lip pendent. D 15, V. 9. Thoracic region with small scales.

The specimens of this species from most of the North Carolina Rivers are rosy on the sides, the larger, light golden ; the inferior fins all orange. The specimens from which the above description is taken are small, only a foot long, but I have seen several specimens in the Catawba River, of three and four pounds in weight.

It occurs in the Neuse, Yadkin and Catawba Rivers, in North Carolina, the Clinch River in Tennessee, and I have a specimen from the Wabash River, in Indiana, and three others without locality, but probably from the Western States or Great Lakes. In the Yadkin and Catawba Rivers it is immensely numerous, and is caught on weir traps in the spring and autumn in quantities, and used as food by the inhabitants. It is not as good a fish as the *P. pappillosus* and *P. robustus*, but is not at all to be rejected.

There seemed to be a larger number of smaller specimens in the Yadkin than the Catawba Rivers at the time of my visit. The specimens from the Neuse have the muzzle a little more prominent. Some specimens from the Yadkin possess only XIII and XIV D. rays.

65. Ptychostomus pidiensis, Cope.

Species nova.

A smaller species than either of the preceding, of more cylindric and less compressed form. The dorsal fin is shorter, containing only XII rays. Head elongate, about four and a half times in length exclusive of caudal fin. Muzzle not conic, but truncate. Scales similar to those of the last species. Length about ten inches.

Color light brownish yellow, fins light red.

This fish resembles at first, the *Pt. cervinus*, both in color, form and size. I obtained a few specimens from the traps in the Yadkin River, at the plantation of John Kuntz, and did not see it in any other river.

I took a variety in a tributary stream, characterized by a longitudinal black spot at the base of each scale, giving a handsome longitudinal striation. (A similar variety of *Hypsilepis analostanus* (q.v.) was taken in the same stream.) Scales 6—44—5. V. IX. A. VII. Head flat above; eye 4 times in head, 1.5 times in interorbital breadth. Dorsal and caudal fins black edged.

66. Ptychostomus coregonus, Cope.

Species nova.

This fish is very easily distinguished by its very small head, with conic muzzle, and elevated arched back, combined with a small size, and other characters.

The head enters the length not less than five times, and is much arched in transverse section posteriorly above. The diameter of the eye is large, entering the head between three and four times; the muzzle is regularly conic, and projects far beyond the mouth. The latter is remarkable for its small size, and lack of projectility; in ordinary individuals it would about admit a pea. The upper lip is not pendent below the front of the muzzle. The shape is broadly fusiform, the dorsal line rising to the fin. It is, nevertheless, more compressed than the species already described. D. XIV constantly.

The ground color is silvery, the scales shaded with leaden above, and with black pigment at their bases, giving a dusky hue to the whole, as is not seen in the species already described, except the *P. pappillosus.* Belly and inferior fins pure white, lacking the red and orange of many others.

This fish never exceeds a foot in length, and is very abundant in the Catawba and Yadkin Rivers. It is caught with the preceding two species and is used for food, but is the least valued of all the species. It is called at Morganton, "blue mullet."

67. Ptychostomus albus, Cope.

Spec. nov.

This large species has the small head of the last, without the small mouth and many of its other peculiarities. The head enters the length not less than five times; muzzle is prominent, but the mouth is less inferior than in Pt. coregonus. The eye, in a specimen sixteen inches long, is relatively larger than in *P. collapsus,* and about as in *Pt. coregonus.* The muzzle is less prominent than in the last named fish, but more so than in *Pt. collapsus.* The mouth is of ordinary size, but the upper lip does not form a free projecting rim as in the latter. The under lip is a narrow crescent following the boundary of the mandible, not folding so as to meet on the middle line as in the species already described.

Dorsal outline a little elevated, rays XIV.

Colors very light; the inferior fins white. In size this species is one of the largest, reaching four pounds and over. It is much valued by the people living in the neighborhood of the Catawba River, North Carolina, as an article of food. They call it the "White Mullet." I have not seen it in the Yadkin or any other river.

68. Ptychostomus thalassinus, Cope.

Species nova.

This fish approaches the *Pt. collapsus,* Cope, in many respects. The head is elongate, about one-fourth the length (exclusive of caudal fin), and is plane above. The muzzle is not very prominent, nor the mouth smaller than usual in the genus. The lower lip is quite different from that of *Pt. collapsus* in its narrow crescentic form. The eye is similar in size to that of that species. The dorsal line is elevated; dorsal radii XIV—XV. Color sea green above, white below; fins white. Reaches four or five pounds, and still greater weight.

It may be that this fish is a form of the *P. collapsus*, but the different mouth and coloration seem to separate it. Its whole proportions differ from those of *P. albus*. I have only observed it in the Yadkin River, where it is abundant, and used for food.

69. Ptychostomus robustus, Cope.

Species nova.

With this species we commence the most numerously represented section of the genus, in which the inferior lip is large and full, entirely covering the space between the rami of the mandible, and having a transverse or convex posterior margin. In this it resembles the true Catostomi, and diverges from the type of Carpiodes, etc.

In *P. robustus*, we have a species, stout in all its proportions, and with marked coloration; with the gibbous or elevated dorsal outline of *P. coregonus*, it combines the short body of the *Pt. collapsus*. The head is short and deep, the muzzle not prominent, truncate in profile. Eye between four or five times in length of head. Dorsal fin short with straight superior margin, radii XII. Scales as in *P. collapsus*.

Color smoky or clouded above, mingled with golden reflections; sides similar, below yellowish. Dorsal, caudal and anal fins dark crimson. Size large. I examined one of six pounds weight.

This species is distinguished by its form and color, from all the others inhabiting the Yadkin. I did not see it in any other river area. It is highly valued for the table by the people living near the river. With the *P. thalassinus* and *T. erythrurus* var, it is taken in spring-nets. These nets are attached by four corners and suspended to the extremity of a lever whose fulcrum, as high as a man's head, is on the river bank. Bait is thrown on it, and when the fishes congregate, the land end of the lever being suddenly depressed, the suckers do not escape. If fishing were confined to this mode, and the autumn weirs not made too tight, an abundant supply of food from the rivers might be promised the State of North Carolina for future time. But unfortunately, too many of the people with the improvidence characteristic of ignorance, erect traps, for the purpose of taking the fishes as they ascend the rivers in the spring to deposit their spawn. Cart loads have thus often been caught at once, so that the supply is at the present time reduced one half in many of the principal rivers of the State. The repopulation of a river is a very different matter from its preservation, and involves much time, attention and expense. It would be far cheaper for the State of North Carolina to enact laws preservative of this important product of her waters, similar to those in force in many of our older States. The *execution* of such laws is, however, the important point, and the destruction by officers, of the spring traps and weirs in the Neuse, Cape Fear, Yadkin and Catawba Rivers, every spring, at the time of running of the fishes, would allow of the escape of immense numbers of them, before the traps could be repaired.

70. Ptychostomus erythurus, Raf.

Ichthyologia Ohiensis, p. 59. *Ptychostomus duquesnei*, Agass part. Am. Journ. Sci. Arts., XIX 90. Cope Journ. Ac. Nat. Sci., Phila., 1868, 236.

This species is probably the most widely distributed, as well as one of the largest of the genus.

The form is somewhat compressed, but the dorsal line is not much arched; the head is of medium size, entering the length 4.5 to 4.66 times. The end of the muzzle is nearly vertical in profile. The lips are full, the posterior truncate or openly emarginate posteriorly; the plicate coarse. Eye 4.5 times in length; 1.66 lines in interorbital width. Depth of body three and two-thirds times in length (exclus. caudal.) Top of head nearly plane. Scales 5——42——4. Radii D. XIII, V. 9., dorsal with straight superior outline. Color silvery, rosy and gray above; dorsal caudal and anal fins orange.

The above description is taken from one of several specimens from the Yonghiogheny River, in Western Pennsylvania. I have procured other and similar individuals from the Holston and French Broad Rivers, in Tennessee. It is, as Rafinesque observes, a most abundant sucker in all the rivers tributary to the Mississippi from the East, and is that which is known every where as "red horse." It is the common fish-food of the people, sharing the distinction with the "blue cat," *Ichthaelurus coerulescens*. It reaches as large a size as any species of the genus, and I have seen them of six and eight pounds. The largest I have heard of, was caught in the French Broad, and weighed twelve.

With various authors, I have formerly regarded it as the *Pt. duquesnei* of Leseuer, but I suspect it to be distinct, as already indicated by Rafinesque. The characters of the latter are pointed out below.

A species resembling the present, as well as the *Pt. robustus*, bears the name of "red-horse," in the country of North Carolina, east of the mountains, but whether the same or not, the present inaccessibility of my specimens prevents me from deciding. A specimen from the Catawba of seven lb. weight had a relatively larger head, and was otherwise stouter than the above described. D. 1.12; scales 6—43—5. The fish is common in that river, and equally so in the Yadkin. Those from the latter have D. XII; muzzle not prominent; head and body rather elongate; shaded with yellow, particularly on sides of head; fins orange. It will be observed that the eastern fish agree in having D. 12 soft rays.

71. Ptychostomus lachyrmalis, Cope.

Spec. nov.

This species is quite near the last, and may at some future day be shown to be only a local variety of it, but in this case *Pt. macrolepidotus* must follow also. Its characters are very similar; our specimen differs in its more numerous scale series, a point in which the *Pt. erythrurus* agrees with all the other species with scarce an exception. I do not know of any genus where the number of scales is so similar in all the species, as in *Ptychostomus*. Scales 7—46—5, in a larger specimen, in a smaller they are 6—44—5. The cranium, however, presents us with the oblique super-opercular region and elevated vertex with a ridge on each side, as in the *Pt. macrolepidotus*. The premaxillary spines and nasal cartilage also projects, leaving quite a depression across the muzzle in front of the nares, a feature not seen in *Pt. erythrurus*, and less marked in *Pt. macrolepidotus*. The mouth is quite inferior, but is large and the lips large and thick. The inferior has a slightly concave posterior margin, and the median posterior fissure is stronger than the others. The orbit is smaller than in *Pt. macrolepidotus*, and enters the interorbital space twice. Depth 3.75 times in length. The dorsal outline is gently arched, and reaches its highest point a little in advance of the dorsal fin. The latter has the superior outline but little concave, rays XII in the larger, XIII in the smaller; V. 9.

The scales of this species are as in *Pt. erythrurus*, not black at base; a trace is seen in the smaller specimen. This mark is seen in *Pt. marcrolepidotus* and *Pt. crassilabris*, the latter also from the Neuse river. The fins are white.

This species reaches a length of eighteen inches. One like it is sold in the market of the city of Newbern, N. C., with a second species much resembling the *Pt. crassilabris*, but whether identical or not, I cannot be sure, as my specimens were lost.

Ptychostomus macrolepidotus. Lesueur.

Agassiz in Sillim. Amer. Journ. Sci., Arts XIX. 89. *Catostomus macrolepidotus*, Les. Journ. Acad. Natl. Sciences I, 1817, 94 Tab.

Fusiform compressed, the depth entering the length $3\frac{5}{8}$ times; the head short, contracted anteriorly, the occipital region elevated, very convex transversely. Length of head 4.6 to 4.5 times in length; orbit large, diameter 4 to 4 3 times in length of head, and twice in interorbital width. Scales 5—45—5, radii D. XIII; V. 9. The lips are well developed, and the posterior is transverse posteriorly.

The length of the specimen described is about a foot. The color in life including fins, is white, yellow shaded above.

Ten specimens have been compared, all from Pennsylvania and Delaware. Of five from the Conestoga Creek, a tributary of the Susquehanna, two have the parietal, median frontal, and nasal bony ridges very prominent, while in two they are almost without trace. In the former the dorsal radii are XIII, in the latter XII. I cannot discover the sexes of these specimens as they have been eviscerated. In the other five there are several with weak crests, but none with XII D. rays.

In a large specimen from the Wabash River, the only departure from the typical form is the more emarginate inferior lip.

This species is especially abundant in the comparatively sluggish streams of Maryland and Delaware, and is but little valued for market. It is no doubt the species described first by Lesueur, as it is the only one of the genus seen in the Philadelphia market. I did not meet with it in North Carolina.

Ptychostomus duquesnei, Lesueur.

A specimen of this fish from near Pittsburg, Lesueur's original locality suggests the correctness of the opinion of Rafinesque, that his *Pt. erythrurus* is a different species. The characters are seen in the 10 ventral radii, and the considerably more prominent muzzle, with correspondingly inferior mouth. The scales are also smaller 7—48—7, (to front of ventral). Dorsal fin little incised above, R. XIII. Length of head 4.6 in that of head and body; orbit four times in head 1.75 times in interorbital space. Cranial crests moderate, the parietal region elevated as in *Pt. macrolepidotus*, not so plane as in *Pt. erythrurus*. Depth $3\frac{2}{3}$ in length. Lips moderately developed. Dentition as in *Pt. erythrurus*. The coloration in spirits is quite like that of other species, except that the dorsal region is a dark steel bluish, which the other species do not exhibit. Scales without black spot at base.

Length of a moderate specimen from the Youghiogheny River, Pennsylvania, one foot.

Kirtland's description in Proc. Boston Sci. Nat. Hist. V 268, leaves it somewhat uncertain as to whether this species or the *Pt. erythrurus* was before him; his figures resembles the present fish. I should not be surprised to find that his female "red-horse" described as so different from the male, was our *Pt. collapsus*.

Ptychostomus carpio, C. V.

This species differs from its near allies in the more numerous dorsal radii, etc. The form appears to be that of *Pt. erythrurus*. Its habitat is given by the French authors, as Lake Superior, and Günther adds St. Lawrence River and Lake Erie. I have not seen it. The lip characters separate it from *Pt. velatus*.

Ptychostomus oneida. Dekay.

Geological survey, New York, III, 189.

This species is also similar in general proportions to the *Pt. erythrurus*, but has, according to Dekay, more numerous scales and a much smaller eye. Dekay says: seventeen longitudinal rows of scales counted at dorsal fin. Head and body 10 in.; tail 2.; head 2.5 (one-fourth); eye., 4 inch (one-sixth head). Radi D. XIII; V. 9. He does not describe the lips.

Oneida Lake.

Ptychostomus aureolus. Les.

Agass. l. c. 89. *Catostomus aureolus*. Lesueur J. A. N. Sci. Phila. I, 95 Tab.

With this species we enter a series characterized by the relatively small size the head bears to the body, and consequent apparent elevation of the latter. The head enters the length exclusive of the caudal fin, five times.

This species resembles the *Pt. macrolepidotus* Les., more than it does the *Pt. erythrurus*, but the proportionate size of the head is less. In a specimen 8 inches long, the scales are 6—49—4; radii D. XIII, V. IX. The supraoccipital region is much elevated and convex, the interorbital region convex, but without keel. The muzzle is prominent, and separated on the upper surface by a deep transverse depression. The mouth is but little overpassed by the muzzle, and is large. The lips are rather narrow. Eyes five times in length, 2.5 times in interorbital breadth of head.

I do not recollect the colors of this sucker in life; Lesueur states the fish to be orange above, bases of scales darker; inferior fins red.

A single specimen from Saginaw Bay, Lake Huron, has furnished me with means of comparison. It agrees exactly with Lesueur's account of it. The basis of the scales of some dorsal series are blackish. The species is supposed to be confined to the Great Lakes.

Ptychostomus sueurii. Rich.

Catostomus sueurii, Richardson Fr. Journ. 1823, 772. Fauna Boreali Americana III, 118.

This species appears to me to be very near the last, and agrees with it in proportions of head to body, of depth, fin radii, squamation, etc. He says, however, that the muzzle projects an inch beyond the mouth, in a specimen nineteen inches long, which is certainly not the case in the species last described. Hence I suspect it to be distinct, and that it will be found to possess other characters when re-examined. Gunther, (Catal. Brit. Mus.) refers it to the *C. macrolepidotus,* to which it is evidently nearly allied.

From the Fur countries, British North America.

72. Ptychostomus crassilabris, Cope.

Species nova.

This sucker is near the *Pt. aureolus,* but has a more contracted conic muzzle, and smaller mouth; it is also a flatter and more clupeiform fish. Supra-occipital region elevated, convex; orbit 4.2 in length of head, 2 times in interorbital width. Depth 3.75 times in length. Scales large, 5—44—5. D. XII; V. 9. Length of specimen described, one foot.

Color in life silver, above with a smoky shading, and the scales black at the bases. Dorsal fin blackish, inferior fins white. Top of head blackish; a black band from occiput to pectoral fin.

The lips of this species are thick, the lower truncate, but the mouth is very small. In these features it is between *P. conus* and *P. aureolus.* The dorsal fin in the specimen described is elevated in front, the basis being only .75 the first soft ray, in length. The margin is deeply concave. The fewer dorsal radii, as well as the less prominent muzzle, distinguish it from *Pt. conus.*

From the Neuse River, near Raleigh, N. Ca.

Ptychostomus breviceps, Cope.

Species nova.

An elongate species with small head, and very convex occipital region, characterized by the presence of X ventral radii.

Depth .25 the length; orbit 3.75 in head, 1.75 in interorbital width. Cranial ridges not strong. Basis of dorsal five-sixths the anterior height, radii XIII; free margin deeply concave. Body compressed, dorsal line very narrow. Scales 6—45—5. Muzzle short conic, projecting beyond mouth. Latter small, lips short, the posterior well developed, not emarginate.

Color white, yellowish below; scales above with a little black at their bases.

Length of specimen examined, ten inches.

This fish belongs to the basin of the Ohio. I have a specimen from the Yonghiogheny. The number of the ventral radii is very constant in this genus, but if the increased number should prove to be accidental, the general characters of this fish would approximate it to Pt. aureolus.

A peculiarity of the type specimen consists in an additional ray in the anal fin—eight instead of seven in the other species, and the alteration of the third and fifth to perfectly simple, unbranched rays, scarcely attaining the edge of the fin. This may be abnormal.

73. Ptychostomus conus, Cope.

Species nova.

This fish represents the *P. coregonus* in the section of the genus with fully developed lips.

Form flat, with elevated dorsal line, and small conic head. D. radii always XIV. Eye large, mouth exceedingly small, far overpassed by the conic muzzle. The superior regions are smoky and the scales with black bases; below, with the inferior fins, white. Dorsal fin dusky.

The lips of this species are smaller than in *Pt. crassilabris*, though the inferior is similarly truncate behind. The muzzle is much more conic and produced than in that fish. The dorsal radii are more numerous.

Numerous specimens from the Yadkin River, North Carolina, where it is taken in large numbers with *Pt. collapsus*, *Pt. robustus*, etc., but is of less value than they.

74. Ptychostomus cervinus, Cope.

Journ. Acad. Nat. Sci., Phila. 1868, 235, Tab. iii, fig. 4.

This species constitutes a well marked section of the genus, characterized by a cylindric form, the transverse diameter of the body being equal to the vertical. Before describing this species in detail, I may premise that I have found no little difficulty in attempting to identify the *Pt. melanops*, Raf., of Dr. Kirtland's fishes of the Ohio. The figure resembles the *Pt. crassilabris* very closely, but the description of "body full, cylindric," will not allow of the identification. Should the fin formula of *Pt. breviceps* be abnormal, the compressed body and lack of spots point to specific diversity. I had thought the present species intended, but the figure given by Kirtland precludes the idea, for the *P. cervinus* is in form much like the *Catostomus nigricans*, and has a much less elevated dorsal region than the *Pt. melanops*. It differs also in the form of the dorsal fin, which in that species displays XI XII D. radii instead of XIII. For the present, therefore, I introduce the *Pt. melanops* by name only.

Head of *Pt. cervinus* one-fifth the length, as broad as deep, plane above. Muzzle truncate, low in profile, lips large, the superior pendent. The inferior lip thick, more produced than in any other species, and with a median longitudinal fissure, the plicæ are more or less broken up. Body sub-cylindric, scales large. Dorsal short, radii XII, margin straight. Above yellowish brown, below yellow; fins not red. The dark of the upper surfaces often forming broad transverse shades. After death the colors above become a dark emerald green. This fish never exceeds a foot in length, and rarely attains that size. It exists in great numbers in the Catawba River, but I did not meet with it in the Yadkin or elsewhere. It has a peculiar habit of leaping from the water, whence the fishermen call it "jumping mullet." It is but little valued as food, though many specimens are caught on the weirs.

Also from the Roanoke River in North Carolina and Virginia, and the James in Virginia.

Günther again confounds this species, so well known to the fishermen of the Southern rivers, with the Pt. duquesnei.

CARPIODES, Rafinesque.

Agassiz, Am. J. Sci. Arts, XIV, 74, 1865.

The species of this genus are extensively distributed in the fresh waters of North America, east of the Rocky Mountains. I am not acquainted with any from the Atlantic streams to the eastward of the Delaware, though they may exist, while they are found in the Great Lakes and the tributaries of the St. Lawrence. Agassiz defined this genus as above, and indicated four species, one described by Lesueur, one by Rafinesque, and two by himself. I have not seen specimens from the Eastern waters of North Carolina, though they no doubt exist, while they are also abundant in the French Broad and other tributaries of the Tennessee. My specimens of those from the latter being lost, I give an account of other species known to me. I add five to the four already known.

I. Anterior rays of the dorsal fin very much elevated and attenuated, exceeding or equalling the length of its basis.

a The muzzle very abruptly obtuse.

Anterior suborbital much deeper than long; anterior margin upper lip below orbit. C. DIFFORMIS.

Anterior suborbital similar; upper lip before nares; eye 4.6 times in head. C. CUTISANSERINUS.

Anterior suborbital sub-triangular, longer than deep; upper lips before nares; eye 3.6 times in head. C. SELENE.

aa The muzzle conic, projecting.

Size medium, back elevated. C. VELIFER.

II. Anterior rays shorter, measuring the anterior half or a little more of the base of the dorsal; (muzzle conic or projecting).

D. XXIV. A. VII. Depth $2\frac{5}{6}$ in length; head 4.3 in same; back much elevated, anterior dorsal rays measure to the 15th ray.

C. GRAYI.

D. XXVIII, V. X. A. VII. Depth 2.5 in length; head 4.25 in smae; scales 8–5; short, stout; long dorsal rays measure to 22 ray.

C. THOMPSONI.

D. XXVI–VII, V. X. Depth 3 times in length, head 3.5 times; muzzle elongate conic; eye median, large; anterior D. rays not thickened, nearly as long as base of fin. C. BISON.

D. XXVII to XXX; A VIII; scales 6–5; oblong, long dorsals to 22 ray in adults; depth 2.7 in length, eye small anterior. C. CYPRINUS.

D. XXX A. VII; anterior dorsal rays thickened, osseous, short, reaching 16th ray; head small, 4.5 to 5 times in length; eye small anterior; fusiform, depth 3 times in length. C. NUMMIFER.

In the number of the radii of the ventral and anal fins, the species are not always entirely constant; thus in one, *C. bison* there are VI, in another VII anals. In *C. cyprinus* some have IX and others X ventrals. In young examples of the species just named, the long anterior dorsal rays are longer than in the adult, but not so much so as to be confounded with the long rayed species of section one. The margins of the scales in this genus and Bubalichthys are serrate, their structure thicker than in the Ptychostomi.

Gill has adopted the genera of the Catostomi as left by Agassiz, while Günther rejects most of them. Moxostoma, Ptychostomus and Catostomus I regard as distinct genera of the typical form, to which I add Placopharynx. Of those with finer and more numerous pharyngeal teeth, Cycleptus is distinct in its completely ossified cranium, as I have pointed out in an essay on the Cyprinidæ of Pennsylvania. Bubalichthys is well characterized by the form of its pharyngeal bones, as shown by Agassiz. The remaining Rafinesquian genera, Carpiodes and Ichthiobus are but doubtfully distinct from one another. Carpiodes is the older name, with which *Sclerognathus*, Cuv., Val., may be associated as a synonyme.

Carpiodes difformis, Cope.

Spec. nov.

This species has a remarkably obtuse muzzle, which with the large eye, almost gives it the appearance presented by monstrous perch and carp where the premaxillary bones are atrophied. Viewing the top of the head from a position opposite a point mid-way between the dorsal fin and end of the muzzle, the spine of the premaxillary bone is not visible. In the *C. selene* these spines are very distinctly prominent, in the *C. cutisanserinus* slightly so.

The dorsal outline of this fish is arched, elevated to the anterior dorsal radii, and then regularly descending. The long dorsal rays extended, reach to beyond the origin of the caudal. Lateral line nearly straight, scales 6——35——4. The end of the pectoral is in line with the origin of the first dorsal ray. Radii, D. XXIV, A. VIII, V. IX.

The head is very obtuse and has a very large eye, beyond whose anterior rim the extremity of the nasals project but a little way. The spines of the premaxillaries project upwards and forwards, but not so far as the line of the nasals, and fail by .25 inch of reaching the line of the inferior rim of the orbits. The anterior edge of the mandible is in line with the anterior rim of the orbit, and the end of the thin upper lip reaches the line of the anterior rim of the pupil.

The diameter of the eye enters the length of the head 3.6 times, and the length of the head the total (exclus. caudal) 4.22 times. Opercle radiate-ridged. Supraoccipital region much elevated, with lateral ridges. Anterior suborbital trapezoid, deeper than long. The size of this species is medium; average length, one foot. The color is uniform brownish golden.

From the Wabash River in Indiana.

Carpiodes cutisanserinus, Cope.

Species nova.

This species is near the last, but present various distinctive features. These may be summed up as follows:

The dorsal fin originates mid-way between end of muzzle and basis of caudal fin—considerably nearer end of muzzle in *C. difformis*. The eye is smaller, 4.5 times in length of head. The spines of the premaxillaries project considerably in advance of the line of the nasal bones, and reach the line of the lower rim of the orbit. The upper lip is much in advance of the orbit, and the end of the same barely reaches the line of the anterior rim of the latter. Scales 7—37—5. Anterior suborbital bone vertical ovate.

The lips are minutely tuberculate. Operculum and suboperculum rugose, former radiate. Long rays of dorsal and anal extending a little beyond the basis of the caudal fin. Head four times in length head and body. Depth 2.6 in the same, Length, a foot; color silvery. In a male in spring, the muzzle and front are covered with closely set small papillose corneous excrescences. Radii D.XXVI, V. X, A. VIII.

From the Kiskiminitas River, Western Pennsylvania.

Carpiodes selene, Cope.

Species nova.

Anterior dorsal outline steeply elevated, also the supraoccipital region, vortex convex above middle of orbit, concave above anterior rim of same, as in the two preceding species. The present fish is intermediate in many ways between the two last, and adds characters of its own. Thus the anterior suborbital bone is longer than in either, longer than high, and narrowed posteriorly. The orbit is large as in *C. difformis*, entering the length of the head 3.6 times, while the muzzle is more elongate than in either. The head is narrowed vertically ; the spines of the premaxillaries extend beyond the nasal crests, but do not quite reach the plane of the lower limbs of the orbit. The premaxillary border is far in advance of the orbit, and the extremity of the maxillary attains the anterior rim of the orbit. Dorsal and caudal radii extended, reach the basis of the caudal; the origin of the first is equidistant between the latter point and the end of the muzzle. Rays; D. XXVI; V. 10. A. VIII. Scales 7—37—5. Color silvery white. Length, a foot. Three specimens of this were taken in the Root River, Michigan, in all probability, though the label which accompanied them has disappeared.

Carpiodes velifer, Rafinesque.

Catostomus, Sp.? Lesueur Journ. Acad. Nat. Sci. Phila. I 110. *C. velifer* Raf. Ichth. Chiensis 56 *Sclerognathus cyprimus* "Val." Kirtland Fishes of the Ohio. Proc. Bos. N. H. S o c. V. 275 Tab. XXII fig. 2 not of Valenciennes.

I have referred my specimens to this species chiefly on the strength of the figure and description of Prof. Kirtland, and from the fact that Lesueur regarded it as so near the *C. cyprinus*, which he would not have done with the *C. cutisanserinus* of the Ohio before him. I had two specimens of the present fish, one of them from the Wabash.

It has a shorter dorsal fin than the preceding, having but XXII rays, of which the anterior two are exceedingly elongate. The prominence of the muzzle is the most distinctive feature; it is conic, the spines of the premaxillaries projecting at an angel of 45° to beyond the nasal crests, and the extremity not reaching the line of the lower rim of the orbit. The extremity of the mandible extends to the nares. Eye 4.25 in length of head. Head 3.75 in length; depth 2.4 in the same. Scales as in the last species. Second suborbital long as deep, trapezoidal. Origin of dorsal .2 nearer end of muzzle than basis of caudal. Length of type specimen ten inches.

Rafinesque says that this species is called skip-jack, from its habit of throwing itself from the water, and sailor, from its elevated dorsal fin which appears above the surface of the water. The first mentioned name is also applied to a clupeoid of the same streams, the *Pomolobus chrysochloris*. Raf. Kirtland says the present species is not much valued as food.

Carpiodes grayi, Cope.

Spec. nov.

In this fish we have the form and proportions of the last group, with the shortened dorsal radii of the succeeding forms.

The origin of the first dorsal radii is nearer the end of the muzzle than the origin of the caudal by one-fourth of its basis. This embraces XXIV radii. Anal radii just to base of caudal. Orbit .25 the length of the head; interorbital width 1 3-5 the former. Occipital region elevated; muzzle much prolonged conic, mouth posterior, as in *C. velifer*. In general this species is quite near the latter; the number of scales is the same, and the proportions quite similar. The orbit is not so elevated, and the long dorsal radii about half as long as those of that species. Length of type eight inches. Locality not well ascertained, but as it accompanied species of Bubalichthys, it is probably from one of the western States.

Dedicated to my friend, Dr. John Edw. Gray, for many years the energetic director of the zoological department of British Museum.

Carpiodes thompsoni, Agass.

Amer. Journ. Sci. Arts, XIX 75. *Catostomus cyprinus* Thompson, Nat. Hist. Vermont. *Sclerognathus cyprinus* pas Kirtland, Fishes of Ohio, Proc. Bost. N. H. Soc. V. 275.

This is perhaps the handsomest species of the genus, and is distinguished by its stout form, numerous narrowly exposed scales, and little elevated dorsal fin. The eye is small, entering the length of the head 5.2 times, and 2.2 times the interorbital width. The muzzle is more elongate, but not so conic as in the two species last described, and projects far beyond the nasal crests, having an obliquely truncate profile. Hence the end of symphysis mandibuli is much in advance of the line of the nares, and the rim of the upper lip just reaches the line of the orbit.

Dorsal line much arched, origin of first dorsal radii midway between end of muzzle and origin of tail. Scales 8—41—6. V. 10, A. VII. Operculum flat, slightly ridged. Length averaging a foot. Color silvery, with a greenish golden band along the middle of each of the series of scales near the dorsal region, producing longitudinal golden bands.

Specimens from Lake George and Saginaw Bay, Lake Huron.

Carpiodes bison, Agass.

Amer. Journ. Sci. Arts, XVII, 356.

The original description of this species is rather too brief to allow of a perfectly satisfactory determination of my specimens. These are from the Wabash, in Tennessee ; those described by Prof. Agassiz are from the Osage, in Missouri.

This species has the general form of the buffalo fish, but has not so elevated a dorsal outline. It is therefore, much less elevated than the Carpiodes above described. It is especially characterized by the elongate form of the muzzle, in which it exceeds any other species of the genus. The profile descends obliquely posteriorly from the end of the muzzle to the mouth, and the end of the mandible is but little in advance of the nares, while the canthus is in line with the anterior limb of the orbit. The lips are well developed for the genus, and delicately longitudinally plicate. The eye is large, the middle line of the cranium falling within its posterior rim ; in other species it falls posterior to this point. Its diameter enters the length of the head 4.5 times, and the interorbital width, twice. Scales 7—40—5. Pectoral fin barely reaching line of anterior dorsal ray. Caudal furcate half its length.

In general proportions this fish is a good deal like the European carp. The occipital region is elevated and narrowly convex. The long dorsal ray is almost as well developed as in the species of group first, extending nearly to the end of the fin in one specimen .75 the distance in another. Color, brownish golden. Length, one foot.

75. Carpiodes cyprinus, Lesueur.

Catostomus do., Lesueur, Journ. Ac. Nat. Sci. Phil. I, 91, Tab. *Carpiodes*, Agassiz, l. c. Günther, Cat. Brit. Mus. VII, 24. *Carpiodes vacca*, Agass., l. c.

This is another elongate species with shorter dorsal radii, and rather large scales. In six small specimens there are 7 rows above the lateral line, and in two young and one adult, six. Length of head $3\frac{2}{3}$ times in length same and body; eye small, .25 times in interorbital width, nearly six times in head in adult of a foot in length, 4.5 times in young of five inches. Muzzle quite prominent, but obtuse. Front scarcely concave between orbits or in front of nasals, (thus differing from most of the other species). End of mandible extending beyond line of nares. Lips faintly plicate. Supraoccipital region elevated, little ridged. Anterior dorsal rays midway between origin of caudal and end of muzzle. Color silvery, dorsal fin black, paired fins white-margined.

Common in the tributaries of the Chesapeake and Potomac, rare in those of the Delaware in Pennsylvania.

C. damalis, Gird., from the Platte R., is very near this species.

Carpiodes nummifer, Cope.

Species nova.

The largest species of the genus, from the Wabash River, Indiana.

The detailed characters have been given in the synopsis of the species. The form is characterized by elongation, and the small proportions of the head. The body is compressed, and the dorsal line elevated to the first dorsal ray, which is considerably nearer the end of the muzzle than the origin of the caudal fin. Its rays are more numerous and the anterior shorter than in any other species here enumerated. The bony and first cartilaginous rays are stouter than in any other species, the latter presents no segmentation on the surface for the basal half.

The orbits are more anterior than in other low-finned Carpiodes, the middle line of the cranium falling .25 inch behind the orbit in a specimen of 20 inches length. Diameter 4.6 in head, nearly twice in interorbital width. Scales 7—36—5. Muzzle short, rather obtuse but projecting much beyond mouth. Symphysis mandibuli extending to nares.

Color of scales an olive silver or nickel color, whence the name nummifer, money-bearer. Sides of head yellow. Length 18 and twenty-four inches at least. Wabash River, Indiana; three specimens.

NOTURUS, Rafinesque.

76. Noturus marginatus, Baird.

From the Catawba and Yadkin rivers.

AMIURUS, Raf., Gill.

This genus is by far the most numerously represented by species among the Siluroids of the United States. Twenty-five are known to the writer, and several others have been described which are not satisfactorily distinguished. Besides the United States, China is included in the range of the genus. In North America they are a most noticeable feature of the ichthyological fauna of the Eastern Coast Streams, abounding there in individuals and species, far more than in the tributaries of the Mississippi, where Ictalurus is the prevailing form. The tributaries of the Great Lakes furnish another resort for them, and the rivers of Texas, according to Girard, also abound in them. This distribution in relation to Ictalurus is to be found in the fact that they are lovers of mud and sluggish waters, while the latter genus prefers running streams and rivers.

The species of Amiurus fall into four sections as follows:

I. Caudal fin rounded or truncate when spread open.

A The anal radii few, 17–22.

α Body slender, depth 1–8 length.

Anal radii 17; eye rather large. A. PLATYCEPHALUS.

αα Body stouter; depth 1–5 or less length.

β Lower jaw longer than upper.

Anal radii 20, its basis 5.5—6. times in length; head narrowed anteriorly, body not shortened. A. DEKAYI.

A. 22, head broad, body short. A. ÆLURUS.

ββ Upper jaw equal or exceeding lower.

* Anal radii 17. A. PULLUS.

** Anal radii 19–22.

† Ventral radii 8.

Head width 4.5 to 4.66 times in length; diameter eye 4.5 times between orbits; depth 3.75 in length, beards rather short, humeral process smooth. A. NEBULOSUS.

Width head four times in length, depth 3.66 times; eyes 4.5 between orbits; colors light; beards as above. A. CATULUS.

Width head 4 times in length; eye 4; other characters as above; colors dark. A. CATULUS, var.*

†† Ventral radii 7.

Eye larger, 3.75 times into interorbital width; head narrowed, width 4.66 times in length; black. A. MISPILLIENSIS.

AA The anal fin longer, the radii 24–8.

To this group belong A. cupreus, Raf., A. cupreoides, Gird., A. atrarius, DeK., A. catus, Linn, A. nigricans, Les., A. cœnosus, Rich'n, A. felinus and A. antoniensis of Girard.

II. Caudal fin furcate or strongly emarginate.

A Anal fin with few radii, (19—22).

α Caudal fin merely emarginate.

* I refer a specimen which I took at Poughkeepsie on the Hudson River, to this species.

Head less than one-fourth length. A. 20 ; eye 4:5 times between orbits ; dorsal nearer adipose fin than muzzle. A. CONFINIS.

Head as above ; orbit 4 times between orbits ; A. 23 ; dorsal nearer muzzle than adipose fin. A. HOYI.

aa Caudal furcate.

Width of head from 4.6 times in length; eye large, 3 to 5 times in interorbital space ; barbels long; caudal fin deeply forked. A. LYNX.

Head very wide, width 3.6 times in length ; eye six times between orbits, barbels very short, caudal not deeply furcate. A. LOPHIUS.

AA Anal fin large ; radii 24.5.

Caudal emarginate ; pectoral spine not denticulate ; barbels reaching gill opening ; head wide as long. A. BOREALIS.

Candal deeply furcate ; head narrow, pectoral spine dentate, barbels to end of humeral process. A. NIVEIVENTER.

Of other species of the genus, I have omitted A. puma Gird. A. natalis Les., and A. felis Agass, all belonging to section I, owing to the imperfections in the descriptions. *A. albidus* Lesueur, is, I think, founded on adults of A. nebulosus Les. *A. obesus* Gill of which I have examined numerous specimens from Minnesota, two from the Miami, Ohio, and one from the Kiskiminitas River, in West Pennsylvania, I cannot distinguish from A. catulus Girard (U. S. Pac. R. R. Rept. X). Of species adopted, A. catulus Girard, may be found eventually to be varieties of A. nebulosus. The A. mispilliensis, A. lophius and A. niveiventris, are now described for the first time.

77. AMIURUS PLATYCEPHALUS, Girard.

Proc. Ac. Nat. Sci. Phila. 1859, 160.

This well marked species approaches nearer the genus Hopladelus than any other Amiurus in its elongate, flattened body and head, and in the large number (11) of its branchiostegal radii. It abounds in the Catawba and Yadkin Rivers, where it is justly valued as an article of food.

Amiurus mispilliensis, Cope.

Spec. nov.

This species is related to the common *A. nebulosus*, but has a narrow muzzle, larger eyes and a ventral ray less than any other species of the section. Width of head 4.66 times in length; eye 3,25 times between orbits, maxillary beard extending beyond base of pectoral fins. Pectoral spine dentate, dorsal spine smooth. DI. 6 ; V.1.6 ; A. 21. Above entirely black ; below, white anterior to anal fin. The mental barbels blackish. The maxillary barbels extend to beyond base of pectoral fin, and the mentals to the branchiostegal margin. Entire length 8 in.; depth 1 in. 8 lines.

I took this specimen in the Mispillion Creek, a sluggish stream in the southern part of the State of Delaware. It doubtless occurs in similar streams in "the Peninsula."

78. Amiurus lynx,* Girard.

This is a variable species in the size of the orbits and width of the head. In the younger of six inches in length, the diameter of the former is contained in the interorbital space three times; in specimens of 9.5 inches four times; up to this size the width of the head enters the length without the caudal 4.5 times. Between this size and eleven inches the width of the head varies from 4.5 to four times; the orbit being one-fifth the frontal width in those of larger size. This is the greatest relative width of head I have seen in this species. The upper jaw always projects below the upper, the humeral process is always rugose and swollen proximally, and the maxillary barbels pale edged below.

