ANNALS

OF THE

CARNEGIE MUSEUM

VOLUME V.

1908-1909

W. J. HOLLAND, *Editor*

PUBLISHED BY THE AUTHORITY OF THE
BOARD OF TRUSTEES OF THE CARNEGIE INSTITUTE
OCTOBER, 1908-JULY, 1909

Press of
The New Era Printing Company
Lancaster, Pa.

TABLE OF CONTENTS.

LIST OF PLATES.

LIST OF FIGURES IN TEXT.

ERRATA AND CORRIGENDA.

Page 32, No. 215, for *Linnæus* read *Boisduval & Leconte.*
Page 40, No. 774, for *Linnæus* read *Lintner.*
Page 41, No. 832, for *apella* read *opella.*
Page 45, for No. 980 (*Apatela morula*) read 990.
Page 52, for No. 1558 (*Feltia subgothica*) read 1538.
Page 59, No. 2204, for *Trigonaphora* read *Trigonophora.*
Page 67, for No. 2766 (*Melipotis nigrescens*) read 2767.
Page 70, under *Bomolocha chicagonis* read *Merrick* for *Engel.*
Page 81, No. 3383, for *persiliata* read *hersiliata.*
Page 92, No. 4100, for *Packadia* read *Packardia.*
Page 96, No. 4386, for *Thaleria* read *Tholeria.*
Page 110, for *ochrotermenana* read *ochroterminana.*
Page 110, *dele Eucosma dorsisuffusana* Kearfott, see p. 109.
Page 110, *dele Eucosma engelana* Kearfott, see p. 109.
Page 134, No. 6502, for *doristrigella* read *dorsistrigella.*
Page 135, No. 6541, for *Hormesetia* read *Hormosetia.*
Page 227, 5th line from bottom, read *Cornus amomum.*
Page 357, for *lonchitis* read *lonchites.*
Page 455, for *colombi* read *columbi.*

ANNALS

OF THE

CARNEGIE MUSEUM

VOLUME V. NO. I.

Editorial Notes.

The twelfth celebration of Founder's Day took place on April 30, 1908. The principal address of the occasion was delivered by the Right Honorable James Bryce, the British Ambassador, who spoke upon "The Influence of Modern Science upon Modern Thought." His scholarly address paid high tribute to the manner in which the exact methods of students of nature have contributed to advancement, more especially in the field of the historical and sociological sciences. The address delivered by Dr. William T. Hornaday upon "The Educational Value of Popular Museums" well sustained the reputation of the speaker as one of the foremost exponents of advanced methods in imparting popular instruction along scientific lines. The address of Mr. Henry E. Krehbiel on "The Orchestra as a factor in Education" was incidentally a powerful plea for the maintenance in Pittsburgh of the splendid orchestra which has done so much within recent years to elevate the standard of musical taste in the community.

The proceedings of Founder's Day have been issued in the form of a pamphlet, the beautiful typography of which reflects the excellent taste which characterizes everything put forth by the DeVinne Press. The only criticism which the Editor of the Annals would make relates to the title of the cut facing page 37, in which his namesake, *Dinohyus hollandi* Peterson, is designated as a "fossil pig." It is "a far cry" from *Dinohyus* to the genus *Sus*.

THE Editor with Mr. A. S. Coggeshall spent the months of April, May, and June in Europe engaged in installing at the Royal Museum in Berlin and at the National Museum in the Jardin des Plantes, Paris, the replicas of *Diplodocus carnegiei* which Mr. Carnegie has presented to the German Emperor and to the President of the French Republic. While the labors incident to this journey were somewhat exacting, compensation was found in the opportunity which was afforded to form friendships with many of the most distinguished scientific men of the German and French capitals. The kind invitation to be present at the sessions of the International Anatomical Congress, which was held in Berlin in April, was gladly accepted and resulted in personal acquaintance with many of those present, who represented the latest achievements in this important branch of scientific inquiry. With charming hospitality the Ministry of Public Instruction and the Faculty of the University of Berlin on the evening of May 13 gave a banquet in honor of Mr. Carnegie and his representative. The pleasures of the occasion will never be forgotten. In Paris President Fallières in person accepted Mr. Carnegie's gift on the afternoon of June 15, and in the evening of the same day the Faculty of the Museum united in a gathering at which in addition to choice viands there was a generous display of gracious and witty oratory. Gratitude for Mr. Carnegie's gifts was shown in everything that was said and done both in Germany and France. The bestowal by the German Emperor of the Royal Prussian Order of the Crown, and by the President of France of the Cross of the Legion of Honor upon the Director of the Carnegie Museum, and the bestowal of the order of Officier de l'Instruction Publique upon Mr. Coggeshall by the French President, furnished striking evidence of their appreciation of the gifts of Mr. Carnegie.

The *Diplodocus* was for the time being the sensation of the French capital and furnished the wise and the unwise, who thrive by pushing their pens, an apparently unlimited field for the exercise of their talents, as is evidenced by a collection of over six hundred clippings taken from French journals. The Editor refuses to be held responsible for a great deal that was published in the guise of accurate information in reference to this interesting fossil; and he certainly cannot be held responsible for the vagaries of French wits, who apparently tasked their ingenuity in order to amuse their readers. One of the funniest productions is that of a writer, who alleges that the founder of the

Carnegie Institute, indignant at the manner in which wealthy Americans have been imposed upon by the sale to them of bogus Rembrandts and Corots, secretly resolved in conspiracy with the Director of the Carnegie Museum to perpetrate upon the unsuspecting European public a gigantic hoax, and accordingly had the *Diplodocus* fabricated, and actually succeeded in palming it off upon crowned heads and the scientific men of Europe. After that the two conspirators are represented as foregathering at Skibo and indulging in quiet chuckles over the success of their wicked scheme. To what lengths will not the journalistic fancy go?

MR. JOHN D. HASEMAN has completed the work of thoroughly exploring the rivers of the Brazilian highlands north and west of Bahia in quest of fishes, and has sent to the Museum a collection of over four thousand specimens taken by him during this portion of his journey. He is at present engaged in collecting in the streams of the Province of São Paulo.

A COLLECTION of birds made at Biskra by Mr. Joseph Steinbach during the last winter has been acquired. It consists of over three hundred specimens, representing eighty-two species of the birds found in that locality.

A CONSIDERABLE collection of skulls and skeletons representing genera not hitherto found in our osteological collection was acquired by the Director of the Carnegie Museum during his stay in Europe, purchases having been made in a number of places. This material is now on exhibition in the Gallery of Mammals.

OPPORTUNITY was afforded while in Berlin and Paris to make search for various works of reference urgently called for in recent years. Among other excellent acquisitions was a complete set of "Palæontographica," Blainville's great work on Osteology, Semon's "Forschungen in Australien," "Zoologica," a complete set of the publications of the Académie Royale des Sciences de Belgique, the "Abhandlungen der Schweizerischen Paleontologischen Gesellschaft," a complete set of the "Jenaische Zeitschrift für Naturwissenschaften," of the "Sitzungsberichte der Gesellschaft Naturforschenden Freunde zu Berlin," of Barrande's "Système Silurien du Centre de la Bohême," and a large number of the publications of Gaudry, Gervais, and others. A beautiful set of Dresser's "Birds of Europe" has been acquired by our reference library from the author.

MESSRS. W. E. C. TODD and M. A. Carriker, Jr., have just returned from the trip which they made to the southern end of James Bay. In addition to bringing home some three hundred specimens of birds with him, Mr. Todd reports that he has made some valuable notes. It is to be regretted that having journeyed so far the party did not remain longer and make larger collections.

MR. O. A. PETERSON has spent the summer at the Agate Springs fossil quarry, Sioux County, Nebraska, where he took the place of Mr. W. H. Utterback, who unexpectedly threw up his commission to continue work in that locality. Mr. Utterback has ceased to be an employé of the Carnegie Museum. Mr. Peterson has been highly successful in his labors.

MR. EARL DOUGLASS during the summer and fall has been laboring among the Eocene deposits of Utah with marked success. The splendid collection of fossils from the Miocene deposits belonging to the Museum will be supplemented as soon as they can be worked out by beautiful collections from the later Eocene made in Utah.

THE Director of the Museum spent the first three weeks of September in a paleontological investigation of the localities at which Messrs. Douglass and Peterson have been working.

DR. D. A. ATKINSON, accompanied by Mr. Otto E. Jennings and Mr. Gustav Link, in the month of July made a journey from Cherrytree, Indiana County, eastward along the West Branch of the Susquehanna River, and then coming up the Juniata, crossed the Alleghenies, returning to the point from which they had started. The object of this journey was to make thorough collections representing the flora and fauna with a view to ascertaining, among other things, the dividing line between the fresh-water fauna of the Susquehanna water-shed and that of the Ohio.

DR A. E. ORTMANN has been making extensive collections of the mollusca of the upper Ohio drainage area. He has found a great deal of material not hitherto represented in our collections and has identified a number of species not hitherto reported as occurring within the limits of Pennsylvania. The collection of *Unionidæ* made by him is one of the largest and most perfect local collections which has ever been assembled, and will furnish the basis of an interesting paper in the Memoirs of the Museum.

WE are indebted to Dr. Charles Halais, of Paris, for the gift to the Museum of an argus pheasant and a pangolin brought by him from French Cochin China.

MR. C. V. HARTMAN, having accepted the Curatorship of the Department of Ethnology in the Royal Museum of Natural History at Stockholm, terminated his connection with the Carnegie Museum on April 15. The Editor is in receipt of a letter from Mr. Hartman, in which he announces that he has entered successfully upon his labors in his new field and is enjoying better health than during the latter portion of his stay in Pittsburgh.

IT is a matter of regret to the Editor that he was unable to he present at the last meeting of the American Association of Museums, which was held in Chicago, and which paid him the signal honor of electing him to its presidency. The next meeting will be held in Philadelphia. The Association has begun a vigorous and useful career. It has been the privilege of the Editor of the Annals to read over the stenographic report of the sessions held in Chicago and to read a number of the papers which were presented there. There is certainly no lack of interest and enthusiasm shown by the membership of the Association.

THE group of orang-outangs mounted in the taxidermic laboratory has attracted a great deal of favorable comment since it has been placed upon exhibition. A magnificent group representing the Diamond-back Rattlesnake in its natural environment is being constructed by the gentlemen in the taxidermic laboratory.

DR. PERCY E. RAYMOND has been continuing with success his researches upon the paleontology of the immediate neighborhood of

Pittsburgh and finds much to deeply interest him. The work hitherto done in this region proves itself to have been very superficial, and Dr. Raymond may be expected to show that some of the accepted views in relation to the geology of the region are not wholly correct.

THE Director of the Museum discovers with the lapse of time that the cares of his office do not tend to diminish, but rather to increase. The belief appears to be general, especially in the rural districts, that in order to obtain information on almost any conceivable subject all that is necessary is to write a letter to the Director of the Carnegie Museum. The correspondence of the office, while indicating great faith in the ability of the gentlemen connected with the Institute to answer every imaginable inquiry, nevertheless at times assumes a bewildering character. The experience of one day is typical of almost every day. On August 25, for example, the Director received a communication, and a box containing a specimen, asking him to decide whether the animal, the remains of which were contained in the box, had died of hydrophobia or not; he was asked to determine the age of a worn coin the inscription upon which had become absolutely illegible; was requested to write an account of the life-history and habits of an obscure caterpillar, a specimen of which was forwarded to him; and to quote prices current upon Indian arrow-heads. The position of Director of a Museum calls for as much versatility as is possessed by the editor of a country newspaper.

THE Editor takes great pleasure in publishing in this number of the ANNALS a List of the Lepidoptera of Western Pennsylvania, which has been prepared by Mr. Engel. This is one of a series of such lists, which have from time to time appeared, and which serve a useful purpose in enabling the student to know what are the species which occur in the neighborhood. The lists which have been published in the past relating to the region are the following:

A List of the Coleoptera of Southwestern Pennsylvania, by Dr. John Hamilton. Supplemented by a list prepared by Mr. Henry G. Klages.

A List of the Hemiptera of Western Pennsylvania, by P. Modestus Wirtner.

A List of the Reptiles of Allegheny County, prepared by Dr. D. A. Atkinson.

A List of the Vascular Flora of Allegheny County, prepared by Dr. J. A. Shafer, supplemented by O. E. Jennings.

Lists of the Fungi, Birds, Mammals, Fishes, and Mollusca are being prepared, and the remaining orders of Insects, as well as the Crustacea, Arachnida, and Myriapoda are being collected and studied with a view to the enumeration of the species which occur in the "back parts of the Colony of Pennsylvania," as the denizens of Philadelphia were in the habit a hundred years ago of naming the region.

I. NOTES ON COSTA RICAN FORMICARIIDÆ.

By M. A. Carriker, Jr.

While recently going over the Formicariidæ in the collection of the Carnegie Museum, I made several interesting discoveries relating to the Costa Rican material collected by myself in the years from 1902 to 1907. Thinking that perhaps they may be of interest to others working in the same field, I venture to make them known.

Myrmotherula axillaris (Vieillot).

Two males and two females were collected in September and October, 1904, on Sicsola River, in the southeastern part of Talamanca. *Myrmotherula melæna* was also taken in the same locality. I believe this to be the first record of the presence of *Myrmotherula axillaris* in Costa Rica, making a total of four species of the genus now known to inhabit that country.

Cercomacra tyrannina crepera (Bangs).

In the Auk for 1901, p. 35, Mr. Bangs describes a new ant-thrush as *Cercomacra crepera*, giving as the type locality Divala, Chiriqui, and states that it is distinguished from *Cercomacra tyrannina* by very much darker coloration throughout. He also states that this form replaces *Cercomacra tyrannina* in Chiriqui and Nicaragua. Later in his article "On a Collection of Birds from Western Costa Rica," Auk, Vol. XXIV, p. 296, he places the form of *Cercomacra*, taken in the Terraba Valley of Costa Rica, under his *crepera*, as *C. tyrannina crepera* (Bangs).

Upon examination of my specimens of this species, I am forced to the conclusion that Mr. Bangs has erred in the determination of his Terraba specimens, and furthermore that there is room for doubt as to the range of *Cercomacra tyrannina crepera* as given by him. I have before me six males and five females from the Pacific slope, distributed as follows :

Bebedéro de Guanacaste, 1 ♂, April, 1906.

Pozo Azul de Pirris, 2 ♀, May and June, 1902.

El Pozo de Térraba, 3 ♂, June, 1907.

Boruca de Térraba, 2 ♂ and 2 ♀, July, 1907.

Buenos Aires de Térraba, 1 ♀, August, 1907.

These skins, with the sole exception of the Bebedero specimen, are identical in coloration and agree exactly with descriptions of the type of *Cercomacra tyrannina* (Sclater).

On the other hand there are 21 skins (7 ♂ and 14 ♀) from various points along the Caribbean watershed from Carrillo to the Lower Rio Sicsola, all agreeing perfectly one with another, with the specimen from Bebedero, and exactly with Mr. Bangs' description of *Cercomacra crepera* ! Such obvious facts can point to but one conclusion, namely, that *Cercomacra tyrannina tyrannina* (Sclater) inhabits the Pacific slope from Colombia northward to, and including, the Terraba and Pirris valleys of Costa Rica, while the variety *Cercomacra tyrannina crepera* is the form confined (?) to the Caribbean coast, a parallel to what we have in so many other cases. However, there still remains to be explained the presence of *Cercomacra tyrannina crepera* at Divala, Chiriqui. It is very evident that it has crossed from the Caribbean to the Pacific through the valley of the San Juan, as explained by the Bebedero bird. Could it be possible that such a thing has occurred farther south ? If so, it would explain the presence of the Caribbean form at Divala.

Drymophila stictoptera Lawrence = **D. læmosticta** Salvin.

During all my collecting in Costa Rica, covering a period of five years, I have never taken or seen a skin of a male *D. læmosticta*, or a female of *D. stictoptera*, and am forced to the conclusion that the same error has been made and perpetuated in regard to these birds, which was made in the case of *Thamnophilus bridgesi* (Sclater) and *T. punctatus* Cabanis, and which was corrected by Mr. Cherrie (Auk, X, p. 279), who showed that *T. punctatus* was the male of *T. bridgesi*.

The type of *Drymophila læmosticta*, from Tucurriqui, Costa Rica, had no sex indicated, and the only other specimen in existence at the time was a female from Santa Fe de Veragua, both collected by Arcé. The type of *D. stictoptera* is a male, collected at Angostura, Costa Rica, by J. Carmiol. The inference is obvious, and I would therefore reduce *D. stictoptera* to a synonym of *D. læmosticta* Salvin.

Myrmelastes occidentalis (Cherrie) versus **M. exsul occidentalis** (Cherrie).

In 1891 (Auk, p. 191) Mr. George K. Cherrie described as new a species from the Pacific slope of Costa Rica, calling it *Myrmeciza immaculata occidentalis*. Since this bird could not be reconciled as a subspecies of (*Myrmeciza*) *Myrmelastes immaculatus* (Lafresnaye), it was subsequently given specific rank as *Myrmelastes occidentalis* (Cherrie). The same year (1891) Mr. Cherrie described as new, the Caribbean race of this form, calling it *Myrmeciza intermedia* (Proc. U. S. Nat. Mus., XIV, p. 345) = *Myrmelastes intermedia* (Cherrie).

Mr. Bangs, in his late article, "On a Collection of Birds from Western Costa Rica" (Auk, 1907, p. 296), calls this Pacific form *Myrmelastes exsul occidentalis*. If this bird was not a subspecies of *M. immaculata*, it certainly cannot be referable to *M. exsul*. The simplest way out of the difficulty, and in my judgment the only correct one, is to give *Myrmeciza immaculata occidentalis* Cherrie specific rank as *Myrmelastes occidentalis* (Cherrie), which has been done by most authors, and reduce *Myrmeciza intermedia* Cherrie to subspecific rank as *Myrmelastes occidentalis intermedia* (Cherrie).

Having had occasion to refer the foregoing observations to Mr. Ridgway, I was surprised and gratified to learn that he had already reached similar conclusions, and it is with his knowledge that I now publish them.

II. VERTEBRATE FOSSILS FROM THE FORT UNION BEDS.

By Earl Douglass.

In the autumn of 1901 the present writer made a small collection of fossil plants, mollusca, and vertebrates in the Fort Union beds at Bear Butte, in Sweetgrass County, Montana. The fossil plants were sent to Professor Frank H. Knowlton for identification, and the mammals were described by myself.[1]

Bear Butte is a mesa-shaped hill east of Widdecombe Creek on the John and William Widdecombe ranch ("Jack and Bill Ranch"), from sixteen to eighteen miles northeast of Melville, in the northern part of Sweetgrass County. A mile or more farther north Widdecombe Creek flows into Fish Creek. The butte is really a portion of the bench land or plateau, lying farther to the southwest, from which it is partly separated by erosion.

On the north and east sides of the northern portion of Bear Butte, the more nearly level surface which skirts its steeper portion is composed of dark clay-shales which disintegrate and weather into flaky particles. In places the wind and water carry away these particles, leaving small areas bare of vegetation. Below these shales are hard, thin-layered sandstones. These belong to division "E" of the "Laramie and Doubtful Laramie" described in another paper to be shortly published. Above these nearly pure shales, near the northern foot of Bear Butte, the shales contain ferruginous concretions, and there are thin lenses, bands, or layers of sandstone. The sandstones sometimes contain impressions of leaves, and in the limestones are fossil clams and bones and teeth of mammals and reptiles (crocodiles and champsosaurus). The shales which are known to be of Lower Tertiary age are, I think, not less than 100 feet in thickness. The thickness of this whole series of shales is probably more then 400 feet, and it may all be Tertiary. Within 10 or 15 feet of the top they contain impressions of plants. Just above the shales, at least on the western side of the

[1] "A Cretaceous and Lower Tertiary Section in South Central Montana," *Proc. Amer. Philos. Soc.*, Vol. XLI, No. 170, April, 1902.

northern portion of the butte, are quite hard sandstones, not many feet in thickness, which break off, and the slabs are found on the slopes below. These sandstones, which are overlaid by others more massive and probably grade laterally into them, contain many beautifully preserved fossil leaves. It is here that those which were identified by Knowlton were obtained.[2] Apparently the sandstones which cap the butte are in places laminated and in places massive at the same geological level; and in some places they are parted by beds of shale, while in other places there are thick masses without intervening shales. The massive sandstones contain some impressions of bark or stems of plants. There are fossil gasteropods in some portions of these beds.

A section of the bluffs south of Bear Butte, near where the road to Melville leaves Widdecombe Creek and ascends to the plateau, does not show any very massive sandstones, but they appear again in the face of the bluffs farther west. In the former locality the beds dip strongly to the southward, while at Bear Butte they are much more nearly horizontal. Following the road toward Melville, after ascending the bench, one passes for a long distance over a grassy prairie, but within three or four miles of Melville there are again outcrops of the Fort Union strata. The beds here are continuous with those which surround Bear Butte and are the same which the present writer examined in 1905.