The younger forms described, are the *Ictalurus kevinskii* of Stauffer, (Mombert's History of Lancaster County, Pa., 1869, 578). The following description applies to such.

It has the narrow head, large eye and furcate tail of *Ictalurus*. The dorsal spine is nearly smooth, other rays 6 ; A. 22 ; V. 8 ; C. VI—17—VII. The depth enters the length times. The largest specimen of this species I have seen does not exceed eight inches in length. The color above is a lively brown, sometimes tinged with purple; sides silvery, belly silver white.

The larger form with relatively smaller eye is *I. macaskeyi*, Stauffer, of the same work. The same form I took in the Mispillion Creek, Delaware. It differs from old examples of the latter in its more slender form, the width of the head entering the length 4.66 times between orbits ; barbels and color as in *A. lynx*. Specimens intermediate in character between this and the wider-headed form served as Girard's types. They were from the Potomac. Two specimens in my possession from that river have the with head 4.25 times in length, eye 4—4.5 times between orbits ; long maxillary, short mental barbels ; dorsal nearly equidistant between muzzle and adipose ; humeral process swollen, rugose.

One specimen from the Susquehanna exhibits the width of the head one-fourth the length, as above mentioned. This renders the distinction of Girard's *A. vulpeculus*, questionable, since the only essential characters he mentions are the following:

Head 4 times ; orbit $\frac{1}{4}$; caudal 6.5 times in length, dorsal nearer muzzle than adipose fin.

I have seen many specimens of this cat-fish from the Conestoga Creek, from the Susquehanna, and from the Delaware, in Pennsylvania.

Some specimens which I obtained at Newberne, on the Neuse River, were lost, but I suspect them to have been this species. As it is common in the James River, it probably occurs also in the Roanoke.

Amiurus lophius, Cope.

Species nova.

This, perhaps the largest species of the genus, is distinguished by the

*In Origin of Genera, 43, I state that the *Gronias nigrilabris* Cope resembles the *Amiurus lynx* most closely among the *Amiuri*. This is an error; the comparison should be made with *A. nebulosus*, from which the form of the anal fin, short barbels, etc., distinguish it.

greater width of its head, and the gape of the mouth, together with the decided but shallow furcation of the caudal fin. The barbels are considerably shorter than in any other species of the fork-tailed section.

Head and dorsal region very flat, the width of the former contained 3.5 times in the length of the body and head, and the length of the same entering the same three times. The depth at the first dorsal ray, enters the same 5.4 times. That ray is exactly intermediate between the end of the muzzle and the posterior margin of the base of the adipose, having thus a more posterior position than in A. lynx, where it measures the middle of a line terminating at the anterior base of that fin. The free extremity of the adipose is in line with the same of the anal. Radii D I. 6; A. II. 19; V. 8. The eye is small, its long diameter entering the length of the head, measured on the middle line above, seven times, and six times in interorbital space. Pectoral spine weakly; dorsal not, serrate. Humeral process strongly rugose to near extremity.

Maxillary barbel reaching two-thirds to three-fourths the distance from its base to the upper part of the branchial slit, the outer only half way to the branchiostegal margin, the inner three-fourths the length of the outer. The extremity of the muzzle is regularly rounded, the upper jaw projecting a little beyond the upper. Branchiostegal rays nine. Total length eighteen inches; length dorsal spine 18 lin.; do. pectoral spine 18 lin.; do. basis of anal 35 lin.; width of head 53 l.

Color above brown; lower surfaces, including lower lip, (yellow or) white in alcohol; mental beards white.

This species is nearest the A. lynx, Girard, which inhabits the same rivers, but is readily distinguished as above pointed out, and in additionally, by the shorter barbels and lower body. In the width of its gape it exceeds any other North American cat-fish, and will allow of a remote comparison with Lophius in this respect.

I obtained three specimens in the Washington, D. C. market, which came from the lower course of the Potomac river. It occurs in the other tributaries of the Chesapeake Bay, and I think I have seen it in the market of Baltimore. I have not yet observed it in Philadelphia. In the former cities it is deservedly esteemed for the table, and is more valuable than the *A. lynx* and *A. nebulosus*, on account of its superior size.

The last named fish is sold in Philadelphia and neighborhood. It often attains a foot in length. I cannot distinguish the *Pim. albidus*, Lesueur. Pale and piebald varieties of the fish occur.

79. Amiurus niveiventris, Cope.

Spec. nov.

This fish presents a great contrast to the last, resembling in fact the *Ictalurus cœrulescens*, Raf., in its slender proportions.

Width of head 4.75 times in length, exclusive of caudal fin. Orbit nearly four times into interorbital width. Depth 5.22 in length as above. Dorsal spine three inches from end muzzle, 3.5 inches from origin adipose fin; its posterior margin with a concealed serration. Pectoral spine strongly serrate. Radii D I. 6; A. 24; V. 8. Maxillary barbel to near end of humeral process; latter very rugose to near extremity. Outer mental barbel to branchiostegal margin. Br. rays ix.

Color above blackish, sides silvery leaden blue; below, including margin of upper lip and outer margin of maxillary barbels, pure white. Fins edged with dusky. Length of specimens 8.5 inches.

From the Neuse River, N. Ca.

In this species, as in all the fork-tailed Amiuri here described, the lower lobe of the caudal fin is wider than the superior. The young of these species, at least in and *A. lynx*, are much more silvery than the adult, as is the case with some of the Ictaluri.

In concluding my observations on this genus, I may add that I took A. cupreus in the Clinch River, in Tennessee.

ICTALURUS, Raf.

Gill emend.

80. Ictalurus cœrulescens, Raf.

This species abounds in the French Broad and other tributaries of the Tennessee, as it does in those of the Ohio. It is everywhere much used as food, though in my estimation inferior to the large Amiuri of the East, for though the flesh is whiter, it is drier.

SALMO, Linn.

81. Salmo fontinalis, Mitch.

This species is found in the rapid streams in which the tributaries of the Tennessee and Catawba Rivers head, in the highest tracts of the Allegheny Mountain Region. I only took them in one of the heads of the French Broad, where the size was much inferior to that of trout from similar localities in Pennsylvania. The experience of other fishermen in this respect was similar to my own. According to Dr. Hardy, a naturalist long resident in Asheville, well known to the old generation of students South and North, this fish occurs in the headwaters of the Chattahoochee, on the south slope of the Alleghenies, in Georgia. This is the first authentic instance of its occurrence in any water flowing directly into the Gulf of Mexico, with which I have met. From the habits of the species it is hardly to be looked for in any other of the Gulf streams eastward of the Mississippi. According to Dr. Peck, of Mossy Creek, Tennessee, it is not found in the Cumberland Mountains. I did not find it there in the heads of the Cumberland or Clinch.

OSMERUS, Artedi.

Although I am not informed as to the occurrence of any species of this genus on the coast or in the rivers of North Carolina, I introduce it here for the purpose of illustrating some species which have been placed in my hands by my friend, Dr. Chas. C. Abbott, of Trenton, N. J. These were procured and forwarded to him at his request, by Chas. G. Atkins, the efficient Commissioner of Fisheries of the State of Maine, whose authority is here given for the notes on their habits and places of abode, appended. Interest attaches to the fact that the greater part of the fishes are derived from the fresh waters of that State, and that species of this genus, like those of the other Salmonoid genera, Coregonus and Salmo, are proven to have a lacustrine distribution in the northern part of the United States.

Land-locked Osmeri occur in the lakes of Norway. According to Professor Esmark of Christiana, they are found in Lake Mjosen, which is 500 feet above the sea, and discharges into it by a stream which has a very high fall; also in Nors Vandsjö, near the town of Moss, and in the Stinksild.

I find three species among our lake smelt, as follows:

Eye large, one-third length of head; head short, 4.25 times in length; scales, l. long. 66; l. transv. 10. O. SPECTRUM.

Eye smaller, 4.5 times in head; head shorter, 4.75 in total; scales smaller, l. long. 68; l. transv. 16. O. ABBOTTII.

Eye 4—4.25; head 4, longer; scales, l. long. 65–7; l. transv. 13 (14). O. VIRIDESCENS.

Osmerus spectrum, Cope.

Species nova; smelt of Wilton.

Established on two specimens sent from the above locality in Franklin Co., Maine. Form slender, the head short, with remarkably large eye, and short mouth and maxillary bones. Mandible prominent when closed, as in O. viridescens, the end of the maxillary bone not extending beyond the line of the middle of the pupil. Both the length of the muzzle and the interorbital width are considerably less than the diameter of the orbit. The form of the body is more slender than in the *O. viridescens*, the depth entering the length without caudal fin, 8.33 times. Radii D. 10. A. 1. 15. V. 8. The pectorals extend $\frac{3}{5}$ the distance to the base of the ventrals. Length of a medium sized specimen, 3 in. 6 lin. Scales in about as many transverse, but several fewer longitudinal series than in the other species.

Color probably translucent in life, a silver band along the upper part of the sides. Side of head and operculum silver. Top of head, middle dorsal line and caudal fin so thickly punctate with black as to be colored.

Wilton Pond is near the head of the south-west branch of the Kennebec River in S. W. Maine. The characteristics of this species, according to Commissioner Atkins, are seen in specimens of larger size than those here described, which were taken in breeding condition.

Osmerus abbottii, Cope.

Species nova.

This fish is in general characters more like the O. viridescens than the last; it is similar in the size of the orbit and posterior prolongation of the maxillary bone, but the scales are more numerous and the head is shorter. Like the last, it is considerably smaller than the common smelt.

The depth enters the length without caudal fin, seven times; the head the same, 4.75 times. The orbit is less than the length of the muzzle, and scarcely equal to the interorbital width. The maxillary is delicately toothed, and reaches the line of the posterior margin of the pupil. The pectoral measures half the distance to the base of the ventral. There are five specimens of this fish, which measure about four inches in length, and they are stated in the accompanying notes to be of medium size. The colors, like those of *O. spectrum*, are darker than those of *O. viridescens*, in spirits. The median line above is dusted with black, and the lateral scales, in several specimens, bordered with the same. Fins blackish, especially the base of the caudal. From Cobessicontic Lake, in Kennebec Co., in Southwest Maine.

According to Commissioner Atkins, this species spawns immediately after the ice disappears, and instead of running into swift brooks, like the varieties of *O. viridescens*, hereinafter described, lays its eggs on the borders of meadows. The specimens described were taken in breeding condition at the breeding season.

As I owe the opportunity of describing these interesting Osmeri to my friend Dr. C. C. Abbott, I dedicate the present species to him.

Osmerus viridescens, Mitchill.

Osmerus sergeanti, Norris. Proceed. Acad. Nat. Sci. Phila., 1868, 93; loc. cit., 1861, March.

Two localities furnish specimens of land-locked smelt, which I can only distinguish from those of salt water by color. The first from Lake Messalonskee, Kennebec Co., have a yellowish color on the sides, and black dorsal line, top of head, chin, and edges of lateral scales. The specimen is 14 inches long, said to be of medium size, therefore exceeding the average of the O. viridescens seen in Philadelphia market, and considerably larger than the *O. abbotti* and *O. spectrum*. They are called the Belgrade smelt.

Commissioner Atkins states that between the 10th and 20th of April, while the lakes are still covered with ice, this fish runs up into the brooks and lays its eggs by night, the eggs adhering to grass and stones. The spawning is complete always before the ice breaks up in the lakes. The temperature of the brooks is from 32° to 40° Fahr.

The second locality is Cochnewagn Pond, Kennebec Co. Specimens of "medium size" are smaller than the sea smelt from the mouth of the Kennebec, and larger than those of *O. abbottii*. They are generally similar to the last variety. These the notes state, breed later by 25 days than the last; that is, 12 or 15 days after the ice disappears, the temperature of the water being 43° to 45°.

The breeding season of the O. abbottii intervenes between those of the above varieties.

Commissioner Atkins says that the majority of the lakes of Maine contain smelt of some kind, and that he frequently finds smelt in the stomachs of trout from these lakes.

ANGUILLA, L.

Species not identified; very abundant in all the Atlantic waters of North Carolina (82).

GANOIDEA.

Lepidosteus osseus, L., occurs in the Yadkin and other eastern rivers of the State, and probably *L. huronensis* in the French Broad, as I have specimens of it from near Dandridge, E. Tennessee. *Polyodon folium* (*Spatularia*) ascends the same river to near Asheville, N. Ca. Various species of *Accipenser* abound in the Atlantic rivers, while descriptions of a fish called "Black fish" or "Brindle fish," found in the Neuse River, induce me to believe that *Amia* occurs there (83–7).

ON THE GEOGRAPHICAL DISTRIBUTION.

The table appended, shows readily, the characteristics of the faunæ of the four rivers of the State examined, though many species are no doubt omitted from each, certainly nearly all the larger ones, which I had not facilities for procuring.

The differences between the ichthyologies of the streams on opposite sides of the Allegheny shed, are rather greater in this State than in Virginia; the mountains here constituting a much more important topographical feature, both as to elevation and number of ranges.

The following points distinguish the two kinds of waters:

The western presents greater abundance of Percoids allied to Etheostoma, of Uranidea, and is the exclusive range of Ambloplites, Micropterus fasciatus, and Polyodon.

On the East, the Catawba and Yadkin are peculiar in their poverty in Etheostomine Perch, and the absence of the forms just named, while the extraordinary development of Catostomidæ, and abundance of Amiurus, Anguilla, and Esox, strike at once the naturalist who travels and collects from one to the other. The Neuse adds to these peculiarities a greater affinity to the more northern streams of Maryland and New Jersey, in the occurrence of Enneacanthus, Aphredodirus, Moxostoma, and Hybopsis amarus. Its pike and Centrarchus are of the South Carolina type.

After a similar investigation of the rivers heading on opposite sides of the Alleghenies of S. W. Virginia, I came to the following conclusions:

I. That after deducting species generally distributed, certain remain which occur in streams separated by high ranges of mountains.

II. That the distribution of species is not regulated by community or difference of outlet, rivers having diverse discharges having sometimes more in common than those having the same destination.

As regards the first, the present investigations are confirmatory. While nearly all the Percidæ, Cyprinidæ, and Catostomidæ, and all the Siluridæ of the French Broad River, differ from those of the East, we have the following common to both sides of the range:

Pœcilichthys flabellatus.
Micropterus nigricans.
Photogenis leucops.
Compostoma anomalum;

All species of pretty wide distribution. A peculiarity of distribution is the occurrence of the Photogenis leucops, confined in Pennsylvania to the heads of the Ohio, and in Virginia to the Kanawha, not only in the Catawba, but in the Neuse. In further illustration, I append a list of species from the South Fork of the Cumberland, in the Cumberland Mountain region, near Kentucky.

Micropterus fasciatus.
Ambloplites rupestris.
Lepomis nitidus.
Percina caprodes.
Etheostoma blennioides.
Pœcilichthys coeruleus.
" camurus.
" sanguifluus.
Hyostoma cymatogrammum.
" simoterum.
Ptychostomus erythrurus.
Catostomus nigricans.
Semotilus corporalis.
Ceratichthys biguttatus.
Hypsilepis cocogenis.
" galacturus.
" ardens.
Alburnellus micropteryx.
Hybopsis longiceps.
Photogenis telescopus
Campostoma anomalum.

Twenty-one species.

Although separated from the waters of the French Broad by the highest ranges of the Cumberland Mountains, and flowing to the North, while the former flow to the South, there is no important difference between their fish inhabitants observable. The difference as compared with the case of the Catawba River, has reference in part to the difference in elevation of the mountain ranges separating them. Those of North Carolina rise to 6740 ft., while according to Prof. Safford, the highest point of the Cumberland is only 3000 feet.

Two curious points in the above list may be observed, viz: the occurrence of Hypsilepis ardens, and Hybopsis longiceps; species which I only found in the James and Roanoke in Virginia, and not in the Western waters, and which, while they occur in the Cumberland (the H. longiceps in the Clinch also) I did not find in the State of North Carolina!

Mimetic Analogy. A curious case of this occurred to me in three species of fishes which I took in a small tributary of the Yadkin River, in Roane Co., N. Ca. Among several others there were varieties of the widely distributed species, Chænobryttus gillii, Hypsilepis analostanus, and Ptychostomus pidiensis, (each representing a different family) which differ from the typical form of each in the same manner, viz: in having the back and upper part of the sides with longitudinal black lines, produced by a line along the middle of each scale. This peculiarity I have not observed in these species from any other locality. Until I had examined them I thought them new species.

The only other species presenting such marking in the Yadkin River, is the large perch, the Roccus lineatus. According to the theory of Natural Selection, a resemblance to this well-armed species might be of advantage to the much weaker species in question, yet the same species coexist in other rivers without presenting the same mimicry.

French Broad.	*Catawba.*	*Yadkin.*	*Neuse.*
			Perca flavescens.
Stizostedium americanum,			
salmoneum.			
	Etheostoma maculatum.		Etheostoma nevisense.
Hypoholus aurantiacus.			
Poecilichthys zonalis,			
flabellatus,	Poecilichys flabellatus,		
vulneratus,	var.		
rufilineatus.			Poecilichthys vitreus.
	Boleosoma maculaticeps.	Boleosoma maculaticeps.	Boleosoma maculaticeps.
Hyostoma cymatogrammum.			
simoterum.			
Micropterus fasciatus,			
nigricans.	Micropterus nigricans.	Micropterus nigricans.	Micropterus nigricans.
			Pomoxys hexacanthus.
			Centrarchus irideus.
Ambloplites rupestris.			
	Chænobryttus gillii.	Chænobryttus gillii.	Chænobryttus gillii.
			Enneacanthus guttatus.
	Lepomis rubricauda.	Lepomis rubricauda,	Lepomis rubricauda.
Lepomis megalotis,			
notatus.		Lepomis purpurescens	
	Pomotis maculatus.	Pomotis maculatus.	Pomotis maculatus.
Amblodon.			
Uranidea carolinæ.			
			Aphredodirus sayanus.
	Esox affinis,		Esox affinis,
	ravenelii.		ravenelii.
Salmo fontinalis.	Salmo fontinalis.		
	Stilbe americana.	Stilbe americana.	Stilbe americana.
Semotilus corporalis.	Semotilus corporalis.	Semotilus corporalis.	Semotilus corporalis.
Ceratichthys biguttatus,	Ceratichthys biguttatus,	Ceratichthys biguttatus,	Ceratichthys biguttatus.
	labrosus,		
hyalinus.	hypsinotus.	hypsinotus.	
Rhinichthys lunatus,.			
Hypsilepis coccogenis,			
galacturus,			
cornutus, var.			Hypsilepis cornutus.
	Hypsilepis analostanus.	Hypsilepis analostanus.	analostanus.
Hybopsis spectrunculus.	Hybopsis amarus,		Hybopsis ? amarus.
	niveus,		
	chlorocephalus.	Hybopsis chiliticus.	

Photogenis leucops,	Photogenis leucops.		Photogenis leucops.
telescopus,			
leuciodus.			
	pyrrhomelas.		
? Alburnellus micropteryx.		Alburnellus altipinnis.	Alburnellus matutinus.
	Clinostomus affinis.	Clinostomus affinis.	
	Hybognathus argyritis.		
Campostoma anomalum.	Campostoma anomalum.		
Catostomus teres,	Catostomus teres.	Catostomus teres.	Catostomus teres.
nigricans.			
	Ptychostomus cervinus.		
		Ptychostomus conus.	
			Ptychostomus crassilabris,
			lachrymalis.
Ptychostomus erythrurus.		robustus,	
		thalassimus,	
	albus,		
	coregonus,	coregonus,	
		pidiensis,	
	collapsus,	collapsus,	Ptychostomus collapsus.
	papillosus.	papillosus.	
Carpiodes, sp.			
Ichthælurus cœrulescens.			Moxostoma oblongum.
Hopladelus olivaris.			
	Amiurus platycephalus.	Amiurus platycephalus.	Amiurus niveiventer.
	Noturus marginatus.	Noturus marginatus.	
	Anguilla.	Anguilla,	Anguilla,
Polyodon folium.			
		Accipenser.	Accipenser.
			? Amia.
Lepidosteus huronensis.	Lepidosteus.	Lepidosteus osseus.	Lepidosteus.
	Petromyzon.		
37 species.	35 species.	27 species.	32 species.

Stated Meeting, August 19, 1870,

Present, four members.

Vice President, Prof. J. C. Cresson, in the Chair.

A letter of acknowledgement was received from the Royal Society of London.

Donations for the Library were received from the Societies at Moscow, Offenbach, Bonn, Strasbourg, Lausanne, Salem and Worcester; the Academies at St. Petersburg, Copenhagen, Vienna, and Chicago; the Observatory at St. Petersburg; the Geological Societies at Vienna, Berlin and Florence; the Hospital at Rome; the Royal and Zoological Societies in London; the Royal Society in Dublin; the Oriental Society, and Yale College at New Haven; the Franklin Institute, and Medical News at Philadelphia; the Freedmen's Bureau and Howard University; Herr Dümichen of Berlin; Sig. Dora d'Istréa of Athens; Dr. Andrews of Chicago, and Mr. Edmund Quincy of Boston.

The death of Mr. Samuel V. Merrick, a member of the Society, was announced by Prof. Trego, as having occurred at Philadelphia on the 18th inst., in the 70th year of his age. On motion, Dr. D. R. Goodwin was requested to prepare an obituary notice of the deceased.

The death of Sir James Copeland, M. D., a member of the Society, was announced as having taken place in London, July 14, in the 77th year of his age. Dr. Pepper was appointed to prepare an obituary notice of the deceased.

Prof. Cope communicated a paper entitled "Eighth Contribution to the Herpetology of Tropical America." (See Proceedings, below.)

Prof. Cope communicated a paper entitled "Contribution to the Ichthyology of the Marañon." (See Proceedings below.)

Prof. Cope communicated certain statements concerning *Liodon perlatus*, Cope; and the results of his studies of the Crania of the orders of Reptilia and Batrachia recent and extinct.

Prof. Cope stated that he had been acquainted for some time with a Mososauroid reptile from the white rotten limestone of Alabama, and had formerly thought it to be the *Mososaurus brumbyi*, of Gibbes. He was satisfied of the error of this determination, and as the hæmal arches of the caudal vertebræ were not co-ossified, he referred it to the genus Liodon, under the name of *L. perlatus*. A dorsal vertebra had been already described in the Synopsis of Extinct Batrachia and Reptilia of North America, Trans. Amer. Philos. Soc., 1869, 198.

Prof. Cope communicated some results of his studies of the structure of the crania of the orders of Reptilia and Batrachia, recent and extinct. He explained the characters of the Ichthyopterygia as follows:

The *quadratojugal* present (squamosal of Owen, Anatomy of the Vertebrata); *postorbital* (of Owen) present.. The *squamosal* (supratemporal of Owen) extending over the inner side of the parieto-squamosal arch so as to conceal the parietal portion of it, to the anterior part of the temporal fossa, and in contact with its fellow of the other side. It sends down a columella to the pterygoid. It extends also for a remarkable distance downwards behind the osquadratum. ? *Opisthotic* present. A distinct element exists behind the quadratum, which he thought might be the *suprastapedial*, otherwise called the incus, or hyomandibular, according to Huxley. The pterygoid prolonged backwards and expanded, in contact with the basi-occipital, and extending from it to the quadratum. The posterior pair of elements of the superior face of the cranium being determined to be squamosals, the interpretation of the anterior elements becomes simple. The rhombic element with fontanelle is parietal (frontal of Owen Anatomy of Vertebrata), and the preceding pair are the frontals (nasals, Owen). The true nasals were shown to lie at the proximal end of the nares.

The structure of the suspensorial region in the Anomodont, Lystrosaurus, was next pointed out. In this order there is no quadratojugal arch, and the zygomatic arch contains a very small postorbital. The *squamosal* has an extraordinary development, and extends on the parieto-quadrate arch, and on the inner side of the temporal fossa on each side of the parietal. The *parietal* is not so far concealed as in Ichthysaurus, but its posterior-lateral process may be seen wedged in between the squamosal and the thin, plate-like opisthotic, which lies external to the supraoccipital on each side. The *opisthotic* is the parietal of Owen, and the parietal branch of the squamosal is the mastoid of the same author.

This branch in Ichthyosaurus and Lystrosaurus is continuous with the zygomatic portion of the bone, though another element might have been originally coössified with it. The posterior portion of the squamosal is prolonged remarkably, it is applied to the posterior face of the quadratum, and extends to its articular extremity. The *quadratum* is a small bone of a plate-like form, in contact with the squamosal above and the ? proötic inwardly and anteriorly. *Suprastapedial* not distinguished. The parietal branch of the squamosal sends down a *columella* to the pterygoid.

The *proötic* is a distinct though small bone, below and in front of the squamosal. The presphenoid is plate like, and much as in the Crocodilia.

Prof. Cope thought that the Anomodontia, one of the earliest (Triassic) types of Reptilia are one of the best examples of a generalized group among the vertebrata. Thus the structure of the posterior part of the Cranium is largely that of Ichthyopterygia, and partially that of Lacertilia; of the oral parts of the cranium, the proötic and mandible, of Testudinata. The vertebral characters are partly those of Ichthyopterygia, and the sacrum and rib articulations those of Dinosauria. The peculiar presphenoid is characteristic of Crocodilia, and the osseous interorbital septum, of the Rhynchocephalia.

The position of the posterior plate of the squamosal in Ichthyopterygia and Anomodontia seemed conclusive as the homology of that element with the bone covering the cartilaginous quadratum in Batrachia Anura, and the osseous quadratum in Urodela and Dipnoi, called tympanique by Cuvier, and temporo-mastoidean by Dugés. This bone had been already homologized with the preoperculum of Teleostei by Huxley, and it is thought that its present determination in the Reptilia established the serial homology of the preoperculum of the fish with the squamosal plate of the mammal.

Prof. Kirkwood communicated a paper "On the Mass of the Asteroids between Mars and Jupiter." (See Proceedings below.)

Prof. Cresson described the thunder storm of the 4th inst. at the Belmont Water Works.

And the Society was adjourned.

On the MASS *of* ASTEROIDS *between* MARS *and* JUPITER. By PROFESSOR DANIEL KIRKWOOD, Bloomington, Indiana.

According to Leverrier, the total mass of the ring of minor planets does not exceed $\frac{1}{4}$th of the earth's mass, or $\frac{1}{1200}$th of that of Jupiter. So great a disproportion between two adjacent planets is without a parallel. Is the fact susceptible of a probable explanation?

Were the sun transformed into a gaseous spheroid with an equatorial radius equal to the diameter of the earth's orbit, a large number of the known asteroids would, in perihelio, plunge into the solar mass and be reunited with it. Now this, in all probability, is precisely what occurred soon after the abandonment of the asteroid zone, while the solar nebula was in the process of condensation. The powerful mass of Jupiter would produce great eccentricity in parts, at least, of the primitive ring. Large portions of its matter, or a considerable number of minor planets in a state of vapor, may thus have been precipitated upon the sun before the latter had contracted within their perihelion distance. The small mass of Mars may perhaps be accounted for on the same hypothesis.

A REGISTER *of* METEOROLOGICAL OBSERVATIONS *made at* BOIS CHÊNE, near Port-au-Prince, Hayti. By PROF. A. ACKERMAN, National Museum.

(*Read before the American Philosophical Society, July* 15, 1870.)

INTRODUCTORY REMARKS.

All the meteorological observations have been made at "Bois Chêne," S.E. from the harbor of the Capital, at an elevation of 52 meters above the mean level of the sea, with the exclusion of those comprised between the 19th May, 1866, to the 17th November, 1867, which have been made at "Lalue," suburb E of the Capital, country seat of General Lamothe, elevation 57 meters*

The rain-guage used is that of Babinet; its surface of reception is four square-decimeters, so that a centilitre of water represents $\frac{1}{4}$ millimeter of rain in elevation. No building, trees or other obstacles influenced the quantity of received rain, and in order to avoid a correction for evaporation, the water was measured after every rain, except what fell at night, which was registered before sunrise, and without having applied a correction. Elevation of the funnel above ground 3 feet.

The diurnal rain comprises that which fell between 6 o clock A. M. and 6 o'clock P. M., and nocturnal rain that which was received in the remaining twelve hours.

As to the division adopted for the electric phenomena of the atmosphere, the first column reproduces the number of days during which it thundered, and lightning was perceived; however, one phenomenon may have been independent of the other, for example: the thunder was heard in the morning, and the lightning seen in the evening of the same day; this day is noted in the first column. In order to diminish a sort of want of precision in this first column, the last column represents the days of "orages"† which passed above town or its near environs, notwithstanding they have already been counted in the first column. The number of days during which thunder alone was heard, or lightning only perceived, form the successive columns and can only be considered as minima, for the phenomena may have escaped observation, principally lightning at night.

There are days during which thundering lasts for hours, and others when lightnings are so numerous in the evenings as to amount from 30 to 80 in a minute of time, and so for several hours. Particulars about lightnings, on colors, numbers, bifurcations, multiple divisions, distances ascending and descending, &c., &c., have been published in the Moniteur Officiel of the Republic.

Relative to temperature, the thermometers are standard instruments, from the best makers in Paris, divided on the stem into $\frac{1}{5}$ centigrades, so that a tenth of a degree is easily estimated; from time to time the variation of zero-point was verified and the correction applied to the observations.

* "Lalue" and "Bois Chêne" are situated about a mile from the sea shore, and both stations near together, about ⅓ part of a mile asunder.

† Thunder storm and rain.

The instruments have no frame, and are freely suspended without being shaken by the wind. The absolute minimum is given by a Rutherford spirit therm., and the absolute maximum by Negretti & Zambra's mercurial therm., both Salleron's construction at Paris.

The hourly observations of temperature are performed by "Breguet's thermometrographe horaire No. 6," [See Arago, not. scientif. vol. V, pp. 628–632, and Desains: physique, vol. I, page 247; or Daguin: phys. vol. II, page 546, etc.] This instrument having an arbitrary scale, it was compared with a standard therm. in two constant temperatures, and further checked by numerous simultaneous observations. Breguet's No. 6 acts in the most satisfactory manner, but is much more sensible than other thermometers, so that for the comparisons the instruments were read at a distance with the aid of a cathetometer, and further all the cares taken to obtain correctness, etc.

The exposure of all the instruments is as follows:

A square room of 14 feet a side, has openings towards the four cardinal points, a covered gallery on the South side, is without ceiling, covered with shingles, so that the air circulates freely day or night, from whatever direction the wind is blowing.

On the North side is the window furnished with latticed blinds, painted white, nearly of the same form as prescribed in the "Directions for meteorol. observ." Smithsonian Institution 1860, fig. 2. Elevation of thermometers above ground 10 feet.

The mean daily temperature (and consequently the mean monthly and annual) are the results of the 24 registered hourly observations. The given factor is the co-efficient by which the difference between the absolute maximum and minimum is to be multiplied, and the product added to the minimum, in order to obtain the same mean daily temperature as given by Breguet's hourly thermometrograph.

About ten personal observ. were made daily, with free thermom., psychrom., barometer, winds, clouds, &c., &c., besides the reading of the maxim and minim and the said thermometrograph, thermometer exposed to the sun, to nocturnal radiation, etc.

The second decimal of Fahrenheit degrees does not occur in observation, and is either the result of the mean addition or produced by the reduction of Centigrades into Fahrenheit degrees.

The barometers, Fortin's, had been compared with the barometer at the astron. observatory in Paris, and the makers had given the correction, a constant, for every one. Further, the observations were corrected for capillarity, the column reduced to the temperature of zero degree (32° Fahrenheit) and reduced to the mean level of the sea by the formula of Jamin, Cours de physique de l'école polytechnique, vol. I, end of page 263.

$$X = 18405^{m} (1 + 0.002552. \cos 2 L) \left[1 + \frac{2(T+t)}{1000}\right] \log \frac{H}{h} ;$$

H & h being reduced to 0° C. X being known the value of H gave the pressure on the level of the sea.

Meteorological Station of Port au Prince.

Extracted from the Registers.

I. Rain and Electrical Phenomena.

1863.	Rain expressed in millim. total.	diurnal	nocturnal	rainy.	Number of days of observed. thunder & lightning.	thund'r alone.	lightn'g alone,	Number of thunderstorms over the town or its environs. total.	nocturnal
Aug.	82.50	47.50	35.00	13	2	0	0	1	1
Sept.	128.00	16.25	111.75	17	17	0	2	3	2
Oct.	257.00	85.00	172.00	23	2	0	1	1	1
Nov.	91.50	27.25	64.25	13	1	0	1	1	1
Dec.	18.50	inappr.	18.50	6	0	0	0	0	0
	577.50	176.00	401.50	72	22	0	4	6	5
1864.									
Jan.	0.75	inappr.	0.75	2	0	0	0	0	0
Feb.	123.75	15.50	108.25	14	3	1	2	0	0
March.	110.75	0.00	110.75	11	0	0	0	0	0
April.	212.00	0.00	212.00	15	2	1	2	2	2
May.	260.75	133.00	127.75	17	5	1	1	1	1
June.	59.50	1.50	58.00	7	5	8	0	2	1
July.	108.75	45.25	63.50	14	8	6	0	3	2
Aug.	223.50	152.50	71.00	19	15	1	0	6	5
Sept.	164.25	11.50	152.75	13	20	2	0	9	1
Oct.	170.75	48.00	122.75	13	1	1	0	0	0
Nov.	61.00	17.00	44.00	13	2	0	0	2	2
Dec.	45.50	10.50	35.00	7	2	0	0	1	1
	1541.25	434.75	1106.50	145	63	21	5	26	15
1865.									
Jan.	20.40	4.00	16.40	5	0	0	0	0	0
Feb.	13.00	0.00	13.00	5	0	0	0	0	0
March.	77.75	0.00	77.75	12	0	0	0	0	0
April.	193.50	8.00	185.50	19	2	1	0	0	0
May.	451.25	157.75	293.50	24	17	4	0	4	2
June.	74.75	44.25	30.50	14	8	8	1	3	3
July.	103.00	38.00	65.00	10	7	2	0	4	3
Aug.	129.00	54.00	75.00	15	9	3	1	3	1
Sept.	298.25	131.75	166.50	20	11	8	1	3	1
Oct.	151.50	46.25	105.25	22	13	3	1	3	2
Nov.	158.50	14.50	144.00	9	4	2	4	1	1
Dec.	28.00	0.00	28.00	2	0	1	1	0	0
	1698.90	498.50	1200.40	157	71	32	9	21	13

II. Rain and Electrical Phenomena.—*Continued.*

1866.	Rain expressed in millim.			Number of days of observed.				Number of thunderstorms over the town or its environs.	
	total.	diurnal	nocturnal	rainy.	thunder & lightning.	thund'r alone.	lightn'g alone.	total.	nocturnal
Jan.	57.25	11.00	46.25	9	2	1	0	2	2
Feb.	75.50	12.00	63.50	12	2	2	1	1	1
March.	149.25	5.00	144.25	11	0	0	0	0	0
April.	362.25	inappr.	362.25	22	8	2	1	3	2
May.	226.50	57.00	169.50	18	13	1	1	7	5
June.	146.00	27.25	118.75	17	13	8	1	3	3
July.	150.50	96.50	54.00	15	13	10	1	6	2
Aug.	125.50	8.75	116.75	18	16	4	0	7	7
Sept.	131.50	37.50	94.00	20	20	3	3	6	5
Oct.	110.00	39.00	71.00	20	7	4	1	4	4
Nov.	125.50	83.25	42.25	11	1	0	0	0	0
Dec.	56.25	inappr.	56.25	6	0	0	1	0	0
	1716.00	377.25	1338.75	179	95	35	10	39	31
1867.									
Jan.	51.25	0.00	51.25	4	0	0	0	0	0
Feb.	26.75	5.00	21.75	9	2	0	0	1	0
March.	22 75	2.00	20.75	5	1	1	1	0	0
April.	199.50	14.75	184.75	13	6	0	0	0	0
May.	322.75	60.00	262.75	17	13	2	2	5	3
June.	177.00	28.25	148.75	17	11	7	0	2	1
July.	54.25	41.50	12.75	9	13	1	4	2	0
Aug.	138-75	47.25	91.50	15	15	8	0	4	4
Sept.	52.75	28.25	24.50	7	14	1	6	2	2
Oct.	126.75	3.75	123.00	12	17	3	1	2	2
Nov.	63.25	19.50	43.75	15	7	2	3	2	1
Dec.	41.50	0.00	41.50	3	0	0	1	0	0
	1277.25	250.25	1027.00	119	99	25	18	20	13
1868.									
Jan.	0.50	0.25	0.25	2	0	0	1	0	0
Feb.	143.25	1.25	142.00	17	7	0	3	1	1
March.	86.75	10.00	76.75	15	1	0	0	0	0
April.	102.00	47.00	55.00	15	4	0	0	0	0
May.	317.50	115.00	202.50	25	17	4	1	6	5
June.	52.00	47.75	4.25	14	6	10	0	1	1
July.	42.75	14.00	28.75	13	14	2	12	5	2
Aug.	129.50	43.50	86.00	13	18	3	5	7	6
Sept.	282.00	151.00	131.00	24	21	4	0	16	12
Oct.	118.00	13.75	104.25	14	10	5	3	1	1
Nov.	117.75	29.00	88.75	17	8	1	2	3	2
Dec.	43.00	20.00	23.00	10	0	0	1	0	0
	1435.00	492.50	942.50	179	106	29	28	40	30

III. Rain and Electrical Phenomena—*Continued.*

1869.	Rain expressed in millim.			rainy.	Number of days of observed.			Number of thunder-storms over the town or its environs.		
	total.	diurnal	nocturnal.		thunder & lightning.	thund'r alone.	lightn'g alone.	total	nocturnal	
Jan.	26.75	15.00	11.75	9	1	0	0	0	0	
Feb.	141.00	7.50	133,50	12	2	0	1	1	1	
March.	108.75	5.50	103.25	14	1	1	0	1	1	
April.	123.25	inap.	123.25	17	5	1	0	0	0	
May.	326.25	105.00	221.25	18	15	3	0	7	5	
June.	139.25	64.50	74.75	12	18	4	1	9	4	
July.	97.50	48.50	49.00	16	21	5	0	8	1	
Aug.	265.50	158.25	107.25	22	21	7	0	10	3	
Sept.	267.25	31.25	236.00	22	19	5	2	7	6	
Oct.	151.50	25.00	126.50	18	17	4	4	6	6	
Nov.	28.75	6.00	22.75	7	4	1	3	0	0	
Dec.	6.00	1.00	5.00	3	0	0	1	0	0	
	1681.45	467.50	1214.25	170	124	31	12	48	27	
					a	b	c			Days of electric phenom. a + b + c.
1864	1541.25	434.75	1106.50	145	63	21	5	26	15	89
1865	1698.90	498.50	1200.40	157	71	32	9	21	13	112
1866	1716.00	377.25	1338.75	179	95	35	10	39	31	140
1867	1277.25	250.25	1027.00	119	99	25	18	20	13	142
1868	1435.00	492.50	942.50	179	106	29	28	40	30	163
1869	1681.45	467.50	1214.25	170	124	31	12	48	27	167

The remarkable increase of days of electric phenomena is not yet accounted for. Nothing has been changed in the mode of observing, or hours of observing, and all are personal observations. I may add, that for the last four years agriculture has been neglected in the mountains surrounding the town.

	Mean value of a rainy day in millim.						
	1863.	1864.	1865.	1866.	1867.	1868.	1869.
January.		0.37	4.08	6.36	12.81	0.25	2.97
February,		8.35	2.60	6.30	2.98	8.43	11.75
March,		10.07	6.48	13.57	4.55	5.78	7.77
April,		14.13	10.08	16.47	15.35	6.80	7.25
May,		15.34	18.80	12.58	18.98	12 70	18.12
June,		8.50	5.34	8.56	10.41	3.71	11.60
July,		7.77	10.30	10.03	6.03	3.29	6.10
August,	6.35	11.76	8.60	6.97	9.25	9.96	12.06
September,	7.53	12.63	14.90	6.57	7.53	11.75	12.15
October,	11.17	13.13	6.90	5.50	10.56	8.43	8.42
November,	7.00	4.70	17.60	11.40	4.21	6.93	4.11
December.	3.08	6.50	14.00	9.25	13.83	4.30	2.00

THE MOST RAINY DAY OF EVERY MONTH SINCE THE 1ST OF AUGUST, 1863.

	1863.				1864.				1865.			
	Date.	Diurnal or not.	Duration	Millim.	Date.	Diurnal or not.	Duration	Millim.	Date.	Diurnal or not.	Duration	Millim.
January,					31			0.75	12	n		7.00
February,					25	n		27.00	4	n		9.00
March,					16	n		58.00	23	n		24.00
April,					20	n	130 min.	58.00	23	n		40.00
May,					4	n		62.00	25	d and n	24 hours.	142.00
June,					28	n		43.00	20	d and n		22.00
July,					16	n		30.00	9	n		33.00
August,	3	d	32 min.	32.00	24	n		46.75	15	n		36.00
September,	18	n		37.75	3	n		35.00	24	n		80.00
October,	12	n		38.00	4	n	4 hours.	62.00	27	n		42.25
November,	2	n		17.50	25	d		13.50	21	d and n		59.25
December,	8	n		8.00	23	n		17.50	1	n		28.00

THE MOST RAINY DAY OF EVERY MONTH SINCE THE 1ST OF AUGUST, 1863—*Continued.*

	1866.				1867.				1868.				1869.			
	Date.	Diurn'l or not.	Duration	Millim.	Date.	Diurn'l or not.	Duration	Millim.	Date.	Diurn'l or not.	Durat'n	Millim.	Date.	Diurn'l or not.	Durat'n	Millim.
January,	17	n		17.25	7	n		34.75	19	d	1	0.25	28	d		7.50
February,	26	n	30 min.	23 75	9	n		12.00	26	n	135 min.	38.00	28	n		67.00
March,	31	n		36.75	14	n		15.00	12	n	45 min.	15.00	17	n		44.75
April,	1	n	105 min.	58.00	23	n		58.00	11	n	105 min.	36.00	9	n		60.00
May,	17	n		56.50	9	n		73.50	17	n	120 min.	57.00	9	d & n		134.00
June,	12	n		65.50	9	n		72.50	9	d	55 min.	13.00	22	d		*60.00
July,	15	d & n	4 h. 30 m.	48.00	4	d & n		31.50	3	n		11.00	29	n		20.00
August,	30	n	2 h.	23.25	22	n		33.25	22	n	55 min.	47.00	19	d & n		34.00
September,	2	n	1 h.	26.00	7	d		19.25	17	d	120 min.	64.00	13	n		72.00
October,	31	n		21.75	6	n		33.75	18	n		61.25	8	n		52.00
November,	25	d	3 h. 30	86.75	10	d	135 min.	16.00	7	d & n	90 min.	35.75	12	n		14.75
December,	21	n	2 h. 30	22.00	15	n		22.25	18	d		10.50	2	n		4.00

* Rain and hailstones.

TEMPERATURE.

	1864.							1865.						
	Mean monthly.	Monthly mean of minim.	Monthly mean of maxim.	Lowest minim.	Highest maxim.	Mean amplit'd.	Extreme amplit'd.	Mean monthly.	Monthly mean of minim.	Monthly mean of maxim.	Lowest minim.	Highest maxim.	Mean amplit'd.	Extreme amplit'd.
	°							°	°	°	°	°	°	°
Jan.	75.74							77.48						
Feb.	75.38							75.56						
March.	76.82							77.90						
April.	78.35							78.26						
May.	77.54							79.95						
June.	81.60							81.78						
July.	81.86							82.10	73.58	92.12	71.24	95.00	18.54	23.76
Aug.	80.87							81.94	73.58	91.04	69.80	97.34	17.46	27.54
Sept.	81.14							78.89	71.60	88.34	67.64	92.30	16.74	24 66
Oct.	80.42							79.88	71.96	88.34	68.54	91.04	16.38	22.50
Nov.	77.45							77.42	70.70	86.00	68.36	90.14	15.30	21.78
Dec.	75.65							77.10	68.00	86.00	65.12	88.88	18.00	23.76

	1866.							1867.						
	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Jan.	74.93	66.38	84.02	56.84	88 34	17.64	31.50	75.08	66.02	85.82	59.90	90.50	19.80	30.60
Feb.	77 00	68.18	86.54	63.68	89.96	18.36	26.28	76.50	66.56	87.80	61.88	91.04	21.24	29.16
March.	74.94	66.92	83.12	60.08	88.88	16.20	28 80	77.60	68.90	89.24	64.76	95.00	20.34	30.24
April.	77.10	68.54	85.64	66 38	89.60	17.10	22.22	79.55	70.52	90.68	67.64	95.36	20.16	27.72
May.	79.12	68.54	86.00	68.36	91.40	17.46	23.04	79.56	71.78	88.88	68.00	92.84	17.10	24.84
June.	80.30	72.32	90.32	69.08	95.90	18.00	26.82	80.37	72.50	91.22	68.36	95.00	18.72	26 64
July.	80.96	72.14	89.78	69.08	97.16	17.64	28.08	81.10	73.58	93.56	70.16	98.06	19.98	27.90
Aug.	82.05	73.58	92.48	69.44	98 24	18.90	28.80	81.63	73.22	93.56	70.16	97 70	20.34	27.54
Sept.	79.97	71.96	90.14	69.80	94.64	18.18	24.84	81.38	72.86	92.30	69.80	96.80	19.44	27.00
Oct.	78.92	71.96	88.88	69.80	93.20	16.92	23.40	80.80	69.98	90.68	69.80	96.80	20.70	27.00
Nov.	76.88	69.44	86.18	64.76	90.86	16.71	26.10	77.48	69.80	86.72	61.88	90.86	16.92	28.98
Dec.	75.20	67.28	86.00	59.72	90.32	18.72	30.60	76 30	65.84	88.16	57.20	90.50	22.32	33.30

Temperature—*Continued.*

	1868.							1869.						
	Mean monthly.	Monthly mean of minim.	Monthly mean of maxim.	Lowest minim.	Highest maxim.	Mean amplit'd.	Extreme amplit'd.	Mean monthly.	Monthly mean of minim.	Monthly mean of maxim.	Lowest minim.	Highest maxim.	Mean amplit'd.	Extreme amplit'd.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Jan.	76.46	64.94	88.70	56.48	93.20	23 76	36.72	76.60	66.38	88.52	59.36	91.40	22.14	32.04
Feb.	75.92	66.56	87.26	62.24	92.30	20.70	30.06	77.58	68.00	88.11	63.50	92.84	20.11	29.34
March.	76.43	67.64	86.36	62.60	91.40	18.72	28 80	77.27	69.28	86.72	64.22	92.30	17.44	28.08
April.	79.33	68.18	90.32	65.30	96.44	22.14	31.14	81.89	70.77	90.21	66.38	95.54	19.44	29.16
May.	78.87	68.36	89.96	67.10	94.10	21.60	27.00	81.69	71.69	91.01	66.74	97.70	19.32	30.96
June.	81.42	71.78	92.48	68.72	98.06	20.70	29.34	82 40	72.14	93.38	67.46	98.24	21.24	30.78
July.	83 84	75.74	95.36	70.34	100.40	19.62	30.06	81.54	71.65	93.54	68.00	98.24	21.89	30.24
Aug.	82.61	73.22	94.82	68.72	100.40	21.60	31.68	80.61	71.50	90.43	67.82	93.20	18.93	25.38
Sept.	78.71	71.24	89.06	67.64	94.64	17.82	27.00	80.96	71.93	89.85	69.62	93.74	17.92	24.12
Oct.	79.35	69.26	88.34	69.26	92.30	19.08	23.04	80.06	71.55	88.63	68.72	91.40	17.08	22.68
Nov.	76.91	68.90	86.72	61.52	91.40	17.82	29.88	78.19	69.46	88.07	64.04	91.40	18.61	27.36
Dec.	75.83	66.74	87.26	61.70	90.86	20.52	29.16	75.52	65.87	87.33	60.44	91.40	21.46	30.96

Mean Monthly Temper. of 6 years.

	°
January,	76.01
February,	76.32
March,	76.82
April,	79.09
May,	79.45
June,	81.30
July,	81.90
August,	81.63
September,	80.70
October,	79.90
November,	77.38
December,	75.94

Mean Annual Temperature.

	°
1864	78.57
1865	79.00
1866	78.12
1867	78.94
1868	78.80
1869	79.52
Mean annual of 6 years,	78.82

The Lowest and Highest Mean Daily Temperature for Every Month.

	1864.		1865.		1866.		1867.		1868.		1869.	
	lowest.	highest.	lowest.	highest.	lowest.	highest.	lowest.	highest.	lowest.	highest.	lowest.	highest.
January,	73°.22	78°.44	73°.40	80°.51	69°.44	78°.98	72°.55	78°.17	73°.04	79°.66	72°.36	78°.84
February,	72.14	77.90	71.60	78.44	72.23	79.25	74.01	78.44	72.91	79.11	75.36	80.26
March,	73.40	79.70	76.64	80.24	68.54	78.26	75.99	80.76	71.42	79.88	73.45	79.75
April,	75.92	80.42	74.66	80.06	74.12	80.06	77.72	81.67	75.43	84.06	78.16	84.11
May,	73.40	80.42	75.56	83.39	75.56	81.50	76.24	81.05	76.82	81.05	74.70	86.07
June,	77.99	84.99	79.88	85.10	77.90	82.76	76.86	85.59	75.22	85.59	78.63	85.35
July,	78.15	85.32	77.99	84.65	78.08	83.66	78.04	85.95	78.08	86.11	78.06	85.57
August,	77.63	85.10	78.62	86.18	78.08	84.65	74.17	84.92	79.70	86.77	77.88	83.53
September,	78.62	84.11	75-11	81.41	76.82	83.51	76.01	84.20	75.94	81.39	79.26	83.21
Obtober,	74.39	81.86	77.18	81,23	77.02	81.50	78.26	84.38	75.83	82.96	77.76	81.64
November,	74.07	80.45	75.74	79.70	74.06	79.50	73.74	80.92	72.09	79.75	75.88	79.77
December,	72.65	78.25	73.94	80.06	71.06	78.33	71.78	79.88	73.40	77.99	72.63	77.99

Mean Monthly Temperatures for every hour—Year 1868.

	mid-night	h 13	h 14	h 15	h 16	h 17	h 18	h 19	h 20	h 21	h 22	h 23	noon.	h 1	h 2	h 3	h 4	h 5	h 6	h 7	h 8	h 9	h 10	h 11	mid-night
January,	71.24°	70.70°	69.62°	68.72°	68.00°	67.46°	67.28°	68.36°	73.40°	77.00°	81.86°	84.38°	85.64°	86.18°	86.54°	86.18°	84.92°	82.22°	79.16°	76.46°	75.38°	74.30°	73.40°	72.50°	71.24°
February,	71.60	70.70	69.80	69.08	68.72	68.18	67.28	68.00	73.58	77.00	80.24	82.40	84.02	84.38	84.20	83.66	83.30	80.42	78.44	77.00	75.92	74.84	73.76	72.86	71.60
March,	72.68	71.96	71.78	71.06	70.52	69.62	68.90	70.52	75.02	78.08	80.24	82.40	83 66	83.66	83.84	83.30	82.40	80.78	78.44	76.46	74.84	74.30	74.12	73.40	72.68
April,	75.38	74.84	74.30	73.58	73.04	72.50	71.42	73.58	79.16	81.86	83.84	85.46	86.90	86.54	86.72	86.18	85.46	82.76	83.30	78.80	77.54	76.82	76.28	75.92	75.38
May,	74.12	73.40	72.68	72.14	71.78	71.42	71.24	76.10	80.06	82.94	84.74	86.00	86.18	85.28	85.64	86.00	84.56	83.84	82.22	79.52	77.72	76.46	75.20	74.48	73.94
June,	77.18	76.46	75.74	74.66	74.12	73.58	73.76	77.72	81 68	84.38	86.54	87.98	89.06	89.60	89.24	88.34	87.44	86.36	84.20	81.50	80.24	79.52	78.80	78.08	77.36
July,	80.78	80.06	79.34	77.90	77.42	77.18	77.00	79.34	82.94	85.64	88.34	90.32	91.58	92.12	91.94	91.40	89.96	88.16	86.00	82.58	81.50	80.60	79.70	78.80	77.90
August,	77.72	77.00	76.28	75.74	75.02	74.48	73 94	77.36	82.04	86.18	88.88	90.32	91.04	90.68	90.86	90.32	89.24	87.62	85.28	82.58	81.14	79.70	78.98	78.26	77.54
September,	74.66	74.30	73.94	77.22	72.86	72.50	71.78	73.40	77.72	81.14	84.02	85.64	86.54	86.18	85.46	85.10	84.56	83.66	80.60	78.44	76.82	76.10	75.56	75.02	74.30
October,	76.28	75.92	75.38	74.66	73.94	73.22	72.14	73.22	77.18	80.78	83.48	85.46	86.72	86.90	86.90	86.18	85.28	84.20	81.14	79.52	78.44	77.54	77.18	76.82	76.28
November,	73.40	73.22	72.68	72.32	71.96	71.06	70.16	70.16	74.30	77.54	80.24	82.40	83.84	84.74	84.38	83.84	83.30	80.96	78.44	76.28	75.20	74.30	74.12	73.58	73.22
December.	72.14	71.96	71.42	70.70	70.16	69.80	68.18	69.08	72.14	76.28	79.52	82.22	83.84	84.56	84.74	83.30	82.40	80.78	77.36	75.92	74.66	73.40	73.04	72.32	72.14
	74.76°	74 21°	73.58°	72.81°	72.29°	71.75°	71.09°	73.07°	77.44°	80.74°	83.49°	85.41°	86.59°	86.74°	86.70°	86.15°	85.24°	83.48°	81.21°	78.75°	77.45°	76.49°	75.84°	75.17°	74.46°

Unusual days. Temperature of days entirely rainy.

1867. August 27.	75.02°	74 30°	74.30°	74.84°	75.20°	75.56°	76.28°	76.64°	74.48°	73.94°	73.94°	74.30°	73.76°	73.76°	73.94°	73.94°	73.76°	73.76°	73.40°	73.04°	72.68°	72.68°	72.68°	72.68°	72.32°
" September 10.	81.50	80.06	81.32	81 14	81 68	81.86	75.92	74.30	73.22	75.20	77.00	77.36	78.98	78.08	75.74	74.48	74.12	73.40	72.68	73.04	72.68	72.50	72.50	71.96	72.14
1868. June 4.	75.20	75.56	75.56	75.20	75.20	75.02	74.30	73.36	74.48	74.66	75.38	74 12	74.48	75.02	76.46	76.46	76.68	76.28	74.30	74.30	74.66	75.20	75.38	75.74	75.74

Mean Monthly Factors for obtaining the Mean Daily Temperature with the Absolute Maxim. and Minim. only.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1865	0.5322	0.4452	0.4019	0.4586	0.4698	0.4645	0.4790	0.4792	0.4322	0.4272	0.4429	0.4797	0.4594
1866	0.4803	0.4782	0.5026	0.4473	0.4610	0.4440	0.4404	0.4580	0.4451	0.4064	0.4366	0.4241	0.4520
1867	0.4496	0.4706	0.4580	0.4476	0.4545	0.4265	0.4356	0.4180	0.4363	0.4775	0.4415	0.4627	0.4482
1868	0.4790	0.4562	0.4667	0.4446	0.4829	0.4620	0.4138	0.4410	0.4173	0.4933	0.4549	0.4341	0.4538
1869	0.4626	0.4778	0.4775	0.5753	0.5516	0.4832	0.4503	0.4749	0.5013	0.4878	0.4651	0.5141	0.4965
Mean of 5 years.	0.4807	0.4656	0.4611	0.4747	0.4840	0.4560	0.4438	0.4542	0.4464	0.4584	0.4182	0.4629	0 4613

The above factors have been calculated for every day in the year, and the mean taken for every month.

If the absolute daily maxim. and minim. are taken only, their half-sum will not represent the true mean daily temperature. The following well-known formula will represent it: (Max—Min) × f + min. = mean daily.

Breguet's instrument having given the mean daily temperature by 24 equidistant observations, and the absolute maxim. and minim. having also been observed, the factor f was obtained by the formula.

$$f = \frac{(\text{mean—min.})}{(\text{maxim.—min.})}$$

Highest temperature observed since 1859. 100°.40 on the 15th August, 1868, between 0^h and 1^h.
Lowest do do do 56.48 on the 28th Jan. 1868, at 6 o'clock, A. M.

Greatest difference observed between free temperature and exposed to sun, 22° 32.

Highest temperature exposed to the sun observed, 115° 16, 1866, August 1st., the free temperature being 94°64, at the same time a thermometer with ivory scale, lying on a piece of board, marked 120°.

Greatest difference observed between free temperature and exposed to radiation at night, 10° 45.

MEAN ATMOSPHERIC PRESSURE AT NOON, DEDUCED FROM EVERY DAY'S OBSERVATIONS MADE AT NOON, AND REDUCED AS STATED IN THE INTRODUCTORY REMARKS.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean Annual at Noon.
1865	763.19	764.33	764.09	762.90	761.70	762.82	763.33	761.72	761.14	760.36	761.19	763.06	762.48
1866	4.39	4.74	4.39	3.41	2.09	3.25	3.20	2.35	2.32	0.03	1.41	3.10	2.89
1867	4.14	4.31	3.32	2.76	1.75	2.04	3.07	2.06	2.02	0.83	2.47	3.54	2.69
1868	4.12	3.75	3.62	3.80	2.58	2.99	3.24	2.84	2.07	1.40	1.59	3.80	2.98
1869	3.31	3.50	4.28	3.53	2.36	3.58	3.70	2.63	1.95	0.89	1.80	2.43	2.83
Mean of 5 yrs.	763.83	764.12	763.94	763.28	762.10	762.93	763.31	762.32	761.90	760.70	761.89	763.19	762.77

Mean Annual Barometrical Oscillation, 10 50 m.m.

Greatest oscillation in five years occurred in 1866, 13.94 m.m.

MEAN DAILY VARIATION, 1867, 1866, 1865, FOR EVERY MONTH COMPARED WITH NOON, IN MILLIMETERS.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Max. of A. M.	+ 1.47	+ 1.46	+ 1.28	+ 1.06	+ 0.90	+ 0.87	+ 0.75	+ 1.00	+ 1.08	+ 1.30	+ 1.34	+ 1.53
Minim. of P. M.	— 1.49	— 1.60	— 1.52	— 1.46	— 1.33	— 1.19	— 1.04	— 1.09	— 1.13	— 1.09	— 1.12	— 1.15
Mean Daily Ampl.	2.96	3.06	2.80	2.52	2.23	2.06	1.79	2.09	2.21	2.39	2.46	2.68

Monthly Amplitude of Atmospheric Pressure.

	Highest stand of Barometer.			Lowest stand of Barometer.			millim. monthly amplitude.	Remarks.
	date.	hour.	millimeter.	date.	hour.	millimeter.		
1865.								
Jan.	31	10h A M	767.19	23	3h P M	759.61	7.58	
Feb.	23	9½ "	767.33	20	5 "	760.15	7.18	
March.	13	10 "	767.70	24	4 "	760.30	7.40	
April.	21	9 "	767.00	26	4 "	758.91	8.09	
May.	5	9 "	764.83	23	4 "	757.33	7.50	
June.	28	9½ "	764.75	19	4 "	760.40	4.35	
July.	7	9 P M	765.70	5	3 "	761.07	4.63	
Aug.	30	9½ A M	763.75	16	4 "	758.85	4.90	
Sept.	4	8h P M	764.07	28	5 "	758.73	5.34	
Oct.	31	10h A M	763.39	2	4½ "	758.00	5.39	
Nov.	29	9½ "	763.85	10	4 "	758.19	5.66	
Dec.	18	9 "	766.59	6	4 "	759.69	7.03	
1866.								
Jan.	12	9¾h A M	769.10[1]	26	3½h P M	760.78	8.32	[1] The highest barom. stand observed between 1863 to 1870.
Feb.	17	9 "	768.80	11	4 "	761.28	7.52	
Mar.[2]	12	9½ "	767,13	31	3¾ "	762.10	5.03	[2] Mar. 4 days without barom. observations
April.	1	9 "	765.10[3]	18	4¼ "	760.98	3.92	[3] On some days the max. A M unobserved
May.	6	9½ "	764.36[4]	25	4¼ "	758 81	5 55	[4] Same remark.
June.	29	10 "	764.75[5]	23	3½ "	760.45	4.30	[5] Same rema.k.
July.	21	10 "	765.07	3	3¾ "	760.49	4.58	
Aug.	6	10 "	764.83	30	3¾ "	758.56	6.27	
Sept.	8	10 "	764.83	30	1¼ "	755 16[6]	9.67	[6] The lowest stand between 1863 to 1870. Great hurricane U. S. coast.
Oct.	14	9¾ "	762 65	7	4¼ "	757.95	4.70	
Nov.	3	10 "	763.95	6	3¾ "	757.70	6.25	
Dec.								
1867.								
Jan.	28	8¾h A M	768 06	20	3h P M	758.74	9.32	
Feb.	1	7 "	767.00	15	4½ "	760.50	6.50	
March.	5	9½ "	766.05	22	4 "	759.85	6.20	
April.	14	9½ "	765.54	22	4 "	759.47	6.07	
May.	12	10 "	763.33	8	4 "	758.60	4.73	
June.	28	9 "	765.86	9	4 "	758.50	7.36	
July.	6	9 "	765.34	30	0½ "	759.38	5.96	
Aug.	11	6½ "	764.75	3	4¾ "	759.64	5.11	
Sept.	30	7½ "	763.81	7	3¼ "	759.82	3.99	
Oct.	1	7½ "	764.62	14	4 "	757.47	7.15	
Nov.[7]	5	7¾ "	766.42	9	3¼ "	760.19	6.23	[7] From 23 to 28 Nov. no barom. observat.
Dec.	21	9½ "	766.37	12	3¼ "	760.72	5.65	

Certif. ten pages to be conform to the registers of the Meteorological Station of Port-au-Prince.

Prof. A. Ackerman.

Stated Meeting, September 16, 1870.

Mr. T. P. JAMES in the Chair.

Present, six members.

Letters accepting membership, were received from Dr. William Pepper, dated 1215 Walnut Street, Philad., July 16; Dr. William Boeckh, dated Christiana, Monday, Aug. 11th; Dr. E. R. Beadle, dated 212 south Eighth Street, Philadelphia, Sept. 7th, 1870.

Letters acknowledging the receipt of the Society's publications, were received from the Russian Geographical Society (79, 80); the Austrian Academy (78, 80); the Cambridge Philosophical Society (XI.ii); and the Cincinnati Observatory (82, 83).

Letters of Envoy were received from the Russian Geographical Society; the Austrian Academy; M. Dora d'Istria; and the United States Naval Observatory.

Donations for the Library were received from M. Prudhomme de Borre, of Brussels; the Geographical Society and Cours des Sciences, at Paris; the British Association; London Meteorological and Geological Societies; Cambridge Philosophical Society; Canadian Naturalist; Silliman's Journal; Prof. C. H. Hitchcock; the Medical News; Penn Monthly; Howard University; and the United States Naval, and Cincinnati Observatories.

On motion, the Howard University was placed on the list of correspondents to receive the Proceedings.

On motion, Prof. Cope's "Eight Contribution, &c.," was ordered to be published in the Proceedings. (See page 553).

Pending nominations 651, 652, 654, 655, and new nominations 660, 661, were read.

And the Society was adjourned.

Stated Meeting, October 7th, 1870.

Mr. Fraley, Vice-President, in the Chair.

Present, sixteen members.

A letter was received from Dr. Goodwin, accepting his appointment to prepare an obituary notice of Mr. Merrick.

A letter acknowledging the receipt of Proceedings 81 and 83, was received from the McGill University, Montreal.

A photograph for the Album was received from Mr. Samuel Foster Haven, of Worcester, Mass.

A letter from M. Carlier, dated Great Coram St., No. 31, near Brunswick Square, London, Sept. 15th, to Mr. Durand, was read, to inform the Society of the fact that he had received the Extrait d'Inscription au Grand Livre, No. 148, 986, Serie 7*éme* rente, 2778; au nom: Philadelphie (La Société Philosophique Americaine), &c.

Donations for the Library were received from the Italian Geological Committee; the London Linnean Society; the Nova Scotian Institute of Natural Science; the Cambridge Museum of Comparative Zoology; and the U. S. R. R. & Mining Register, of Philadelphia.

A donation for the Cabinet was received from Mr. J. A. McNeill, consisting of a Cap worn by the natives of Chiriqui, made of the sheath of the Coible Galen nut.

The decease of Judge Robert C. Grier, a member of the Society, was announced with appropriate remarks, by Judge Strong. On motion of Mr. Price, Mr. Aubrey H. Smith was appointed to prepare an obituary notice of the deceased.

Mr. Cope presented for publication in the Transactions, a Memoir on the Ichthyology of the Antilles, which was referred to a committee consisting of Dr. Leidy, Dr. Bridges, and Dr. Rushenberger.

Dr. Brinton described and proposed the purchase of two rare works now for sale in London—one a Maraho Mexican theological work and grammar, the other a Moska New Granada grammar. The subject was referred to a committee, consisting of Dr. Brinton, Mr. Hopper and Mr. Price.

Mr. McNeil was then introduced by Prof. Cope, and gave a sketch of his explorations in Central America, undertaken for the Peabody Institute, in Salem, and for the Kent Scientific Institute, at Grand Rapids, Michigan, and his plan for a fifth expedition, to explore ruined cities on the river which flows into the Chiriqui lagoon. With $1,200, he could carry on his researches for six months, and send to the Society which employed him, objects of antiquarian, ethnological, and natural history interest.

Dr. Brinton said it was unexplored territory. No stone monuments were known so far south. They were valuable as furnishing possibly a key to the connexion between the Mexican, Central American and Peruvian stone monuments.

Prof. Cope exhibited the remains of a new Cretaceous tortoise, of the genus *Adocus* Cope, to be called *A. syntheticus*. He explained that he had been able to establish more fully the characters of the genus Adocus; that it was found to possess an intergular shield, as in the Pleurodira, but had not the sutural union of the inferior pelvic elements with the plastron, characteristic of that type. These characters had been heretofore known as correlatives in the order, from the Cretaceous period to the present time, and that this genus presented us with the first exception to the rule. The genus was therefore regarded as a generalized type, and typical of a new family, the *Adocidæ*.

He also made some observations on the metatarsal region of *Laelaps aquilunguis*, exhibiting the first example found, and said it proved the distinctness of those elements from each other in that genus, and their slender collective proportions. The specimen was an external one, without trace of a rudimental one on its outer face. That its measurement, 10 inches, was indicative of a length of 18 inches for the median metatarsus, a length he had already assigned to it on theoretical grounds.

Nominations Nos. 651, 652, 654, 655, 660, 661, and new nominations Nos. 662, 663, were read.

And the Society was adjourned.

Stated Meeting, October 21, 1870.

Dr. EMERSON in the Chair.

Present, seven members.

Dr. Brinton stated that the Choctaw Grammar, recently published by the Society, is being translated into German. It appears from two letters recently received from Dr. Berendt, at present prosecuting his researches into the Maya language and history in Central America, that he has added an additional amount of knowledge of the subject equal to that which was possessed before.

Prof. Cope read a paper on the Osteology of Megaptera Bellicosa, one of the few whalebone whales of economic value found within the tropics. He gave a detailed account of the structure of a specimen from the island of St. Bartholomew, W. I., and its variations from known species of Megaptera, especially in the forms of the mandible and nasal bones.

Dr. Emerson read a paper on the part taken by the American Philosophical Society and Franklin Institute in establishing stations for meteorological observations, detailing arrangements for procuring full reports from fifty-two points in the State of Pennsylvania. He spoke of the important bearing which those efforts had had upon the present state of meteorological science:

In February last, the Congress of the United States passed a law for instituting meteorological observations throughout the country by means of Government telegrams. This duty has been assigned to the War Department, and active measures are now in progress to carry out the objects contemplated by the act of our National Legislature.

Through the medium of a pamphlet issued by the Signal Officer appointed by the War Department, we are informed that stations for making observations have already been designated throughout all of our States and Territories, from the Atlantic to the Pacific. By such means, we shall soon be put in possession of data for determining the conditions of the atmosphere over a vast region, and enabled to trace the boundaries and progressive movements of storms and tornadoes, which, generally following definite courses, may have their coming anticipated through storm signals.

Such utilization of simultaneous meteorological observations, with immediate transmission by the magnetic telegraph, is now carried on in England and most parts of Europe, including Norway, Denmark, Holland, Belgium, Prussia, Austria, France, Italy, and throughout the Russian Empire. At your breakfast table in London, Paris, or any other of the principal cities of Europe, you can now read in the *Times*, *Galignani*, and other leading newspapers, the condition of the weather almost at the same hour in the morning, in every part of Europe.

More than thirty years ago, a very active interest was taken in this country, and especially in this city, in regard to meteorological investigations, and especially those relating to the origin and progression of storms. Espy, Redfield, Loomis and Olmstead, on this side of the Atlantic, were the most prominent leaders in the investigations carried on.

The work was not, however, left entirely to individuals, but learned societies engaged in it. In this city, a "*Joint Committee on Meteorology*" was instituted, consisting of four members of this Society and five members of the Franklin Institute, which for several years labored in the collection of observations, and other measures calculated to promote the advancement of meteorological knowledge, and the programme of their plans was almost identical with that now proposed to be carried out under the auspices of Government.

The primary meeting of this "Joint Committee" was held on the 9th of September, 1834, and the first project set on foot by it was the establishment of competent observers, in different parts of our State and country, to make simultaneous observations of the conditions of the weather, the occurrence of storms of rain, hail or snow, the direction of the wind and atmospheric currents, quantities of aqueous precipitations, movements of the barometrical column, temperature, &c.

Of the nine members of this "Joint Committee" when first appointed, I find myself the only survivor; and it seems to me a duty I owe to the Society by which I was appointed, to bear testimony to its former efforts for the advancement of meteorological science—efforts made at a time when the only means of transmission was by the tardy and costly mail service, now superseded by the marvellous capacities combined in the magnetic telegraph.

For carrying out the projects of the "Joint Committee" money was needed. This could not be advanced by our Society, then in a condition of pecuniary embarrassment, nor by the Franklin Institute, which, strange to say, in this great city, where it should be cherished as a grand capitol of the industrial arts creating most of wealth, has always been comparatively poor.

In this dilemma, application was made to the Legislature of our Commonwealth, from which liberal appropriations in money were obtained for our use, $4,000 at one session, and $3,000 at another. Some of this money was used by the "Joint Committee" to defray expenses incurred in printing, corresponding and collecting reports. The largest portion, however, was spent in supplying each of the fifty-two counties then in the State, with a set of instruments, consisting of a barometer, two thermometers (one self-registering), and a rain-guage.* The manufacture and distribution of these instruments was all entrusted by the Committee to my own supervision. Most, if not all, of these instruments doubtless exist at the present day, in the court-houses or academies in the counties to which they were sent.

At the time to which I refer, I was much devoted to meteorological investigations, and for several years delivered lectures on meteorology, before the class of the Franklin Institute. I made observations several times a day, noting the atmospheric changes as to density, temperature, dew-point, winds, aqueous precipitations, &c. &c. It was whilst so engaged, that I made a communication to this Society, relative to the inapplicability, in this country, of the prognostic words inscribed on the scale-plates of European barometers, such as *fair*, *set fair*, *rainy*, &c., which generally indicate the reverse of the prognostic on this side of the Atlantic, where the barometer has never acquired any high degree of credit as a weather-glass. "Stormy" is, perhaps, the only inscription which might be retained for both sides of the Atlantic at or near the sea-level.

In the course of my observations, I found that storms from the north and north-east were generally preceded by high risings in the barometer, especially during the winter months. This observation was recognized as original by Sears C. Walker, a distinguished member of this Society, and by Mr. Espy, who regarded it as one of the main supports of his theory of storms. My communication upon these subjects, I suppose, still exists among the manuscripts in the archives of this Society. In reference to the barometers made for distribution in this State, it is worthy of notice that they do not contain the European inscriptions on their scale plates, "fair," "set fair," &c., which, as I have already stated, are calculated to mislead observers on the western side of the Atlantic, and bring the instrument into discredit. Another reason for omitting the inscriptions exists in the fact, that many of the barometers went to points in the State so greatly elevated as to render deceptive and useless any inscriptions made on scales graduated from the sea level. The main consideration of the Committee was to ascertain the fluctuations of the mercurial column as influenced by atmospheric conditions.

In pursuing his investigations concerning the phenomena connected with the origin and movements of storms, tornados, and water-spouts, Mr. Espy was chiefly indebted for his data to the materials brought together by the labors of the "Joint Committee," from which he was enabled to map the courses of many remarkable storms, hurricanes and water-spouts, which drew marked attention from men of science at home and abroad.

In 1840, Mr. Espy went to Europe, and laid his views before the British

*The original standard barometer and thermometer from which the other instruments were graduated, are now in the possession of the Frank

Directions to Observers accompanying First Circular of Joint Committee.

Days.	Hour.	Temperature of Air.	Temperature of Wet Bulb.	Dew Point.	Course of Wind.	Lower Strata of Clouds.	Middle Strata of Clouds.	Upper Strata of Clouds.	Strength of Wind.	Weather.	Beginning of Rain.	End of Rain.	Barometer.	Observations.

Scientific Association, accompanied by numerous maps and diagrams. His communication elicited great interest, and, after its reading, was discussed by some of the most eminent men in the grand Scientific Congress, among whom were Professors Forbes and Phillips, and Sir David Brewster.

Mr. Espy also visited Paris, and communicated his views to the French Academy, by which a committee was appointed to report upon the subject, consisting of Messrs. Arago, Pouillet, and Babinet. A report was made at considerable length, containing a beautiful analysis of Mr. Espy's theory, with conclusions extremely flattering to our countryman. This, with the paper read before the British Association, may be found in Mr. Espy's treatise on the Philosophy of Storms—a work which contains much of the information collected by the "Joint Committee" in a condensed form.

I cannot conclude this communication without expressing my opinion, that a strong and very effective impulse was given to meteorological investigations at home and abroad by the combined efforts of this Society and its associate, in organizing that system of simultaneous meteorological observations which has since been spread over the European continent, and is now resumed in our own country under the most favorable conditions.

In claiming for our Society the credit fairly due for its efforts formerly made in the cause of meteorology, I do not wish to derogate from the just claims of other institutions or individuals who have been working earnestly in the same field of philosophical research. Any proper notice of even one of these—the Smithsonian Institute, for example—would lead me beyond the just limits of a communication adapted to the usual order of business established by this Society.

The names appended to the first Circular issued in September, 1834, by the "Joint Committee," were

James P. Espy, *Chairman*,
Gouverneur Emerson, M. D.,
C. N. Bancker,
Alexander D. Bache,
Committee of American Philosophical Society.

James P. Espy,
Alex. D. Bache,
H. D. Rogers,
S. C. Walker,
P. B. Goddard, M. D.
Committee of Franklin Institute.

Mr. Briggs made some remarks on the results in meteorology obtained by Prof. Henry twelve years ago.

Pending nominations, Nos. 662 and 663 were read.

After balloting for Candidates for Membership, the following named gentlemen were declared to be duly elected members of the Society:—

Mr. Henry F. Q. D'Aligny, of New York.
Mr. William P. Blake, of New Haven, Conn.
Mr. George L. Vose, of Salem, Mass.
Mr. J. Imbrie Miller, of Pennsylvania.
Mr. Eckley B. Coxe, of Philadelphia.

And the Society was adjourned.

Stated Meeting, Nov. 4th, 1870.

Vice-President, Prof. Cresson, in the Chair.

Present, eight members.

Letters were read from Nassau Hall and Yale College, acknowledging the receipt of Proceedings and Transactions.

The following letter was received from the Philadelphia College of Pharmacy, transmitting copies of resolutions adopted by them on the subject of the establishment of a Botanic Garden in Fairmount Park, and asking concurrence, and the appointment of a committee.

Philadelphia, *Nov.* 2d, 1870.

Sir:—

In accordance with instructions, it is my agreeable duty to communicate to you the following action of the Philadelphia College of Pharmacy.

At a Stated Meeting of the Board of Trustees of the Philadelphia College of Pharmacy, held November 1st, the following Resolutions were unanimously adopted:—

"*Resolved*, That a Committee of three be selected to confer with the Park Commissioners, in conjunction with other Committees that may be appointed for the same purpose, in reference to the establishment of a Botanical Garden in Fairmount Park."

In accordance with the above Resolution, the following Committee was selected :—

Prof. William Proctor, Jr.,
Prof. Robert Bridges, M. D.,
Prof. John M. Maisch.

It was also *Resolved*, "That the Secretary be directed to communicate the action of this College to the President of the Park Commissioners, to the Horticultural Society, and to the American Philosophical Society."

I have the honor to be

Yours, respectfully,

ALFRED B. TAYLOR,
Secretary.

To Prof. George B. Wood, M. D.,
President of the American Philosophical Society.

A letter transmitting a donation for the Library, was received from Mr. Abbe, of the Cincinnati Observatory.

Dr. Lea took the Chair, and Prof. Cresson described the recent auroras, of one of which he presented for publication in the Proceedings, the following account:—

An Auroral display occurred on the evening of the 24th of October, observed from half-past eight o'clock. A faint Auroral arch was visible to the north, extending from Cor Caroli, which was just setting, nearly to Castor, which was just rising, the elevation of the arc being equal to that of star Dubhe, in Ursa Major, which was nearly at its lowest culmination. At the same time, a band, of ten degrees in width, of pink auroral light, spanned the heavens, apparently on an arc of a great circle, extending from the northwestern point, where the Northern Crown was setting, to a point in the east, where Bellatrix, in Orion, was just rising, and passing through Menkar, in the head of the Whale, south of Aries, through Pisces and Aquarius, through the Dolphin, through the Eagle, with Altair near the centre of the band, south of Lyra, and through the head of Hercules. The average width of the luminous belt was about ten degrees, its median line corresponding very nearly with the celestial equator.

Dr. Emerson informed the Society that the earthquake of October 20th, 1870, was felt in Canada, the New England States and New York. The strongest manifestations of it were along the St. Lawrence River, and especially on the shores of the Gulf of St. Lawrence, where the shocks were reported so severe as to occasion some loss of life. In certain quarters of New York city no movements were noticed, but in others shocks were felt to an alarming extent, driving people from their houses and workshops, and children from the public-school rooms, into the street, with a sensation of nausea or sea-sickness. Walls were cracked, clocks were stopped, articles were thrown from tables, steeples vibrated. See detailed account in the Scientific American of October 29th.

Pending Nominations Nos. 661, 662 and 663, and New Nominations Nos. 664 and 665 were read.

Prof. Wood offered the following resolution, which was adopted:—

Resolved, That a Committee be appointed to act with Committees that may be appointed by other Societies, in the matter of procuring the establishment of a Botanic Garden in Fairmount Park.

Prof. H. C. Wood, Prof. Jos. Carson, and Mr. Durand, were appointed said Committee; and, on motion of Mr. Price, the President, Dr. G. B. Wood, was added to the Committee.

By request of Mr. Cuyler, who had been obliged by another engagement to retire from the meeting, Mr. Price asked that notice be given on the cards for the next meeting, that Mr. Cuyler will then present a proposition for the removal of the Society to Fairmount Park, with the view of obtaining an expression of the opinion of the members as to the expediency of such removal.