Mr. A. C. Silberling has spent a considerable time in searching for fossil mammals in the vicinity of Bear Butte and Melville, and has obtained an interesting collection of remains, especially teeth, of early Eocene mammals. Only a small portion of these are the property of the Carnegie Museum. It is extremely interesting in the varied fauna which it suggests and the problems which it raises. It is of the greatest importance that collections be made from these beds accompanied by data as to the exact horizons from which the specimens come, as they may represent successive faunas instead of only one fauna. This is important in any collection, but especially so when the remains represent the earliest of the higher mammalian faunas which we know in this country.

The larger remains found here most nearly represent the Torrejon stage, but we have also a micro-fauna, part of which is different from

[2] See "Cretaceous and Lower Tertiary Section, etc.," *Proc. Amer. Philos. Soc.*, Vol. XLI, No. 170, pp. 217–218.

that of the Puerco and Torrejon of New Mexico. From Mr. Silberling's accounts and the data with the collections, it would appear that this micro-fauna is of the same age as the larger mammals in the collection (*Pantolambda*, *Euprotogonia*, etc.). From a chart and section which Mr. Silberling has kindly sent me, I judge that his collections are all from the same band — perhaps not more than 40 to 60 feet wide — from which the present writer obtained *Anisonchus*, *Euprotogonia*, *Mioclænus*, and *Pantolambda* in 1901. The principal source of these small mammals is a stratum of greenish sandstone, which Mr. Silberling found near Bear Butte. He quarried out some of this rock, broke it up, and found a considerable number of remains of mammals which have not been found elsewhere. Judging by the sketch and diagram which he sent to me, this layer is about 75 feet lower than the sandstones which form "the rim" of Bear Butte. This would be approximately in the same general horizon from which I obtained the specimens above mentioned.

The following list shows the fossils described in this paper, which, judging by the matrix, came from this quarry. Undoubtedly some of the other specimens came from the same place. Others came from the gray shales and from the layers or lenses containing *Unios*, which are 75 feet or more below the "rim rock."

Chirox	No. 1101.
Chirox	No. 1012.
Ptilodus montanus	No. 1673.
Ptilodus montanus	No. 1682.
Ptilodus montanus	No. 1684.
Cimolestes ?	No. 1013.
Picrodus silberlingi	No. 1670.
Coriphagus montanus	No. 1699.
Megopterna minuta	No. 1675.
Mixodectes ?	No. 1672.
Tricentes ?	No. 1677.
Tricentes ?	No. 1676.
Mioclænus	No. 1680.
Pantolambda	Silberling, Coll.

Order *ALLOTHERIA* Marsh.

Family BOLODONTIDÆ Osborn.

Chirox Cope.

(Proc. Am. Philos. Soc., XXI, 1884, p. 321.)

This genus is represented by three teeth: one tritubercular premolar

(No. 1012, Carn. Mus. Cat. Vert. Fos.), and two quadritubercular (No. 1685). They may all belong to one individual as they were found near together. The two quadritubercular teeth are apparently the corresponding premolars of opposite sides. Whether they are the third or fourth of the series is difficult to determine. Their antero-posterior diameter is nearly equal to that of the second premolar. According to Cope's figure[3] of *Chirox plicatus*, $P^{\underline{2}}$ and $P^{\underline{3}}$ are nearly equal in length while $P^{\underline{4}}$ is smaller. These teeth apparently represent a much smaller animal than the one described by Cope.

	mm.
Antero-posterior diameter of $P^{\underline{2}}$ (No. 1012)	3.
Transverse diameter of $P^{\underline{2}}$ (No. 1012)	2.6
Antero-posterior diameter of $P^{\underline{3}}$ (?) (No. 1685*A*)	3.3
Transverse diameter of $P^{\underline{3}}$ (?) (No. 1685*A*)	3.1

From beds of rather soft greenish sandstone (Silberling quarry) near Bear Butte, in the northern portion of Sweetgrass County in Montana. Collected by A. C. Silberling.

No. 1101 consists of four teeth, two at least of which belong to the genus *Chirox*. They are quadritubercular and are somewhat smaller than those just described. They are probably fourth premolars. A triangular pyramidal tooth may be a $P^{\underline{1}}$ or ante-premolar of *Chirox*. Collected by Silberling in 1903 from the Silberling quarry east of Bear Butte.

Family PLAGIAULACIDÆ Gill.

Ptilodus Cope.

(Am. Nat., XV, 1881, p. 921.)

In the collection there are quite a number of teeth of *Ptilodus* consisting of molars, premolars, and incisors. Probably two or three species are represented. The teeth are associated with remains of reptiles, and with eutherian mammals (*Pantolambda*, etc.).

Ptilodus montanus sp. nov.

(Type No. 1673, Carnegie Museum Catalogue of Vertebrate Fossils.)

The type consists of a last lower premolar and a first lower molar inserted in a portion of the left ramus of a mandible.

Crown of $P_{\overline{4}}$ *semi-elliptical in a lateral view; crown not high, and upper portion of cutting-edge not extremely convex; eleven distinct and two posterior indistinct ridges on the crown;* $M_{\overline{1}}$ *nearly one half the*

[3] *American Naturalist*, Vol. XXI, June, 1887, p. 566.

length of $P^{\underline{1}}$, *with four external and six internal tubercles; anterior portion of tooth narrower than posterior portion.*

The last premolar is larger than that of *Ptilodus trouessartianus* Cope, but not so large as that of *P. mediævus* Cope. The longitudinal valley on the first molar is broadly V-shaped. There are two perpendicular ridges, separated by a median groove, on the inner surfaces of each of the outer tubercles. From Silberling quarry, east of Bear Butte.

	mm.
Length of $P_{\overline{1}}$	7.5
Length of $M_{\overline{1}}$	3.7

There are several fourth premolars in the Carnegie Museum collection (1682, 1683, etc.), and in the small collection loaned by Mr. Silberling, which evidently belong to this species, also a first molar (No. 1684). There are other smaller teeth which probably belong to a smaller species.

No. 1933 is an upper molar tooth. It is rectangular in shape, nearly square. Instead of having three rows of tubercles it has two rows and a continuous ridge on which is one rudimentary tubercle. There are four tubercles on the median and three on the outer row. The tubercles are neither quite conical nor crescent-shaped, but are intermediate between the two and are quadrangular at the bases.

Order *MARSUPIALIA ?* Marsh.

Family CIMOLESTIDÆ ? Marsh.

Batodon ? Marsh.

(Am. Jour. Sc. (3), XLIII, 1892, p. 258.)

A lower molar (Carn. Mus. Cat. Vert. Foss., No. 1693) somewhat resembles the teeth figured by Marsh as *Batodon tenuis*, though there is much doubt that it belongs to that species. The specimen is somewhat larger than the figure and the trigonid is higher. The heel is low and has three low cusps, two lateral and one median, which bound the basin of the heel posteriorly.

	mm
Length of molar	3.
Height of trigonid	2.9

Another tooth (No. 1692, Plate I, Figs. 7–8) is of approximately the same size, but is shorter antero-posteriorly. The anterior portion is high and the two principal cusps equal in height. The posterior face of the trigonid is nearly perpendicular. The anterior cusp is antero-posteriorly compressed and is oblique. It is somewhat cingulum-like in form. The heel is short antero-posteriorly and is composed of three distinct cusps.

	mm.
Length of molar	2.4
Height of trigonid of molar	3.4

A lower molar (No. 1691, Plate I, Figs. 1–2) probably belongs to the Cimolestidæ. The trigonid was composed of two prominent cusps and an anterior conule. One of the cusps is broken off at the base. The remaining cusp is high and curves backward toward the apex. The anterior conule is well defined. The heel is separated by a transverse valley from the trigonid and it has three small, low, blunt, nearly equal-sized tubercles.

	mm.
Length of molar	3.25

Cimolestes ? Marsh.

(PLATE I, FIGURE 16.)

(Am. Jour. Sc. (3), XXXVIII, 1889, p. 89.)

The left ramus of a mandible (No. 1013), is referred provisionally to this genus. It has the alveoli of the molars and premolars, but no tooth, except a somewhat injured last molar. Ten comparatively large, transversely oval alveoli are shown anterior to $M_{\overline{3}}$. The alveolar border of the mandible is nearly straight and the anterior portion of the coronoid process ascends abruptly. The lower border of the jaw is somewhat convex. The heel of the last molar is low and has three low, blunt tubercles. Associated with *Ptilodus*, *Chirox*, crocodile teeth, etc. From Silberling quarry east of Bear Butte, Montana.

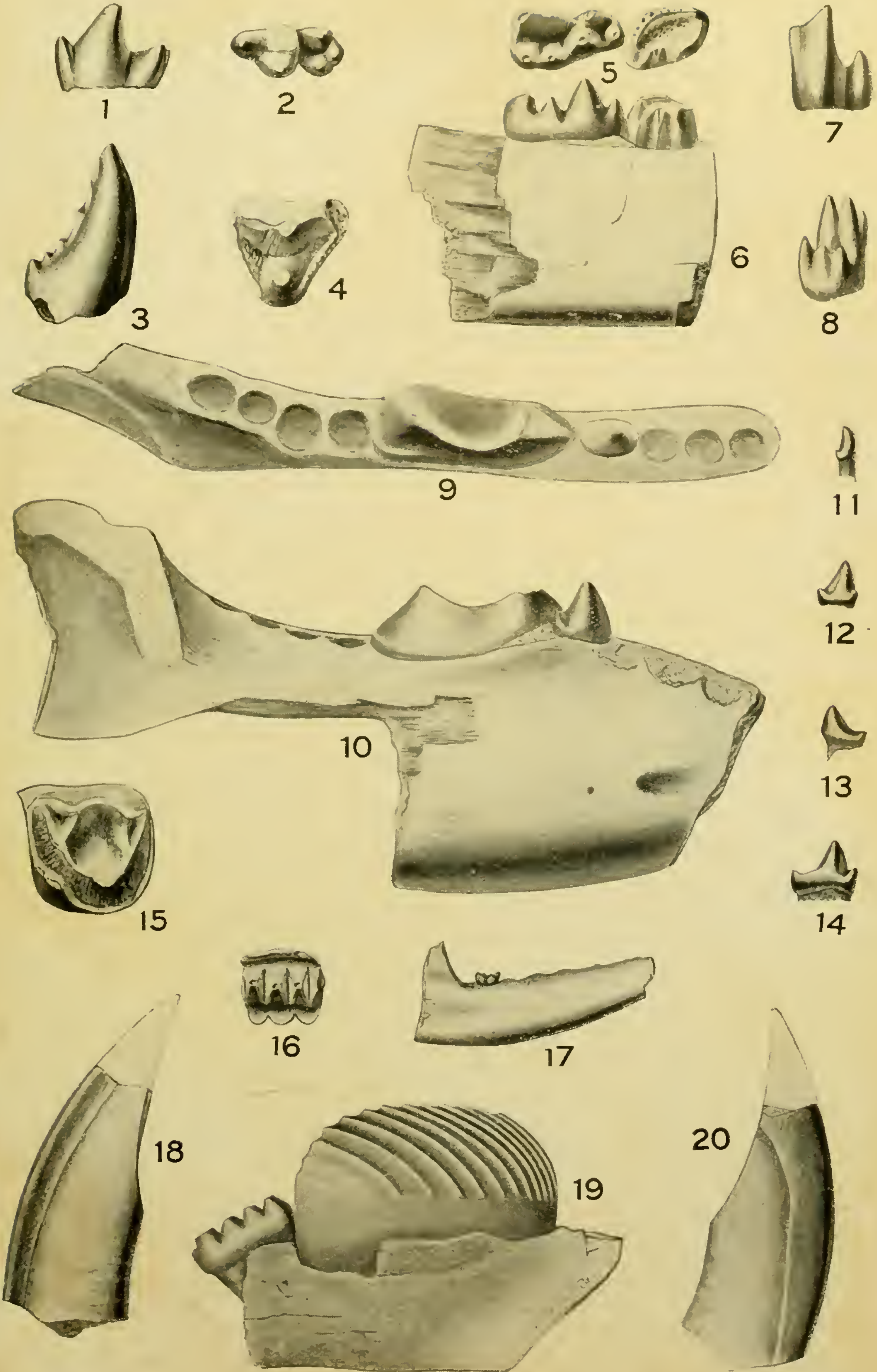
	mm.
Length of $M_{\overline{3}}$	2.9
Length of portion of mandible preserved	22.0
Depth of mandible under $M_{\overline{3}}$	5.4

Family DIDELPHYIDÆ Gray.

Peratherium ? Aymard.

(Ann. Soc. Agr., Sci., Arts et Comm. du Puy, XIV, 1850, pp. 81, 83–84.)

Number 1001, Carnegie Museum Catalogue of Vertebrate Fossils, is a fragment of a mandible with one nearly perfect molar tooth, which considerably resembles the second lower molar of *Peratherium alternans*



Fort Union Mammals.

as figured in Cope's Tertiary Vertebrata, Pl. LXII, Fig. 23. The trigonid is high and has three small tubercles arising from the summit, the median being minute. The anterior face of the trigonid is transversely convex, the posterior face flat. The heel has a small, long, sharp-pointed posterior cusp and two short lateral lobes which are hardly well enough developed to be termed cusps. The heel is separated from the trigonid by a transverse valley.

Family EPANORTHIDÆ? Ameghino.

Picrodus silberlingi gen. et sp. nov.

(Plate I, figures 9–10.)

(Type No. 1670, Carnegie Museum Catalogue of Vertebrate Fossils.)

The type consists of a portion of a mandible with two teeth.

Size small; mandible short and deep; the last premolar a simple, minute cusp with a small heel; molar a long, low tooth with the long, sharp cutting edge curved downward and outward in the middle. The first molar is about three times the length of the last premolar.

The teeth and jaw of this animal are peculiar. In certain of the characters of its dentition it suggests some of the Epanorthidæ which Ameghino has discovered in Patagonia. Though only two teeth are preserved, portions of seven alveoli can be seen in the mandible. Three of these are anterior to $P_{\overline{4}}$ and are undoubtedly the alveoli of the first three premolars. Behind $M_{\overline{1}}$ are four alveoli for two two-rooted molars. Apparently the premolars were all simple, conical, one-rooted teeth. The length of the anterior molar was greater than the combined lengths of the last two molars. The depth of the mandible under the first molar is about the same as the length of $P_{\overline{4}}$ and $M_{\overline{1}}$. From Silberling quarry east of Bear Butte, Montana.

	mm.
Length of portion of mandible preserved	10.
Length of $P_{\overline{4}}$	1.2
Length of $M_{\overline{1}}$	3.3

Order *INSECTIVORA?*

Coriphagus montanus gen. et sp. nov.

(Plate II, figures 3–4.)

(Type No. 1669, Carnegie Museum Catalogue of Vertebrate Fossils.)

The type is the left portion of a mandible lacking the anterior part, the angle, and the upper portion of the ascending ramus, with the molars and the last three premolars in place.

Ramus of mandible moderately long and slender; masseteric fossa large and deep; teeth rather heavy and with low cusps; lower premolars 2, 3, and 4 two-rooted, cusps simple, oblong, lens-shaped in horizontal section, with one outer convex and two inner concave surfaces; molars with anterior trigon and a lower tuberculate heel, external cusps higher than internal cusps.

Nearly all of the teeth are somewhat worn. P and $P_{\overline{4}}$ are longer than $P_{\overline{2}}$. The outer faces of the premolars are very convex and are quite low-crowned. $M_{\overline{1}}$ has a heavy antero-external and a small antero-internal cusp. The anterior accessory cusp is minute. The heel is low but the external portion is highest. As seen from the outside, the latter is tuberculate. M has nearly the same form and size as $M_{\overline{1}}$ but $M_{\overline{3}}$ is smaller. I do not know of any species with which this can be closely compared. From Silberling quarry east of Bear Butte, Montana.

	mm.
Length of portion of mandible preserved	34.
Depth of mandible under $M_{\overline{2}}$	5.8
Length of last three premolars	8.
Length of molar series	8.7

Megopterna minuta gen. et sp. nov.

(PLATE I, FIGURES 5–6.)

(Type No. 1675, Carnegie Museum Catalogue of Vertebrate Fossils.)

The type consists of a portion of a mandible with two teeth attached, probably a last lower premolar and a first lower molar. From the same locality as the types of *Picrodus silberlingi*, and *Coriphagus montanus*.

Size minute, mandible deep in proportion to the height of the teeth; $P_{\overline{4}}$ not showing distinct cusps, but with a raised inner border, the longest diameter being antero-internal and postero-external; $M_{\overline{1}}$ with three distinct anterior cusps, and a posterier basin-shaped heel much larger than the anterior trigon, which is bounded externally by two distinct tubercles and posteriorly and internally by a raised border.

The mandible is nearly as deep under $M_{\overline{1}}$ as the combined lengths of $P_{\overline{4}}$ and $M_{\overline{1}}$. The first premolar is so minute and the surfaces of the enamel reflect so much light, that it is difficult to figure its exact shape, yet the figure gives a very good idea of the form of the tooth. The outer surface of the tooth had perpendicular ridges and depressions. The top is nearly flat, but bounded postero-internally by a raised border.

The molar is quite peculiar. The anterior trigon is composed of three distinct cusps, of which the postero-external one is the larger and the anterior one the smaller. The heel of the tooth is much larger than the anterior portion. It is bounded externally by two tubercular cusps, while the posterior and internal borders form sharp ridges which meet at the postero-internal angle of the tooth forming a right angle. At this angle is a little thickening suggesting a rudimentary cusp. From Silberling quarry east of Bear Butte, Montana.

	mm.
Length of the two teeth preserved	2.7
Depth of mandible	2.7

Order *GLIRES? (RODENTIA)* Linnæus.

Family MIXODECTIDÆ? Cope.

Mixodectes? Cope.

(Am. Nat., XVII, 1883, p. 191.)

(PLATE II, FIGURES 9–10.)

One specimen (Carn. Mus. Cat. Vert. Fos., No. 1672) I am unable to assign with certainty to any genus that has been described, so I place it with much doubt in the genus *Mixodectes.* The specimen consists of two teeth in a portion of a mandible. They are so much worn that the exact original pattern of their crowns cannot be made out, but each had three cross-crests which were united on the outer portion of the tooth thus forming a figure something like a W, or an M. The large amount of wear indicates that the animal subsisted on hard substances, undoubtedly of a vegetable nature. From Silberling quarry east of Bear Butte, Montana.

Another lower molar (No. 1936) apparently belongs to the same genus. It is less worn and the anterior portion is higher than the posterior portion.

A portion of an incisor tooth (Plate I, Figs. 18 and 20) in the collection loaned by Mr. Silberling very strongly suggests that of a rodent. The tooth is broad antero-posteriorly and compressed laterally. The point is broken off. The tooth curves in the same manner as those of rodents. The anterior and posterior edges are rounded, making a cross-section of the tooth an oblong ellipse. The anterior face of the tooth is covered with enamel which overlaps one of the lateral surfaces more than the other.

Order *FERÆ* (*CARNIVORA*) Linnæus.

Family OXYCLÆNIDÆ Scott.

Protochriacus Scott.

(Proc. Acad. Nat. Sci. Phila., Nov. 15, 1892, p. 296.)

(PLATE II, FIGURE 15.)

There is a specimen (No. 1928), evidently a first upper molar, which I cannot distinguish from Matthew's figure[4] of the corresponding tooth of *Protochriacus hyattianus* (Cope) except that the present specimen is larger and has a continuous cingulum on the inner face.

Chiriacus? Cope.

(Proc. Acad. Nat. Sci. Phila., May, 1883, p. 80.)

(No. 1681, Carnegie Museum Catalogue of Vertebrate Fossils.)

This is a first lower molar which is provisionally placed in this genus. The anterior portion of the tooth is composed of two nearly equal-sized cusps and a minute anterior conule. This portion is considerably higher than the heel. The external cusp of the heel is larger than the internal cusp. At the posterior internal angle of this cusp is the posterior conule which is minute and is continued downward in a cingulum on the posterior face of the postero-external cusp.

	mm.
Length of tooth	5.9
Height of anterior portion of crown	3.6
Width of posterior portion of tooth	3.8

Tricentes? Cope.