And the Society was then adjourned.

Stated Meeting, Nov. 21st, 1870.

Vice-President, Mr. Fraley, in the Chair.

Present, twenty-four members.

Letters accepting membership were received from Mr. Geo. L. Vose, dated Minneapolis, Minn., Nov. 14th, 1870, and Mr. Wm. P. Blake, dated New Haven, Conn., Nov. 18th, 1870.

A letter acknowledging receipt of diploma of membership, was received from Mrs. Mary Somerville, dated Naples, Oct. 26th, 1870.

Letters acknowledging the receipt of the Society's publications, were received from Sir J. F. W. Herschell (series); Mr. R. W. Fox (82); Leeds Phil. Soc. (83); Rhode Island Hist. Soc.; Georgia Hist. Soc.; Peabody Inst.; and Essex Institute (all 84); the Belgian Academy (XIII. 3; and 78, 79, 80, 81); Amherst College (asking for deficiencies to be supplied); New York Lyceum; N. H. Mass. Hist. Soc.; Howard College; New York State Library; and Penna. Hist. Soc. (all XIV, 2, and 84).

Letters of envoy were received from the Belgian Acad., May 30; Holland Soc., July 1st (asking that deficiencies in their series be supplied); Royal Geographical Soc., June 1; and the Ulm Art and Antiquity Union, March 6th, 1869, requesting an exchange of publications. On motion, the Ulm Art and Antiquity Union was ordered to be placed on the list of correspondence to receive the Proceedings.

Donations were received from M. Zantedeschi, of Padua; M. Finzi, of Florence; the Ulm Union; Judge Lowrie; the London R. Astron. Soc.; Mr. John Tyndall; Mr. John Lewis Peyton, of London; Prof. E. Loomis, of Yale College; New York Lyceum N. Hist; Prof. T. Eggleston, Jr.; the Albany Institute; Franklin Institute; and the Minnesota Historical Society; which, on motion, was ordered to be placed on the list of Correspondents to receive the Proceedings regularly.

The Committee to which was referred Prof. Cope's Memoir on the Ichthyology of the Maranon, reported in favor of its being published in the Proceedings, with wood-cut illustrations, which, on motion, was so ordered.

Dr. Wm. Pepper read the following Obituary notice of Sir James Copland:—

OBITUARY NOTICE OF THE LATE JAMES COPLAND, M. D.

Read by Dr. William Pepper, before the American Philosophical Society, Philadelphia, Nov. 21, 1870.

It would be amiss to occupy any large share of the time of the Society by a lengthy eulogy upon the wise man, whose death has furnished the occasion of my remarks; yet in some respects the life of James Copland presented more of variety and vicissitude than falls to the lot of most students or practitioners of medicine. He was born in the Orkney Islands in November, 1791, and was the eldest of nine children. His early education was conducted at Lerwick, one of the Shetland Islands, but at the early age of sixteen, having decided to adopt the profession of medicine, he repaired to the justly renowned University of Edinburgh, where he continued four years. In 1815, at the age of twenty-four, having obtained his diploma, he turned his footsteps towards London, following the example of a long list of distinguished predecessors. It is certainly strong testimony to the high standard of requirements, the great educational facilities, and the distinguished abilities of the Faculty at the University of Edinburgh, during the latter half of the last century, that so many of her graduates attained the highest eminence. It was to this school that we owed our own Kuhn, Rush, Morgan, Shippen, Wistar, and Physick, and many of the most successful and distinguished Physicians in London had migrated there from Edinburgh. Of all these eminent men not one sought the metropolis with a better equipment of vigorous health, strong and well trained mental powers, and indefatigable energy than Copland.

Still he did not succeed in establishing himself there immediately, but within a few months after his arrival in London, crossed the channel to Paris, and spent two years in study at the French and German schools. Upon his return to London in 1817, he became one of the Health officers of the African Company, and spent twelve months on the Gold Coast. While there both his own exceptionally robust constitution and wide experience in the treatment of fever and dysentery, underwent a severe trial, for not only was he obliged to treat and nurse almost the entire ship's crew in an attack of yellow fever, but, after accomplishing this arduous duty, he was himself seized and was dangerously ill. He subsequently returned to England, but after paying a brief visit to his Orcadian home, he again crossed to France and spent some months in attendance on the Parisian Hospitals.

It was not until 1820 that Copland, at the age of twenty-nine years, finally settled in London, and commenced an unbroken course of fifty years' laborious study and practice. From this time his success was steady and uniform. In 1820 he was appointed Physician to the Royal Infirmary for Diseases of Children, a post which he subsequently changed for Senior and finally for that of Consulting Physician. In 1823 he was elected Consulting Physician to Queen Charlotte's Lying-in Hospital. He was also sometime Physician to the South London Dispensary. His practice increased quite rapidly, and for many years before his death was among the largest and most lucrative in London. The professional honors which he received were numerous and distinguished. In 1833 he was made a Fellow of the Royal Society; in 1837 a Fellow of the Royal College of Physicians; in 1838 he was Gulstonian Lecturer; in 1841, 1842, and 1861 he was Censor of the College; Croonian Lecturer in 1844, 1845, 1846; seven times Councillor between 1844 and 1863; Lumleian Lecturer in 1854 and 1855; and Harveian orator in 1857; in 1853 he was elected President of the Royal Medico-Chirurgical Society. He was also honored by being made a member of many learned societies out of England; and in Jan. 17, 1845, was elected a member of the American Philosophical Society at Philadelphia.

Despite, however, the arduous practical duties of his profession he was indefatigable in literary labors. He edited the "London Medical Repository" for five years from 1822 to 1827, and contributed to it a vast number of articles He also edited Richerard's Physiology in 1824; contributed notes to Griffith's translation of Cuvier's "Animal Kingdom;" assisted in the preparation of Annesely's magnificent work on the Diseases of India, to such an extent that it is stated by one well informed that he may be considered its author. His occasional articles are too numerous to mention, but the great work of his life was his colossal "Dictionary of Practical Medicine." The idea of such an enterprise occupied his attention as early as 1827, and he then issued a prospectus of a plan for bringing out an "Encyclopedial Dictionary of Medical Science." The undertaking was not accepted by the publishers, however, though they subsequently entered into an arrangement with Drs. Forbes, Conolly, and Tweedie, which resulted in the publication of an excellent Medical Encyclopedia.

Copland was not to be thus thwarted in his plan, and accordingly in 1830 he began, single-handed and unaided, the task of writing a similar work. The first part of this truly great work appeared in 1832, and others followed in regular succession, so that the greater part of it was published in the first three years, though the last two parts composing the Dictionary did not make their appearance until 1860, twenty-eight years after the first part. The entire work comprises about 7,000 closely printed double-columned royal octavo pages. The success of this publication was immediate and marked. Over 10,000 copies of the English edition were sold, it was reprinted in America and translated into German. It has also been reissued in an abridged form under the editorship of his nephew, Mr. James C. Copland. It is no exaggeration to say that but few more colossal literary works have ever been achieved by any author. The number and variety of the articles are only equaled by the profound erudition and great practical knowledge which they evince, and the vigor and clearness of the style in which they are composed. One of the most important features of the work, and which has endeared it to every true medical student, is the copious and exhaustive Bibliography appended to every article in the Dictionary. In the preparation of these Bibliographic lists, the acquirements and wide range of reading of Copland are conspicuous. The work has served as a mine from which countless medical workers have extracted precious materials, which they have, in but too many instances, reissued without the stamp of the original and real author. Doubtless many of the theories and views expressed in it will be, ere long, superseded; many of the facts require rearrangement or new explanation; but the work itself will long live and command the admiration of posterity as an enduring monument to the great intellect, sustained ambition, and indomitable energy of James Copland.

In person he was about the common height, of a robust build and striking countenance. In social life he possessed many friends, and was of a most generous and hospitable nature.

For some years before his death he had retired from the active practice of his profession. He had suffered for a long time from gout, and for some years had had occasional attacks of rheumatism. His death occurred on July 12, 1870, in the 79th year of his age, after a severe illness of about ten days.

Mr. Dubois made the following written communication respecting Lake Superior Silver Mines.

Mr. Du Bois asks attention to a specimen of ore from the new silver-mining region on the northern shore of Lake Superior. The precise location of the mine is on a very small island, about half a mile from the main land near Thunder Cape, to the east of Thunder Bay, and north of Isle Royale. Silver Island only measures a few feet long and broad, out of the water, and it was necessary first to fence it with a coffer dam: it is still necessary to use the pump daily. They are now at work a few feet below the bed of the lake.

Herewith two specimens are shown; one is the ore (in two pieces); the other is a button of fine silver extracted from precisely the same amount of ore. The comparison will give an idea of its surprising richness, and will also show how much may be hidden under an exterior not promising to a casual observer.

The matrix is a calcareous spar, or carbonate of lime, with granular galena; the silver occurs in two conditions: mineralized in the galena, and native in small needle-shaped filaments, some of them visible with a glass. The return of this specimen was over $13,000 a ton; but as we are cautious of reporting such ores by such large measure, we gave it as $6.73 a *pound*. However, it turns out that they are really getting up tons of rich ore, and sending it to be smelted at Newark, New Jersey. Other specimens tried at the Mint yield about half as much as the extraordinary piece here shown.

That Lake Superior should thus offer on its northern shore a bed of silver associated with lead; and on its southern shore a mixture of silver with copper, as well as copper alone; is an interesting fact in mineralogy. That it should promise us more silver, at a time when we want it for currency, is equally interesting in another point of view.

The mine, although in Canada, is owned and worked by a company of our citizens, of Detroit and other places.

Prof. Henry made a verbal communication of the doings of the International Commissioners who assembled at Paris last summer, to consider a revision of the French metre.

Mr. Cuyler offered the following Preamble and Resolutions:—

WHEREAS, The Building now owned and occupied by this Society has ceased to be central and convenient, and has also the disadvantage of affording only imperfect and unsafe accommodations to its Library and other valuable properties; whilst those who desire to consult its Books and Manuscripts have not proper conveniences for that purpose; and,

WHEREAS, It has been suggested that it may be practicable to enlarge the field of usefulness of this Society by adding to its other offices that of providing for and controlling the Observatory (both Astronomical and Meteorological), and for the Study and Recording of such other natural phenomena as may be appropriately observed and investigated in connection with such an Institution, and that for these purposes the removal of the Society from its present location, and its re-establishment in Fairmount Park, is desirable and practicable, therefore be it

Resolved, That the President be, and he is hereby, authorized and requested to appoint two Special Committees, each of which shall consist of a Chairman and four other members, and with each of which Committees the President is requested to meet and act as an additional member.

Resolved, That to one of these Committees shall be entrusted the duty of digesting the plan for such an Observatory as is described in the Preamble, so far as, in their judgment, it is expedient this Society should undertake the work of its establishment, and that they be requested also to describe such instruments as it is requisite should be provided for use therein, and an estimate of their cost, together with an estimate of the probable annual expense of maintaining and conducting such an Institution.

Resolved, That the other Committee shall be charged with the duty of considering the financial questions which are involved in such changes as are contemplated by the Preamble and the preceding Resolutions, and of reporting to the Society how the funds requisite for such an undertaking can be provided.

Dr. Carson moved that the further consideration of the Preamble and Resolutions offered by Mr. Cuyler, be postponed to a special meeting of the Society, to be held on the evening of the second Friday in December, notice of which should be given to all the members of the Society, with a printed copy of the Preamble and Resolutions; which was ordered.

And the Society was adjourned.

ON THE SAURODONTIDÆ.

By Edward D. Cope, A. M.

Read before the American Philosophical Society, November 18th, 1870.

The genus *Saurocephalus* of Harlan and its allies have been referred to the neighborhood of the Acanthopterygian family of the *Sphyrænidæ* by Prof. Agassiz in his Poissons Fossiles, after having been regarded by Harlan and Hays as reptilian. This was an important step in the right expression of its affinities ; but I take the present opportunity of making another progress in the true interpretation of its relations, favored as I am by the opportunity of examining new material not accessible to former authors. My conclusion, it will be observed, differs widely from that heretofore maintained.

Some years after Harlan's description of *Saurocephalus lanciformis* appeared, Dr. Hays described a second species under the name of *Saurodon leanus.* This I believe to represent a genus distinct from the former. A third genus more remote is characterized in the present article.

The characters of first importance which may be assigned to these genera are :—

Vertebræ short, numerous ; their neural arches united with centrum by persistent suture. Tail vertebrated or heterocercal. Superior arch of the mouth formed by the short premaxillaries and long maxillaries. Teeth one-rowed, with fangs received into alveoli more or less confluent at their openings. Anal or caudal radii with complex segmentation.

These characters are most of them entirely contradictory of any affinity to the Sphyrænidæ, those presented by the vertebræ indicating a nearer approach to *Amia.* The structure of the mouth is not that of any Acanthopterygian fish, and with the complex segmentation of some of the radii approaches nearer such types as the Characinidæ. The form of the vertebral centra is utterly different from that of the Sphyrænidæ : in the Saurodontidæ they are short, little contracted medially, and deeply grooved on the sides ; in the Sphyrænidæ, elongate, much contracted, and exceptional among Teleosts in being smooth and grooveless !

The characters presented by the teeth and vertebræ of Saurocephalus remind one much of Serrasalmo, though the genus is no doubt in other respects widely removed from that group. On the characters above enumerated, I propose the family Saurodontidæ. Its precise position I am not prepared to determine at present, though I have little doubt that Amia is its nearest living ally. With the remains of species of this group occur numerous scales, which may belong to the former. They are cycloid and without ganoine.

The three genera are distinguished by the form of their jaws and teeth : in *Saurocephalus* the crowns are shortened, much compressed, and with sharp edges ; in *Saurodon* the crowns are elongate, subcylindric and slightly curved near the apex. In *Ichthyodectes* the teeth are similar to those of *Saurodon;* but the margins of both jaws are without the large foramina so prominent in both the other genera. There appear to be some important differences also in the vertebræ, which will be mentioned below.

In the Transactions of the American Philosophical Society for 1856, Dr. Leidy treats *Saurocephalus* as a Sphyrænoid fish, and regards *Saurodon* as a synomyme. He corrects the erroneous references of some European authors, showing the Saurocephalus of Dixon to be a Xiphias, and the Saurodon of Agassiz to be some other genus which he calls *Cimolichthys,* without characterizing it. This form is supposed to be established on palatine teeth, and if so, is well distinguished, as it will be seen below, that Saurocephalus has no teeth on the palatine bones. He also refers two other species of supposed *Saurocephalus* of Agassiz to a new genus called *Protosphyræna,* without characters. This I think rests on mandibular teeth of true *Saurocephali.*

SAUROCEPHALUS. Harlan.

Journ. Acad. Nat. Sci. Phila. III. 337. *Xiphactinus* Leidy Proc. Ac. Nat. Sci. Phil. 1870. 12.

SAUROCEPHALUS LANCIFORMIS. Harlan l. c.

Med. and Phys. Researches, 362. Leidy Trans. Amer. Philos. Soc. 1856. Tab. *Saurodon lanciformis,* Hays Trans. Amer. Philos. Soc. 1830, 476.

Established on a right superior maxillary bone from a locality near the Missouri river. It differs from that of the other species in having a very elongate superior suture with the premaxillary bone, and in the very short dental crowns, which are as wide as deep. The largest species; known from the jaw.

SAUROCEPHALUS PHLEBOTOMUS. Cope sp. nov.

Established on some vertebræ and portions of the cranium, the latter including the dentary, maxillary, part of the premaxillary, the palatine and vomerine bones, compressed into a mass by pressure, the separate pieces preserving nearly their normal relations. From the latter the following characters may be derived:

Palatine bones toothless; teeth of both maxillary and dentary, with compressed crowns, which are longer than wide at base, and closely placed, those of the dentary twice as large as those of the maxillary. Maxillary bone proximally deep; dentary shallower, the maxillary with elongate suture with the premaxillary behind.

The teeth are equilateral, without intermarginal groove or barb, and with smooth enamel surface, or only minutely striate under the microscope. A series of larger foramina extends along the alveolar margin of the maxillary and dentary bones, one foramen to each tooth. The alveolæ are confluent as they approach this margin.

There are three vertebræ, which present two pairs of deep longitudinal grooves, viz.: two on each side, two on the inferior, and two on the superior face of the bone ; the last receives the basal articulation of the hæmapophyses. The centra are crushed, their measurements with those of the jaws are as follows :

	M
Length centrum	0.025
Long diameter (crushed)	.035
Short " "	.0175
Depth maxillary bone anteriorly	.031
Depth dentary " "	.015
Length crown inferior tooth	.006
Number " " " in .01m	3
" " superior " "	4.5
Length crown " " "	.0046

The vertebræ are about as large as those of a fully grown "drum fish," *Pogonias.*

From the yellow chalk of the upper Cretaceous of Kansas, found on the Solomon or Nepaholla River, Kansas, at a point 160 miles above its mouth, by Professor B. F. Mudge, Professor of Natural Science in the State Agricultural College of Kansas.

I append a description of some caudal vertebræ of a species probably different from the *S. phlebotomus.* It is indicated by three consecutive caudal vertebræ which resemble those of *S. prognathus* and *S. thaumas,* but which differ also considerably from both ; the several arches and spines are of very great width : in *S. thaumas* they are narrow, and in *S. prognathus,* as wide, but here their width exceeds the depth and equals the length of the centrum. As in the other caudals, the lateral grooves are wanting and the inferior pair remain separated by a lamina. The neural suture is very distinct, and not two angled as in *S. prognathus,* but with a median decurvature and rise anteriorly. The neural spines are twice as wide as deep and lie on each other. The third vertebra is shorter than the others and contracted distally ; it is probably the penultimate of the series ; neural canal minute. Surface striate ridged.

Measurements.	*M.*
Length centrum anterior vertebra	0.021
Depth " (at middle) anterior vertebra	.015
Width neural arch at base spine	.010
Depth spine	.0072
Length third vertebra	.0135
Width neural arch	.014
" " spine	.0176

From a point twenty miles east of Fort Wallace, Kansas. Professor Mudge's collection.

In this species the vertebræ in question are longer in proportion to their other dimensions than in those described, besides carrying wider neural arches and spines.

SAUROCEPHALUS PROGNATHUS. Cope *sp. nov.*

This species is represented by a premaxillary and attached proximal portion of the maxillary bones of the right side, and by a large number of vertebræ and other bones. These portions were associated in the collections placed in my hands by Prof. Mudge, and relate to each other in size, as do those of the preceding species and the *Ichthyodectes ctenodon.*

The premaxillary is characterized by its great depth as compared with its length, and by the shortness of its union with the maxillary. The palatine condyle of the maxillary reaches a point above the middle of the alveolar margin of the premaxillary. The latter contains alveolæ of seven teeth, the anterior of which only presents a perfect crown. This is still more elongate than the crown of the teeth of *S. phlebotomus.* It is compressed, equilateral, smooth, and acute. Its direction is even more obliquely forward than the anterior outline of the bone, which itself makes an angle of 50° with the alveolar border.

The vertebræ consist of cervicals, dorsals, and caudals, to the number of about sixty, most of which are supposed to have been derived from the same animal. The groves are as in *S. phlebotomus,* there being two below, two on each side, and two above. The latter receives the bases of the neurapophyses, which are in many cases preserved. The inferior pair of grooves becomes more widely separated as we approach the cervical series, leaving an inferior plane, which is longitudinally striate grooved. This plane widens till the grooves bounding it disappear. The inferior lateral groove becomes widened into a pit which some of the specimens show to have been occupied by a plug-like parapophysis, as in *Elops,* etc., or a rib-head of similar form. The neurapophysial articular grooves become pits anteriorly, and these only of all the grooves, remain on the anterior two vertebra in the collection. Some of the posterior caudals preserve large portions of the neural arches and spines. They form an oblique zigzag suture with the body, consisting of two right angles, one projecting upward anteriorly another downward behind. The neural spines are very wide and massive and in close contact antero-posteriorly; these probably support the caudal fin. They are deeply and elegantly grooved from the basis upwards. The centra exhibit no lateral grooves.

An unsymmetrical fin ray accompanied these remains, and from its mineralization, color, size, and sculpture, probably belongs to them. The anterior margin is thinned, and with obtuse denticulations, the posterior truncate. The section is lenticular, with a deep rabbet on one side of the posterior edge; section at the base, apex circular lost. The sculpture consists of fine longitudinal raised striæ, which bifurcate and send numerous similar ridges to the teeth of the anterior margin. It is probably a spine of a pectoral fin. It is identical in form and sculpture with that recently described by Leidy as *Xiphactinus audax,* but differs in specific details.

	M
Long diameter of spine	0.0245
Basal " "	.019
Length, two cervicals (not distorted)	.033
Diameter of the anterior	.021
Length of a dorsal	.016
" " caudal	.014
Width neural spine of caudal, at base	.012
Length alveolar margin premaxillary	.022
" anterior " "	.02
Depth from condyle of maxillary	.026
Length crown premaxillary tooth	.0042
Diameter " " "	.002

A fragment of a large flat bone exhibits very delicate radiating grooves which are marked by spaced impressed dots.

From the upper Cretaceous of Kansas, six miles south of the town of Sheridan. Prof. B. F. Mudge. This species was about two thirds the size of the species last described.

SAUROCEPHALUS AUDAX. Leidy, sp.

Xiphactinus audax. Leidy. Proc. A. N. Sci. Phil. 1870, 12.

Established on a pectoral spine, supposed by Leidy to be that of a Siluroid. According to the description, it does not differ from that of *S. prognathus* in more than specific characters. Thus the anterior margin is weakly serrate in the latter, a feature not described by Leidy in the former. In *S. audax* the posterior portions of both sides are said to be grooved; in that part of the spine of *S. prognathus* preserved, one surface only exhibits the groove in question, one of whose edges is obliquely ridged, as in *S. audax*. From Kansas; museum Smithonian.

SAUROCEPHALUS THAUMAS. Cope sp. nov.

This is larger than any of the species here described. It is represented by wholes or parts of from seventy to eighty vertebræ, with numerous neural and hæmal spines and fin radii, and perhaps some ribs. There are no teeth nor cranial fragments. The bulk of the vertebræ is double that of those of *S. phlebotomus*, and appropriate to an animal of the size of the *S. lanciformis*. It may be ultimately found to be identical with that species; but there is no evidence conclusive of such a view at present in my possession.

The vertebræ present the usual two inferior, two lateral, and two superior grooves—the last for the neural arch. There are no cervical vertebræ, for these characters show them all to be dorsals and caudals. The suture for the neurapophyses forms a regular angulate convexity projecting downwards. The arch is not closed above anteriorly, and is expanded laterally, while the spine is directed very obliquely backwards. The concavities of the articular extremities are equal in the dorsals; but in the caudals one surface is much more deeply concave than the other, one being funnel-shaped, and the other nearly plane in a few.

A number of consecutive vertebræ are preserved, which represent the posterior portion of the caudal series. One of these is fortunately the very extremity, and they demonstrate the tail to have been vertebrated or heterocercal, after the manner of Amia. On the anterior series of three the lateral grooves have disappeared from the centra; the neural canal is very small, and the spines are very massive and curved backwards, but much less than in the more posterior parts of the column; they are flattened, wider than deep, and in close contact with each other. The anterior of the three, on the other hand, presents a narrowed edge forwards. The hæmapophyses are thin, and suturally united by a flat gomphosis. The terminal series embraces six vertebræ, which have a minute or obsolete neural canal, but hæmal canal distinct, but apparently interrupted. The hæmal arches are united to the centra by a rather smooth suture.

The general direction of these vertebræ forms a light upward curve. The hæmal spines are flat and laminar, and their margins in contact; they decrease in width and length to the end of the series. The neural spine lies obliquely backwards, and has a narrowed anterior ridge, but stout shaft.

The anterior hæmal spine in place exhibits a subglobular base, like an articulation, and its shaft is wider than those posterior to it. A subtriangular flat bone, with neck and subglobular extremity, applies very well to a concavity between the anterior pair of pleurapophyses, but does not in that position preserve contact with the anterior margin of the second spine. One margin of the enigmatical bone is thin and divergent; the other expanded laterally and straight. The latter gives off a transverse prominence like half a globular knob before reaching the extremity. Just within the latter are two large foramina, which are connected with the extremity by a groove on each side, which meet in a notch where the thin edge passes into the knob.

Both sides of the neural and hæmal spines are concealed in this species and in the *S. prognathus* by numerous parallel osseous rods, which are somewhat angulate in section. They lie along the centra of the anterior series of caudal vertebræ, but are not to be found on vertebræ of any other part of the column. Numerous loose and fragmentary rods of the same character accompany the loose and attached caudal vertebræ, and all of them, according to Prof. Mudge, belong to the "posterior swimming organ" of this animal. There is also a collection of these rods from the anterior region of the body, which Prof. Mudge thought occupied the position of an anterior limb. They do not any of them present a segmentation such as would be exhibited by the cartilaginous radii of caudal and pectoral fins, and their nature might have remained doubtful but for the explanation furnished by the anterior compound ray or spine of the posterior, probably caudal fin. This ray, as in the case of the pectoral spine and first anal rays of some existing Siluroid and Loricariid fishes, is composed of a number of parallel rods closely united. These are in their distal portions remarkably and beautifully segmented, of which a very simple form has been figured by Kner, as existing in the pectoral spine of the Siluroid genus, *Pangasius*. This segmentation becomes more obscure proximally, and finally disappears altogether, leaving the spine and rods homogeneous. This portion of them is quite identical with the rods found in the positions of fins already described, and I therefore regard these as fin radii of the attenuated form presented by cartilaginous rays of most fishes, but ossified sufficiently to destroy the segmentation. They are thus in the condition of the anterior rays of the dorsal fin of some of the large Catostomidæ, where they are proximally homogeneous and bony, distally segmented and cartilaginous. This is an important character when found in pectoral and caudal fins, and such as I have not found described. It adds another feature to the definition of this group.

The segmentation above alluded to presents the following characters. The spine consists of four principal parallel rods, of which the external on each side thins, the one to an obtuse, the other to a thin edge. The more obtuse edge presents a groove on one side, which is occupied by a very slender rod, and a shallow rabbet along the flat edge is occupied by a slender flat rod. Of the four principal rods the two median are the most slender, and the flat marginal the widest. Of the two median, that next the last is the wider. The stout marginal, or probably anterior rod, is segmented en chevron, the angle directed forwards and lying near the free margin. The suture of the segments is entirely straight, except when returning it approaches the margin, where it suddenly turns to the margin at right angles to it. The next rod is segmented without chevron obliquely backwards and inwards; where it leaves and reaches the margins, it is at right angles to them, and the margin projects obtusely at those points. Between them the suture is very irregular and jagged, sending processes forwards and backwards. The segmentation of the next rod is similar, but more regularly serrate; distally it becomes as irregular as in the last. The transverse marginal termini of the sutures are serrate in both. The inner and widest rod presents a still more regularly serrate suture, with the truncate extremities; but, owing to the width of the rod, the near approximation of the sutures continues for a longer distance. When broken, the suture appears step-like,

This remarkably beautiful segmentation is paralleled remotely, as has been stated, by some Siluroids. Much more like the recent type are the segmented rays of the carboniferous genus, Edestus of Leidy, regarded variously by authors as a jaw or a ray; but now generally regarded as a ray.

Measurements.	*M.*
Length fragment of (?)caudal spine	0.25
Width " at proximal fracture	.06
Greatest thickness " "	.013
Width posterior rod " "	.0245
Length of six distal caudal vertebræ	.10

	M.
Width hæmal spine of second of series	.024
Vertical diameter centrum first "	.025
Length of neural spine and centrum of anterior caudal	.108
Transverse diameter of neural spine " " at base	.0235
Antero-post. diam. four anterior caudal neural spines in contact	.069
Length centrum of a dorsal	.04
Vertical diameter " "	.0615
Transverse " " " (crushed)	.041

These remains were found in place by Prof. B. F. Mudge: he states that their extent was eight feet. As they embrace no cervical vertebræ nor portions of cranium, two feet are probably to be added, giving a total of near ten feet for the length of this fish. It was discovered at a point on the bank of the Solomon's or Nepaholla river, in Kansas, 160 miles from its point of junction with the Kansas river.

SAURODON Hays.

Transac. Amer. Philosoph. Society, 1830, 476.

Saurodon leanus, Hays.

Loc. cit. Tab. xvi. Leidy Trans. Am. Philos. Soc. 1856.

From the cretaceous green sand of New Jersey.

ICHTHYODECTES. Cope, *gen. nov.*

In this genus the teeth are subcylindric and slender, without cutting edges. The inner margins of the maxillary and dentary bone exhibit no dental foramina, which are in *Saurocephalus* and *Saurodon,* of large size.

Ichthyodectes ctenodon. Cope, *sp. nov.*

This species is established on one complete maxillary bone, and three-fourths of the other, a large part of the dentary bone, with the entire dental series; numerous portions of cranial bones, with thirteen vertebræ. These, according to Prof. Mudge, were found together, and to all appearance belong to the same animal.

The dental characters differ from those of Saurocephalus, as above pointed out, and in this species more than in *S. leanus.* The crowns of the teeth are more exserted and slender. The inner face of the crown is more convex than the outer; but there is no angle separating the two aspects. The apex is moderately acute, and directed a little inwards, owing to a slight convexity of the external face. Enamel smooth. The alveoli are very close together, and are probably only separated in their deeper portions. There are forty-two teeth and alveoli in the maxillary bone. The palatine condyle is low, and its anterior border falls opposite to the last tooth, or the indented surface which was occupied by the premaxillary bone. The more proximal part of the maxillary curves inwards and backwards behind the position of the premaxillary more than in *S. prognathus.* The maxillary is a rather thin and narrow bone, with a broad obtuse and thinned extremity. Its superior margin is marked with one or more acute ridges, which look as though it had a contact with a large preorbital bone. Two fractured bones with an elongate reniform condyle on a wide peduncle, look like the articular extremity of an operculum, which view is confirmed by their application to some flat, coarsely rugose bones which resemble parts of the latter.

The dentary bone is remarkable for its straightness and laminar character, and for the depth of the symphysis. The length of the latter is preserved, while posteriorly to it the lower margin of the dentary is broken away. The alveolar margin is slightly concave, and unites with the symphyseal at an angle of 65°. There are twenty-seven teeth and alveolæ, which grow a little larger to the posterior extremity of the series; anteriorly the alveoli are confluent externally, but posteriorly the septa are frequently complete, though thin. In neither this bone nor the maxillary are to be found the foramina along the bases of the teeth, characteristic of *Saurocephalus* or *Saurodon leanus*, as pointed out by Harlan and Hays. The vertebræ form a series of 13.4 inches in length, embracing thirteen caudals. This is indicated by the close approximation of the inferior pits and inserted pleurapophyses, and absence of lateral grooves. There are important differences from what has been described as characteristic of *Saurocephalus*. The neural arches, whose bases only are preserved, are much lighter and narrower than in it, and its sutural union with the centrum is less distinct. Their bases issue from pits; but their anterior portions appear in some cases at least to be co-ossified. They exhibit a longitudinal rib near one side. There are no heavy neural spines preserved. The sides of the centra are longitudinally rugose striate; inferiorly they are rugose with exostoses.

Measurements.	*M.*
Length maxillary bone	0.158
Depth at condyle	.031
" " extremity	.022
Length crown of a tooth	.0061
Diameter crown at base	.0038
Length alveolar border of dentary	.106
Depth symphysis " "	.047
Length opercular condyle	.018
Length centrum anterior caudal	.024
Width " (crushed)	.0278
Depth " "	.047

Specimens from six miles south of Sheridan, Kansas, on the north fork of the Smoky Hill river near its mouth.

General Considerations.

There have been described above, remains of three species, which include jaws with teeth, and associated vertebræ. In two of these cases the jaws and teeth were found together; in the third they came in the same small box without special indication of locality; but the vertebræ are of precisely the same size sculpture, mineralization, and color as a large series whose locality is exactly known, to which they probably belong. Moreover, the jaws and vertebræ bear the same relation of size to each other in all three series. These facts render it highly probable that the remains are in each case rightly referred to the same animal. That no mixture has occurred is also probable from the fact that the large and small series (Ichthyodectes and S. prognathus) came from the same locality (Sheridan), while the species of intermediate size was discovered 160 miles from the mouth of the Solomon river, a long distance off. The pectoral spine, accompanying and belonging to the S. prognathus, I have shown to be the same as the Xiphactinus of Leidy, but probably not of the species *X. audax*.

The fourth series described above as *S. thaumas* exhibits precisely the vertebral characters of the two other species of Saurocephalus, and I cannot resist the evidence that it belongs to that genus or the same family. Its remains pertain to one animal, as asserted by Prof. Mudge, and their color and condition, coated with a chalky deposit of a ferruginous yellow color, lends great probability to the statement, to say nothing of more important reasons. No remains of pectoral spine are preserved; but instead, the remarkable segmented ray described. This comes from the posterior region of the vertebral column, and is, I believe, an anal spine, or the adjacent rays or compound ray forming the margin of the caudal fin. This finds support in the analogous structures already mentioned as occurring among Siluroids, etc., and the resemblance of the pectoral spine to the same weapon of the same group adds to the probability of the correctness of this conclusion.

These remarks are made because Prof. Agassiz, in the Poissons Fossiles, has referred several spines to the Cestraciont genus, Ptychodus, which are very similar in character to that described above as the anal or caudal support of Saurocephalus thaumas. These were derived from the upper cretaceous chalk of Kent, England, where Ptychodus teeth also occur. The Saurocephalus teeth, described by Prof. Agassiz in the same work, were, however, derived from the same chalk and the same locality, and, from what has preceded, I believe the segmented spines should be referred to the latter genus rather than to Ptychodus. This is the more probable, in view of the fact that Prof. Mudge did not procure a single Ptychodus tooth during his exploration.

ON THE FISHES OF A FRESH WATER TERTIARY IN IDAHO, DISCOVERED BY CAPT. CLARENCE KING.

By E. D. Cope.

The materials on which the present account is based were placed in my hands by the Smithsonian Institution. They were obtained by Capt. Clarence King, on his expedition sent out by the Government, for the geological exploration of the fortieth parallel west of the Mississippi river.

As will be seen, the fossils described are evidently from a fresh water basin, once a lake, which has, at a comparatively late period of geological time, been elevated and desiccated.

The species and genera are chiefly cyprinidæ, and from the number of the former, ten, important as throwing light on the character of the forms of that family at a time not long preceding the establishment in their present habitations of those now living. Remarks on these relations are deferred to the close of the descriptions.

CYPRINIDÆ.

Characters of the genera represented :—

A. Pharyngeal tooth series transverse to longer axis of the pharyngeal bones.

Pharyngeal teeth 0.4—?.? with compressed roots, and probably molar or masticatory crowns on an oblique basis, the highest extremity being inferior, the lowest superior. DIASTICHUS.

B. The pharyngeal tooth series very oblique to the longer axis of the pharyngeal bone.

Pharyngeal teeth 2.3(?4)—??, with round bases, and probably conic prehensile crowns ; no ala of the slender pharyngeal bones. OLIGOBELUS.

C. The pharyngeal tooth series nearly in the longer axis of the pharyngeal bones.

Pharyngeal teeth 2.5—4.2 conic prehensile. SEMOTILUS.

Pharyngeal teeth 0.5—?.?, with short, compressed crowns and narrow, transverse masticatory face, and no prehensile hook ; bone alate. ANCHYBOPSIS.

Pharyngeal teeth 0.4—4.0, or the outer row 1 or 2 rudimental ; crowns molar, broad, truncate, with enamelled grinding surface. MYLOCYPRINUS.

DIASTICHUS. Cope.

Genus novum.

DIASTICHUS MACRODON. Cope sp. nov.

Represented by three right pharyngeal bones, of which the distal extremities are lost. The proximal limb of the bone is long and flat, the extremity first dilated, then contracted coincidently with a transverse depression of the superior face, the end everted or expanded, with symphyseal surface within. There is no proper horizontal alar expanse, but rather an anterior one, the front face (inferior when on a plane surface), being a little oblique. Tooth series in the line of the axis of the superior limb of the pharyngeal bone, its base rising exteriorly and proximally. Outer face nearly vertical, grooved. The teeth are knocked off in all the specimens ; their bases are a broad, oval or parallelogram. The form of the crown is uncertain, but I suspect it to have been more or less truncate.

Measurements. *M.*

Length proximal limb No. 1	0.027
Depth at base first tooth	.01
Width limb at middle	.008
Length limb No. 2	.017
Depth at first tooth	.0058
Length tooth series	.0135
Width third tooth basis	.005

These teeth indicate a species of about the size of the carp (*Cyprinus carpio*).

From Catharine's Creek, Idaho. Mus. no. 9792.

DIASTICHUS PARVIDENS. Cope sp. nov.

In this species the bases of the teeth are considerably smaller than in the last, and the proximal limb of the pharyngeal bone less depressed, and more cylindric. A section of the latter below the basis of the first tooth, is a triangle, the inner side a little shorter than the others. In the last species it is flat in that place.

	M.
Depth limb at first tooth	0·011
Width limb at middle tooth	.0065
Length tooth series	.014
Length basis third tooth	.0054

This species is represented by one pharyngeal bone of the right side, with the extremities incomplete, associated with many fragments of the cranium, etc. The size the same as that of D. macrodon.

No. 9782, Catharine's Creek, Idaho.

The peculiar arrangement of the tooth series in this genus, almost at right angles to that which is usual among Cyprinidæ. is not, so far as I know, shared by any recent genus of the family.

OLIGOBELUS. Cope.

Genus novum.

The direction of the dental series in this genus is intermediate between that seen in Diastichus, and the usual type. It resembles and exceeds the last described genus in the great elongation of the proximal limb of the pharyngeal bones, which are here considerably more curved. No bone of the genus preserves its distal end or its teeth complete. The bases of the teeth are round or oval, and not in close contact. It is scarcely likely that there were more than three in the outer row, though this is not certain. The proximal end of the series is abbreviated, as the first tooth of the index row is opposite its first, and the second opposite its second. The proximal end of the series is most elevated, but does not project beyond the lateral plane of the bone.

Should the outer series have embraced four teeth, a resemblance between the form of this bone and that of Ericymba and Exoglossum can be traced. This genus will, however, be distinguished from those by the entire want of the lateral external ala common to these and other genera of Cyprinidæ. Two species are represented in Capt. King's collection.

OLIGOBELUS ARCIFERUS. Cope sp. nov.

Established on four right and one left pharyngeal bones, none of them with the distal extremity complete. The best preserved shows teeth 2. 3—, and there is no indication of space for a fourth, though its place of support is lost.

The proximal line is very strongly curved, and is long and slender. Its extremity is neither grooved nor recurved, but slender; its section would be a flat triangle, the inner face about equal to the outer. The size of the species equals that of *Diastichus macrodon*, the largest specimen exceeding any of the latter. It is probably the largest species obtained by Capt. King.

	M.
Length proximal limb No. 1	0.04
" " " " 2	.025
Depth near basis first tooth	.0065
Width " "	.0085
Length basis three outer teeth	.011
" " two inner "	.007

Nos. 9782, 9791, Catharine's Creek, Idaho.

OLIGOBELUS LAMINATUS. Cope sp. nov.

Established on a left pharyngeal bone which lacks the distal extremity. It differs from the other species of the genus in its broad, flat proximal limb of this bone. Its section is not triangular, but that of a plate with a thin outer edge.

	M.
Width limb just below first tooth	0.008
Depth " " " " "	.004

The expansion continues to near the proximal end.

No. 9791. Catharine's Creek, Idaho.

SEMOTILUS, Rafinesque.