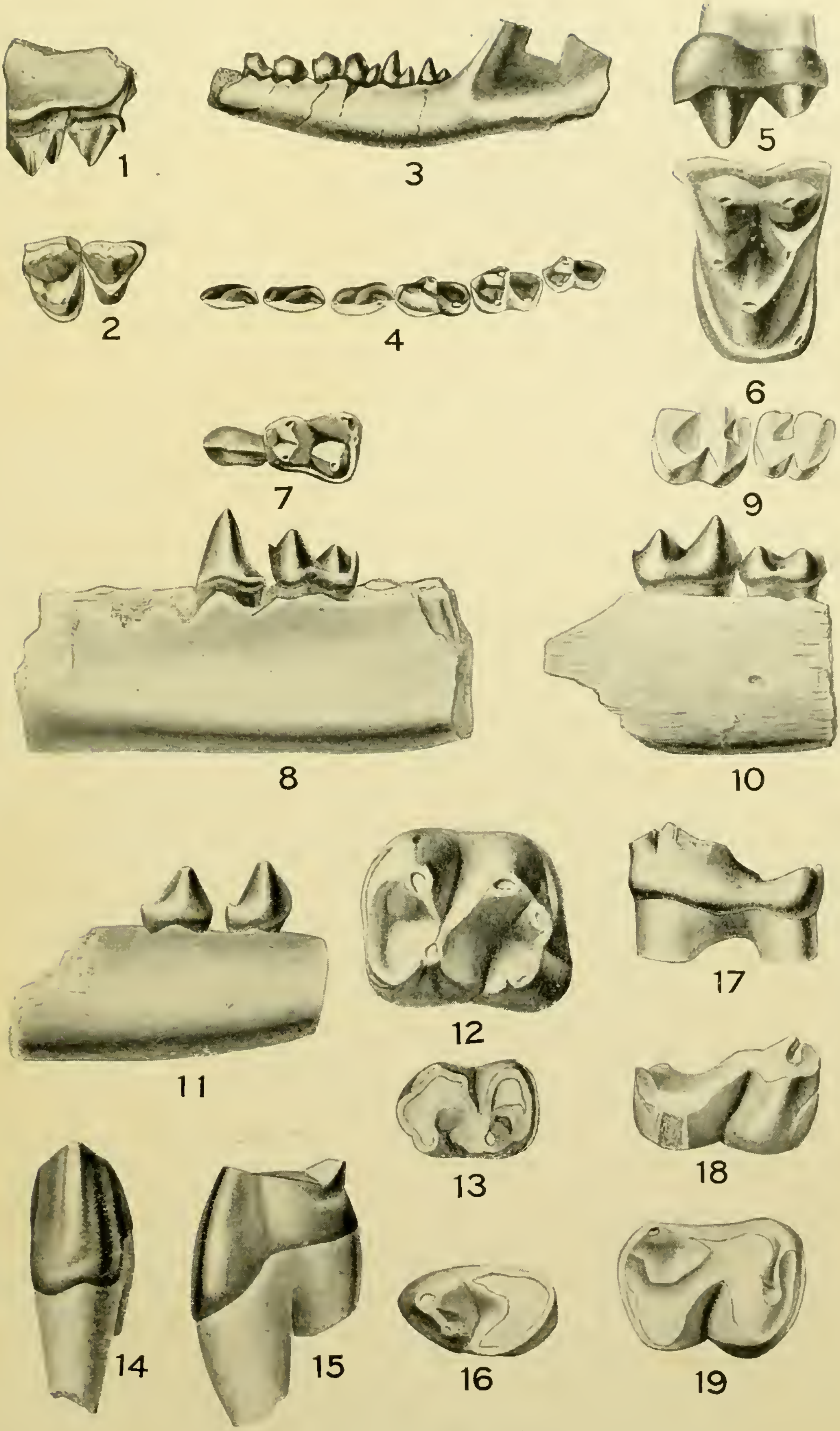
(Palæont. Bull., No. 37, 1883, p. 315.)

(PLATE II, FIGURES 5–8.)

An upper molar (No. 1676) and a portion of a mandible with the last premolar and first molar (No. 1677) are referred provisionally to this genus.

The upper molar exclusive of the cingulum is V-shaped. There are two principal external cusps, one internal cusp, and two smaller intermediate, nearly equal-sized conules. There are quite heavy external and internal cingula. The postero-internal portion of the cingulum is

[4] "A Revision of the Puerco Fauna," *Bull. Am. Mus. Nat. Hist.*, Vol. IX, Art. XXII, 1897, p. 269, Fig. 2.



Fort Union Mammals.

developed into a rudimentary cusp. From Silberling quarry east of Bear Butte, Montana.

The mandible (No. 1677) is quite heavy in proportion to the size of the teeth. $P_{\overline{4}}$ is high, conical, and sharp-pointed. There is a rudiment of a heel. $M_{\overline{1}}$ is oblong and the posterior is broader than the anterior portion. The two principal antero-lateral cusps are about equal in size, while the antero-median one is much smaller. The postero-lateral cusps are different in size and form. The external one is conical and bordered externally and posteriorly by a cingulum, while the internal cusp is continuous with the cingulum and is inwardly flattened. There is a rudiment of a cusp on the cingulum a little inward from the middle of the posterior border of the tooth. From Silberling quarry, east of Bear Butte, Montana.

	mm.
Length of premolar	4.2
Height of premolar	5.5
Length of molar	5.5
Width of molar	4.5
Height of molar	4.5

Deltatherium? Cope.

(Am. Nat., XV, 1881, p. 337.)

(PLATE II, FIGURES 1–2.)

(No. 1698, Carnegie Museum Catalogue of Vertebrate Fossils.)

This specimen consists of two upper premolars in a fragment of a jaw. The cusps of the teeth are quite high and sharp-pointed. A section of the anterior tooth is nearly an isosceles triangle, the base being external. The cusp is surrounded by a cingulum which, on the inner angle, forms a minute tubercle. The posterior tooth has a transversely narrower principal cusp, which is somewhat higher, and the inner cusp is comparatively large. There is a small rudimentary conule behind the latter. The tooth was surrounded by a cingulum. Each large external cusp has a small anterior rudimentary accessory cusp.

	mm.
Length of the two premolars	9.4
Length of the anterior premolar	5.2
Length of the posterior premolar	4.2
Width of the anterior premolar	4.9
Width of the posterior premolar	7.3

Order *BRUTA* (*EDENTATA*) Linnæus.

Family STYLINODONTIDÆ Marsh.

Calamadon ? Cope.

(Rept. Vert. Fossils New Mexico, Extract from App. FF, Ann. Rept. Chief of Eng., 1874, p. 5.)

(PLATE II, FIGURES 14–16.)

(No. 1674, Carnegie Museum Catalogue of Vertebrate Fossils.)

It is very uncertain to what animal this tooth belongs. It is probable that it is the premolar of an animal related to *Calamadon* of the Wasatch beds. The tooth had one large and two small roots, one of the latter much larger than the other. These correspond with the three unequal-sized cusps of the crown. The tooth is oblong-suboval in section and probably the long axis of the oval was transverse to the axis of the jaw. The enamel extends downward much farther on the side of the largest cusp, which was probably the external portion of the tooth, than on the other side. The enamel is faintly ribbed, and there are broad vertical convexities, and minute pits, or short, tranverse striations. The tooth is moderately high, but the cusps are very low, and the triturating surfaces of all are worn.

	mm.
Antero-posterior diameter of tooth	9.5
Transverse diameter	14.5
Height of crown, outer	13.
Height of crown, inner	7.5

Order *UNGULATA* Ray.

Family PHENACODONTIDÆ Cope.

Eutoprogonia Cope.

(Am. Nat., XXVII, 1895, p. 378.)

(PLATE I, FIGURE 4 ; PLATE II, FIGURES 12–13.)

There are several specimens in the collection which are referred to this genus, though I do not know of any teeth which exactly correspond to them in form. No. 1016 (Pl. I, Fig. 4) is apparently a fourth upper premolar, though it may be the third of the series. A horizontal section of the tooth is nearly an equilateral triangle. The angles are rounded. The outer pyramidal portion of the tooth is apparently composed of two united cusps, one higher and larger than the other. The partial separation of the outer cusp is a condition intermediate between that of the third and fourth upper premolars of *Euprotogonia puercensis* Cope. The inner cusp is small, low, and conical. A cingulum nearly surrounds the tooth and the enamel is considerably wrinkled.

	mm.
Length of tooth, antero-posterior	7.5
Width of tooth	7.2

No. 1164 (Pl. II, Fig. 12) is the crown of an almost unworn lower molar. The crown is low. There are two large anterior conules and a transverse ridge or ledge anterior to them. On the talon or posterior portion of the tooth there are three cusps, the external and internal of which are large and the median small. A low ridge passes from the antero-internal to the postero-external cusps.

	mm.
Length of molar, antero-posterior	11.5
Width of molar	9.5

No. 1932 (Pl. II, Fig. 13) consists of one complete crown of a lower molar and the posterior portion of a second, which may belong to different species. They are much smaller than 1164.

	mm.
Length of complete molar	8.

Family MIOCLÆNIDÆ Osborn and Earle.

Mioclænus Cope.

(Proc. Amer. Philos. Soc., XIX, Sept. 17, 1881, pp. 487 and 489.)

(No. 1680, Carnegie Museum Catalogue of Vertebrate Fossils.)

The specimen consists of a first lower molar in a portion of a mandible. The antero-internal and antero-external cusps are united to near their tops. From the anterior portion of the antero-external crescent, a ridge extends inward across the anterior portion of the tooth uniting with the anterior portion of the antero-internal cusp, but there is no distinct anterior conule. The postero-external is a little larger than the antero-external cusp, but is not quite so high. Internal to the postero-external cusp is a depression which is bounded internally and posteriorly by a crescent-shaped cingular cusp. This cusp is divided by a groove above and internally, making it appear like a flattened double cusp.

	mm.
Length of molar	5

Order *AMBLYPODA* Cope.

Family PANTOLAMBDIDÆ Cope.

Pantolambda Cope.

(Am. Nat., XVI, 1882, p. 418.)

(PLATE II, FIGURES 17, 18, AND 19.)

No. 1679, Carnegie Museum Catalogue of Vertebrate Fossils, is a portion of a lower molar tooth. This and a complete tooth in the Silberling collection probably represent a different species from either *Pantolambda bathmodon* or *P. cavarictis*, as it is larger than the former, and smaller and somewhat different in form from the latter. Probably No. 1679 is the posterior portion of M_3. Posterior and internal to the postero-external crescent is a basin-shaped area, behind which, forming the posterior angle of the tooth, is a subconical cusp which terminates in a minute tubercle. Internal to the median portion of the basin is another small tubercle.

A complete tooth, in the Silberling collection, appears to be a second lower molar. In this specimen the postero-internal basin has an inner tubercle.

	mm.
Length of molar	16.
Width of anterior portion	11.5

INCERTÆ SEDIS.

No. 1689 (Plate I, Fig. 11), Carnegie Museum Catalogue of Vertebrate Fossils, is a minute one-rooted tooth. The upper portion of the principal cusp is curved backward. On the posterior base of the tooth there is a minute rudiment of a heel. It may be either an incisor or a premolar.

No. 1687 (Plate I, Fig. 13) is a much larger tooth than the preceding and has a proportionally much larger heel which, however, is low.

No. 1690 (Plate I, Fig. 12) is a much larger, more robust tooth than No. 1687 and the cusp is more perpendicular. There is a distinct but not large heel and a minute antero-external (?) basal cusp. It looks very much like the third lower premolar of *Chriacus pelvidens* which is figured in Cope's Tertiary Vertebrata, Plate XIII, Fig. 8, but it is much smaller. A cross-section of the tooth is subtriangular and the postero-external face is concave.