I have referred to this existing North American genus two species of the present series, without being entirely certain that such reference will be finally adopted. It is based on the evidence of two pharyngeal bones of two species, one of the right and one of the left side, the former bearing four, the latter five teeth in the larger series. Should the series of the other bone of each prove to have the same number of teeth as the sides preserved, the species will be referable to two genera, the former 2.4–4.2 to Ceratichthys, the latter 2.5–5.2 to Gobio, both existing genera. To whichever of the three genera the species are referred, it remains to be one still in existence.

SEMOTILUS POSTICUS. Cope sp. nov.

Indicated by a left pharyngeal bone, of which the distal extremity has been broken away. The apices of the teeth of the exterior series are broken away, those of the inner row are perfect. The bases of the former are cylindric, the latter are also cylindric, with conic crowns. Some fragments belonging to this or an allied species present conic proximal teeth, while specimens from other collections confirm the reference to Semotilus.

The expansion of the ala is very gradual, and projects anteriorly rather than outwards. Hence the outer face of the bone is one oblique plane from the bases of the teeth to the edge of the ala. The latter projects beyond the plane of the inner margin, so that the anterior face of the bone is oblique also. The external surface of the ala is cross-ribbed. The proximal limb of the bone is contracted, and slightly compressed near the teeth. Teeth 2.5— ; the interspace between the inner pair, opposite the fourth of the outer series. The bases of the inner descend to the inner anterior margin of the base vertically.

Measurements.	*M.*
Length of tooth series	0.033
Depth at fourth tooth	.019
" first "	.011
Width " "	.0085
Length inner tooth	.011

This chub was larger than the common Eastern species, the S. rhotheus, the largest of the genus. The pharyngeal bone indicates a fish of five or six pounds weight. The gradual and slight expanse of the ala of this bone distinguishes the species from any of the existing ones. Named from the posterior direction of the teeth.

From St. Catharine's Creek, Idaho; obtained for Capt Clarence King by J. C. Schenk. Smithsonian, No. 1489.

SEMOTILUS BAIRDII. Cope.

Sp. nov.

This species differs from the last in the much less expansion of the external or alar margin of the pharyngeal bone. It has scarcely any alar prominence of the angle, which also projects so little beyond the inner margin as to render the anterior or perforated surface almost transverse. Distal end of the bone gently curved; proximal limb compressed near the teeth. Teeth 2.4—, those of the inner pair opposite the third and fourth of the outer series. Bases cylindric; crowns not preserved; outer face of the bone with numerous foramina penetrating it backwards.

Measurements.	*M.*
Length of tooth series	0.021
Depth at third tooth	.01
Width " "	.006
Depth at first "	.008

From the same locality and explorer as the last species. No. 1482.

This species is dedicated to Prof. Spencer F. Baird, to whom the author is under greater obligations than to any other man, in respect to his special pursuits.

ANCHYBOPSIS. Cope.

Genus novum.

This form, characterized above, is nearly related to several now existing in the rivers of the United States, so far as the pharyngeal teeth serve as an indication. It is well known that they are more significant than any other part of the skeleton among the Cyprinidæ. They are arranged in one series of five on the right side, which rises and stands on a prominent basis superiorly, as in various genera, as Stilbe, most Hybopses, etc. This prominence is due to the abrupt incurvature of the superior limb of the bone. The crowns of the teeth are compressed, the grinding face truncate a little obliquely, and with a slightly concave transverse worm surface. Proximal limb small.

In *Hybopsis* the teeth are 4–4, but in *Hemitremia* Cope, 5–4, and quite similar to those of this genus. In *Hemitremia*, however, the lateral line is incomplete, and coincidence in this point is necessary for the reference of the present form to that genus. Imperfection of the lateral line is not known among the larger forms of true Cyprinidæ on this continent, and may not have existed in this genus. The principal ground of separation from *Hemitremia* is found in the transversely compressed and very short crown of the teeth; in the latter they are elongate and subcylindric. *Anchybopsis* is a more typically herbivorous form, and probably had much convoluted intestines, while in *Hybopsis* they are of the short carnivorous type.

ANCHYBOPSIS LATUS. Cope.

Spec. nov.

The only species of the genus. The pharyngeal bone expands rather abruptly into a prominent ala, without angular outline, and which soon turns into the outline of the superior limb. Surface of ala with transverse grooves to margin. Sizes of teeth 4, 3, 2, 5, 1, the first smallest, and with obtuse, subconic crown. Section of proximal limb at base of last, a triangle with truncate apex directed outwards. Teeth directed inwards; nutritious foramina on front of bone numerous and large.

Measurements.	*M.*
Length tooth series	0.026
" third tooth	.011
Long diameter crown tooth	.0075
Width bone at third tooth (exterior)	.016
" " " (anterior)	.016
" " first tooth (exterior)	.006

MYLOCYPRINUS. Leidy.

Proceedings Academy Natural Sciences. Philadelphia, 1870, p. 70.

This genus, named by Leidy, as above, had been noticed by Dr. J. S. Newberry* as allied to Mylochilus, Agass. Leidy compares it to the carp and other Cyprinoids. Its affinities are apparently between Mylo-

* In Proceedings New York Lyceum Natural History, 1870. Copied into Nature, 1870, p. 385.

chilus and Cyprinus; though it has fewer teeth than either, its formula 4—4 or 2.4—4.2, being that of the majority of the existing American genera. According to Agassiz, the first-named displays 2.2.5—5.2.3 etc.; while in the latter they are 1.1.3—3.1.1, and have concentrically sulcate grinding surfaces. In the present genus, these surfaces are smooth, except where excavated by use. The inner series is represented by two rudimental teeth, which are often wanting.

In describing the pharyngeal bones which belong to this genus, Leidy commits the error of inverting them, calling the inferior extremity the superior, etc. The symphyseal articulation of the bones he then regards as designed for articulation with the cranium, a structure which, it is needless to observe, has no existence in this division of fishes.

Among the numerous specimens brought by Capt. King, I recognize at least three species, as follows:—

Mylocyprinus robustus. Leidy.

L. c.

Teeth rapidly diminishing in size upwards, the last with crown from one-fourth to one-sixth the area of that of the first, and standing on an elevated base which projects upwards. Alar margin expanding very gradually, its greatest expansion generally below opposite to the basis of the first tooth, and considerably contracted opposite to the last tooth. The superior limb short, flat, abruptly incurved.

Eleven specimens, of which six belong to the left side. They vary in the outline of the basis of the teeth; in most, it is quite straight, in others curved; and, as a consequence, in these the superior part does not form such a prominent buttress as in the first. A large species. Greatest length of longest bone, 0.046 M.

No. 9792, Catharine's Creek, Idaho.

A single right pharyngeal of large size may indicate another species. The tooth series is curved, and the first tooth unusually small. The principal peculiarity is seen in the superior limb, which is long, slender, and transverse, with a median contraction, and less flattening than in the other specimens. Locality the same.

Mylocyprinus kingii. Cope.

Spec. nov.

This is represented by a single right pharyngeal bone of large size, and is distinguished by peculiarity in the character of its teeth. These, instead of diminishing in size upwards, increase, so that the fourth tooth is larger than the first, instead of one-fifth the size as in *M. robustus*. The second and third are intermediate in proportions. The crowns are broad, transverse ovals. The proximal limb of the bone is short, and gradually expands into the ala, whose greatest width is opposite the second tooth. The superior limb is short, narrow, and incurved. A trace of basis for a small tooth of an inner series.

Measurements.	*M.*
Greatest length of bone	0.046
" " dental series	0.026
Transverse diameter first tooth	.008
" " third tooth	.009
" " fourth tooth	.008
Width bone at second tooth (exterior)	.017
" " " " (anterior)	.018
Length proximal limb	.02

From the same locality as the last. Dedicated to Capt. Clarence King, to whom science is indebted for the survey of the fortieth parallel, and the palaeontological discoveries incidental to it.

MYLOCYPRINUS LONGIDENS. Cope.

This third species of the genus is represented by one right pharyngeal bone bearing the upper three teeth. It is quite distinct from the species already named, in several points. The ala commences by an abrupt expansion opposite to the middle of the first tooth, instead of by a gradual widening of the proximal limb. Hence, in this species the latter is more slender than in the others. Next, the teeth are of nearly equal size, the transverse diameter of the three being about equal, though the last is rather flatter than the others. Thirdly, the teeth are more slender, the length of the shanks being much greater than the long diameters of the crowns; these measurements are nearly equal in the other species. Lastly, the type of the present species is scarcely half the size of the most numerous individuals of the *M. robustus* and *M. kingii.* The basis of the tooth series rises obliquely backwards, as in M. robustus, and within it are the bases of two small teeth of the inner row, better developed than in that species. The diameters of the second and third teeth are equal.

Measurements.	*M.*
Greatest length right pharyngeal	0.029
" " tooth series	.018
" " proximal limb	.012
Elevation second tooth	.007
Transverse diameter crown	.0048
Width bone at crown (exterior)	0.115
" " " (anterior)	.013

From Catharine's Creek, Idaho, No. 9192. Capt. King's Expedition. Collected by J. C. Schenk.

SALMONIDÆ.

RHABDOFARIO. Cope.

Genus novum.

Teeth on the maxillary and mandibular arches large, numerous; teeth on the vomer, glossohyal, and palatine bones, also well developed. Teeth with hollow crowns and plicate dentine, which is ribbed on the pulp cavity, and grooved externally. Muzzle and mandible sub-equal. Maxillary bone much prolonged, sub-cylindric, but little compressed distally, bearing reduced teeth near its extremity. Preorbital bone short, suborbital narrow. Inferior basihyals as deep as long.

This genus is nearlly allied to Salmo. With no other portions of the animal than the cranial bones, the only difference I discover is in the form of the maxillary bones, which are subcylindric or rod-like, instead of flat or laminiform, as in Salmo. At the extremity, though flat, they are still narrow, and I do not find surface of attachment for the supernumerary bone of Salmo.

RHABDOFARIO LACUSTRIS. Cope.

Species nova.

This fish is represented by a large part of the cranium, including all anterior to the middle of the orbits above, to the metapterygoid medially, and to the posterior part of the dentary below. Both dentaries remain, but the premaxillary and maxillary of one side only are preserved. There are separate portions of the maxillary bone, of four other individuals, and mandibular and palatine of one. These indicate a salmon of the average size of the migratory marine species, *Salmo salar*.

The cranium has been compressed, but apparently not depressed, so that the plane of the muzzle from the frontal bones is perhaps nearly preserved. In its present condition the profile descends very gradually, and the muzzle has an acuminate form. The frontals are ornamented by numerous grooves which radiate anteriorly, and are more numerous medially. The premaxillaries are subvertical, or roof shaped, and their broad lateral face is prolonged well backwards—to opposite the fifth mandibular tooth. The distal part of the maxillary and the dentary are striate-grooved, the latter obliquely downwards. The extremities of the dentaries are rugose, and emarginate in profile. They are not produced or recurved at the symphysis, and the latter is not coössified in the specimen. The anterior extremity of the premaxillary is lost, but the remaining portion supports five teeth. There are seventeen on the part of the maxillary preserved, three in 0 M.01. There are 14–15 on the dentary, two in 0 M.01. The palatine, vomerine and the glossohyal teeth are a little smaller than the dentaries, and more as the maxillaries. All the teeth have swollen bases, with a plurodont attachment. The crowns are cylindric, acute, and on the lateral bones, incurved.

Measurements.	*M.*
Length of the tooth series of the dentary..	0.092
Depth of symphysi...	.018
Depth pterygoid and palatine at last mandibular tooth....	.027
Depth premaxillary at middle............................	.018
Length crown of a mandibular tooth....................	.008
Width of half frontal bone at nares......................	.014
" suborbital...................................	.0085

The preorbital region is occupied by a bone somewhat T-shaped, the vertical limb spatulate, directed downwards and forwards, with grooved margins. Suborbital with rough marginal face.

This specimen was found by J. C. Schenk for Capt. Clarence King, at Castle Creek, Idaho. No. 9790 Smithsonian Collections. The other specimens are from Catharine's Creek, Idaho; Nos. 9785—9786. A portion of a maxillary of one of these forms indicates a fish half as large again as the one above described.

General Observations.

The six genera of fishes above described, present interesting relations to existing ones. One of them, Semotilus, is recent, while three are closely allied to existing genera; viz.: Rhabdofario, Anchybopsis, and Oligobelus. Distichus and Mylocyprinus are less nearly related to living genera. The five representing the Cyprinidæ can be referred to the groups into which the existing members of the family fall; thus Semotilus and Oligobelus are carnivorous, and Anchybopsis and Mylocyprinus herbivorous and molluscivorous. Accompanying these fossils are three species of the recent genus Astacus, (A. subgrundialis, etc) which I describe in the Proceedings of the American Entomological Society for 1870.

The molluscs of this formation have already been described by F. B. Meek, and they, like the fishes, determine it to be lacustrine and fresh, as already stated by Prof. Newberry. The species are stated by Meek * to be distinct specifically, and in some cases generically, from all others hitherto described from the West. Leidy observes,† that Mammalian Remains received from Capt. King's expedition include portions of *Mastodon mirificus and Equus excelsus,* which indicate an age similar to that of the bad lands of the Niobrara, which Hayden calls Pliocene.

The remains described in this paper furnish few means of determining the age of the deposit. There is, however, a great probability of their being later than Miocene, and nothing to conflict with their determination as of Pliocene age.

It may be added that numerous portions of skeletons of fishes remain to be identfied, in Capt. King's collection

ON THE ADOCIDÆ.

BY E. D. COPE.

ADOCUS. Cope.

Proceed. Acad. Nat. Sci., Phila., 1868, 235. Proceed. Amer. Philos.. Soc., 1870, 295; Transac. Am. Phil. Soc., 1869, 232.

Additional material enables me to add important characters to this genus, and to define its position with something like precision.

In the first place I find that it possesses a large intergular plate. This I have verified on A. beatus and A. syntheticus, sp. nov. Having also perfect xiphisternal bones of these two species, I can show that there is no sutural attachment for the pelvic bones. The coexistence of these two characters has been hitherto universal, and the present deviation from it is a point of much interest. Instead of sutural surfaces, there

* Proc. Acad. Nat. Sci., Phila., 1870, 56.

† l. c. 1870, 67.

is an obtuse ridge corresponding to the pubis, and a knob answering to the extremity of the ischium, both more prominent than is usual in genera of Emydidæ.

This exceptional combination of characters points to the propriety of separating Adocus as the type of a family equally distinct from the Emydidæ and the Hydraspididæ, to be called the Adocidæ.

Further characters of the genus have been already pointed out in the later essays above quoted. They are: the free lobes of the plastron narrowed and shortened, furnishing extensive posterior and anterior entrances to the carapace. A series of intermarginal scuta on the bridge. Costal capitula reduced or wanting.

No recent or even tertiary form of the Testudinata has yet been discovered, which possesses the remarkable combination found in this genus, and I think it must be regarded as a generalized group, and as such of much interest to the student of palæontology.

The determination of the presence of the intergular plate in this genus enables me to isolate from it the *Baptemys* of Leidy, which is otherwise very similar. This being the case, there is reason to believe that the latter is a Tertiary genus, and not Cretaceous one, as I had before been inclined to suspect.

The species then are:

I. With mesosternum deeply received.

Plastron very thick. A. PECTORALIS.

Plastron thin. A. PRAVUS.

II. With transverse mesosternum.

a. Posterior lobe of plastron contracted, long as wide.

Plastron of medium thickness. A. BEATUS.

aa. Posterior lobe broader than long, rounded.

Plastron thick, sparsely punctate. A. SYNTHETICUS.

Plastron thin, closely punctate. A. AGILIS.

ADOCUS SYNTHETICUS. Cope.

Spec. nov.

Established on a plastron which lacks the mesosternal, one episternal, and one hyposternal; also on a marginal bone from the bridge, two imperfect costal bones, proximally complete, and some smaller fragments.

The bones of the plastron present that oblique junction of element with element diagonally across the point of crossing of longitudinal and transverse sutures, as has been observed in all the species of the genus, except A. pectoralis. Thus the right hyposternal, besides the usual union with the left, presents a considerable suture for the left hyposternal, and a lesser one for the left xiphisternal. The median dermal suture does not coincide with the osseous behind the hyosternal bone; but it is considerably to the left of it, dividing the xiphisternal bones unequally. The osseous suture is irregular and undulating. The hypo-xiphisternal suture extends abruptly backwards near the margin of the plastron. This margin behind the groin is thinned rather abruptly, with a marginal groove inside near the bridge, but it descends abruptly at the median xiphisternal suture behind. The anterior extremity of the plastron is rather broadly truncate, but little excavated, and with thick margin. The form of the mesosternum is easily made out, from the fact of the preservation of at least one of all its corresponding marginal sutures. Its antero-posterior length is at least .75 less than its transverse. It had no posterior median process or spine, as in many Emydes.

As regards the scuta, the femoro-anal suture is directed backwards outwardly; the abdominal scuta are the longest. The pectorals, instead of narrowing medially, as in most Cryptodira, widen interiorly, their common anterior apex being on the mesosternal bone. The gulars are much reduced by the large intergular; each forms a spherical triangle—the apex outwards, the suture with the humeral, concave. The intergular is marginal, behind as wide as before, and convex; each half .66 wide as long.

The plastron is everywhere quite thick medially, but less so than in the A. pectoralis. The superior surface of the xiphisternal bone presents a curved ridge in the position of the pubic scar of the Pleurodira, which is nearer the margin than either suture, and slightly curved backwards. A marked sublongitudinal depression is seen between it and the median suture. Near the latter, more than one-fourth its length from the margin, thus farther from the latter than in Taphrosphys sp., is a smooth, low knob corresponding to the ischium.

The posterior lobe of the plastron is broad and regularly rounded, resembling thus the A. agilis. In the latter the pelvic ridges are scarcely developed at all, and the bone is everywhere thinner.

The axillary margin within presents a strong ridge, which becomes elevated as it rises with the axillary internal buttress of the carapace. This ridge is much weaker in A. beatus and the other species. The external surface of the bones is studded with impressed dots, which are separated by intervals posteriorly, but on the episternal bone are confluent, leaving the surface rugose with small elevations. The sculpture differs from that of A. agilis in being minuter, less distinct, and not disposed in regular rows. The fragment of the bridge displays the axillary and part of the anterior intermarginal plate. The former extends considerably in front of exterior to the axillary notch; the latter can only be compared with the same in A. pectoralis, as it is not preserved in the A. agilis. It is relatively broader than in the former, and with less oblique anterior border; the exterior angle which joins the suture of the marginal is situated more anteriorly. A considerable extent of a marginal scutum of the bridge is preserved. Its transverse exceeds its longitudinal extent, and its anterior margin is regularly convex.

One costal presents a rudiment of capitulum; the other none.

	M.
Length of plastron	0.484
Width " to first marginal of bridge	0.33
Width posterior lobe at groin	0.23

		M.
Length posterior lobe from groin		0.155
" median suture episternal		0.038
" mesosternal		0.07
Width "		0.095
Thickness hyosternal behind medially		0.015
" hyposternal "		0.020
Width intergular scute		0.053
Length gular (antero-posterior)		0.003
" caudal sentum		0.083
Width costal proximally No. 1		0.038
" " " No. 2		0.055

This fine species was discovered by my friend, J. C. Voorhees, in the upper bed of cretaceous green sand, at Barnesboro, N. J. This gentleman is well known as the preserver of the unique and invaluable fossil of the *Lælaps aquilunguis.*

ZYGORAMMA. Cope.

Genus novum familiæ? Adocidarum.

Marginal bones of the carapace united wi h the costals by both suture and gomphosis : the suture existing on the free marginals, as well as on those of the bridge, the gomphosis inferior to and more distal than the suture. Hyposternals uniting with the marginals only, by gomphosis. Dermal scuta distinct.

This genus is represented by a single species, which has left us but few remains. These do not furnish positive indications for its reference to the Cryptodire or Pleurodire divisions. The mode of union of the plastron and carapace is, however, much more likely that of the Emydes and Adoci ; and I therefore suspect it to be Cryptodire. The character of its sculpture is also that of the last named genus, rather than of Taphrosphys.

Zygoramma striatula. Cope.

Sp. nov.

Represented by five marginal bones, three incomplete costals, and both hyposternals with their external margins broken off. These bones indicate a species of light and elegant construction. The hyposternals are thin, and of nearly equal thickness transversely. Their sutures are very coarse, and present but little irregularity at an intersection, in those of opposite corners, excluding the other pair from contact, as is usual in Adocus sp. The gomphosis of the hyposternal rises very obliquely. The posterior lobe of the plastron has an acute margin, which continues as an angle beyond the inguinal notch anteriorly. The fracture of the surface prevents my ascertaining the existence of a series of intermarginal scuta. The suture between the femoral and abdominal scuta divides the hyposternals about equally.

The marginals at and near the bridge are nearly twice as deep as long. The posterior of the bridge is gently convex, with the margin a little recurved. The two following (posterior to the bridge), are nearly plane without recurved margin, which is slightly prominent at the point of contact of the dermal suture of the marginal scuta. The posterior marginal bones are concave superiorly, the margin not otherwise recurved. These marginals are, as usual, thickened underneath beyond the proximal suture; and into this the free end of the rib is inserted into a deep, oval pit. On the terminal marginals of the bridge the pit is more distal, and round. The free end of the rib springs from the costal bone at the suture, and its length varies from an inch to a half an inch. The pit for the hyposternal is chiefly in the last bridge marginal, partly in the first free marginal. It extends along the edge of the inner thickening, as the latter descends on the bridge.

The sculpture of the costal bones consists of longitudinal shallow grooves, which are more or less confluent (they are thus transverse to the costal axis). On the marginals, the same ornamentation is varied by the grooves being impressed punctate; behind the dermal suture, they are directed slightly upwards; anterior to it, they rise more obliquely. On the posterior marginals, they are still more oblique. The sculpture of the plastron is obliterated.

	M.
Inguinal width of plastron	0.124
Length hyposternal	.08
First free posterior marginal width	.067
" " " length	.046
" " " greatest thickness	.011
Corresponding costal, width	.037
" " thickness	.0045

From the upper bed of cretaceous green sand, Burlington County, New Jersey. Discovered by my friend, Judson C. Gaskill.

The size of this species is about that of a snapping-tortoise (Chelydra).

HOMOROPHUS. Cope.

Genus novum Adocidarum.

Costal capitula wanting or rudimental. Vertebral bones of the carapace co-ossified with the costals, sometimes, outlined on the inner surface, where they appear to be lanceolate in form. The original costo-vertebral suture, when traceable, very oblique; the superior face of the vertebral much wider than the inferior. Vertebral scuta often narrower than the supposed outline of the vertebral bones; on the posterior portions of the carapace wanting.

This genus is evidently allied to *Adocus* by the character of its costal capitula, but not having the episternal nor xiphisternal bones, nor the outer part of the median sternals, I cannot add other points of resemblance or difference. The coössification of carapacial elements is without parallel in the order, and the form of the vertebral bones prior to this union, probably at an early period of life, was very peculiar. Their transverse section would be that of a broad wedge with slightly truncate inferior apex. The neural spine lamina is attached in a strong inferior groove of these pieces. The groove becomes wide and shallow posteriorly. At the extremity of the vertebral series there are two isolated rugose elevations, perhaps for the last neural spines. On each side of the last a shallow concavity marks the point of contact of the ilium.

Homorophus insuetus. Cope.

Species nova.

The mesosternal bone is joined by an openly concave sutural margin of the hyosternals on the lower surface. On the superior face the sutural margins are straight, projecting further posteriorly and forming an obtuse angle. The pectoro-abdominal dermal suture crosses the hyosternals near their middle; the abdomino-femoral, which is rather obscure, at the posterior third.

The superficial sculpture of carapace and plastron is destroyed. The inferior surface of the costal, displays a marked concavity exterior to the position of the rudimental costal capitulum. The curvature of the costals is well marked. When separated from each other, a fine sutural face forms the inferior third of the thickness, the superior two-thirds being fracture only. There are three vertebral dermal scuta more or less completely preserved. The outline is coffin-shaped anteriorly; in one the lateral margins are convex, in another concave, and then expanding again posteriorly, the whole being fiddle shaped (panduratus). The two posterior costal scuta meet on the middle line, and the last pair embraces a pygal which is elliptic in front.

The shell is every where stout, and excessively thick; neither hypo nor hyosternals being thickened medially. The left hyosternal joins the right hyposternal at the intersection of the sutures.

	M.
Length hyosternal on median suture	0.095
" hyposternal " "	.105
Thickness " " "	.015
" median costal proximally	.011
" anterior vertebral	.014
Length " "	.06
Width do. anteriorly	.0285
" " posteriorly	.91
" anter. vertebral scute anteriorly	.035
Length " " " "	.06

The free edge of the hyposternal is thinned to an edge rather abruptly. The last distinct vertebral scutum is wider than the others, a costal suture going off near its posterior margin.

The slight enclosure of the mesosternal bone gives the plastron a resemblance to those of *Adocus syntheticus*, *A. beatus*, and *A. agilis*. The last is much thinner; the second differs entirely in the characters of the vertebral scuta, &c. It is nearer the A. syntheticus, but besides the generic differences in the carapace, the abdomino-femoral dermal suture crosses at the posterior third of the hyposternal bones, instead of at their middle, as in the Adocus syntheticus.

This species, like the last, was found in the upper bed of the Cretaceous green sand, at the works of the Pemberton Marl Company, New Jersey, by Judson C. Gaskill, the director. The name of this gentleman frequently occurs in my contributions to the paleontology of the Cretaceous, and I take the present opportunity of expressing my indebtedness for the constant liberality with which he has aided in the advance of the science. Without his attention to and enlightened interest in the subject, many interesting points in the history of the life of the Cretaceous periods would not have come to light. Those desirous of seeing one of the fine sections of the middle marl bed to be found in the state, will be repaid by a visit to the opening made under the direction of Mr. Gaskill.

EIGHTH CONTRIBUTION TO THE HERPETOLOGY OF TROPICAL AMERICA.

Read before the A. P. S., September 16, 1870.

By E. D. Cope.

The materials whose examination has furnished the following additions to zoological science, consist of four collections. These are, first: one from Pebas, Equador, on the Amazon, from John Hauxwell; second, that made by Prof. Agassiz, of the Thayer Expedition to Brazil; third, a collection from Turk's Island, West Indies, obtained from Prof. Adrian J. Ebell; and fourthly, a small collection made by Dr. R. E. van Rijgersma at St. Eustatia.

The first collection furnished the following species in addition to those already determined by me from the same locality, in two papers, viz: in Proceedings Ac. Nat. Sciences 1868, 96, and do. of the American Philosophical Society 1869, 156.

OPHIDIA.

Erythrolamprus æsculapii.
Lygophis nicagus, Cope, Proc. Ac. Nat. Sci. Phil. 1868, p. 132.
Oxyrhopus petolarius, var. G. (Günther)
Oxyrhopus plumbeus. L.
Xenodon angustirostris? Peters.
Hydrops callostictus, Günth., Ann. Mag. N. H. tab.
Helicops chrysostictus, Cope, (*Tachynectes*) Pr. A. N. S. Phil. 1862, 71.
Thrasops ahaetulla. L.
Rhinobothryum lentiginosum Scopoli.

LACERTILIA.

Anolis nasicus.
Polychrus marmoratus.
Doryphorus castor, Cope, sp. nov.
Hyperanodon ochrocollaris Spix.

BATRACHIA.

Hyla polytaenia, Cope, Proceed. Am. Philos. Soc. 1869, 164.

Hyla leucophyllata Beireis var. *triangulum* Gthr ; see Cope, l. c. p. 156.

Hypsiboas* punctatus Daud. Dum. Bibr. etc. Of a pink color in the yellow dots, in life.

Hypsiboas hypselops, Cope, sp. nov.

Hypsiboas lanciformis, Cope, sp. nov.

Scytopis (Dryomelictes) aurantiacus Dandin.

Pithecopus tomopternus, Cope, Proc. Acad. Nat. Sci. 1868, 112.

Pithecopus tarsius, Cope, l. c, 113.

Phyllomedsa scleroderma, Cope, l. c. 112 ; very large examples.

Coecilia.

HYPSIBOAS HYPSELOPS, Cope, *sp. nov.*

Of the group of H. crepitans Wied. The fingers are not webbed beyond the basis of the proximal phalanges, except perhaps on the external one. When the arm is extended, they reach a trifle beyond the groin. The hind limb extended brings the heel a little beyond the muzzle. The general form is slender ; the head broad and flat. The canthus rostralis is distinct, but very concave, and the rostrals prominent on a narrow truncate muzzle. The outline of the head is rather acuminate to the apex, intermediate in form between H. crepitans and H. boans. The eyes are very large and prominent, entering only 1.5 times in the rather elongate muzzle. The tympanum is small, one-third the orbit in diameter and one-half the interorbital width. Dermal free, margins none ; a slightly prominent fold on the elbow and spur on the heel, only a prominence on the other. Skin above smooth. Digital dilatations hardly .50 diameter of tympanic membrane.

Color, above bright chestnut brown, below pale violet ; no marks on the head or back. Upper arm of the same color, as is a band on superior face femur. Front and back of femur, sides .66 of distance to axilla, and intero-anterior face of tarsus and metatarsus, with vertical black bands. They are very distinct and wider on the front than the back of the femur ; the latter connect faintly above. Three or four faint cross bars on tibia above. Two black spots on back of brachium, and one or two on front of antebrachium.

Vomerine tooth series arched as in other species, tongue broad. Ostia pharyngea very small, one-fourth choanæ.

Length of head and body, 0m. 056 ; of hind limb, .091m ; of foot .038m; of tarsus .02 ; width of jaws below tympanum .02 ; length from same point (axial) .016.

The acuminate muzzle, larger eye, and anterior femoral bars, distinguish this from the H. crepitans. The same characters separate it from H. indris, with the additional ones of smaller tympanum and larger limbs.

From Pebas Equador, Jno. Hauxwell's collections.

*The name of the allied genus *Cinclidium*, Journ. Ac. N. Sci. 1867, 200, having been used before for a valid genus of plants, I propose to change it to Cincloscopus.

Hypsiboas indris, Cope.

Journ. Ac Nat. Sci. Phila. 1867, 201.

This species with the small feet and dilations of the H. crepitans, exhibits the broader head of the H. leprieurii type, with the vomerine series incurved anteriorly as in the majority of species of the genus. The spur on the thumb is smaller than in any species of the genus in the single specimen at our disposal, and the antebrachial and tarsal folds are distinct. Gular region smooth. There is a cross band between the eyes darker than the ground color; the femora are crossed above by broad, rather indistinct cross-bands very different from those on the posterior face, and similar to those on the tibia; in H. circumdatus, the same narrow black bands are continued from behind to the front of the tarsus, without interruption. Indistinct brown markings on the labial regions.

The shorter hind limbs, distinguish this species from the H. crepitans.

Habitat Surinam *Hering*. Mus. Academy Nat. Science, Philada.

Hypsiboas circumdatus, Cope.

Journ. Ac. Nat. Sci. Philada. 1867, 201.

Breadth of cranium at tympanum equal from end muzzle to opposite middle line of humerus; canthus rostralis little marked, concave. Sacral width twice in coccyx, three times from articulation of latter to opposite outher canthus of eyes. Tympanum two-thirds occular opening. Vomerine series width divergent, oblique, scarcely curved; palmation of band to middle antepenultimate of foot to origin of penultimate phalange of longest toe. Thumb an incurved unusually elongate osseous spur. Areolations wanting on the breast, upper and under lip indistinctly yellow margined. Femoral bands ten, blackish, very narrow and nearly surrounding the leg: seven broader cross the tibia.

This species differs from the H. palmata in its much shorter palmation, smaller size and different coloration; from the H. crepitans, in its stouter form, and much stouter feet and hands, and different coloration, comparative measurements given under the head of the latter exhibit this.

Habitat, Brazil, no. Mus. Compar. Zoology, one specimen.

The thumb-spur of this species is more striking than in any other of the genus.

	H. crepitans		H. circumdatus.	
	in	line	in	line
End muzzle to end coccyx	2	3	2	8
do do origin coccyx	1	5.75	1	9.75
do do poster. marg. tympanum		8.5		10
Width cranium at latter point		9.5		11.25
From muzzle to opps't outer canthus eyes		3		4
Anterior extremity	1	5,5	1	9.25
Carpus and longest digit		8.5		9.25
Posterior extremity	3	10.25	4	9.25
Tibia	1	2	1	5
Tarsus		8.5		10
Metatarsus and longest digit		10		13.25

The three species just described have the palmation of the toes extending to the base of the third phalange. In H. fasciatus Gthr. the web only extends to the base of the second.

HYPSIBOAS LANCIFORMIS, Cope. *Sp. nov.*

This is a large species of the H. boans group. It is characterized by its elongate acuminate head, with nearly straight, sharp canthus rostralis and vertical concave loreal region. Eyes prominent, large, their diameter twice in length of muzzle, equal to interorbital width, and not quite twice the diameter of the membranum tympani. A prominent dermal fold proceeds from it, overhanging the tympanum, to near the middle of the side; its margin is roughly glandular. No dermal margins nor spurs on the limbs. Fingers not webbed beyond the metacarpals; reaching when the limb is extended, to the hind face of the femur. Hind limbs very long, the muzzle making the second third of the extended tibia. Web extending to the end of the second phalange of the fourth toe of the foot. Ostia pharyngea small, one-fifth of the very large choanæ. Tongue oval, longer than wide. Vomerine teeth forming two angulate series, the two short limbs of the angle uniting on the median line, without interruption. Finger-dilatations large, not quite half the tympanum in diameter.

Color, bright chestnut brown above and on the sides, shading into smoky in the groin. The whole under surface a dark maroon. A black band passes from the end of the muzzle, as wide as the loreal region, through the eye and tympanum to along the axilla. Upper lip with a broad yellow band, interrupted on the premaxillary apex, and continued a short distance in front of the canthus oris on the mandible. No cross bars or bands on the sides or limbs; femur behind and before, smoky maroon. A few irregular scattered dots on the back, and an indistinct series of fourteen brown cross bands on the back and head. Dilatations of the three inner fingers yellow above. Length, head and body, 0m.087; of hind limb .158m.; of foot .067; of tarsus .033. Width of sacrum .016; of head below posterior margin of tympana .028m.; length (axial) from same point .027. Length of fore limb .05m.

This peculiar species resembles externally, a Polypedates. It need only be compared to the Hypsiboas boans D. B. and H. oxyrhina R. and L. From the former it differs in the entire absence of black or other colored bars on the femora and flanks, in the darker coloration of the under surfaces, etc., and the more elongate, lance-shaped head. Its thumb spur is much weaker than in most species of the genus. From H. oxhyrhina it differs much in coloration and in the longer hind limbs. Thus according to Reinhardt, and Lütken in that species, the proportion of their length to the total is, .107m. to .075m.; that is, 1.33 per cent. In H. lanciformis, the proportion is 1.81. The white margins of the limbs, breast and lower lip as well as the marbled coloration described by these authors; are here entirely wanting. Pebas, Equador. J. Hauxwell's collection.

DORYPHORUS CASTOR, Cope. *Sp. nov.*

Scales of the abdomen weakly keeled, nearly equal to those of the back, which are more strongly keeled. Scales of the sides scarcely smaller than either. Gular fold moderate, its scales subequal. Mental scales uniform, smooth. No auricular scales; temporal scales rough. Occipital plate large, longer than wide; interorbital series three; muzzle scales large smooth, polygonal, only four rows between canthus rostralis. One canthal scale; two loreal rows; nostril between two scales; labials (large) 5—6. Oblique folds on sides of neck. The arm extended reaches the middle of the femur; the leg, the tympanic drum. Body slender; tail perfectly flat, wider than the body, with 35 cross-rows of keeled scales, which are only produced into spines at the edge of the tail.

Color, blackish olive, gradually lighter to the head, which is thickly black spotted on a green ground. A broad crescentic black collar which is broadly light margined behind, much more indistinctly before. The posterior border is against broadly margined with black behind. Limbs closely green spotted on a blackish ground. Tail uniform brown. Belly black, on the sides dark green, medially, femora dark.

Total length, 0m.093; from muzzle to angle of mandible, .016; to collar, 021; to vent, .06; length fore limb, .032; of hind limb, .038; width head at mandibular angles, 01.

From Pebas Equador; J. Hauxwell's collection.

TRETIOSCINCUS LÆVICAUDUS, Cope. *sp. nov.*

Scales large, those of both body and tail, entirely smooth. Several behind the occipital plates larger than the others. Limbs short. Size about that of the T. bifasciatus.

Color, a dark clear olive above; paler below, a light green band from the temporal region along the canthus rostralis to the end of the muzzle, and another parallel along the upper lip. No other markings.

From Occidental Department, Nicaragua. Discovered by J. A. MacNeil, a successful explorer of that region. Mus. Essex Institute, and Acad. Nat. Science.

This Ecpleopod, differs from its congener T. bifasciatus Dum. in the absence of carinæ on the caudal scales, and in other points, and in the coloration.

HOMALOCHILUS CHRYSOGASTER, Cope. *sp. nov.*

General form quite slender, the head narrow. Scales in forty-three longitudinal series, those of the median larger than the lateral. Occipital and parietal regions covered with numerous enlarged smooth polygonal scales. Two short longitudinal plates represent the frontal; each is in immediate contact with the superciliary of its side, which exceeds it in length. Three pair of supranasals, the anterior not separated from the anterior nasal; six scales in two cross rows in the place of the prefrontals bound the superciliaries and frontals in front. Superciliaries undivided. Nasal a little higher than wide, the apex visible from above. Two loreals, the anterior larger; two prococulars, the superior large, the inferior in place of the summit of the sixth and seventh labials. Four postoculars, the superior bounding the posterior margin of the superciliary. Superior labials fourteen, seventh and eighth entering the orbit. Inferior labials fourteen ; anterior four, very elongate inward. Gastrosteges, 255 ; anal, 1 ; urosteges, 78.

Color, light fawn brown above, below golden yellow. A series of fifty-four deep brown spots extend on the dorsal region to opposite the vent, and seventeen on the tail, in the individual described. These spots are darker edged and are occasionally confluent into a short irregular band. They are often transverse and are generally twelve scales wide, and three or four long.

Length .0m 665 ; of tail, .108 ; rictus ovis, .016.

From Turk's Island, obtained by my friend, Professor Adrian J. Ebell. This Boa is very distinct from the Homalochili heretofore described, and exhibits a decided tendency to Ungalia, especially to such species as U. dipsadina. The species of Homalochilus Fischer, are ; *H. multisectus*, Cope, Proc. A. N. Science, Philadelphia, 1862, 70. *H. striatus*, Fischer, Abh. Natur. Hamburg. 1856, 101. *H. strigilatus*, Cope, l. c. p. 71 ; *H. chrysogaster*, Cope, supra, and *H. tortilis*, Jan. (*Dendophilus tortilis* Jan. Iconographie des Ophidiens Plate). The last named belongs here, as I learned from a study of the type specimen in the Mus. Milan. It differs very much from the species above described, but I cannot now point out its characters, having mislaid my MS. description. The *Epicrates versicolor* of Steindachner, beautifully figured in the Denkschriften of the Wiener Academie, belongs to this genus, and appears to be *H. strigilatus* m., previously named.

The collection from Turk's Island embraced the following species :

Homalochilus chysogaster, Cope.

Mabuia cepedei, Gray.

Anolis ordinatus, Cope, Pr. A. N. Sci. Phila. 1864, 175.

Cyclura (Ctenosaura) carinata, Harlan Journ. A. N. Sci. IV, p. 242.

I would here notice that Dr. John Gündlach, has published in the Repertorio Fisico, etc., de Cuba, 1868, a catalogue of the Batrachia and Reptila of the Island of Cuba, which furnishes a desideratum of long standing. I observe, however, that he interjects assertions as to the probability of several of my species being synonymes of others, as Anolis porcus, A. isolepis, Liocephalus raviceps and macropus, etc. As I suspect that these suggestions are not original with Dr. Gündlach, I will observe that as a general rule, it is unsafe for American naturalists to rely on assertions of some Continental European zoologists, as to identity of the species of each other, or of American zoologists, since it is an old practice, the offspring of autocracy rather than of science, and which deceives only temporarily.

Enulius murinus, Cope. gen. et. sp. nov.

Char. Genericus. Palatine, pherygoid, and anterior portion of maxillary bones edentulous ; a long, strong grooved tooth on the posterior part of the maxillary bone. Internasal plates present ; rostral prominent depressed ; two distinct nasals, a loreal, no preocular, two postoculars.

Scales smooth, with one apical pore-pit. Anal plate and subcaudals double.

This genus has head-shields arranged like those of *Rhegnops*, Cope, (Proc. Acad. Nat. Sci. Phil. 1866, 128), but the dentition is entirely distinct. It is nearer to *Tantilla* B. and G. but that genus does not present the edentulus characters, and exhibits a preoccular instead of a loreal plate. The pupil is round. The general form is slender for a Calamarian serpent, and the tail is unusually elongate; the head is not distinct.

Char. Specificus. Scales in sixteen or seventeen rows. Labials 6-7, third and fourth in orbit. Two postorbitals; temporals, 1—2—3. Rostral broad, crescent shaped; internasals half as large as prefrontals. Frontal nearly triangular, with apex behind; anterior border strongly convex. Superciliaries sub-triangular, with short apex anterior. Occipitals elongate. Geneials one pair followed by a row of three scales. The tail measures between one-third and one-fourth of the total length, nearer one-third, but the only specimen now by me has the extremity mutilated. Gastrosteges, 216. Length of a specimen, 0m.220; other larger ones are not now before me.

Color, mouse-color above, white below, a pale spot on each nasal plate, and a dusky one on each side behind the rictus oris. From Chinandega, in the Occidental department, Nicaragua, discovered by J. H. McNiel. Several specimens were taken from a well, forty feet deep.

This species in scutellation and form of head is related to the Calamarinæ, and it is doubtless a borrower, but its scale pores and long tail are exceptional features.

CONTRIBUTION TO THE ICHTHYOLOGY OF THE MARAÑON.

(*Read before the Amer. Phil. Soc. Aug.* 19 1870.)

BY E. D. COPE, A. M.

CHARACINIDÆ.

Tetragonopterus orientalis, Cope.

D. 11, A. 29; scales 7-37-8. The depth of the body one-half the length (without caudal fin); the head one-fourth of the same. Dorsal fin above a point a short distance behind the origin of the ventrals. Anterior anal rays not elongate. Diameter one-third length of head, 1.5 times in the convex interorbital width. The extremity of the mandible extends a little beyond the line of the anterior rim of the orbit. Pectoral extending a little beyond basis of ventrals. A broad silver band from upper opening of operculum to caudal, with a black spot near each end. Length 0.097 M.

From Para. Mus. J. Carson Brevoort.

Tetragonopterus stilbe. Cope.

Depth contained 2.4 times in length (without caudal); length of head 3.5 times in the same. Radii, D. 11, A. 38, scales 8—39—10. Interorbital width equal that of eye, and one-third length of head. Dorsal fin elevated, a little behind the line of the origin of the ventrals. The maxillary extends to near the line of the anterior margin of the orbit. The anterior radii of the anal fin are elongate. Total length .075 M. Length of anterior dorsal rays .018 M. ; length of anal rays .013 M.

A silver lateral band with a posthumeral and basal caudal spots, the former very distinct.

This species has much the shape of an Abramis; its form is deep, rather abruptly contracted at the extremities, and the supraoccipital region is slightly concave. Allied to the T. abramis of Jenyns.

Para. Mus. J. Carson Brevoort.

TETRAGONOPTERUS HAUXWELLIANUS. Cope.

Radii D. 11 ; A. 47; squamation 9–10—47—10–11. Depth of body 2.2 times in length, exclusive of caudal fin. Profile above concave ; end of muzzle convex. Interorbital width greater than diameter of orbit ; eye three times in head. No teeth on the maxillary, which extends only to the line of the anterior margin of the orbit. Caudal peduncle contracted. Color silver olive, with silver white band on side, and indistinct humeral and caudal spot. Total length .056 M.

This is a deep bodied species, with more than usually distinct lateral silver band. Its anal radii are more numerous than in any other species, except the T. spilurus C. V., which differs in having teeth on the maxillary bone, etc.

Dedicated to John Hauxwell, a successful naturalist and explorer, from whom most of the species here described were procured.

Pebas, Equador.

TETRAGONOPTERUS PECTINATUS. Cope.

Radii D. 10, A. 41 ; scales 4–5—41—6. Form elongate, fusiform, compressed ; depth into length without caudal 2.75 times ; length of head nearly four times in the same. Interorbital width equal diameter orbit ; diameter of eye one third length of head. Maxillary bone elongate, extending to below middle of pupil, furnished with minute teeth throughout the length of its anterior margin. Profile straight, convex between orbits, muzzle projecting beyond mandible. Dorsal rays prolonged ; anterior anals also moderately elongate. The origin of the dorsal is exactly over that of the anal.

A *narrow* silver green band on the posterior half the body ; no caudal spot ; humeral spot half way between lines of operculum and dorsal first ray. Total length .045 M.

This is a peculiar species, resembling technically only the T. artedii of Cuv. and Val. as described by Günther. This is a more elongate fish, with smaller eye, and other characters. The complete dentition of the maxillary bone is unusual in the genus.

From Pebas, Equador. Hauxwell's collections.

HEMIGRAMMUS ROBUSTULUS. Cope.

Radii D. 10, A. 27; scales 7—35—6. Form deep compressed; length without caudal 2.25 times depth, and 3.5 times length of head. Profile straight, steeply descending to the obtuse muzzle. Interorbital width greater than diameter of orbit; eye one-third of head. Five stout but small teeth on the maxillary bone, which latter reaches to the line of the middle of the pupil, hence the gape of the open mouth is greater than in some other species. The dorsal fin is not so elevated as in some species of Tetragonopterus, and originates behind the line of the ventrals. The greatest elevation of the dorsal line is in advance of its origin. Suborbital bone large; mandible longer than muzzle.

Muzzle black; cheeks black punctate; body brown, a greenish lateral band with indistinct humeral and caudal spots. Middle of caudal fin blackish. Total length .051 M.; to origin ventrals .018 M.; to origin of anal .025 M.

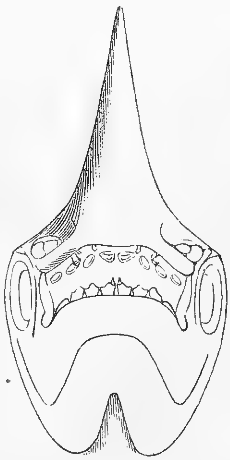
This little Characin I refer to the genus Hemigrammus of Gill,* because the lateral line is only half developed, extending in the present species to beneath the middle of the dorsal fin. The general form and dentition are stout. The gill rakers are elongate on the inferior, but sparse and short on the superior limb of the hyoid arches.

* Ann. Lyc. New York, 1858.

From Pebas, Equador. Numerous specimens from Hauxwell's collection.

MYLETES LIPPINCOTTIANUS. Cope.

Radii D. 16, A. 39; lateral line 80. Depth of body two-thirds length without caudal; thus the form is discoid. Muzzle very obtuse; mandible longer. Orbit one-third of head, and 1.5 times into very convex interorbital region. Thirty-two ventral spines. Adipose fin two-thirds the length of the rayed dorsal; caudal with a very narrow sinus-like emargination above the middle of the edge. Ventrals not reaching vent, commencing a little in advance of the line of the first dorsal ray.



Color yellow silvery; dorsal region with steel reflections; a dusky spot above the middle of the pectoral on the lateral line.

The teeth of the external premaxillary series are very small, and in close contact with those of the second.

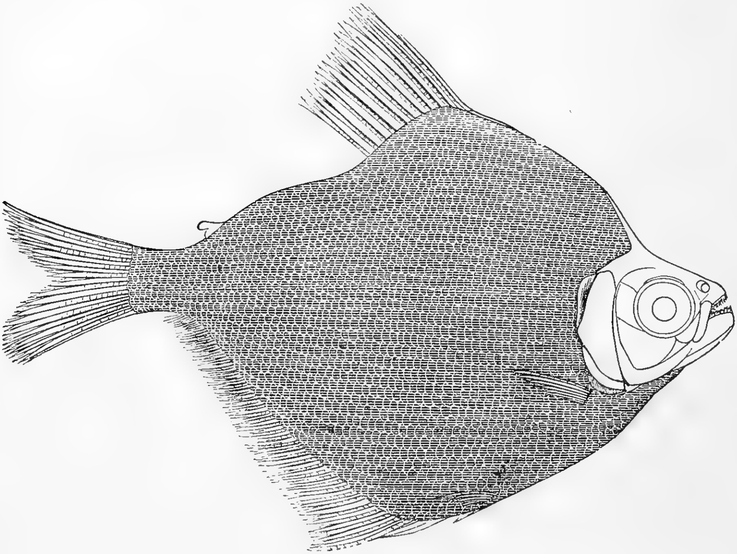
Length .112 M. to line of origin of anal .057; depth .068; do. of head at orbit .022 M.

From Para, Brazil, J. C. Brevoort's collection.

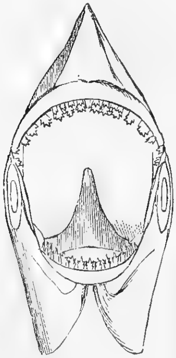
Dedicated to my friend, James S. Lippincott, author of important contributions to Meteorology, Agriculture and other subjects.

STETHAPRION ERYTHROPS. Cope gen. et sp. nov.

Character genericus. Dorsal not elongate, anal prolonged. Premaxillary teeth compressed, lobed, in two rows; no maxillaries. Mandibulars lobed, without conic teeth posteriorly. No keel of spines on the ventral region. Branchial fissures extended.



This new genus displays most of the characters of Mylesinus Cuv. Val., but is entirely without the exposed ventral spines characteristic of that genus and of Myletes. The trenchant four-lobed molars of the posterior series differ entirely from those of Myletes; the dentition, indeed, is not very different from that of Tetragonopterus.



Character specificus. Radii; D. 12; A. 40; squamation 21—61—21. Form discoid, abdominal outline more convex than the dorsal, which is irregular. It is convex above the nape, descending along the base of the dorsal fin, convex in front of the adipose, and concave behind it. Depth 1.5 times in length without caudal, head 3.66 times in the same. Eye large, not quite equal to the diameter of the moderately convex interorbital space, 2.5 times in length of the head. The maxillary is elongate, and extends to the line of the anterior margin of the orbit. The denticulations of the teeth are apical, those of the mandibulars four or five in number. The outer teeth of the anterior premaxillary series small. Ventrals small, below the line of origin of the dorsal. Adipose fin small, caudal furcate. Anal fin narrow, not lobed, anterior radii moderately elongate.

Color silvery, anal fin dark edged ; a brighter band on caudal peduncle, darker edged above. An indistinct postscapular spot. Total length .095 M. The color of the irides in the type specimen, which has not been very long in alcohol, is a dark red.

There is a spine directed forwards from the base of the first dorsal ray, along the back, which is free for more than the eighth of an inch.

From Pebas ; J. Hauxwell's coll.

HOLOTAXIS MELANOSTOMUS. Cope gen. et sp. nov.

Char. Genericus No adipose fin ; origin of dorsal fin posterior to that of the ventral. Teeth on the premaxillary, maxillary and mandibular bones, all simple conic, those of the first and last, in two rows. Suborbital bones very large ; gill opening large. Scales without lateral line.

This genus is simply Pyrrhulina with maxillary teeth.

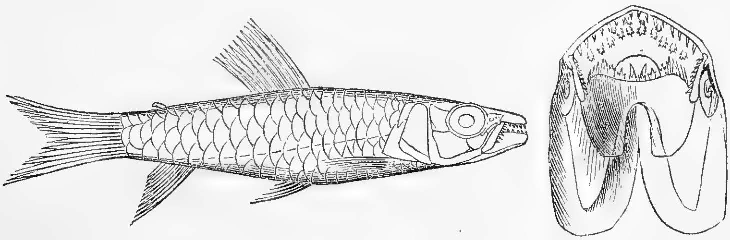
Character specificus. Rather elongate ; depth .0125 M.; length .07 M., length of head .014 M.; width of do. behind .0065 M. Radii D. 9.; A. I. 10 ; V. 8. Scales 7—25. Above brownish, below yellowish ; on the sides the scales with orange bases and brown edges forming longitudinal lines. A black band through the operculum and orbit round the edge of the premaxillary ; another round the edge of the mandible. A black spot on the middle of the dorsal fin.

This species is evidently near the Pyrrhulina filamentosa of Cuv. and Val., but the caudal fin is regularly emarginate, and has not the peculiar form ascribed to that species by those authors.

Numerous specimens from Pebas, Equador, Hauxwell's coll.

PLETHODECTES ERYTHRURUS. Cope gen. et sp. nov.

Character genericus. Adipose fin present, dorsal short, originating



above the ventrals. Anal short. Lateral line present on the inferior row of scales ; belly not compressed ; gill opening wide. Teeth on the maxillary, premaxillary and dentary bones. Maxillaries in one row, simple, conic ; premaxillaries in two rows, those of the external simple conic, of the inner tricuspid ; mandibulars in an outer row of tricuspid teeth, and two simple conic in the middle behind them. Maxillary arch angulate, the maxillary bones extending downwards on each side of the dentary.

This genus appears to be nearest to Piabucina Cuv. Val. It differs in the presence of the lateral line, and in having two series of premaxillary teeth instead of one, of which the external is simple and not tricuspid. There are also two series of teeth on the dentaries of Piabucina. The suborbital bones of this genus are large.

Character specificus. Form medium, head elongate, broad and flat above, interorbital width 2.5 times in length. Diameter of orbit nearly three times in length of head, equal to length of muzzle. Length of head one-third of total without caudal fin. Greatest depth one-fourth of same. Scales large, l. series 6 at ventrals; transverse (above l. line) 16. Radii, D. 12; A. 11; V. 9; caudal deeply forked.

Color light olive; top of head and muzzle, ventral, anal, and dorsal fins blackish. Caudal fin red, dusky medially.

There are three longitudinal ridges on the cranium above, of which the median is very weak. Total length 0 M.068; length to opercular margin, .0175 M.; to basis of ventral, .0285 M.; to basis of anal, .042 M.; to bases of caudal, .052 M. From Pebas, Equador; Hauxwell's collection.

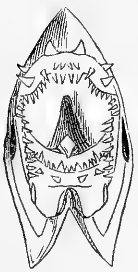
APHYOCHARAX FILIGERUS. Cope sp. nov.

Head small, the length contained five times in total, without caudal fin; height 4.25 times in the same. Eye three times in length of head, a little exceeding muzzle. Dorsal fin originating half way between lines of origin of ventrals and anal. Anal long, the anterior rays much prolonged, filiform, extending backwards to the last fifth of the length of the base. Dorsal elevated; Radii, D. 10; A. 28. L.l. scales 38; tubes on a few of the anterior only; l. tr. 12. Premaxillary teeth seven on each side, maxillaries numerous, occupying most of the margin of the bone. Color olive above, yellowish below, lower lobe of caudal blackish. Length 0M. .06.

This, the second species of this genus just described by Günther (Proc. Zool. Loc. London, 1868, 245), differs from the type species, A. pusillus, in the longer anal fin (there are only 18 rays in the latter), with much prolonged anterior radii, the shorter head, the more numerous maxillary teeth, &c.

From Pebas, Eastern Ecuador, Hauxwell's Collection. Dedicated to the discoverer, a successful naturalist and explorer.

ROEBOIDES BICORNIS. Cope sp. nov.



Radii D 11, A 51; scales l. tr. 18—16; the back is gibbous; the outline of the front plane; the muzzle slightly descending, and overhanging the mandible; depth one-third of length, without caudal fin; length of head 3.5 times in same; eye large, 3.5 times in head; inter-orbital region narrower, convex; two horn-like teeth projecting forwards; two small ones on each side posteriorly, directed outwards; mandible with four equal conic processes; mandible with four canines; premaxillary teeth irregular, maxillaries sparse; pectorals and ventrals extending beyond basis of anal; length 0.07 M.; to ventrals .02 M.; to anal .025 M.; origins of dorsal and anal opposite.

Color pale, with a silver lateral band, and black humeral and basal caudal spot.

Pebas, Eastern Equador, Hauxwell s Collection.

This species is near the R. myersii Gill, M.S., but is a shallower fish, with smaller eye, and fewer horns on the upper jaw. The Hystricodon xenodon Reinhardt, Vidensk. Med. Kjobenhavn, 1849 37, has much larger scales.

ANACYRTUS TECTIFER. Cope sp. nov.

Radii ; D. 11 ; A. 37. Scales from basis of dorsal to basis of anal 12—10. A short, deep species ; depth 3.2 times in length, without caudal fin ; head 3.6 in the same ; eye 3.75 times in length of head ; equal interorbital width ; head elevated, front slightly concave in profile, end of muzzle descending ; scales rather large ; ventrals reaching anal fin, pectorals not Maxillary teeth numerous, equal, premaxillary series confluent, three canines on each side ; mandible with two on each side ; mandible longer than muzzle, when open.

White, without silvery lateral band ; inferior half operculum golden ; a large black spot in front of the origin of the dorsal, on the side : a black spot at the basis of caudal ; ante-orbital region punctulate ; length 0.M. 068 ; to end of maxillary .0075 M. to origin of ventral fins .0225 M. ; to origin of anal .031 M. The origin of the dorsal is in advance of the line of the origin of the anal. Its last ray is much behind the latter point.

This species is named from the fact that the free anterior margin of the nasal bones is more prolonged than in other species, and overhangs the nares and premaxillaries. The few anal radii and coloration also distinguish this fish from its allies.

Pebas, Ecuador. Hauxwell's Collection.

CYNOPOTAMUS GULO. Cope sp. nov.

Form slender ; the depth of the body near three-fourths the length of the head, four and one-third times in the total, without caudal fin. Length of head three and a quarter times in the same. Eye 3.75 times in the length of the head. Maxillary bone extending a little beyond the line of the posterior rim of the orbit. Fourteen rows of scales between origin of dorsal and lateral line. Fin radii D. 12, A. 41. The profile of the head is scarcely concave and slopes regularly to the premaxillary border. A few scattered canines form an inner premaxillary row. There is a canine at each end of each premaxillary of the outer row. The outer mandibular row consists of four equidistant canines on each side in front, and numerous small teeth behind.

Color pale. Lower half the opercle golden. A black humeral spot, and a silver lateral band extending from it to the caudal fin, at the base of which is a black spot.

Length 0M .09. To opercular margin .025. To origin dorsal (vertical line) .035. To origin of anal .044.

From Pebas, Eastern Peru. Numerous specimens from Hauxwell's Collection.

Other Characinidæ contained in the collection are, Macrodon trahira Spix; Erythrinus brevicanda, Günth; Hydrocyon sp. indet; Myletes duriventris Cuv.; Tetragonopterus ortonii, Gill M.S.S. Proc. A. N. Sci., Phila., 1870; Gasteropelecus stellatus Kner; Chalcinus brachypomus, C. V.; Leporinus frederici, Bloch; Curimatus sp. indet.

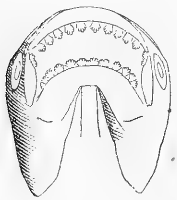
The Characins obtained at Para by De Schulte Buckow for J. Carson Brevoort's Collection, already mentioned, are Leporinus striatus Kner.; L. megalepis, Gunth.; Schizodon fasciatus, Spix; Tetragonopterus lepidurus Kner.; T. fasciatus; T. stilbe, Cope, T. Gasteropelecus sternicla L.; Chalcinus brachypomus C. V.; Myletes lippincottianus, Cope; Serrasalmo piraya; Serrasalmo maculatus, Kner. The last agrees closely with Kner's figure and description, except that the young only is spotted, and the caudal fin of young and adult are yellow-edged outside the blackish cross band.

ODONTOSTILBE FUGITIVA. Cope gen. et. sp. nov.

Char. Gen. Teeth in a single series on the premaxillary and dentary bones only, broadly spatulate and crenate. Anal fin elongate. Lateral line continued to the caudal fin.

This genus differs from *Chirodon* (Girard) chiefly in the complete development of the lateral line of tubules.

Char. Spec. D. 10, A. 24, l.l. 35. Transverse line at vent 11; at ventral fins 5—5. Teeth, two on each maxillary, five on each premaxillary, and six on each dentary. The premaxillaries with seven cusps each, the median more prominent. Those of the other bones with similar cusps of more equal length. Depth of body 3.5 times in length, exclusive of caudal fin. Head four times in the same, its profile convex longitudinally and transversely, with interorbital width equal diameter of orbit. Latter 2.5 times in length of head. Caudal fin deeply forked. Ventral just in advance of below first dorsal ray. Pectoral barely reaching ventral. Olive silvery, with a silver band, dark-edged above and below, from opposite middle of pectoral fin to basis of caudal. A dark spot at latter point. Cheeks silvery. Length two inches.



Pebas, Eastern Equador. Hauxwell's Collections.

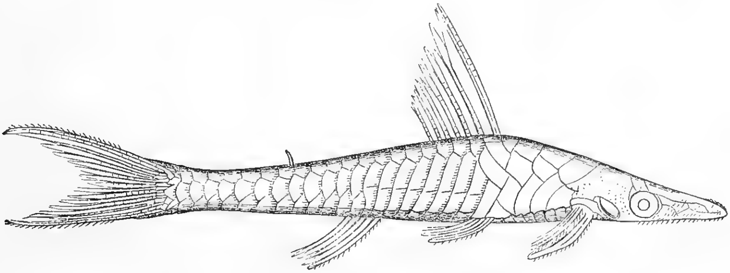
This little Characin is allied to the *Chirodon alburnus*, Gthr. (P. Z. S. Lond. 1869, 424,) but has teeth on the maxillary, fewer and differently formed on the other bones, more anal radii, different proportions, etc.

SILURIDÆ.

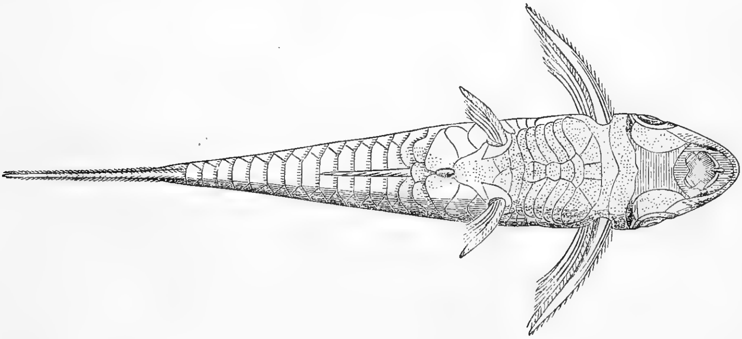
HYPOPTOPOMA BILOBATUM. Cope sp. nov.

Character.—Form rather slender. Adipose fin reduced to a microscopic spine. Teeth numerous, $\frac{24+?3}{23}$ on each side of the mouth. Caudal fin deeply forked, with nearly equal lobes.

Description.—Radii, D. I. 7, A. 6, P. I. 6, V. I. 5. Two rows of plates of the lateral line to a little behind the anal fin; then one row. Transverse series 24 to caudal. Three plates between occiput and dorsal fin.



Fourteen plates across dorsal line behind dorsal fin. Sutures of vertex obliterated, but those on each side of the suture rising from the middle of the orbit are of equal width. Three plates along each canthus rostralis, with a median rostral. Temporal region rugose. Sides and muzzle below, with close, card-like spinules. Plates everywhere comb-like behind. Spines and outer radii of all the fins, spinulose. The pectoral spine is, in addition, serrate on the inner margins.



Length of head to occiput 3.5 times in total less caudalis; width behind pectorals five times, and depth at dorsal 7.5 times in the same. Orbit round, one-third of interorbital width. Pectorals to middle of ventrals; ventrals to beyond vent, but not to anal fin. Basis of dorsal twice to adipose spine (!), which is small, articulating in a groove in the summit of the interhæmal bone, which appears between the shields. First dorsal ray weak, jointed distally.

Interoperculum very large, entirely inferior. Thoracic bones covered with rugosities, separated externally. Three rows of abdominal plates, four in the first cross-row.

The lobes of the caudal fin are acute and nearly equal. Length four inches. Color olive, top of head and dorsal region darker. A black spot in the middle of the caudal fin.

This is the second representative of a remarkable genus recently described by Günther (Proc. Zool. Soc. London, 1868, 234), and which has as yet been found only in the upper Amazon and its tributaries. The opercular apparatus is so modified as to reduce the operculum to a very small bone, and to give the interoperculum an entirely inferior position and increased size. The general appearance is intermediate between that of *Hoplosternum* and *Loricaria*.

From Pebas, Equador. Hauxwell's collection, with *Callichthys asper* and the following species of *Nematognathi*.

DORAS PECTINIFRONS. Cope sp. nov.

Radii D. I. 5, A. 12; P. I. 5; V. 6. Lateral line 27. Superior and inferior face of caudal region with shields with posterior and lateral spines. Lateral plates elevated, with a prominent point posteriorly directed above and below the prominent median spine. On the anterior half the side one to three series of irregular posteriorly directed spines above the lateral series, and a few irregular ones below it. Margins of the cephalo-nuchal shield prominent all round, often recurved, rugose; pectinate above the orbits, and at the posterior projection on each side the dorsal fin. Two serrate ridges mark the premaxillary spines, and the preorbital bones are crested laterally and superiorly, the superior crest comb-like. Preopercular angle with a serrate crest; scapula serrate. Dorsal and pectoral spines elongate, both serrate before and behind, and with two spinulose ridges on each side. Humeral spine reaching last third of pectoral, with an external series of straight spines. Caudal fin rounded. Maxillary barbel not quite reaching basis of pectoral spine. No spine in adipose dorsal.

Color everywhere black, gular, thoracic, and abdominal regions white spotted. Caudal fin with a yellowish cross-bar near the extremity. Length of type specimen three inches.

Pebas, Equador. Hauxwell's collection. Allied technically to the *D. armatulus* of Cuv. and Val.

BUNOCEPHALUS ALEUROPSIS. Cope sp. nov.

Radii D. 5–6, A. 9, P. I. 4, C. 10. Base of first dorsal ray nearer end of muzzle than origin of caudal fin; its distance from former a little more than .4 of total length. Maxillary barbel extending to near the middle of the pectoral spine. Width of head at preopercula 5.66 times in length, exclusive of caudal fin. Length of caudal fin 5.75 times in total length. Length of head to operculum 6.1 times in total (without caudal). Five series of wartlets along each side of the tail. Tail wide as deep medially, compressed distally. Length four inches; greatest (scapular) width a little less than .25 of the total (with caudal fin).

Color brown, the head densely punctulated with white above. Sides and back with dark brown blotches. Dorsal fin with extremities of anal and caudals, black or blackish.

From Pebas, Eastern Equador. John Hauxwell's collection.

This species is near the *B. gronovii* Bleeker, but has different radial formulæ and larger maxillary barbels, etc. In the latter the fins have, according to Günther, D. 5, A. 6, P. I. 5.

Pseudorhamdia piscatrix. Cope sp. nov.

Head above granular rugose, except between and in front of the prefrontals. Occipital process convex, not keeled, apex in contact with basal dorsal shield; its length exceeding a little its width at the base. Head narrow, with narrow truncate muzzle and nearly equal jaws; the width at base of pectoral spines equal length to behind orbit. Orbit 3.3 times in length of head, equal interorbital width. Radii D. I. 6, A. 12, P. I. 9, V. 6, not reaching anal. Caudal deeply forked lobes subequal. Beards very long; the maxillary reaching to near the extremity of the caudal fin, the external mentals to beyond the base of the pectorals, the inner to beyond the middle of the pectorals. The pectoral spine is serrate on both edges; the dorsal on the posterior only. The longest ray of the dorsal when depressed reaches the base of the adipose fin. The adipose subtriangular, its base one-seventh the total length, without caudal fin. Head to opercular opening 3.75 times in length to basis of caudal fin. Length five inches. Pebas.

Rhamdia cyanostigma. Cope sp. nov.

Radii D. I. 6, the spine not thicker than the other rays, and weaker than the pectoral; A. 12, V. 6; P. I. 8; its spine minutely serrate within and without. Top of the head smooth, or with a slight rugosity on the postfrontal region. Head to operculum a little more than .2 of length to basis of caudal fin; length to basis of dorsal one-third of the same. Depth of body 7.33 times in the same length; length of adipose fin 3.33 times in the same. Depressed dorsal not reaching adipose; pectoral reaching only .66 distance to ventrals; latter reaching half way to anal. Caudal fin very deeply furcate, lobes equal. The maxillary barbel reaches to near the end of the adipose fin. Length four inches; general form slender. Color plumbeous; head above blackish, with an iridescent blue spot above the posterior margin of the orbit on each side.

From Pebas, Equador. Hauxwell's collection.

This species is allied to the *R. dorsalis* Gill, from the same region, but is a more slender fish, with more numerous anal radii and longer barbels.

CHROMIDIDÆ.

Crenicichla cyanonotus. Cope sp. nov.

D. xxiv. 11, A. III. 8; scales 5–66–13. Depth of body 6.25 times in total length; length of head a little more than four times in the same. Orbit large, equal length of muzzle, 3.75 times in length of head, a little less than interorbital width. The head is thus broad and short; above quite plane. Scales of body rather large, seven rows on the cheek. End of maxillary marking anterior third of orbit. External teeth stronger. The ends of the pectoral and ventral fins mark the thirteenth dorsal spine. The longest dorsal spine equals the length of the premaxillary bone with spine. Color olive, with seven indistinct brown cross-bands directed obliquely backwards to the middle line of the side. A dark band from orbit to axilla. A black, white(?) edged spot on the upper caudal radii. Dorsal and anal fins without spots, blue at the base. Length six inches.

From the upper Marañon, near Pebas. John Hauxwell's collection.

CRENICICHLA LUCIUS. Cope sp. nov.

Radii D. xix. 13; A. III. 10. Squamation 4—64—13. Depth of body one-seventh of total length. Length of head three and a half times in the same. Head elongate, pike-like, the mandible strongly projecting, the outer series of teeth not larger than the others. Orbit, diameter less than length of muzzle, nearly five times in length of head, equal inter-orbital width. Length of longest dorsal spine three-fourths that of the premaxillary bone with spine. Scales large, eight rows on the cheek. Maxillary bone reaching the anterior fourth of the orbit. Ventral and pectoral fins marking the eleventh dorsal spine.

Color olivaceous, above brown. A darker band from muzzle to opercular angle. A black spot *at base* of caudal radii, edged with yellow. Dorsal and anal fins unspotted. Length six inches, width of head behind .75 inch.

This species is near the *C. lacustris* of Castelnau's fine work, and differs in the following points. The latter is a less elongate species, the depth being only one-sixth the length. The scales are less numerous, counting 4—51—11. There is a brown spot on the middle of the dorsal fin, and some longitudinal shades on the posterior part not found in the *C. lucius*.

Both species were sent by John Hauxwell from the tributaries of the Upper Maranon, in Equador.

ACARA FLAVILABRIS. Cope sp. nov.

Three series of scales on the cheek. Radii D. xvi. 10. A. III. 8 squamation 3—26—9. Depth 2.25 times, head three times in length without caudal fin. Orbit, diameter a little exceeding muzzle, one-third length of head; inter-orbital width two-fifths the same. The length of the longest dorsal spine is equal to that of the muzzle.

Color brown, several darker cross shades across the dorsal region; a large black ocellus on lateral line, No other spots. Fins dusky. Lower lip yellow, Total length four inches; depth of head 1.1 inch. Front slightly convex in profile.

From near Pebas, Ecuador, John Hauxwell's Collections. It was associated with several specimens of *Mesops taeniatus* Günth. (Catals. B. M. iv. p. 312), from the same locality. In the same collection occurred *Rivulus micropus Steind. var.*, *Sternopygus macrurus*, *S. virescens* and *Carapus fasciatus.*

TETRAODONTIDÆ.

TETRAODON PSITTACUS L.

Cheilichthys (Müll). Steind. Verh. Zool. Bot. Ver. Vienna 18, p. Tab.

This species was brought by Natterer from some of the fresh waters of Brazil, according to Steindachner. It occurs in the present collection from Equador, from a point 2,300 miles from salt water.

EXPLANATION OF WOOD CUTS.

Fig. 3. *Myletes lippincottianus*, Cope, mouth showing dentition.
Fig. 4. *Odontostilbe fugitiva*, Cope, ibid.
Fig. 5. *Stethaprion erythrops*, Cope, natural size; 5a, mouth with dentition.
Fig. 6. *Plethodectes erythrurus*, Cope, natural size; 6a, mouth with dentition.
Fig. 7. *Rœboides bicornis*, Cope, mouth with dentition.
Fig. 8. *Hypoptopoma bilobatum*, Cope, natural size; 8a, same seen from below.

Stated Meeting, December 2d, 1870.

Dr. G. B. Wood, President, in the Chair.

Present, fourteen members.

A letter of acknowledgment was received from the R. Danish Society of Sciences, dated November 5, 1870 (81, 82, xiii. 3).

Donations for the Library were received from the Prussian Academy; Silliman's Journal; the Connecticut Academy; the American Oriental Society; Mr. James J. Barclay, of Philadelphia; and Dr. Rushenberger.

Dr. H. C. Wood presented for publication in the Transactions of the Society a Monograph of the Fresh Water Algæ of the United States, which was referred to a Committee consisting of Dr. Carson, Dr. Bridges, and Mr. Durand.

Dr. Pepper communicated "Observations upon a Skeleton," exhibiting a unique case of Universal Hypostasis associated with Osteoporosis, illustrated by Drawings. Dr. Leidy, Dr. Coates, and Dr. Allen were appointed a Committee to act in conjunction with the Secretaries respecting the publication of this paper.

Prof. Cope communicated a paper on the Fishes of the Fresh Water Tertiary in Idaho, discovered by Capt. Clarence King; and another on the Adocidæ.

Prof. Cope made the following verbal communication on fossils, which he exhibited and described:—

Prof. Cope exhibited vertebræ of two species of Pythonomorpha, the largest known to exist. One of these, *Mosasaurus maximus* Cope, from the New Jersey Cretaceous, was represented by vertebræ, whose centra were 3.5 inches in diameter across the articular extremities. Those of *M. missuriensis* Harl. measured 2.5 inches in a specimen of seventy-five feet in length, according to W. E. Webb; so that the *M. maximus* probably exceeded that length. This measurement was also confirmed by statements of persons engaged in digging marl in New Jersey. The second species exhibited was still larger, and appeared to belong to the genus *Liodon*. The diameter of the convex articular extremity was more than 5.5 inches, indicating a great length for the animal, perhaps one hundred feet. It was named *L. dyspelor* Cope. The centra were depressed in the dorsal region, and had the smooth margin bordering the ball and rugose surface within this band. An emargination for the neural canal. Caudals pentagonal anteriorly, becoming soon higher than wide. From near Fort McRae, New Mexico.

Several other species of the order had recently been found by Prof. Mudge in Kansas. Two of these were *Liodons*, and were named *L. ictericus* and *L. mudgei*, respectively. The former was allied to *L. validus* Cope, having depressed dorsal vertebræ; but the quadrate bone had a less prominent and more medially placed external angle and ridge. The *L. mudgei* had depressed vertebræ; but the external angle of the quadrate more posterior, and not continued so far down. The third was a Clidastes, much the largest of the genus, nearly equalling the *Liodon validus* in size, and differing from the described species in the lack obliquity of the articular extremities, and other points. He named it *Clidastes cineriarum* Cope.

The Treasurer's report was read.

Prof. Trego, Chairman of the Publication Committee, read the report of that Committee; when,

On motion, the Committee was instructed no longer to forward copies of the Transactions to delinquent subscribers, after due notice given.

Pending nominations Nos. 661, 666, and new nominations, Nos. 667, 668, were read.

And the Society was adjourned.

Special Meeting, December 9th, 1870.

Dr. Wood, President, in the Chair.

Present, twenty members.

The Preamble and resolutions for considering which this meeting was called, were read, debated, and withdrawn by Mr. Cuyler, by permission of the Society.

It was then on motion of Mr. Cuyler,

Resolved, That a Committee consisting of the President of the Society and five members be appointed, whose duties it shall be to consider and report whether it is desirable, and if desirable, whether it be practicable to establish in the city of Philadelphia, under the auspices of the Society, an Observatory, Astronomical and Physical, either or both, and if so at what cost, on what site, and what instruments are requsite for such purposes, and at what cost such instruments can be procured.

The following gentlemen were nominated and on motion appointed to constitute said committee; Mr. Cuyler, Prof. Frazer, Prof. Henry, Prof. Kendall, and Mr. Fairman Rogers.

And the Society was adjourned.

Stated Meeting, December 16th, 1870.

Dr. G. B. Wood, President, in the Chair.

Present, fourteen members.

Letters of acknowledgement were received from the Emden Nat. Hist. Society (77–80), the Buenos Ayres Museum (78, 79, 80), the Soc. Antiquaries, London (82), and the Nat. Hist. Soc. at Newcastle on Tyne (82).

Letters of envoi were received from the Emden N. H. Society, Oct. 1, and the Bureau of Geological Research of Sweden, Stockholm, May 1st, 1870.

A printed Circular memorial in behalf of the collections in Paris, threatened by the bombardment, was received from the Provost and professors of Trinity College and the University of Dublin.

Donations for the Library were received from the Imp. Russian Academy, the Nat. Hist. Soc. at Moscow, the Austrian Geological Ins., Dr. Heidinger of Vienna, the Observatory at Prague, the Societies at Emden and Frankfort, the Societies of Science and Antiquities at Copenhagen, the Swedish Geological Bureau, the R. Lombard Institute, the Institute at Venice, M. A. de la Rive of Geneva, the London Geographical Soc., the Meteorological Committee of the R.S., and the Editors, of Nature, the Hist. Soc. at Quebec, the Essex Institute, Boston N. H. S., New Jersey Historical Society, Prof. A. M.

Mayer of Bethlehem, the Medical News and Penn. Monthly, Peabody Institute in Baltimore, Surgeon General's Office in Washington, the Publishing Bureau of the U. S. Commissioners to the Paris Int. Exp. of 1867, War Maps from the Chief Engineer's Bureau in the War Office, a map of Ohio from Prof. Newberry, and the Annals of the Buenos Ayres Public Museum.

The Committee to which was referred the paper of Dr. Horatio C. Wood on Fresh water Algæ, reported in favor of its publication in the Transactions. The subject was, on motion, referred to the Publication Committee with instructions to report at the next meeting.

An obituary notice of Mr. Franklin Peale, a late member of this Society, was read by Mr. Robert Patterson.

An obituary notice of Mr. Samuel Vaughan Merrick, a late member of this Society, was read by the Rev. Dr. Goodwin.

Prof. Cope made a communication on certain extinct Astici from the Fresh water Tertiary of Idaho. And another on four species of Pythomorphia from the Cretaceous of Kansas.

The reading of the report of the Finance Committee was, on motion, postponed to the next meeting.

Mr. Marsh, Treasurer of the Building Fund Trust, presented the annual Report of the Trustees.

Pending nominations 661 to 668 were read.

Motions for appropriations for the ensuing year were postponed to the next meeting.

And the Society was adjourned.

ON SOME SPECIES OF PYTHONOMORPHA FROM THE CRETACEOUS BEDS OF KANSAS AND NEW MEXICO.

BY PROF. E. D. COPE.