No. 1686 (Plate I, Fig. 14) is much larger antero-posteriorly than No. 1690, has a much larger heel and a larger anterior cusp.

No. 1678 (Plate II, Fig. 11) is a portion of a mandible with two premolars in position. The teeth are moderately high and are not large in proportion to the size of the mandible. The teeth are slightly spaced. Both are simple, compressed-conical cusps with minute heels. The second premolar is longer antero-posteriorly than the first one which is represented in the specimen.

EXPLANATION OF PLATES.

PLATE I.

Fort Union Mammals.

Figs. 1–2. A lower molar tooth. Carnegie Museum Catalogue of Vertebrate Fossils, No. 1691. Fig. 1, lateral view. Fig. 2, top view. × 4.5.

Fig. 3. Tooth with serrated posterior border. Silberling Collection. × 4.5.

Fig. 4. *Euprotogonia.* No. 1016. A premolar. Top view. × 2.25.

Figs. 5–6. *Megopterna minuta.* No. 1675. Type of genus and species. Fig. 5, top view of teeth. Fig. 6, side view of portion of mandible with teeth. × 9.

Figs. 7–8. Lower molar tooth. No. 1692. Side and posterior oblique views. × 4.5

Figs. 9–10. *Picrodus silberlingi.* No. 1670. Type of genus and species. Top and external views of mandible with two teeth. × 9.

Fig. 11. Premolar tooth No. 1689. × 2.25.

Fig. 12. Premolar tooth No. 1690. × 2.25.

Fig. 13. Premolar tooth No. 1687. × 4.5.

Fig. 14. Premolar tooth No. 1686. × 4.5.

Fig. 15. *Protochriacus ?* No. 1928. × 2.25.

Fig. 16. *Ptilodus.* No. 1933. Top view. × 4.5.

Fig. 17. *Cimolestes ?* No. 1013. Left ramus of mandible. × 1.5

Fig. 18. Incisor tooth. Silberling Collection. Side view. The other side represented in Fig. 19. × 4.5.

Fig. 19. *Ptilodus Montanus.* No. 1673. Type. Portion of mandible with two teeth. × 4.5.

Fig. 20. Same specimen as Fig. 18. View of opposite side. × 4.5.

PLATE II.

Fort Union Mammals.

Figs. 1–2. *Deltatherium ?* Carnegie Museum Catalogue of Vertebrate Fossils, No. 1698. Two upper premolar teeth in portion of maxillary. Fig. 1, external view. × 1.75. Fig. 2, crown view of teeth. × 1.75.

Figs. 3–4. *Coriphagus montanus.* No. 1669. Type of genus and species. Fig. 3, outer view of ramus of mandible. × 1.5. Fig. 4, top view of teeth. × 3.

Figs. 5–6. *Tricentes ?* No. 1676 Views of molar tooth. × 4.5.

Figs. 7–8. *Tricentes?* No. 1677. Fig. 7, crown view of last lower premolar and first lower molar. Fig. 8, external view of mandible. × 2.25.

Figs. 9–10. *Mixodectes?* No. 1672. Portion of mandible with two molars. Crown view of teeth and lateral view of specimen. × 4.5.

Fig. 11. Portion of a mandible with two premolar teeth. No. 1678. × 4.5.

Fig. 12. *Euprotogonia.* No. 1164. Lower molar. × 9.

Fig. 13. *Euprotogonia?* Silberling Collection. Lower molar. × 2.25.

Figs. 14–15–16. *Calamodon.* No. 1674. × 1.5.

Figs. 17–18–19. *Pantolambda.* Silberling Collection. Lower molar. × 1.5

III. A PRELIMINARY LIST OF THE LEPIDOPTERA OF WESTERN PENNSYLVANIA COLLECTED IN THE VICINITY OF PITTSBURGH.

By Henry Engel.

About four years ago the Entomological Society of Western Pennsylvania adopted a resolution providing for the preparation of a list of the lepidoptera found in this section of the country. For various reasons, principally lack of interest on the part of the membership, and lack of knowledge of the material contained in the smaller collections, the undertaking made little progress, and was finally abandoned.

My personal knowledge of all the local collections has led me to believe that the lepidopterous fauna of our district has been pretty thoroughly explored, and I have therefore thought it advisable myself to prepare a list. The area covered by this list is comparatively small. The most of the collections made in the vicinity of Pittsburgh have been secured within a radius of about fifteen miles from the heart of the city. At New Brighton, Pennsylvania, Mr. Frank A. Merrick and his son, the late Henry D. Merrick, accumulated a very interesting collection by industrious work. Occasional trips by local collectors to Ohio Pyle, Pennsylvania, have added a number of interesting species to our faunal list.

The various collections examined by me and containing the material here listed are the following: The collections in the Carnegie Museum, gathered by Dr. W. J. Holland, Mr. Hugo Kahl, Mr. Henry G. Klages, and Mr. H. H. Smith; the collections of the Merrick Museum, New Brighton, Pennsylvania; the private collections of Mr. Zarobsky of Wilmerding, of Mr. P. Foerster of Walls, of Mr. Frank Knechtel of Swissvale, of Messrs. F. H. Lippold, Christian Meyer, and F. C. Overbeck of Allegheny, and those of Messrs. F. W. Friday, F. Marloff, and George and Bernard Krautwurm of Pittsburgh. To these I may add the collections made by myself, which are in large part in the Carnegie Museum. All of the gentlemen above mentioned have cheerfully given me their assistance in the preparation of this list by granting me the privilege of examining their collections, by loaning to me undetermined material, and by freely communicating to me their notes and observations. My sincere thanks are jointly extended to them for their courtesy. I am under special obligations to Dr. H. G. Dyar, Professor John B. Smith, Mr. August Busck, and Mr. W. D. Kearfott for their kind assistance in determining numerous species for me. Dr. W. J. Holland has accorded to the list his editorial supervision, and has added here and there the names of species known to him as occurring in the region, and has here and there appended notes.

I have followed the nomenclature and order given in "A List of the North American Lepidoptera," published by Dr. H. G. Dyar, as "Bulletin No. 52 of the United States National Museum." I have departed in some places from that List, especially in the case of the Micro-lepidoptera, where these have been studied and revised by authors who have published since Dr. Dyar gave his List to the world. This is more particularly true in the case of the *Tineidæ*, upon which Messrs. Dietz and Busck have recently published extensively. The rapid increase in our knowledge of the subject very soon causes the best list to become antiquated.[1]

[1] In going over Dr. Dyar's List my attention has been called by various friends to typographical errors which are found in that publication, to which it may not be improper to call attention. I only cite those which relate to the following list.

Page 2 for "IPHIDICLES" read IPHICLIDES.

Page 71 for "excæcatus" read excæcata. The noun *Pæonias* is feminine, and "Excæcata" is the specific name first given.

Page 72 for "promethia" read promethea.

Page 116 for "miseloides" read miselioides.

Page 153 for "ligitima" read legitima.

Page 165 for "oviducta" read oviduca.

Page 189 for "arcifera" read arcigera.

Page 199 for "thyatiroides" read thyatyroides.

Page 202 for "falcigera" read falcifera.

Page 209 for "muscoscula" read muscosula.

Page 224 for "robinsonii" read robinsoni.

Page 238 for "PHEOCYMA" read PHÆOCYMA.

Page 264 for "herminiata" read hermineata.

Page 265 for "CLADORA" read CLADARA.

Page 269 for "refusata" read refusaria.

Page 280 for "ruficilliata" read ruficillata.

Page 282 for "vasaliata" read vasiliata.

Page 285 for "gibbocostata" read gibbicostata.

Page 290 for "HÆMATOPSIS" read HÆMATOPIS.

Page 291 for "insularia" read insulsaria.

Page 292 for "ennucleata" read enucleata.

Nearly fifteen hundred species and varieties are enumerated in this list as occurring within the region covered by it. There are in the collections in and about Pittsburgh over one hundred species, which have not as yet been determined. It will be observed from this that the neighborhood possesses a very extensive lepidopterous fauna.

RHOPALOCERA.

Family PAPILIONIDÆ.

5.[2] **Iphiclides ajax** Linnæus, var. **telamonides** Felder.

April 30–May 15; var. **marcellus** Boisduval & Leconte, July 18–August 20. General, but not common. Larva on *Asimina triloba.*

11. **Papilio glaucus** Linnæus, var. **turnus** Linnæus.

April 30–June 25; July 21–August 13. Common. Larvæ on wild cherry and tulip-poplar. [Both yellow and black females are common. *Editor.*]

13. **Papilio troilus** Linnæus.

May 7–June 25; July 21–August 10. Common. Larvæ on sassafras and spicebush. Var. **radiatus** Strecker.

Two specimens were reared by Mr. Lippold.

14. **Papilio cresphontes**[3] Cramer.

July and August. This handsome species is rare in this vicinity. About twelve specimens are distributed in the various collections, which were taken in the neighborhood.

22. **Papilio polyxenes** Fabricius.

May 20–June 25; July 14–August 27. Common. The larvæ are abundant on carrots and allied plants.

23. **Papilio philenor** Linnæus.

May 24–June 10; July 14–September 15. Common. The larvæ are found on the two species of *Aristolochia*, which occur in Alle-

Page 305 for "PSYSOSTEGANIA" read PHYSOSTEGANIA.
Page 321 for "unipuncta" read unipunctata.
Page 327 for "intextata" read intertextata.
Page 334 for "athasiaria" read athasaria.
Page 337 for "HYPEIRTIS" read HYPERETIS.
Page 343 for "armantaria" read armataria.
Page 348 for "ABBOTANA" read ABBOTTANA.

[2] The numbers at the left correspond to those in Dyar's list.

[3] *P. cresphontes* is not synonymous with *P. thoas*, as stated by Dr. Dyar. *P. thoas* is a southern form, which occurs in Texas and southward, but is not known to occur north of the Gulf States. *Editor.*

gheny County. They are particularly common on *Aristolochia macrophylla*, The Dutchman's-Pipe-Vine.

Family PIERIDÆ.

37. **Pontia protodice** Boisduval & Leconte.

July 28–August 27. Common.

37a. **Pontia vernalis** Edwards.

Pittsburgh, April 18–28 (Engel & Marloff).

38g. **Pontia napi** var. **virginiensis** Edwards.

New Brighton, April 4–26 (Merrick); Pittsburgh, April 9–30 (Engel & Marloff).

40. **Pontia rapæ** Linnæus.

April 23–October 6. This common species may be observed throughout the season from early spring until the occurrence of heavy frosts. (The editor has observed it on the wing on several occasions in January and February, when there had been a succession of mild days.)

40b. **P. rapæ** var. **immaculata** Skinner & Aaron.

New Brighton, April 23, 1899 (Merrick).