Read before the American Philosophical Society, December 18th, 1870.

Liodon dyspelor. Cope.

Species nova.

This species is represented by numerous vertebræ of the dorsal, lumbar, and caudal regions, and other remains, which will at a future time be more fully described than is possible at present. The vertebræ indicate the largest Mosasauroid reptile known, and are remarkable for their form as well as size.

The centra of the dorsals are much depressed, quite as in *L. perlatus*, Cope, and *Mosasaurus brumbyi*, Gibbes. Their articular faces are of transverse lenticular form, the superior arch being a little more convex than the inferior, and obtusely emarginate for the floor of the neural canal. The superior outline is thus bilobed; the lobes rounded. The transverse curvature of the articular ball is quite regular, and not, as in *Mosasaurus maximus*, more steeply inclined at the external or lateral angles. A rather broad, smooth band separates the edge of the ball from the surfaces of the centrum adjacent. The latter are rather finely striate ridged from the edge of this band. The inferior outline of the centrum is strongly concave, and with two venous foramina separated by a wide interval. The basis of the diapophysis on a lumbar is very broad, measuring more than half the length of the centrum. In general characters this lumbar resembles the dorsal, including the emargination for the neural canal, but is shortened in relation to its length.

The depressed form of the lumbar centra gives place gradually on the caudals to a more elevated pentagonal outline, which is still more reduced in width in more posterior regions. The hæmal arches are articulated, and on the anterior caudals to slightly elevated bases; on the more posterior, the bases are reduced in height, and more widely and deeply excavated. I have not seen the most distal caudals, and hence cannot determine whether their chevron bones articulate in pits, as is the case with those of *L. perlatus*, *L. proriger*, etc. On a caudal where the depth of the centrum a little exceeds the transverse diameter, the diapophysis has become narrow and thick. The excavation for the neural canal is strongly marked on the more anterior caudal. The smooth border of the articular ball is here narrow, and the superficial rugæ are fine, and confined to the anterior part of the centrum.

Measurements.	*M.*
Transverse diameter ball posterior dorsal	0.144
Vertical " "	.097
" " anterior caudal	.094
Transverse " " "	.107
Length centrum caudal	.071
Transverse diameter neural canal	.0145
" " basis diapophysis	.032
" " " " of a more distal caudal	.0278
Longitudinal diameter chevron articulation of caudal	.023
Length centrum	.068
Depth ball centrum	.093
Width " "	.091
Length centrum of a lumbar	.106
Width of articular ball	.125

In instituting a comparison between this and other known Mosasauridæ, it will be necessary to consider species referred to Mosasaurus as well as to Liodon, from the fact that some of the former may really be Liodons.

The Liodons with compressed or round dorsal or lumbar vertebræ may be dismissed from comparison. Of the depressed species, *L. perlatus*, Cope, is known from specimens of one-third or less the size of the present one, which are further peculiar in having the diapophyses of the lumbars to stand on the anterior half only of the centrum. In *L. ictericus*, Cope, the centra are less depressed, and the size still smaller than in the last.

Among Mosasauri with depressed vertebral centra, it is to be noted that none present so great a degree of depression and lateral extension except the *M. brumbyi* of Gibbes. They are all also much smaller. The *M. brumbyi* was founded by Dr. Gibbes on two lumbar vertebræ from the Cretaceous of Alabama, which resemble those of the *M. dyspelor* in form, and also in size. It is probably its nearest ally, and may be a Liodon. Dr. Gibbes established the genus Amphorostens for it, but without sufficient evidence to support it. The principal point of distinction between it and the *L. dyspelor* which I observe is the lack in the former of the strong emargination of the superior margin of the articular surface for the floor of the neural canal, which is so marked in the latter. I have only the figures of Gibbes to rely on for this particular, and it is scarcely probable that the artist would have overlooked it had it existed. Should the bounding prominences have been worn off, then the restored centrum would have had a notably greater vertical diameter than in the *L. dyspelor* in the same portions of the vertebral column. As a second character, I note that, relying as before on Gibbes' figures, the external angles of the depressed ball are not so extended laterally in *M. brumbyi.*

In size the vertebræ of the present animal exceed those of the *M. brumbyi.* The latter has been hitherto the largest known species of the order Pythonomorpha, exceeding two-fold in its measurements the *M. giganteus* of Belgium. So the present saurian is twice as great in dimensions as the New Jersey species I have called *M. maximus.* If, as appears certain, the *M. missuriensis* discovered by Webb measures seventy-five feet in length, the *M. maximus* measured eighty, and the *M. dyspelor* could not have been less than one hundred feet in length. This is much the largest reptile known, and approaches very nearly the extreme of the Mammalian growth seen in the whales, though of course without their bulk. Such monsters may well excite our surprise as well as our curiosity in the inquiry as to their source of food supply, and what the character of those cotemporary animals preserved in the same geologic horizon.

The locality whence this reptile was procured is near Fort McRae, in New Mexico. It was discovered by Dr. W. B. Lyon, surgeon at that post, and by him sent to the Army Medical Museum at Washington, whose director placed it in the collection of the Smithsonian Institution. The attention to the palæontology of his neighborhood by Dr. Lyon will always be cause of satisfaction to students, and his name will be remembered with that of Turner (discoverer of the *Elasmosaurus platyurus*, Cope), Sternberg, and others.

The stratum is the yellow chalk of the upper cretaceous, which has yielded the *L. ictericus*, *L. proriger*, *Polycotylus*, etc., in Kansas, and of whose western extension into New Mexico, the present species is evidence.

LIODON ICTERICUS, Cope.

Char. External angle of the os quadratum close by the meatus, and continued as a rounded ridge separating the anterior and external faces of the bone. Median posterior ridge not prominent. Centra of dorsal vertebræ depressed. Humerus broad, short.

Description. This species is represented by portions of cranium, as postfrontal, suspensorial, pterygoid, articular, and quadrate bones; by parts or wholes of several vertebræ, which are all dorsals, and by scapula and coracoid with many elements of the fore limb. The latter include humerus, radius, a carpal and numerous metacarpals and phalanges.

The species is first well characterized by the form of the quadrate bone. This element lacks a portion of the ala, and the postero-superior decurved process, but is otherwise perfect. Its form is intermediate between that in *L. validus*, Cope, and *Mosasaurus depressus*, Cope. Its external angle of the proximal extremity is posterior to its usual position, as in the former species, but is less prominent than in it. It extends to near the distal end, disappearing between the extremities of the median posterior, and the distal longitudinal angles. The former of these is short, and it disappears by a gradual descent distally, in a very rugose margin. The distal longitudinal is short and acute, not prominent at the distal extremity. From the posterior position of the proximal external angle, the alar articular surface is somewhat elongate. The postero-external face above the meatus is proportionately short. The meatal pit is scarcely one fifth the usual size, so far as determinable from the present surface, but it is possible that the greater part is filled by an impacted mass of bone derived from the adjacent ridge. The margins of the articular extremities and of the ala are striate and papillose rugose. No meatal knob.

The suspensorium is slender. It is peculiar in the great extent of the exoccipital element, which covers the whole superior surface, and extends externally over the opisthotic to the squamosal, concealing the former except its anterior margin. The proötic sends a small proximal portion only to the superior face.

The pterygoid has been free from its fellow medially. A distal and median portions have been lost; the remaining fragments present bases and alveolæ for eleven teeth. The fangs are rugulose and but little swollen; probably five to seven stood on the lost portions. The bases of the crowns are circular. The external process of the bone is slender and flat.

The portion of the mandible preserved, includes much of the articular, and adherent parts of the angular. The latter forms a narrow band on the lower edge of the external face, and one twice as wide on the inner face. The only characteristic feature is the lowness of the ridge which descends and extends anteriorly from the anterior margin of the cotylus for the quadratum.

Of the vertebræ several are so distorted by pressure as to be uncharacteristic. Two well preserved anterior dorsals have transversely oval articular surfaces excavated openly above for the neural canal. One is from a position anterior to the other, and these surfaces are less oval, though still transverse. The centra of both are very concave in profile below, and expand both inferiorily and laterally to the edge of the cup. A deep groove surrounds the base of the posterior face. In the anterior dorsal the neural arch is preserved. It exhibits an approach to a zygosphen articulation more marked than in any other *Liodon*, and is hence nearer *Clidastes* in this respect as well as in the slender pterygoid. A zygosphen is not separated from the zygapophyses, owing to their connection by a lamina of bone. The notches at the posterior end of the arch for this prominence are marked. The neural spine had a long anterior ala, the base of which extends to the summit of the neural arch. It presents a fine striation vertical to the centrum and oblique to the edge of the bone, as is seen in *C. propython*, Cope. The diapophysis on this vertebra looks obliquely upwards and carries a vertical articular surface which is concave behind. The line of its lower extremity falls the depth of the neural arch below the latter, and of its upper reaches the apex of the canal in front. The more posterior vertebra has as usual a broader articular rib surface, the diapophysis being flattened above and below. The marginal and angular surfaces are striate-rugose on these and the other vertebræ. One of the free hypapophyses of a cervical is preserved. It has a subtrigonal section and is longer than wide, and obtuse. Its posterior faces are exceedingly rugose.

A cervical rib is compressed and short. Head narrow, large simple, the adjacent sides striate-rugose. Sides with a shallow groove.

The scapular arch is represented by an entire right scapula and proximal part of right coracoid. The former is broader than in any of the species in which I have seen it (four only), and is flat, and thin above. Its anterior extension is greatest below ; its posterior above, at the superior angle. The lower posterior margin is strongly concave and thickened. The antero-superior margin is a regularly convex arc of more than 180°. The lower portion in front is on a different plane, and is the rudimental acromion. The articular surface is rugose, and the glenoid cavity not less so.

The proximal portion of the coracoid is flat. It presents the usual foramen near the anterior margin, and the shorter concavity of the anterior margin leads to the belief that the anterior extremity of the bone is the more prolonged as in *Clidastes propython.*

The glenoid cavity is not concave, but merely two adjacent flattened rugose surfaces.

Consequently the *humerus* has no head, but merely an elongate articular surface, which exhibits a median keel and a short angular expansion near the middle. This bone is of remarkable form, more resembling that I have described in *Clidastes propython* * than any other, and very different from that described by Leidy in *Platecarpus tympaniticus*. It is a broad flat

* See Trans. Amer. Philos. Soc., 1869, 219. Tab. XII, fig. 17,

bone expanded at the extremities in one plane distally, so as to be as wide as long. In the present individual it is crushed by pressure, so that its thickness is not readily determinable. Its external surface rises into a crest medially at the narrowest portion, which continues to the lateral angle of the proximal end, following parallel to one of the borders. A moderate thickening exists on the opposite side a little beyond the extremity of the crest. Strongly rugose striæ extend to the edges of the articular faces. An oval rugose muscular insertion exists on the least prominent of the distal angles, and not on a process as in *C. propython.*

A bone which from its analogy to the *radius* of the last named species I suppose to be that bone, accompanies the others. It is flat, truncate proximally and with nearly parallel borders on the proximal half. Distally it is obliquely expanded, the outline forming a segment of an ellipse whose axis is oblique to that of the bone. Its extremities are rugose-striate.

One *carpal* remains : it is a quinquelateral bone, one side being marginal and concave. Perhaps it is the intermedial. There are several elements which are probably metacarpals. The general structure of the whole limb may be determined from these and from the numerous *phalanges.* The former are flattened and with oblique extremities ; the latter more cylindric, with a transverse truncation. Both have a median contraction, which becomes less marked in the distal ones ; these are also more cylindric, entirely so at the distal extremities, which are concave. All of these element are rod-like, much more slender than any of those figured by Cuvier or Leidy. Those immediately following the metacarpals are flattened, but thickened distally.

The number of *digits* cannot be readily determined, but four may be certainly distinguished. The general similarity in construction of the manus to that of a Cetacean mammal is noteworthy.

Measurements.	*M.*
Length suspensorium (anteriorly)	0.111
Width " medially	.031
Quadrate, greatest length	.099
" width of ala	.066
" thickness behind	.03
" length distal extremity	.043
Pterygoid, length six alveoli	.055
Anterior dorsal, length centrum	.059
" " width cup	.0515
" " depth "	.038
" " expanse poster. zygapophyses	.0395
" " " diapophyses	.091
" " width neural canal	.0135
" " depth "	.011
Posterior " " ball	.049
" " width "	.0425
" " length centrum	.0555
" " expanse diapophyses	.088

Scapula length	.145
" width proximal	.07
" " median	.112
Coracoid width, proximal	.066
Humerus length	.154
" width proximal	.119
" " median	.075
" " distal (restored from C. propython)	.158
Radius length	.115
" width proximal	.061
" " distal (oblique)	.105
Carpal length	.04
" width	.037
Metacarpal length	.095
" width proximally	.045
" " medially	.018
" " distally	.034
Phalange (medial) length	.085
" " width proximally	.027
" (distal) length	.059
" " width distally	.0082
Ramus mandibuli, depth in front of cotylus	.056
Cervical rib, length	.074

The total length of the anterior limb could not have been less than 0.90 M., which allows of five phalanges in the longest digit. There may have been more. That the digits were of unequal length is indicated by portions of two in matrix accompanying the specimens, where the articulation of two phalanges falls opposite the shaft of one of the adjoining digit. The phalanges were separated by a short interval of cartilage.

The size of this reptile was near that of L. validus, perhaps thirty-five to forty feet in length.

The affinities of this species as incidentally pointed out, are to those *Liodons* which approach *Clidastes*. This is indicated by the many pterygoid teeth, the rudimental zygosphen articulation, the regular striæ of the bones, and the forms of the limb bones. In Mosasaurus the humerus is shorter and the phalanges are longer.

The specimens on which this species rests were discovered by Prof. B. F. Mudge, formerly State Geologist of Kansas, now Professor of Geology in the State Agricultural College of Kansas, on the north bank of the Smoky Hill River, thirty miles east of Fort Wallace, Kansas.

Numerous fragments of another larger individual were found by Prof. Mudge near the same locality, which belong probably to the same species. Among them is a portion of the maxillary bone with bases of two teeth; the bases of the crowns where broken off are not compressed, but slightly oval. A radius is a flat bone, more dilated at one extremity than that of *Clidastes propython.*

	M
Length of radius	0.108
Width do. narrower extremity	.064
" " wider "	.08
" " medially	.042

This species cannot be confounded with the *L. proriger*, Cope, and *L. congrops*, Cope, owing to its depressed vertebral centra ; from *L. mitchillii*, DeKay, the equal and numerous pterygoid teeth separate it at once.

LIODON MUDGEI, Cope.

I am not quite sure whether this species belongs to this genus or to Mosasaurus. The characters of its quadrate bone, size, &c., induce me to refer it provisionally to the former.

Its determination rests on a series of specimens from the yellow chalk at a point six miles south of Sheridan, Kansas. They consist of three vertebræ and fragments of atlas, with numerous portions of cranium and proximal extremity of scapula.

The parts of *cranium* preserved are the frontal bone without the anterior extremity, and with the adjacent parietal almost complete, parts of the basisphenoid, the suspensorium, the ossa quadrata, and the greater part of the articular. The frontal is flat with thin edge, longitudinally hollowed on each side of the median line, which is marked by a low but acute keel. There is an abundance of foramina and delicate grooves on the surface, and posteriorly elevated striæ, which converge to the median keel. The median square projection of the border of the parietal is in advance of the lateral portion of the same, and not behind it as in *Clidastes propython*. The fontanelle is large. A marked feature is that the parietal crests unite into a low median ridge a short distance behind the fontanelle and are not, as in *Clidastes propython*, separated by a horizontal plane. The sutures of the bones forming the side of the brain-case are very obscure. Nevertheless it appears that the descending margin of the parietal does not descend to the front of the alisphenoid, but is margined inferiorly by the latter to the postorbital expansion. No part of the inferior margin of the alisphenoid can reach the sphenoid, as it terminates in a thin edge except for a short distance medially where it is broken off.

The inferior aspect of the parietal and frontal bones presents a furcate keel corresponding to the divergent parietal crests, and a very large funnel for the epiphysis of the brain. The olfactory groove is deep and regular.

The *articular* bone is characterized by the prominent longitudinal crest which descends on the inner side, from the front of the glenoid cavity to below the posterior attachment of the coronoid bone, where it terminates in a thin edge. Also by the short distance between the margin of the glenoid cavity (cotylus) to commencement (or end) of coronoid suture, indicating a shortening of the posterior part, at least, of the cranium. The bone is continued forwards only immediately under the coronoid (cfr *L. ictericus*).

The proximal extremity of the *quadrate* is characteristic, and exhibits features intermediate between those of *Liodon ictericus*, Cope, and the typical species of Mosasaurus, as *M. fulciatus*, *M. dekayi*, &c. The proximal articular face is much like that of *M. depressus* (Trans. Amer. Philos. Soc., 1869, p. 181, Fig. 48, No. 3). The external angle is much smaller than in the Liodons and more anterior, nevertheless it is continued distally as a ridge-like angle separating the antero-lateral from the postero-lateral faces as in them, and not presenting the gradual blending of the two surfaces characteristic of the genus *Mosasaurus*. The postero-lateral face is thus flat proximally, and the meatal pit, which is well developed, cannot be seen from the antero-lateral face. The distal part of the quadrate is lost, so that I cannot determine the character of the ridges there.

The basal element of the axis bears a strong hypapophysis without articular faces, but very rugose surfaces. The same portion of the atlas is a convex parallelopipedon, with median rugose tuberosity and very rugose extremities. Its surface is not separated from its body anteriorly by a deep groove as in *L. ictericus*.

The articular facets of the *scapula* are much broader than in the other species here described, indicating a head or wider articulation of humerus. No limb bones were preserved.

The vertebræ are too much injured to be characteristic, with one exception. This one is a posterior dorsal, and had had compressed centrum, or at least not depressed. The inferior face is convex transversely, and there is a slight concavity below each diapophysis.

Measurements.	*M.*
Parietal, length	0.074
" width between anterior and crests	.048
" least width	.022
Frontal interorbital width	.092
Quadrate width above	.02
" length from pit to proximal end	.023
Articular, length lower edge	.015
" depth in front of cotylus	.35
" " at end coronoid	.055
Posterior dorsal length	.0495
Scapula proximal width	.051

This species differs from all those of *Mosasaurus* and *Liodon*, in which the form of the quadrate is known in the character of that bone. From L. lævis and L. congrops in which that element is unknown, it differs in the stouter or less slender vertebræ; from *L. proriger* in its much smaller size.

Its size is a little less than the *L. ictericus* or *L. validus*. It is dedicated to Professor Mudge, in recognition of the valuable results of his investigations as State Geologist of Kansas.

CLIDASTES CINERIARUM, Cope.

The largest species of this genus as indicated by the zygosphen articulation of the vertebræ.

The locality where it was found is the same as the last, but the specimens were taken from the gray bed, perhaps the same that produced the *Elasmosaurus platyurus*, Cope. They consist of vertebræ and pterygoid teeth. There are two anterior dorsals, three lumbars, and one caudal. The articular faces of the caudals are broad vertical ovals. They increase in width on the lumbars till on the last of these they assume the subpentagonal form characteristic of many species, and which is still more marked on the caudal. The centrum of the anterior dorsal is much compressed; inferiorly, slightly concave longitudinally, regularly and prominently convex transversely. Conversely, the rims of the cup and ball are strongly expanded, the latter with surrounding groove. The diapophyses of the lumbars are of considerable length, exceeding in this respect those of *Mosasaurus* we possess, where these parts are preserved. On the median of the lumbars the inferior surface of the centrum first becomes truncate or plane, and separated from that below the diapophyses, which become slightly concave. The expansion of the ball becomes more abrupt and striking on these vertebræ. The caudal is a little more compressed than the lumbars, and presents the character of coössified chevron bones. These are slender and longitudinally grooved.

A single pterygoid tooth was found in the matrix on one of the dorsals. The basis is short and much swollen; the crown curved, acute, a little compressed, and with an obtuse cutting edge posteriorly.

Measurements.

Vertebræ, &c, from brown bed.

	M.
Anterior dorsal, length centrum	0.0608
" " depth articular ball	.038
" " width " "	.038
" " diameter behind diapophyses	.029
" " depth articular face for rib	.022
Lumbar, length centrum	.06
" depth ball	.037
" width	.039
" length remnant of diapophysis	.046
" No. 2, length centrum	.055
" " width zygosphen	.0182
Caudal length centrum	.041
" depth cup	.04
" width	.04
" " basis diapophysis	.0245
" " between chevron rami	.0115
Pterygoid tooth height crown	.0125
" " diameter pedestal	.013

This species was found by Prof. Mudge near the locality of the *Liodon mudgei*, six miles south of Sheridan, Kansas.

It is only necessary to compare this species with *C. intermedius*, Leidy,* as the *C. iguanavus* and *C. propython* have depressed vertebral centra. Those of the first are rounded, of the present compressed. The C. intermedius also agrees with the two others in the obliquity of the articular faces to the vertical transverse plane of the centrum; in the present species these planes are *parallel*. This species is also larger than the *C. iguanavus*, Cope; the *C. intermedius* is smaller.

There is another species from New Jersey to which it is more nearly allied, a vertebra of which I have described under the head of *Liodon lævis* (Trans. Amer. Philos. Soc., 1869, 205), and figured l. c. Tab. V. fig. 5, under the erroneous name *Macrosaurus validus*. This probably does not belong to the *Liodon lævis*, which does not possess the zygosphen articulation but is most likely allied to the present species, and a true *Clidastes*. When compared with a vertebra from the same position in the column as determined by the position of the diapophyses, the articular faces are still more compressed, and the inferior surface of the centrum instead of being regularly convex, forms a plane separated from lateral concavities by an obtuse angle. There is less expansion of the margins of the cup and ball. The size is also greater. I propose to distinguish this species as *Clidastes antivalidus*, Cope. It is from the darker stratum of the green sand near Medford, New Jersey.

Obituary Notice of Samuel Vaughan Merrick, Esq., by Daniel R. Goodwin, D. D.

(*Read before the American Philosophical Society*, December 16, 1870.)

Mr. Samuel Vaughan Merrick, who died on the 18th of August last, was, at the time of his decease, among the oldest members of this Society. Elected in 1833, his membership covered more than the average period of a generation. His was a noiseless and unobtrusive, but an eminently active and beneficent life, moving on like the current of a deep and quiet river, silently depositing the accumulations of rich alluvium along its banks, and bearing the freighted wealth of thousands upon its bosom. He was not what is commonly recognized as a great or a distinguished man. His life does not stand out before us in bold relief, in marked individuality, leaving upon the mere casual observer the impression of its definite outline; but was buried and mingled in the moving and surging mass of the world around him. It might be thought fitting, therefore, to dismiss our notice of him in a few passing words; but to me there seem to be special reasons, in this very peculiarity of the case, for pursuing an opposite course; and I shall, therefore, ask the indulgence of the Society in giving a somewhat greater extension to this paper than is usual; though less, after all, than the subject, in my judgment, demands. Great usefulness was Mr.

* Proc. Acad. Nat. Sci., Phila., 1870, p. 4,

Merrick's distinction. Solidity, energy, practical sagacity, were his characteristics. In the wildly moving and fermenting mass with which his life was mixed up, it was ever a guiding and propelling element of progress, and a leavening element of good, but an element requiring some attention and study for its distinct apprehension and full appreciation. If we have more men of this kind of greatness than of the other, we have reason to rejoice in the fact. A community in which such men abound need never be ashamed, unless social improvement and happiness are occasions for humiliation.

This is a Philosophical Society; but we are not, and we need not all be philosophers in the narrower technical sense. He who leaves the world in a high degree better, wiser and happier, for his having lived in it, is either, in the large and more generous sense, a philosopher, or something more and better than a philosopher.

It is true, that classifications of men are always deficient in logical precision. They express only leading tendencies or marked degrees. But one of the most general, and, at the same time, most simple and fruitful in its applications, is the two-fold division into men of *thought* and men of *action*. But these two classes are not to be kept aloof from each other, still less to be arrayed in mutual conflict. They are reciprocally complementary and helpful. One aim of this Society is, to aid in bringing them into their appropriate relation to each other. And few among us have labored more successfully for the accomplishment of this end, or have presented in themselves a better illustration of the happy union of these two characters, than Mr. Merrick. To suppose that this Society was designed to embrace only men of mere thought, that it confines its mission to mere speculation or pure science, is a great mistake. Its aim is eminently practical. It seeks thought, scientific observation, certainly; but it seeks thought only as related to its applications. It would utilize thought, and it would rationalize action. It would reduce action under the stimulus and guidance of thought; and it would provoke thought to its intensest and, at the same time, its most healthful exertion on the field of action. This Society is not the arena of combat, but the armory and *foyer* of the combatants; it is not the theatre of action, but the *post-scenium* of the actors. It seeks to bring thought into its widest play as well as its fullest development. It aims to make thought permeate and leaven the mass. Not only do we, therefore, welcome men of action rising into the sphere of thought, but we admire and cheer on men of thought descending into the dust and struggle of action. The dignity of labor is the true dignity of man. To enforce this truth is one of the highest aims of this Society. The elevation of man is the noblest end of philosophy.

It is in this view that Mr. Merrick's career presents itself in its true significance, and in its proper relations to this Society.

This will best appear from a rapid sketch of his life and character.

Mr. Merrick was born at Hallowell, Maine, on the 4th of May, 1801. His father, John Merrick, was a man of marked character, and extraordinary mental vigor. In 1798 he came to this country from England, where he had been educated for the Unitarian pulpit. Not finding in this his vocation, he lived in Hallowell as a gentleman of retired leisure, or rather, of great and varied and beneficent activity. The mother was a daughter of Samuel Vaughan, Esq., a merchant of London. His brother, John Vaughan, uncle of our Samuel Vaughan Merrick, was, for a long series of years, identified with this Society, as its Librarian and Secretary. He is remembered with affectionate respect for his genial social qualities, and for his rare benevolence and kindness of heart. He cared for the stranger. Every foreigner, of whatever nationality, who chanced to be in Philadelphia, found in him more than the official consul of his country,—a sympathizing friend.

In his uncle's business house, our S. V. Merrick was placed at the age of 15, to be trained as a wine merchant. At the age of 19, a proposition was made to him to leave that business, and enter an opening which presented itself for the manufacture of machinery. This was to exchange the profession of the merchant for that of the mechanic,—a step which it is significant to observe was at that day regarded as involving little less than social degradation. Young Merrick, in the full determination to hew his own way in the world, accepted the offer, doffed his coat, and rolled up his sleeves to the work. The firm of Merrick & Agnew was established; and soon gained unusual celebrity as manufacturers of improved Fire-engines. Professors in New England colleges used to exhibit these engines to their classes as illustrations in mechanics and specimens of American ingenuity and workmanship.*

Young Merrick rapidly developed, under his own teaching, a remarkable engineering and mechanical talent.

After some years he was ready to enlarge his field of operations; the "Southwark Foundry" was established; the firm of "Merrick and Towne" was founded in 1837, and entered into the general and extensive manufacture of various kinds of machinery and apparatus, particularly of steam engines and boilers. As an illustration of the energy and enterprise of the firm may be mentioned the fact, that, at so early a period and in the infancy of mechanical engineering in this country, they contracted for and constructed the engines of the U. S. Steam frigate Mississippi, which proved to be one of the speediest, safest, most trustworthy and serviceable ships in the navy. It was chiefly due to the faithfulness, skill, and perfect finish with which her machinery was constructed, that abroad, as well as at home, she became an object of national pride. In her Commodore Perry made his visit to Japan and rode out the cyclones of the China sea; and she continued high in the list for effective service, until, on the night of the 14th of March, 1863, she ran aground and was blown up under the guns of Port Hudson.

In 1849 Mr. Towne retired from the firm, which was continued under the

*Later in life, Mr. Merrick retained his early interest in the improvement of Fire Engines, although they were no longer manufactured at his works; and for many years he took personally an active and leading part in the Fire Department, until he secured the introduction of the Steam Fire Engines throughout the city.

well-known style of "Merrick and Son," and "Merrick and Sons," although Mr. Merrick's active connection with it ceased from the year 1860. The development of this great business establishment was the main work of his life, and he persevered in it for a period of near a quarter of a century. He retired from it with large wealth honorably acquired in a business whose great private gains were conditioned upon conferring immensely greater public benefits; in works and enterprises which sensibly contributed to the growth and prosperity of the city and to the welfare of the state. He retired when the establishment which he had reared was still in the flood tide of success, for it was never more active or useful than during the years of the late rebellion.

At an early period in his career, Mr. Merrick became deeply impressed with the importance to mechanics, for their success and elevation, of more thought and intelligence, of more acquaintance with the progress of mechanical arts and inventions, and of more of mutual intercourse and social stimulus. With this view he projected and urged forward the establishment of the Franklin Institute; and it may be said, I think, without disparagement to the claims of any other of its original members, that no man has a better title to be considered its *founder* than Mr. Merrick. For a long series of years he continued one of its most active and honored members; until, from its small and unpretentious beginnings, as little more than an association of mechanics for mutual improvement, it was developed into the chief centre of practical science in the city, became an honor to Philadelphia, and enjoyed a familiar national and European reputation.

In one point of view the Franklin Institute has taken as its specialty and almost absorbed into itself one portion of the work which pertains to the general scope of this Society. Among our own founders was Benjamin Franklin himself, a most thorough utilitarian, who always regarded science with an eye to its practical applications, and considered them among the principal motives for all scientific effort and enquiry. And, in general, so far as the founders of this Society were philosophers, they were eminently Socratic philosophers; and such is the philosophy which they designed the Society they established always to represent. The Franklin Institute may, therefore, be considered as an offshoot, or a department, or a section—not in form but in fact—of the American Philosophical Society. And this may explain why, in later years, Mr. Merrick may seem to have relinquished his active participation in our work—it was because his interest and energies were absorbed in the Franklin Institute.

The Managers of the Institute have expressed their own sense of the merits and character of Mr. Merrick, in the resolutions which are here subjoined:

"*Resolved*, That the Managers of the Franklin Institute have received with the deepest sorrow the announcement of the death of Samuel V. Merrick, the founder of the Institute, for many years its president, and always its earnest, liberal and devoted friend. Associated with it as he was in its early efforts for the public confidence and support; participating as he did in all the great labors and enterprises by which it won its way to the honorable reputation it now enjoys; his name and character are so mingled with its history that, while the Institute endures, his will be an enduring memory.

"*Resolved*, That the Managers of the Institute, many of whom have been for years associated with the deceased in the care of its affairs, and in the other walks of life, in which he was so distinguished for broad and wise intelligence, for untiring zeal, and for great public spirit, will ever cherish with feelings of proud and affectionate remembrance, the kindly and honorable associations which have always distinguished his relations with them.

"*Resolved*, That, in token of our sense of the loss we have sustained, the Hall of the Institute be closed on Monday next; that the Managers attend his funeral in a body, and that the members of the Institute be invited to join with them in paying the last earthly tribute of respect to their honored associate and friend."

To Mr. Merrick before all others, the City owes the introduction of gas as a means of illumination, instead of the oil formerly relied upon for the purpose—a reliance so precarious, inefficient, clumsy, filthy and expensive, that we all, as we look back, should now feel its restoration emphatically a return to the Dark Ages. Not so did the case look from the other end of the glass. Mr. Merrick, with his characteristic, practical sagacity, early saw the advantages of substituting gas for the material formerly employed; and he perseveringly urged its substitution, amidst an extraordinary excitement of public feeling, and a most earnest and confident opposition on the part of some of the most respectable and intelligent of his fellow citizens—an opposition which we now regard with wonder, and which those who participated in it remember as a strange dream. We see things now in a different light; and it is difficult for us to place ourselves at the point of view from which the subject was then contemplated; yet it is only by so doing that we can duly appreciate the prophetic vision and indomitable energy of those who persevered for years in urging on, step by step, the proposed improvement.

Mr. Merrick sought and obtained a seat in the City Councils, that there he might labor directly to secure the change. He was appointed Chairman of a Committee of the Common Council, which, after corresponding with the authorities of the few other cities in this country where gas had been partially introduced, reported with a full and triumphant answer to all the objections which had been urged against it. To his great satisfaction, he subsequently received an appointment from the Councils to visit England and parts of Europe, for the purpose of inquiring into the facts connected with the use of illuminating gas in those countries.

On his return, in 1834, he made a full report, which was marked by great wisdom and ability. Whereupon it was resolved that the experiment should be tried in Philadelphia. Mr. Merrick was appointed, as chief engineer, to take charge of the erection of the works, of the manufacture of the gas, and of the whole business of introducing and distributing it in the city. This task he performed without the least waste, failure, mistake, or delay, but with singular economy, skill, and promptitude, to entire and universal public satisfaction. On the 8th of February, 1836, the lamps were lighted; and in their next annual report the Trustees of the Gas Works render the following emphatic testimony:

"The works are built in the most substantial manner, and, for the perfection and economy of their operation, are certainly unrivalled in this country; the rapidity with which they were constructed and the complete adaptation of every part of the apparatus to its intended purpose, reflect the highest credit on the engineer, Samuel V. Merrick, Esq., whose faithfulness and ability in discharging the arduous and novel duties of this undertaking, it gives us much pleasure thus publicly to notice."

In their report of the year following they say:

"In conclusion the Trustees have to state that Samuel V. Merrick, Esq., the able engineer who constructed the first section of the works, having found that his continued attention to them interfered too much with his private engagements, tendered his resignation, which the Board reluctantly accepted on the 8th of February, 1837. As the extensions were about to be made, the trustees requested Mr. Merrick to devote occasionally, to a general superintendence of the new works, so much of his time as he should be able to spare, or as might be deemed necessary, in consultation with the superintendent. This duty has been performed to their utmost satisfaction, and the trustees can only repeat here their unqualified approbation of the conduct of that gentleman, and their admiration for the signal success which has attended the works put up by him."

At a meeting of the Stockholders held in the ensuing week, it was resolved:

"That the trustees be hereby authorized to appropriate the sum of $600 to be expended in the purchase of one or more pieces of plate; to bear such inscription expressive of the approbation of the Stockholders as they may think proper; to be presented to Samuel V. Merrick, Esq."

Nothing is more striking in all Mr. Merrick's connection with this business than the largeness of his views for the general good, and the unselfish public spirit which marked all his labors. He sought to promote the comfort and convenience of his fellow citizens, and permanently to diminish the burden of taxation. He sought also to develop the resources and industrial wealth of the State. In his report on his return from Europe are these noteworthy words: "I deem it an argument of no small moment in favor of this mode of lighting, that every material used in the fabrication of this gas will be the product of Pennsylvania labor. The bituminous coal from which it is to be made, may be drawn from the rich mines now open in the interior of the State; the fuel, from the exhaustless body of anthracite; and the lime for purification, from our own vicinity; and not a lamp will shed its rays over our streets which has not paid a tribute to the internal improvements of the State."

In like manner, it was distinctly as a public benefactor, it was from a sensitive regard for the welfare and prosperity of the city and State of his adoption, that, some ten years later, Mr. Merrick led off in another great enterprise. He was one of the prime movers in the establishment of the Pennsylvania Central Railroad Company, and was its first President. The books were opened for subscription to its stock in 1846, and its

President made his first report in 1847. This document contains a clear and business like statement of the means of the Company, and of the plans for their immediate use. And not only so, it wisely suggests and urges their increase, also without incurring any debt,—the avoidance of which was a fixed principle in all his administrative arrangements; and it sets forth such far reaching views of future growth and enlargement that it looks almost like history written before the time.

His motives for throwing himself into this enterprise, and the motives upon which he invited others to participate in it, appear in his report addressed to the stockholders in September of the next year (1848), in which he earnestly urges them to increase their subscriptions. "The absolute necessity," says he, "of this road to the trade of Philadelphia is universally acknowledged. The completion of the Cincinnati and Sandusky road brings that city within three days ride of New York for eight months in the year.

"The trade of the Ohio river, which once belonged to Philadelphia, is now diverted to New York by this new channel of the lakes.

"Hundreds of passengers daily pass over that road to New York. Where the travel goes, there goes the trade. * * * *

"You are engaged in a great struggle for the trade of the West. To obtain it a portion of your earnings must be devoted to open the highway. Once open, it will maintain and enlarge itself. Railroads and Canals have built up New York; and so well convinced are the citizens of their value, that they are now making a third avenue to the lakes, both the others being crowded with trade.

"Boston has been built up by the same means, and if we expect to maintain our position, we must follow their example."

In fact even Baltimore had got the start of Philadelphia; and if the Pennsylvania Central had not been opened just when it was, not only the trade of Ohio and the far West, but even that of the western part of our own State would have been irretrievably diverted to Baltimore, on the one side, and New York on the other.

Such were the circumstances and motives under which this great work was undertaken. When Mr. Merrick, again compelled by the pressure of his own private business, retired from the Presidency, Sept. 1, 1849, the road was opened for travel from Harrisburg to Lewistown, and nearly completed to the base of the Alleghanies, the western division was begun, and a small portion in use, the whole route was surveyed and the cost of construction estimated, and negotiations had been successfully concluded for connection with the cities of Ohio and with the avenues of the more distant West. The Board of Directors in the following November, thus refer to Mr. Merrick in closing their report:

"The distinguished gentleman who had, with signal ability, administered the affairs of the company from the date of its organization, was constrained, by reasons altogether personal and private, to tender his resignation in August last, and it was reluctantly accepted by the Board.

His continuance as a Director ensure to the Company the benefit of his enlarged experience, sound judgment, and thorough acquaintance with the work.*

Thus the foundations of the great edifice were laid, and the plans and materials provided for the superstructure. The seed was planted, and had germinated; it had shot up its trunk, and was already beginning to send out its wide-spreading branches. The Pennsylvania Railroad Company is now one of the greatest and most powerful corporations in the country, with a gross annual income exceeding the original estimated cost of the construction of its entire original track from Harrisburg to Pittsburgh. It is by far the most important and indispensable business agency of Philadelphia and of Pennsylvania. Strike it out of existence, and the city would be stunned by the blow, and even the State would stagger under it. It is an immense power for good or for evil. But whatever motives may actuate its present or future managers, and however its influence may be abused or its energies perverted, we have this security that it cannot be made profitable to its owners without continually benefiting the community. And by whatever motives or principles its action may hereafter be controlled, "the past, at least, is secure;" its projectors and originators were actuated by a generous devotion to the public good, they sought to promote the prosperity of the city and the growth and development of this great commonwealth. As one of its founders, and as its first President, Mr. Merrick's name is identified with its whole history. He shares the glory of its subsequent greatness, while it inherits the prestige of his noble purpose and character.

When, after nearly another decade, an effort was made to construct a Railroad from Sunbury to Erie, thus completing the connection between Philadelphia and the lakes, through the great western coal fields of Pennsylvania; and when, after many ineffectual struggles, the enterprise threatened to prove a disastrous failure, all eyes were turned to Mr. Merrick. He was recognized as the only man in the community who

* The following is Mr. Merrick's letter of resignation:

"Office Penna. R. R. Co., Philada, Aug. 22, 1849.

"To the Directors of the Penna. R. R. Co.

"Gentlemen:—Circumstances connected with my private affairs compel me to announce to you my intention of resigning the office with which you have entrusted me.

"I need scarcely say that I take this step with great reluctance.

"Identified as I am in feeling and interest with the great work which, above all others, is destined to add to the prosperity of Philadelphia, I had hoped to have been prominently instrumental in urging it to final completion; and although I relinquish the position I have occupied as the President of the Company, my exertions will not be wanting in forwarding its interests.

"It is no small cause of regret that my official connection is severed with gentlemen, both of the Board and in the office, with whom I have acted in the most uninterrupted harmony and good feeling, a continuation of which it will always be my pleasure to cultivate.

"Desirous of resuming my private business at as early a date as possible, and at the same time give an opportunity to select a successor, I leave to the Board to fix the date at which my resignation shall take effect.