52. **Callidryas eubule** Linnæus.

(The editor has twice observed this species on the wing in Pittsburgh, but failed to take the specimens. The late Dr. John Hamilton took it on one occasion near Tarentum, and a worn specimen was captured in the early summer of 1908 by Mr. Hugo Kahl.)

61. **Zerene cæsonia** Stoll.

Wilmerding (Foerster). A rather worn specimen, the date of capture of which was unfortunately not preserved.

65. **Eurymus eurytheme** Boisduval.

New Brighton, September 25 (Merrick); Pittsburgh, October 22 (Marloff); Jeannette (Knechtel); Wilmerding (Zahrobsky).

66. **Eurymus philodice** Godart.

April 22–May 20; June 27–July 3; August 10–November 9. There are apparently three broods in the season. The white female occurs frequently, especially in the summer brood.

Var. **nigridice** Scudder.

One male in fine condition is contained in the Merrick Museum, collected by Mr. Glasser, August 20, at Millvale, Pa.

83. **Eurema nicippe** Cramer.

New Brighton, September 23 (Merrick); Pittsburgh, May 6

(Engel); Millvale, July (Lippold). This species is contained in several other collections taken in this vicinity, but dates of capture are lacking. (The larva feeds upon the various species of the genus *Cassia*, and where these plants occur abundantly, as used to be the case in the neighborhood of Tarentum, the insect is not uncommon in the early fall. *Editor.*)

85. **Eurema euterpe** Ménétries.

New Brighton, October 19 (Merrick); Pittsburgh, October 19 (Marloff), Millvale, September (Lippold).

Family NYMPHALIDÆ.

92. **Euptoieta claudia** Cramer.

Pittsburgh, July 15–August 11 (Engel & Friday); second brood, September 28–October 20. Common. Specimens representing the first brood are rather scarce, and are as a rule larger and darker than those of the fall brood.

95. **Argynnis idalia** Drury.

July 25–August 30. Rare. Nearly all of the collections contain one or more local captures of this handsome butterfly.

99. **Argynnis cybele** Fabricius.

May 26–July 8; August 10–September 12. Common. I have occasionally found the larvæ under loose boards along fences in pasture-fields.

100. **Argynnis aphrodite** Fabricius.

May 24–July 5; August 20–September 7. Common. The larvæ may be found in pasture-lands where violets grow.

102. **Argynnis atlantis** Edwards.

Taken at Cresson by Dr. Holland and Mr. George Ehrman.

131. **Brenthis myrina** Cramer.

May 30–June 15; July and August. Rather rare in the immediate vicinity of Pittsburgh, but abundant at Idlewild and New Brighton.

141. **Brenthis bellona** Fabricius.

May 14–June 25; July 3–30; September 7–12. Common.

146. **Euphydryas phæton** Drury.

Pittsburgh, June 12 (Marloff); New Brighton, June 17, 18 (Merrick); Mr. Lippold has repeatedly collected the hibernating larvæ in a swamp at Aspinwall, and has reared them in abundance.

185. **Charidryas nycteis** Doubleday & Hewitson.

June 20–July 10; August 1–20. Common. Several dozen larvæ were reared by the writer some years ago. They were feeding on the leaves of sneezeweed, *Helenium autumnale* Linnæus.

189. **Phyciodes tharos** Drury.

May 17–June 26; July 28–August 20. The form **morpheus** Fabricius, and several aberrations, in which the normal ground color is replaced by white, were noted among the local material.

205. **Polygonia interrogationis** Fabricius.

August 30–October 13. Form **umbrosa** Lintner. June 13–July 10; September 12. The latter record is a specimen reared by the writer among a batch of larvæ of the fall brood. All the other specimens proved to be **interrogationis**. Foodplant: elm.

206. **Polygonia comma** Harris.

August–September 7; March 29–April 25. Form **dryas**, Edwards, June 21–July 30. Mr. Krautwurm has reared the larvæ on nettle. Both forms are common.

209. **Polygonia faunus** Edwards.

Pittsburgh, July (Friday); New Brighton, Pa., August 20 (Merrick).

214. **Polygonia progne** Cramer.

New Brighton, June 15–July 12 (Merrick); Pittsburgh and Rock Point, July 2–10 (Marloff, Engel & Friday). Mr. Marloff reared several specimens from larvæ found on currant.

215. **Eugonia j-album** Linnæus.

July 4–12, March, April. This handsome butterfly is rare in the vicinity of Pittsburgh, but commoner at New Brighton and Rock Point.

217. **Euvanessa antiopa** Linnæus.

March 3–April 14; June 6–July 14; August 12–September 25. Common. The larvæ are abundant on willow, elm, and poplar.

218. **Aglais milberti** Godart.

Allegheny, July (Lippold); Swissvale (Knechtel); Wilmerding (Zahrobsky and Foerster). Mr. Lippold has reared the larvæ on nettle.

219. **Vanessa atalanta** Linnæus.

April 18–May 12; June 30–July 29; September 20. Common.

220. **Vanessa huntera** Fabricius.

May 13–26; July 14–23; September 6–October 10. Common.

221. **Vanessa cardui** Linnæus.

June 22–July 12; August 7. This species is quite common in some years, and very rare in others. Mr. Marloff has reared the larvæ on thistle.

223. **Junonia cœnia** Hübner.

New Brighton, September 11 (Merrick). Pittsburgh, July 20 (Friday). Riverview Park, Allegheny (Lippold and Overbeck).

236. **Basilarchia astyanax** Fabricius.

May 28–June 25; July 23–August 6. Common. Foodplants: apple, wild cherry.

B. astyanax var. **albofasciata** Newcomb.

Pittsburgh, July 23 (Friday & Marloff); Wilmerding (Zahrobsky); New Brighton (Merrick). This form had been referred to *arthemis* Drury in all the local collections. The ground color will at once separate it from the latter.

239. **Basilarchia archippus** Cramer.

May 28–June 19; August 4–September 2. The larvæ are not uncommon on willow.

244. **Chlorippe celtis** Boisduval & Le Conte.

July 18–25. This species is rare, but represented in nearly all the collections.

248. **Chlorippe clyton** Boisduval & Le Conte.

June 30–July 18.

Var. **proserpina** Scudder.

June 30–July 12. Both forms are quite common locally, where the foodplant is present. Mr. Krautwurm has reared the larvæ and the writer has observed many colonies on hackberry (*Celtis*) late in the fall.

258. **Cercyonis alope** Fabricius.

July 4–27. Local specimens of the typical form, as well as **nephele** Kirby, are represented in nearly all the collections. Both forms and numerous intergrades were taken at New Brighton and Rock Point, Pa.

286. **Enodia portlandia** Fabricius.

New Brighton, June 19 (Merrick); Ohio Pyle, May 30 (H. Klages).

299. **Cissia eurytus** Fabricius.

June 18–July 20. Common.

Family LYMNADIDÆ.

308. **Anosia plexippus** Linnæus.

June 4, July, August, September and October.

Var. **fumosus** Hulst.

New Brighton, July 21, 1899 (Merrick); Pittsburgh (Marloff). Larvæ abundant on milkweed (*Asclepias*).

Family LIBYTHEIDÆ.

311. **Hypatus bachmani** Kirtland.

June 12–July 2. This interesting butterfly is rare in this vicinity. One or more specimens are in nearly all the collections.

Family LYCÆNIDÆ.

330. **Eupsyche m-album** Boisduval & Le Conte.

Wildwood Hollow, Penn Township, Allegheny County, July 13 (B. Krautwurm); Panther Hollow, Schenley Park (Holland).

335. **Uranotes melinus** Hübner.

Pittsburgh, August 22 (Engel). One specimen taken at Pittsburgh, on ironweed blossom, in collection Carnegie Museum; August 9, 1908 (Friday).

347. **Thecla calanus** Hübner.

June 20–July 27. The butterfly is common on blossoms of the milkweed. Mr. Krautwurm has reared the larvæ on oak.

362. **Mitoura damon** Cramer.

Indiana County, September (Holland).

384. **Strymon titus** Fabricius.

Pittsburgh, June 28–July 9 (Marloff, Engel & Friday).

385. **Feniseca tarquinius** Fabricius.

May 10–17; July 4–22. The butterfly is common in sunny places in woods. Mr. Krautwurm reared the larvæ, which were collected among colonies of the mealy bug, upon which they feed.

393. **Chrysophanus thoe** Boisduval.

May 31–July 3; August 10. Rather rare, but well distributed in this vicinity. The butterfly occurs mostly in moist bottom lands.

399. **Heodes hypophleas** Boisduval.

May 7–June 10; July 12–August 23. Very common. The form **fasciata** Strecker, with white ground, has been taken by Messrs. Marloff and Krautwurm. The larva and chrysalis were collected by the writer under loose boards in pasture-fields.

440. **Cyaniris ladon** Cramer.

April, May, June and July.

Var. **marginata** Edwards.

New Brighton and Pittsburgh, April 30–May 14 (Merrick and Engel).

Var. **violacea** Edwards.

April 8–May 17. Common.

Var. **neglecta** Edwards.

April 3–June 9. Common.

Var. **nigra** Edwards.

New Brighton, April 12–May 12 (Merrick). Very local in a swampy spot in an extensive forest five miles north of New Brighton. A nice series of this blackish form shows it to be constant.

442. **Everes comyntas** Godart.

May 7–June 26; July 20–August 25. Common in moist meadows.

Family HESPERIIDÆ.

459. **Amblyscirtes vialis** Edwards.

April 13–June 8; July 25–August 12. Common.

472. **Ancyloxypha numitor** Fabricius.

May 20–June 15; July 23–August 20. Very common along water courses and in swamps.

483. **Atrytone zabulon** Boisduval & Le Conte.

One male taken in Allegheny is the only record of this species (Lippold).

484. **Atrytone hobomok** Harris.

May 18–June 10. Common.

Var. **pocahontas** Scudder.

May 26–June 19. This melanic female is quite rare, but represented in most of the collections.

488. **Erynnis sassacus** Harris.

Idlewild, May 30 (Engel); Pittsburgh, May 26–June 21 (Marloff, Engel, and Friday).

515. **Hylephila phylæus** Drury.

New Brighton, August 7 (Merrick); Allegheny (Lippold).

519. **Thymelicus otho** Smith & Abbot.

June 21–July 8. Common on flowers of milkweed.

Var. **egeremet** Scudder.

Pittsburgh, June 14–July 6 (Marloff & Friday).

520. **Thymelicus mystic** Scudder.

Pittsburgh, May 17–31 (Engel, Marloff, and Friday).

523. **Thymelicus cernes** Boisduval & Le Conte.

May 28–June 26. Common.

526. **Polytes peckius** Kirby.

June 4–July 23; August, September. Common.