"Very respectfully,

"S. V. Merrick,

"President Penna. R. R. Co."

could retrieve its affairs, and push it on to speedy success. Early in 1865 the Presidency of this road was offered him, and urged upon his acceptance. He was upon the point of declining it when the following letter was addressed to him, which, with its signatures, speaks for itself, and for him also.

" PHILADELPHIA, Feb. 21st, 1856.

"To SAMUEL V. MERRICK, ESQ.:

" Dear Sir: We have learned that the Presidency of the Sunbury and Erie Railroad Company has been tendered to you, under such circumstances as render it reasonably certain that your character and ability may conduct that enterprise to a successful completion.

"We are sensible that such a position cannot present any peculiar attractions, but that any favorable consideration you may give to the application would have its origin in a high sense of public duty.

" There are occasions when purely personal motives ought properly to yield to public claims, and in the exigency which calls for an efficient and tried man to administer the affairs of the important work above named, we may well address ourselves to you to assume the Presidency. Your perfect organization and successful administration of the affairs of the Pennsylvania Railroad Company are so well remembered by our fellow citizens, that we are sure the whole community would hail with pleasure your acceptance of the proffered trust.

" We feel confident that you can organize an administration and adopt financial and other plans, which will at once place the Sunbury and Erie Railroad in its proper attitude before the people, and insure such aid from public and private sources as will realize an early completion of a work that must open for the trade of our city one of the richest agricultural and mineral districts of the State.

"On behalf of the great interests involved, we call on you to accept the office.

We are very truly and respectfully yours,

JOHN GRIGG,	C. H. FISHER,
THOMAS ROBINS,	THOS. T. LEA,
WM. E. BOWEN,	S. A. MERCER,
ISAAC R. DAVIS,	F. FRALEY,
ALG'N S. ROBERTS,	C. S. BOKER,
A. E. BORIE,	S. F. SMITH,
FRED'K LENNIG,	C. H. ROGERS,
JAMES C. HAND,	JOS. PATTERSON,
A. J. LEWIS,	JOHN FARNUM,
MORRIS L. HALLOWELL,	J. RICHARDSON,

THOMAS ALLIBONE."

To such an appeal to his sense of public duty Mr. Merrick could not turn a deaf ear.

The following was his reply :

"PHILADELPHIA, Feb. 23d, 1856.

"GENTLEMEN : I was duly honored with your letter of the 21st inst., urging my acceptance of the Presidency of the Sunbury and Erie Railroad Company. The peculiar circumstances in which that work had recently been placed, gave a weight to the application made to me, which was well calculated to overcome all considerations but those of public duty. Without, however, the expression of such a wish on the part of my fellow citizens, as indicated in your letter, I should have felt constrained to decline the offer ; but the reasons urged by you, in addition to those presented by the gentlemen who tendered the appointment, caused me to yield a reluctant assent.

* * * * * * * * *

"Accepting this trust at your solicitation, as representatives of the public feeling and interests of the city, and relying upon your co-operation, I remain,

Very truly and respectfully,

S. V. MERRICK."

Mr. Merrick began at once with an energetic reformation and remodeling of the whole organization and administration of the road. But scarcely had he addressed himself to the Herculean task, when the terrible commercial crisis of 1857 swept over the country, prostrating even many old establishments, and utterly paralyzing new enterprises, completely thwarting all plans for securing aid, public or private, arresting the progress of the road, and bringing the Company to the verge of bankruptcy. In fact, it was saved only by large advances from Mr. Merrick's own private resources—advances equally difficult and dangerous for a business man at that time to make. At the risk of ruining himself, and by almost superhuman efforts, he carried the Company through the storm. His own health was prostrated ; and, after remaining in the Presidency nearly two years—as long, in fact, as he had ever anticipated being able to continue in it—he sent in the following letter of resignation :

"*To the Board of Managers of the Sunbury and Erie Railroad Company:*

Gentlemen : I have long contemplated declining a reëlection to the post of President of this Company in February next, as it interferes too much with my own affairs to warrant further continuance. Believing that the interests of the Company will be promoted by the immediate election of some other gentleman who will devote himself to the important interests at stake, I beg leave to tender my resignation.

* * * * * * * * *

The field is now open for an energetic prosecution of the work as soon as the returning tide of prosperity shall have fairly set in upon the commerce of the country, and I may indulge the hope that a brighter day may soon dawn on the Sunbury and Erie Railroad.

With every wish for the final success of the enterprise, I remain, very respectfully,

S. V. MERRICK, *President.*"

The road was soon after completed, and its bonds, that were issued with Mr. Merrick's name, have long been at par.

Nor did his labors in the cause of the public improvements of the State, and for the enlargement of the business and prosperity of Philadelphia end here. To his vigorous and wise counsels it has been, in a large degree, due, that the affairs of the Catawissa Railroad have been retrieved from a condition of imminent ruin. The road owes it to him that it now rests upon a solid basis, and has a promise of permanent prosperity and usefulness. The regard in which he was held by the Managers of that road will appear from the resolution adopted by them on the occasion of his decease.

"The death of our late associate, Samuel V. Merrick, Esq., who for fourteen years has been a Director of this Company, the value of whose counsel all appreciated, has been announced to us so unexpectedly, in the midst of current business, in which his energies were actively engaged, that we fail to realize the extent of our loss.

"The character of Mr. Merrick needs no eulogy at our hands; his long and useful life has been spent in 'good works.' The mention of his name in connection with any enterprise has always inspired confidence and respect. In relation to this Company, the interest of which appeared to be his special pride—through the period of its darkest history, he always manifested a cheerful confidence that time and energy would relieve it of all difficulties; and we rejoice that he lived to see his prediction verified."

In the eleemosynary institutions of the City, Mr. Merrick took a deep and active interest, and particularly in anything that promised to help the poor and weak to help themselves. He was among the founders, and most efficient managers of the Western Savings Fund; and to him is largely due the safe and solid character of this beneficial institution. Its Managers have given expression to their deep sense of his wisdom and worth in the following testimonial:

"*Resolved*, That it is with profound sorrow the Managers of the Western Savings Fund Society record the unexpected demise of Samuel V. Merrick.

"By this sad memorial they will perpetuate the recollection of a man associated with the Institution from its foundation, who was distinguished by remarkable traits of character, that rendered him eminently useful to the world, and made him universally honored in every position he was called to fill. Wise in council, broad and comprehensive in his views, liberal and good in his deeds, and, above all, crowned with the possession of a truly Christian and Catholic spirit, his loss to society, and especially to his friends, will be long and keenly felt."

At the time of his decease, Mr. Merrick, besides an active connection with many other of the public corporations, and most of the leading charities of the city, was a prominent member of the Board of Trade, one of the Port Wardens of Philadelphia, and a member of the Board of Commissioners for the erection of the South Street Bridge.

Immediately upon his demise, the following expression was adopted by the last mentioned body:

"Whereas, This Board, and the City of Philadelphia, have suffered a great loss by the death of our colleague,

Mr. SAMUEL V. MERRICK,

who for many years devoted his abilities, services and time, in promoting the interests of the municipal, charitable and scientific institutions of Philadelphia.

Resolved, That the President be requested to communicate to Mr. Merrick's family our sympathy and condolence in their affliction."

But neither Philadelphia nor Pennsylvania bounded his sympathy and public spirit, or his ideas of loyalty and patriotism. His heart embraced the whole country. He loved her flag. He was devotedly attached to her Union. When that flag was assailed, and that Union imperilled, his soul was stirred to its lowest depths. All conservative as he was in principle and feeling, he gave his full support to the Government through all the changing fortunes of the dark struggle, until the rebellion was suppressed. In the work of the Sanitary Commission he took a special interest, not only contributing freely to its funds, but rendering his personal services, at the time of the Great Central Fair, until his health was seriously endangered.

After the war, his attention was particularly drawn to the cause of general education at the South ; and he gave large sums for the support of schools in that part of the country, both for blacks and whites. At the suggestion of a younger sister, he joined forces with her and his brother, and they, with their own independent funds, have built a commodious school house of brick, and established a school for the instruction of the negroes, in one of the counties in Virginia.

In fact, his benefactions have been more and larger than will ever be generally known ; and always bestowed in a spirit of glad liberality, and with a modest unconsciousness of doing anything more than a matter of course. In this feeling he resorted to no artificial contrivances to hide his gifts ; still less did he ever seek to have them bruited abroad. Cases have come to light in which an applicant, in behalf of some scheme of benevolence, after having explained the object, has hoped for a hundred or two dollars at the most, and been surprised by receiving from him a check for ten times that amount. Other cases of his giving by thousands have been known only in the circle of his own family, and to them only after a time and, as it were, by accident—in such a way, in short, as to indicate that these were but specimens of many similar cases of which his intimate friends knew nothing. It was a saying of Sir Isaac Newton, that "those who give nothing before their death, never in fact give at all." On this principle Mr. Merrick acted. He gave while he lived, and left it to his heirs to follow his example after he was dead. And surely the living spring, with its perennial flow, is better than the sudden inundation from any pent-up reservoir.

Mr. Merrick was a consistent Christian. In this relation, also, his *active* benevolence, so characteristic of him, could not fail to display itself. At the time of his death he was one of the Wardens of Grace Church, of which he had been a member nearly thirty years. In the erection and endowment of the Episcopal Hospital, he manifested a lively and practical interest ; and to him, more than to any other man, the Diocese of Pennsylvania is indebted for its Episcopal residence.

Mr. Merrick's was an eminently successful life. He was always equal to what he undertook, to every occasion and to every position in which Providence placed him. He sought to raise others with himself. He respected labor, and he dignified it. Few men have done more to elevate the mechanic to a higher intelligence and a more respectable social position. There have been men who have amassed millions, and who have not failed to give generously of their abundance when it could be done with great éclat; but who had, nevertheless, either grown rich at the expense of their neighbors, as mere gambling speculators, or been loose in their principles of integrity, or excessively parsimonious in their personal habits, or hard and rigorous to the last cent in all their daily transactions, especially with their dependents, employés, and clerks. Not so with Mr. Merrick. He expended freely as he went; he was generous and kind to all his dependents; in raising himself he lifted up others; their rising was the very mode and condition of his; all his operatives respected and loved him; all his business transactions were for the mutual benefit of the parties concerned; all his prosperity was the prosperity of those around him, and of the city in which he lived.

It is no small achievement thus to acquire a large property—by honest industry, by extraordinary skill, and tact, and enterprise, without parsimony, or stint, or exaction, but in the spirit and constant exercise of a large liberality. Indeed, this is one of the grandest schemes of benevolence and philanthropy that a man can conceive and carry out.

It implies a certain greatness of mind, a certain self-containedness, voluntarily to stop in the career of acquisition and leave the field to others.

It is no slight mark of the eminence and worth of any man that, at his decease, he should leave a sensible gap *in a great city*, that his departure should be widely felt as a public bereavement.

Every gas-burning lamp that lights our streets, our halls and our parlors, is a perpetual illumination of the name of Merrick. Merrick and Franklin, both sons of New England, will remain indissolubly associated as long as our Franklin Institute retains its name and remembers its founder. The great railways converging upon Philadelphia will be avenues and radiants for the enduring fame of the citizen who planned, and early presided over, the Pennsylvania Road, which has become the head of the great family, and now stretches its arms over a continent. His fire engines were long since eloquent with his name in many a city and village of the land; the beautiful frigate Mississippi bore it proudly around the globe; and later, in our great national life struggle, the same name reverberated along the rebel coast with the guns of our best and mightiest armored steamship of war.*

To sum up the character of our departed friend: He was a man of quick perception, of clear intelligence, of singular forecast, of large and liberal views, of rare sagacity, of imperious, even overbearing, will, and of indomitable energy; a just man, of honorable sentiments, of strict integrity, to be trusted anywhere and in anything, faithful in the least and in the greatest alike; a man of a kindly nature, of ready sympathy, instinctively and on principle benevolent, always benevolent—his benevolence

* The New Ironsides was furnished to the Government, hull, armor, and machinery, by "Merrick & Sons."

was not stinted by increasing years or increasing wealth, but grew rather with his means and his habit of exercising it; a man of ardent patriotism, he identified his own life with that of his country; of an ever generous and ready public spirit, he was in all relations a good citizen; religious, not without profession, but without cant, and beneficent without ostentation; his character, like his person, was of a noble and massive rather than of a graceful make. He was every inch a man.

And now, should it be thought that I have but followed the example of all manufacturers of obituaries, dealing only in loose and empty panegyric, I do not plead guilty to the charge. What has been said rather falls short of the truth than transgresses it.

If it be suggested that, after all, this certainly cannot be so very extraordinary a case, that Mr. Merrick was not so very great or remarkable a man, for we have among us every day many men quite as great, as good, and as useful as he, I cannot by any means concur in the suggestion; and yet I do believe, and rejoice to believe, that we have more good, earnest, public spirited, sagacious and energetic men, quietly working on among us, than we are sometimes, in our habitual querulousness, disposed to acknowledge. Amidst all our complaints, often unreasoning and inconsiderate complaints, of the degeneracy and corruption of the times, there is more of real greatness and goodness around us than we are aware of. Great and good men have not all passed away with the former generations. They are with us still. And it is one of the lessons we may learn from a review of such a life as Mr. Merrick's, to see and recognise the treasures we possess. If we have many such men as Mr. Merrick, let us rejoice; let us so look to them while they live, and so remember them when they are gone, that by all means we may have more.

An *Obituary Notice* of Franklin Peale:

Read before the American Philosophical Society, December 16th, 1870, by Robert Patterson.

At the meeting of the American Philosophical Society, held February 19th, 1796, the proceedings were diversified by a singular incident, which we find thus recorded in the minutes:

"Mr. Peale presented to the Society a young son of four months and four days old, being the first child born in the Philosophical Hall, and requested that the Society would give him a name. On which, the Society unanimously agreed that, after the name of the chief founder and late President of the Society he should be named Franklin." Tradition adds, that the infant was thereupon so named in the President's chair, given to the Society by Benjamin Franklin.

This child, in a peculiar sense the child of the Society, was Franklin Peale, our late associate, to whose memory I now, honored by your choice, seek to render a feeble tribute.

The father of Franklin Peale was Charles Wilson Peale, a man of various gifts, but eminent as a painter, and as the founder of the once noted Philadelphia Museum. To him the country owes an extensive series of portraits of the most distinguished men of our revolutionary and post-revolutionary era. In the course of his profession, having been called on to make drawings of bones of the mammoth, his attention became attracted to natural history, and he began the accumulation of objects illustrating that department of science.* From very small beginnings, Wilson Peale, by energy, enthusiasm and self-sacrifice above all praise, succeeded in building up the Museum referred to, which Philadelphians of a past generation recall as one of the most interesting and useful institutions of our city. He was a member of our Society—which was naturally much interested in the success of his work—whence it happened that, while the Museum was still in its early stage of growth, in the year 1794, it was located in our building, the same which we now occupy; and here, in the northwest room, second story, now known as the Librarian's room, FRANKLIN PEALE was born, on the 15th day of October, 1795. His mother was Elizabeth De Peyster, second wife of Charles Wilson Peale. She died while he was quite young, but his childhood and youth were tenderly cared for by a stepmother, Wilson Peale's third wife, a member of the Society of Friends.

The father's views on the subject of education were peculiar. The children were not directed according to any systematic routine, but left much to their own choice in their course of study. They were guided according to a fancied ability, and means were furnished (but not always the teachers) to stimulate them to the acquisition of the knowledge towards which their minds seemed naturally bent. Books, tools, canvas, and pencils, besides the opportunities to see what had been done by others, he thought sufficient, provided there was a disposition to learn; otherwise he considered any attempt to push them forward as but lost time. If such a plan of education seems open to criticism, it may, perhaps, be justified by the result, which has furnished to us, in the Peale family, Rembrandt, the artist; Franklin, the mechanician; and Titian, the naturalist.

The instruction received by Mr. Peale seems, therefore, to have been quite irregular. He had no systematic course of training, either in school or college. He went first to a country school in Bucks County, was a short time at the University of Pennsylvania, and finished his education at the Academy in Germantown, where the family then resided.

The bent of Mr. Peale's genius towards mechanics was developed at a very early period. While quite young, he became distinguished as a manufacturer of all the usual apparatus for games, and many curious toys. As a school boy, he demonstrated a fondness for surveying as well as mechanics—in the interval of school hours surveying his father's farm near Germantown, and developing also the water power of some neighboring streams.

* I may be pardoned, I trust, the mention of the fact, since it illustrates a family friendship, extending now through several generations, that the first article presented to Mr. Peale, and the earliest encouragement of his project, was from Robert Patterson, a former President of the Society, and the grandfather of the writer.

At the age of 17, he entered the factory of Hodgson & Bro., on the Brandywine, Delaware, to learn machine making. From his industry, patience and neatness, he rose superior to his teachers. He became skilful as a turner and founder, and in the use of tools, and a very excellent draftsman. He here prepared the working drawings for the machines required for a cotton factory at Germantown, and had them constructed under his supervision, and in great part by his personal skill and labor. When barely 19 he left Delaware to take charge of the cotton factory just mentioned, of which he had the management for several years. He afterwards removed to Philadelphia, and entered into the establishment of John & Coleman Sellers, making machinery for card sticking.

Mr. Peale now separated himself for a time from the strict line of his profession, and entered upon the management of his father's Museum. For this duty he was well fitted, on account of his administrative abilities, his taste, and his talent for arrangement, as well as by a competent knowledge of the subjects to which it was devoted. The Museum was something more than a place of deposit for birds, beasts and fishes, but was a collection of curiosities in art, in mechanism, and in antiquity. Mr. Peale, in the pursuit of his own profession, had not neglected other fields of knowledge. He was ever an ardent student and observer. It was not likely, therefore, that he should have been unlearned in any of the subjects which the Museum was intended to illustrate, and which he had heard discussed from his childhood. While not professing a particular fondness for natural history, he so far mastered the subject as to deliver lectures upon it, availing himself of the special facilities placed at his disposal. His mechanical genius, also, found room for display, in adding to the curiosities of the establishment. Many of us will remember his curious speaking toy, besides other ingenious inventions which cannot now be specified.

It was while engaged at the Museum that Mr. Peale placed there a miniature locomotive, the first seen in this country, and manufactured by his friend, M. W. Baldwin, on a plan agreed on between Mr. Peale and himself. It was put in operation on a track, making the circuit of the Arcade, in which the Museum then was, drawing two miniature cars, with seats for four passengers. The valuable aid of Mr. Peale was afterwards given to Mr. Baldwin in the construction of the locomotive for the Philadelphia and Germantown R. R., in 1832, the success of which led to the establishment of Mr. Baldwin in the great business of his life.

Mr. Peale's position at the Museum was of advantage in bringing his peculiar and varied talents more conspicuously before the public. The establishment was largely visited, often by distinguished men of our own and other cities, and many learned to admire the ingenious young manager. His society and friendship were sought after, and he assumed his proper place as one of the select band then most active among us in the pursuit of science and art.

The Franklin Institute, then young and earnest, as it still is in the advancement of knowledge, secured the services of Mr. Peale for a series of lectures on a subject adapted to his special talents. He here delivered two courses, in the winter of 1831–2 and 1832–3, on Mechanics, or rather on Machines. These were fully illustrated either by the machines themselves, or diagrams, were novel in their character, and justly added to Mr. Peale's reputation. He was long an active member of the Institute, giving efficient labor on its most important committees, and at the annual exhibitions, and occasionally contributing articles on mechanical subjects to its Journal.

In 1833, Mr. Peale entered upon that connection with the Mint of the United States, which gave a full opportunity for the display of his special abilities, and through which his reputation was firmly established. Dr. Samuel Moore, then Director, conceived the project of a mission to Europe, for the purpose of examining and reporting on such chemical, mechanical and metallurgic methods and improvements, as might be deemed worthy of introduction into our Mint. He procured the needful authority, and appropriations, and having the fullest confidence in Mr. Peale, selected him as the agent for this purpose. He accepted the trust and sailed for Europe in May of the same year, being officially designated as Assistant Assayer. Mr. Peale remained abroad two years. The subjects of special interest to the Director had been the Sulphuric Acid process of Refining (or Parting,) and the Humid Assay of Silver, on which full investigations were required, but Mr. Peale was not restricted in his inquiries, nor in truth was he one likely to overlook any particulars bearing directly or remotely upon the broad objects of his mission. His intelligent, patient labor, mastered every detail. By partial reports during his absence, but more especially by a full and final report after his return, accompanied by plans and drawings, our Mint was placed in full possession of all that was then worthy to be known of the establishments, public and private, whose organization and methods affiliated them with our own. The direct results of the mission, were the introduction of the humid assay, some improvements in the details of the refining process, and the labor-saving method of duplicating working dies for coinage. The indirect results were perhaps, equally important. For the thoughts and labors of a man of genius in mechanics (as Mr. Peale was,) could not be concentrated on the details of Mint processes, without planning many valuable improvements. Happily for the public service, Dr. R. M. Patterson, the Director who succeeded Dr. Moore, (in July, 1835,) was Mr. Peale's warm friend, and a great admirer of his talents. His "mission" did not cease, therefore, with his return from Europe, but he became associated permanently with the Mint, for a time as Assistant Assayer, then as Melter and Refiner (in 1836), and finally as Chief Coiner (in 1839). His first great work was in the construction of the steam coining presses, substituted for the hand presses then in use. The first steam press was manufactured under his supervision, by Merrick, Agnew & Tyler, and turned out its first specimens in March, 1836. Presses subsequently manufactured for our own and other mints, have been improved in minor points, but their principle of action remains the same. Other improvements which he introduced, were the so-called milling machine, for raising the edge of the planchet; the steam engines, small and large; the automatic or retroactive return of the draw-bench; and, in particular, the scales for the weighing of gold and silver. These last are models of simple mechanism and nice accuracy. So, in fact, was all of Mr. Peale's work. And we may add, that he brought to all the eye of an artist. It was not enough that a machine should be effective; it must also be graceful and attractive. "Nihil tetigit quod non ornavit." But I cannot enter at large into details of his labors at the mint. I simply add my conviction, (which I know to have been that of the revered Director already named, under whose administration the work was accomplished,*) that without Franklin Peale, the most of that which attracts the admiration of the visitor to the coining department of the Mint would have been wanting. The mark of his inventive genius is here conspicuous, and I have often thought, as I passed through that part of the establishment, how appropriately might be there ascribed to his honor, the words, "Si monumentum requiris, circumspice." But a more competent judge than myself, thoroughly qualified by long experience in mint affairs, has spoken to this point in words which I take the liberty to quote: "It has been my privilege (he says,) to visit the mints of London and Paris, and to witness their inferiority in their mechanical arrangements, to the Mint in Philadelphia. The superiority of our Mint is most manifest in just those points where his hand has touched, and when Americans visiting the mints of Europe, feel a pride in remembering the superiority of their own, they ought to know that to the genius and taste of Franklin Peale are they mainly indebted for it. At the mints of both Paris and London, he was well known and inquired for with interest."

Mr. Peale's connection with the Mint ceased in December, 1854, and he retired for some time from all public employment. In 1864, he was elected President of the Hazleton Coal and Rail Road Company, in the direction of which he had been for many years an active member. He continued in this office until 1867, when he resigned, and finally closed his long career of active business life.

I have thus hastily sketched the professional life of Mr. Peale, by which his public reputation was established; but any notice of his character would be far from complete which left out what we may call its æsthetic side, including those varied accomplishments and elegant tastes, which made him one of the most interesting of men.

We have already referred to the artistic hand which he brought to his mechanical work. This was a characteristic naturally growing out of his strong love and devotion to art. In the society in which he was brought up, —his father and brother eminent as painters,—he came to a knowledge of the subject rare among amateurs. He was for many years a member of the Academy of Fine Arts, which his father had been instrumental in establishing, and for the last fifteen years of his life, one of the Board of Directors, and a member of its most important committees. We are told

*Dr. Robert M, Patterson, the father of the writer, and late President of this Society.

by one of his eminent associates in the Academy, that "he was zealously devoted to the discharge of the duties assigned him, always observing a scrupulous regard for the interests of the contributing artists and pupils of the Academy. His courtuous manners and almost feminine gentleness, made him a great favorite with the lady students especially. He was sincere in the utterance of his convictions, honest in action, and sound in judgment. His taste was refined and his ideas elevated. He was, in short, a most valuable member of the Board. His departure from the scene in which he labored so industriously and efficiently, has created a vacuum not easily filled."

Mr. Peale was an excellent musician, and I believe a self-taught one. He was endowed with a most agreeable cultivated tenor voice, to which the guitar was the appropriate accompaniment, and on which instrument he became a great proficient. His love of music was a passion, and in private circles and public associations he was foremost in promoting its cultivation. His house was for many successive seasons made charming to his friends, as the resort of the best amateur and professional talent of our city, met together to illustrate, in a manner altogether worthy the choicest instrumental and vocal compositions. Mr. Peale was one of the founders of the Musical Fund Society, to which Philadelphia owes so much as the means of spreading a cultivated musical taste among us. He was among the most active members in promoting its objects in art and charity, and at his decease was President of the Society.

In manly accomplishments, Mr. Peale was conspicuous, carrying into these the elegant refinement so marked in his character, and lending also the aid of his mechanical genius. The graceful art of archery was particularly attractive to him, and in his efforts to establish it as an addition to our out-door amusements, I cannot but think he showed a taste and judgment in happy contrast to what has been exhibited in the development of those boisterous and half-savage games, cricket and base ball, of which we now hear so much. He was one of the founders of the club of United Bowmen, and a long series of medals and badges, which he preserved with some pride, attest a skill in which he was confessed the chief. His love of the art and affection for his fellow-members, was shown to the last, for by his special request his remains were borne to the grave by his associates of the club.

In another beautiful gymnastic art, that of skating, he was a proficient from his youth to the last years of his life. And it was, I think, an admirable sight to observe him, when past seventy, moving along with firmness and grace, happy in the enjoyment of his younger friends, and never so pleased as when aiding by his hand or counsel the fairer sex. He was President of the Skaters' Club at his death. And I ought to mention here that Mr. Peale was the inventor of Skaters Reel, a simple expedient for rescuing persons breaking through the ice that has probably been the means of saving many lives.

But the activity of Mr. Peale was by no means limited to his professional duties, or to art and recreation. He was zealous in good works.

In particular, the Pennsylvania Institution for the Instruction of the Blind long engaged his sympathy and unwearied labor. He was elected a manager in 1839, served on its most important committees, and was finally elected President in 1863, holding that office at his decease. He was rarely absent from the managers' meetings, and presided only a few weeks before his death. His tender, affectionate manner made him greatly loved by the pupils, while his intelligence and the soundness of his judgment secured the esteem and confidence of the officers and of his fellow managers.

For some years before his death, Mr. Peale was greatly interested in that branch of Archæology which relates to the so-called Stone Age. He determined to make a collection of implements illustrating that age, and by energy and patience succeeded in accumulating over twelve hundred specimens, many of them very choice. The most of these were gathered by himself at the ancient homes of the Shawnees and Delawares, around the Water Gap where he spent many autumns; others were secured by exchange or purchase. These have all been arranged for easy examination on a plan devised by himself, and full of his characteristic ingenuity and taste, and he has left behind a manuscript catalogue with an introduction and full descriptive details which leave nothing further to be desired. It affords me great satisfaction to add that this valuable collection, the latest labor of Mr. Peale, is to be presented to this Society.

I have left to the close, what perhaps should have been earliest mentioned, all reference to Mr. Peale's association with our own Society. He was elected a member October 18, 1833, and ever after took a constant and active interest in our proceedings. He was for many years one of the Curators, and filled that office at his death. Our published minutes show many communications from him, on a variety of subjects, but of late these were mostly relative to the stone age, on which he was always heard with the interest inspired by his enthusiasm and fulness of knowledge.

Mr. Peale was twice married. By his first marriage, which took place in his minority, he had a daughter, his only child, who still survives. His second wife was a niece of Stephen Girard. She lives to lament the death of her husband, and I may not, therefore, refer more particularly to those accomplishments and virtues by which she crowned his happiness, and made delightful his home.

I have thus far considered for the most part the outer life of Mr. Peale, by which he became known to the public at large, but I cannot conclude without some reference to his inner life as it was disclosed to his more intimate friends. These, while they admired his varied knowledge, saw upon a close inspection other traits which made still more excellent the character of the man. Of these I may mention his gentleness and loving tenderness to all, but especially to the young. With children he was a universal favorite. He never wearied in contributing to their amusement or instruction. And this was no light burden on his time, for a toy from Mr. Peale was not such as comes from the shops, but all that he accomplished, from a kite to a complicated engine, was beautiful in form and finish. On occasions, and especially if a charitable object were to be promoted, he would don the costume of an Eastern Juggler, and astonish the young, and even children of a larger growth, with apparently miraculous feats, for which he had constructed apparatus of his own. Even to the brute creation the same tender nature was exhibited. A scientific friend recalls even now the self restraint with which, when a youth, ardent in the search for entomological specimens, he spared a water-spider, of rare species, that had shown a touching instinct in the protection of its young. He was always most ready in imparting information to inquirers whom his happy faculty and clearness in explanation gathered round him. An enthusiastic lover and explorer of nature, it was in the fields and woods that he became perhaps most interesting. He was familiar with the names and habits of plants, animals, and insects, and mineralogy and geology, and from the fulness of his knowledge dispensed liberally.

A marked characteristic of Mr. Peale was his untiring energy. He was never idle, always laboring on some systematic plan. Even his recreations were methodically arranged, and a part of the means by which his body and mind were invigorated for work. And with him there were no *small* duties. Each one was sacred. No temptation or pleasure could induce him to forego a responsibility. A promise was its performance. Punctuality was a prominent virtue, any infringement on which he regretted as wasting another's time.

Finally, Mr. Peale was a reverential, humble, Christian man. A faith better than philosophy sustained him in the closing hour, and he went calmly to his rest murmuring "The Lord is my Shepherd," like unto a little child trusting to a parent's promise. His dying words distinctly and clearly uttered were: "If this is death, it is as I wished, perfect peace, perfect comfort, perfect joy."

The vigorous constitution of Mr. Peale carried him in robust health to a term some years beyond that allotted to man by the Psalmist. For months before his death, however, he was observed to be failing, a fact of which he was himself fully conscious, speaking to his friends with perfect composure of his approaching end. He was nevertheless able, almost to the last, to attend to his accustomed duties, and his closing illness was but a brief one. He died at his residence, 1131 Girard Street, on the 5th of May, 1870, in the 75th year of his age.

ON THREE EXTINCT ASTACI FROM THE FRESH-WATER TERRITORY OF IDAHO. By Prof. E. D. Cope.

(Read before the American Philosophical Society, Dec. 16th, 1870.)

Astacus subgrundialis, Cope.

This craw-fish is represented by four specimens, which include the cephalothorax and region of the front, one of them including, also, the post-abdomen to the end, with limbs; three specimens with cheles, one including a pair; and one other specimen representing the post-abdomen.

The prominent characters of the species may be stated diagnostically thus: Two tubercles on each side the front, the anterior spiniform and external to the basis of the lateral ridge of the ensiform process. The latter narrow, medially grooved, acute, with five spinous points on each side, and a terminal recurved spinelet. Surface of the cephalothorax smooth or obsoletely wrinkled. Cheles nearly smooth, not granulate, the superior edge spiniferous. Margins of the segments of postabdomen produced into acuminate plates.

I cannot determine the presence or absence of hooks on any of the legs. The cheles are badly preserved in specimens of this species.

The last segment of the cheles is furnished with a longitudinal series of strong reverted spines along the superior margin. They diminish in length proximally; four or five are most prominent. In a specimen much smaller than the type, where the surface is preserved, it is nearly smooth, and minutely striate. The longitudinal groove of the penultimate joint is well marked; this segment is not spiniferous.

The antennal plates are large, and extend to nearly opposite the end of the ensiform process at the front. The free abdominal segment is punctate on its anterior half. The outer lamina of the postabdominal segment is four times as wide as that of the others, with convex outline to a point directed outwards and backwards. The laminæ of the other segments are acuminate triangular and transverse.

The transverse suture of the external lamina of the flipper, marks the posterior fourth of the whole length of the lamina.

The lateral suture of the cephalothorax is deeply impressed.

Four of the specimens represent individuals of large size: two are smaller. The measurements are as follows:

	M
Length to dorsal suture, No. 1	0.0415
" of ensiform process only	.0182
Width " " at base	.005
Length postabdominal and flipper	.072
" (width) free lamina 1st segment	.013
" outer lamina flipper	.02
" terminal segment flipper	.005
" femur, second pair abdominal legs	.024
" dorsum No. 2 from basal spine to suture	.021

Width basis fixed claw of cheles	.009
Length penultimate joint cheles, No. 3	.0175
Width distal end of same	.0115

In the small specimen (No. 2) it appears to be the inferior margin of the cheles which is spiniferous. The mesonotum is exposed, and is of moderate width.

From a fresh water deposit in the Teritory of Idaho, near Hot Spring Mountain. Obtained by Capt. Clarence King's expedition. Museum Smithonian, No. 9779.

Astacus chenoderma, Cope, sp. nov.

This species is represented by the cheles of opposite sides of one individual, with which I associate with great probability one from the right side of a second. Part of a cephalothorax of a third is associated, but without conclusive evidence of identity, chiefly because of a near resemblance in the sculpture.

The first mentioned are remakable for their long slender form, and the absence of all spinous armature from their margins. The surface of all parts is covered with thickly placed granular tubercles. The external surface is regularly convex on the middle line, the inner convex on the lower portion, the convexity separated from the lower margin by a groove. Upper portion gradually thinned out to the edge. The edges are simply rugose like the sides, though more coarsely so, with small granular prominences. The denticulation of the opposed edges of this joint are insignificant, though but a small part of the latter is cleared from the matrix.

In the second specimen part of the penultimate segment is preserved. Its inferior margin is unarmed, but on the middle of the outer face is a series of short spines rather distantly placed.

In the third, represented by a cephalothorax, the dorsal suture is regularly convex backwards, and the mesonotum of moderate width. The surface is delicately wrinkled by the confluent bases of fine pointed granules directed forwards. They become more scattered on the sides of the cephalothorax. As in the last species there are two spines on each side the front.

	M.
Length from anterior spine to middle of cross suture	0.0235
Width between posterior spines	.0105
" mesonotum .25 inch from front	.007
Length of last segment of cheles (No. 1)	.045
Width basal part	.0173
" terminal at middle	.006

From Catharine's creek, Idaho; collected for Capt. Clarence King by J. C. Schenk. No. 9779, Museum Smithonian.

Astacus breviforceps, Cope.

Species nova.

Established primarily on three cheles or last segments of the fore limbs; with these I have associated a cephalothorax of one, and abdominal and postabdominal regions of three individuals. The only reason for such reference of the latter, is their superficial texture, in which they resemble the cheles, and differ from the corresponding parts in the two other species.

The cheles are short and thick, the section of the stoutest proximal part being an oblique oval. The inferior edge is thinned by longitudinal contraction above and below it. The fixed process is of a rather short conic form. The surface is granular tuberculate, except on the convex faces, where it is finely vermiculate rugose.

	M.
Length last segment cheles,	0.039
Width	021
Proximal transverse diameter	.013

The cephalothorax associated is quite similar to that of *A. subgrundialis*, and may possibly belong to it. It however, differs in the finely vermiculate rugose character of its surface. The rugæ are generally transverse on the back and sides. The supra-anteunal lamina is exhibited in a clear manner ; it is as long as the spine of the muzzle, and as wide at the base.

The superior surfaces of the abdominal segments are marked with a delicate vermiculate rugosity, like that of the last specimens. In *A. subgrundialis*, it is impressed punctate. This species also differs from the latter in that the transverse marginal lamina of the first postabdominal segment, is narrower than in the latter, its width not equaling twice that of one of the others, instead of being four times as wide. The succeeding laminæ are acuminate elongate, and slightly curved forward. It is, however, quite uncertain as to whether these postabdominal specimens belong to the species which has the stout cheles. Some of the specimens indicate individuals larger than those referred to *A. subgrundialis*.

From the same locality and collection as the last. No. 9779.

General remarks.

The preceding species differ from those at present inhabiting North America, as I have been able to determine by examining the excellent monograph of the latter, published in the catalogue of the Museum. Compar. Zoology, by Dr. J. H. Hagen. They differ from all of them in the prominence and acumination of the lateral margins of the postabdominal segments. In the serrate simple frontal process, the first described resembles the *Astacus gambelii* Girard, but its process is longer and narrower.

I have already described * twelve species of fishes from the same locality and deposit, whence these Astaci were procured.

* Proceed. Amer. Philos. Soc. 1870, December 8.

NOTE ON SAUROCEPHALUS, HARLAN.

By E. D. Cope, *in the Meeting November* 18, 1870.

Prof. Cope called attention to the cretaceous group of fishes represented by *Saurocephalus* of Harlan. He said they had been regarded as related to the Acanthopterygian family of *Sphyrænidæ*.

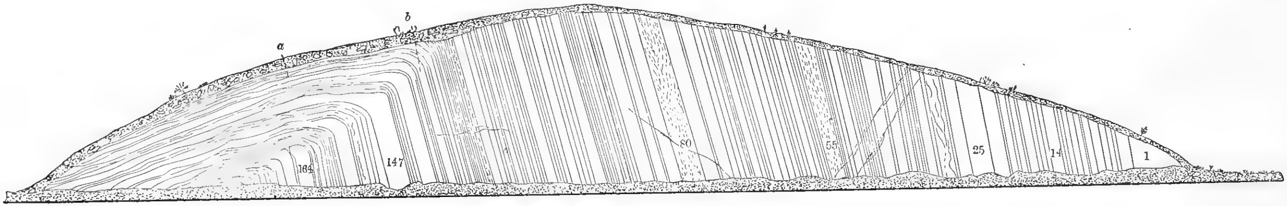
He showed that they were more like certain Malacopterygian families in the structure of the mouth; that the neural arches of the vertebræ were not coössified; and that the tail was vertebrated in a manner between the types of *Salmonidæ* and *Amiidæ*. He said the pectoral rays of the group had been described by Leidy under the name of *Xiphactinus*, and that the caudal rays were remarkably and beautifully segmented. He said that they had been hitherto regarded by authors as spines or rays of the cestraciont genus *Ptychodus*.

Prof. Cope also made a communication on the results of the explorations of certain caves in the island of Anguilla in the West Indies, by Dr. Van Rijgersma. He stated that the vertebrata embraced eleven species, of which one was a Crocodilian, two birds, one a deer, and five rodents. Of the latter, three were of gigantic size, including, beside the two species of Chinchillas already described (Proceed. Amer. Philos. Soc., 1869, 183), a third, larger than either, which was named *Loxomylus latidens*, Cope. It differed from the *L. longidens*, Cope, in having teeth with triturating surface less oblique to the axis of the tooth, and wider than long, instead of longer than wide, and with a certain irregularity in the outer margin. The distal end of the femur measured $3\frac{1}{3}$ inches across; the series of superior molars $2\frac{1}{3}$ inches; width of two inferior incisors in place one inch and two lines. The bones of the deer indicated a species a little over half the size of the Chinchilla.

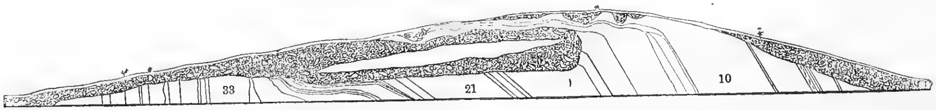
SECTIONS OF TERTIARY ROCK STRATA

In Cuttings of the Union Pacific Railroad, one mile west of Bear River City, Wyoming Terr., U. S.

RAILROAD CUTTING, No. 1 (page 420).



RAILROAD CUTTING, No. 2 (page 424).



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