528. **Euphyes verna** Edwards.

June 20–July 18. Common on flowers of milkweek.

557. **Limochores manataaqua** Scudder.

Pittsburgh, May 26 (Friday). This specimen was determined by Mr. Laurent of Philadelphia. It is very similar to 523.

584. **Epargyreus tityrus** Fabricius.

May 14–June 25; July 20–September 6. Common. The larva is abundant on locust (*Robinia pseudacacia*).

591. **Achlarus lycidas** Smith & Abbot.

Pittsburgh (Marloff). New Brighton, July 7 (Engel). The last record is from a specimen seen, but unfortunately its capture could not be effected.

599. **Thorybes bathyllus** Smith & Abbot.

June 11–July 13. Rather rare, but generally distributed.

601. **Thorybes pylades** Scudder.

May 28–June 19. Rare, but represented in nearly all the collections.

605. **Pholisora catullus** Fabricius.

May 6–June 10; July 23–August 12. Common.

617. **Thanaos brizo** Boisduval & Le Conte.

April 28–May 13. Common.

618. **Thanaos icelus** Lintner.

Pittsburgh, May 17–22 (Marloff).

625. **Thanaos juvenalis** Fabricius.

May 10–June 13. Common.

642. **Hesperia tessellata** Scudder.

July 23–31; August 27–November 9. This species is very erratic in its appearance, being very common in some years and almost absent in others.

HETEROCERA.

Family SPHINGIDÆ.

653. **Hemaris diffinis** Boisduval.

July 12–24. The larva occurs on the cultivated snowberry common in gardens. (The editor in 1886 bred several scores of specimens from larvæ found on the snowberry bushes in gardens in Oakland, Pittsburgh.)

Var. **tenuis** Grote.

April 30–May 4. Rare[1] (Engel). Several specimens were taken on wild plum blossoms.

[1] In former years was very common. (*Editor.*)

656. **Hemaris thysbe** Fabricius.

July 15–August 19.

Var. **ruficaudis** Kirby.

May 22–June 15. Not common. Like the summer form, it occurs at various flowers on sunny days. The larvæ feed on snowball and hawthorn.

667. **Amphion nessus** Cramer.

May 20–July 3. Common. The moth occurs at flowers during the late afternoon and it is freely attracted by the fermented sap of wounded oak trees. The larva occurs on Virginia-creeper and wild grape.

668. **Sphecodina abboti** Swainson.

May 12–June 4. The moth frequents lilac blossoms and is also attracted by sugar. Larvæ have been reared by Mr. Krautwurm on Virginia-creeper and grape.

669. **Deidamia inscriptum** Harris.

April 25–June 1. The larva of this species feeds on the wild grape and in forests where this plant abounds the moth is not rare. They emerge during the evening hours and may be found the following day clinging to the vines or dead weeds near their foodplant.

670. **Deilephila gallii** Rottemburg.

Allegheny, July (Overbeck). One specimen taken on flowers of *Saponaria*.

671. **Deilephila lineata** Fabricius.

May 30–June 29; July 21–September 1. Common at flowers. The very variable larvæ occur on wild portulaca and the writer has reared them on four-o'clock (*Mirabilis jalapa*).

672. **Theretra tersa** Linnæus.

August 1–20. Rare. The moth occurs on the flowers of *Saponaria* during the evening hours. (The editor has found the larvæ on *Euphorbia*, and has bred them.)

678. **Pholus pandorus** Hübner.

July 7–August 12. Common at *Saponaria* blossoms during the early evening. Larva on grape and Virginia-creeper.

679. **Pholus achemon** Drury.

June 29–August 11. This species has the same habits as the preceding species.

681. **Ampelophaga chœrilus** Cramer.

Pittsburgh, July 3, 1895 (Friday). New Brighton, May 8 (Merrick). Pitcairn and Schenley Park, Pittsburgh (Holland).

682. **Ampelophaga myron** Cramer.

June 12–July 10; August 13–24. Common. The writer has reared a large number from ova and secured the forms **cnotus** Hübner in about equal proportions among the adults. The larvæ are variable and feed on the wild-grape.

683. **Ampelophaga versicolor** Harris.

May 31–June 22. Rather common in this section. The larvæ are abundant on *Hydrangea americana*.

686. **Dilophonota ello** Linnæus.

New Brighton, July 5, two specimens (Merrick); Wilmerding (Zahrobsky); Allegheny, July (Overbeck). All taken at light.

696. **Phlegethontius quinquemaculata** Haworth.

July 16–29; September 1–12. Common at flowers. The larva feeds on the tomato.

697. **Phlegethontius sexta** Johanssen.

August 4–September 5. The moth is found on the blossoms of four-o'clock and jimson weed. The larvæ occur on tobacco and tomato-plants.

699a. **Phlegethontius cingulata** Fabricius.

New Brighton, September 10, two specimens (Merrick); Pittsburgh, August (Marloff).

700. **Sphinx Kalmiæ** Smith & Abbot.

July 15–28. Rare at flowers of *Saponaria*. Mr. Krautwurm has reared the larva on ash.

701. **Sphinx drupiferarum** Smith & Abbot.

May 30–June 12; July 13–August 2. Mostly taken at light, rarely at flowers. The larvæ feed on wild cherry and plum.

703. **Sphinx gordius** Stoll.

Wilmerding (Zahrobsky). The specimen is in the Carnegie Museum.

706. **Sphinx chersis** Hübner.

July 17–28. Rare. Mr. Krautwurm has reared the larva on ash.

716. **Sphinx eremitus** Hübner.

June 29–August 16. The moth occurs at the flowers of *Saponaria* and the larva on peppermint.

721. **Ceratomia amyntor** Geyer.

May 26–July 17. The moth is mostly found at rest on or near elm, the foodplant of its larva.

722. **Ceratomia undulosa** Walker.

May 7–22; July 21–September 10. Common. Foodplant: ash.

728. **Marumba modesta** Harris.

New Brighton, July 4–9 (Merrick); Pittsburgh and Wilmerding (Krautwurm, Zahrobsky, and Foerster). Foodplant: poplar.

729. **Smerinthus jamaicensis** Drury.

May 23–June 16; July 20–August 25. Common. The larvæ feed on willow.

731. **Paonias excæcata** Smith & Abbot.

June 15–July 19. Common. Foodplants: maple, wild cherry.

732. **Paonias myops** Smith & Abbot.

May 30–July; July 27–August 29. Common. Foodplant: wild cherry.

734. **Cressonia juglandis** Smith & Abbot.

June 16–July 30. Common. Foodplants: hickory, walnut.

Family SATURNIIDÆ.

739. **Samia cecropia** Linnæus.

May 18–June 25. Common. The foodplants are all arboreal Rosaceæ, Betulaceæ, Salicaceæ, *Sambucus*, and other plants. I have found it very commonly on *Salix* and *Sambucus*.

744. **Callosamia promethea** Drury.

June 14–July 20. Common. Larva in small colonies while young, and later scattered on spice-bush, wild cherry, and tulip-tree.

745. **Callosamia angulifera** Walker.

May 26–July 12. Rare. Larva on tulip-tree (*Liriodendron tulipifera*). The Messrs. Krautwurm have reared the larvæ and collected the cocoons from the branches of the tulip-tree. The cocoons are often attached to the branches, but are not suspended like the cocoon of *promethea*.

747. **Tropæa luna** Linnæus.

May 1–June 2; July 23–September 2. Common. The larva occurs on hickory and black and white walnut, and persimmon.

748. **Telea polyphemus** Cramer.

June 1–August 13. Common. The larvæ of this very variable species occur on a great variety of plants, but seem to prefer hawthorn, willow, chestnut, maple, and oak.

753. **Automeris io** Fabricius.

May 2–July 7; September 6–27. Common. The latter dates are from several specimens which emerged from a large number reared by the writer, the balance of which laid over until the following year. The larvæ occur on many plants, but thrive well on wild cherry [and dog-wood (*Cornus florida*), *Editor*].

Family CERATOCAMPIDÆ.

768. **Anisota senatoria** Smith & Abbot.

New Brighton, June 15 (Merrick). Several large colonies of the larvæ of this species were collected and reared to maturity by the writer. They feed on different kinds of oak.

770. **Anisota virginiensis** Drury.

May 5–July 21. Rare. The larvæ live in small colonies on various kinds of oak.

771. **Anisota rubicunda** Fabricius.

June 10–July 15. Common. Foodplant: maple.

774. **Syssphinx bisecta** Linnæus.

Wilmerding, two males (Zahrobsky & Foerster).

776. **Citheronia regalis** Fabricius.

June 28–July 18. The moth is rather rare. The larvæ occur on many different plants, but principally on walnut, hickory, sumac, linden [and persimmon, *Editor*].

778. **Basilona imperialis** Drury.

July 3–24. Common.

Var. **didyma** De Beauvois.

Pittsburgh, July 5 (Friday). The larvæ feed on maple, locust, oak, walnut, and many other plants.

Family SYNTOMIDÆ.

787. **Scepsis fulvicollis** Hübner.

May 30–June 30; August 5–October 4. Common.

792. **Lycomorpha pholus** Drury.

July 1–28. Rare. Taken in different localities flying during the daytime.

798. **Ctenucha virginica** Charpentier.

Pittsburgh, June 14 (Engel); New Brighton, June 15 (Merrick); Allegheny (Lippold). The latter was taken on the wing during the daytime the other specimens occurred at light. [Abundant in Cambria, Forest, and Elk Counties. *Editor.*]

Family LITHOSIIDÆ.

——. **Crambidia allegheniensis** Holland.

East Pittsburgh (Holland).

807. **Hypoprepia miniata** Kirby.

August 7. Rare about Pittsburgh.

808. **Hypoprepia fucosa** Hübner.

July 23. Rare about Pittsburgh. This species and the preceding are contained in most of the smaller collections, but lack dates of capture. They evidently were more common some years ago than they are now. [Abundant about Cresson, and in the mountain counties. *Editor.*]

817. **Clemensia albata** Packard.

New Brighton, June 8–12, August 23 (Merrick); Ohio Pyle, June 10, August 7 (Kahl, Klages, and Engel); Pittsburgh (Krautwurm). [Formerly abundant in Panther Hollow, Schenley Park, on trunks of beech-trees. *Editor.*]

821. **Illice subjecta** Walker.

West Liberty, two specimens (John Link).

Family ARCTIIDÆ.

832. **Eubaphe apella** Grote.

New Brighton, June 6–18 (Merrick); Pittsburgh (Marloff and Krautwurm).

Var. **nigricans** Reakirt.

New Brighton, June 9–20 (Merrick).

Var. **belmaria** Ehrman.

An intermediate form which occurs with the typical *apella*. The species and varieties occur in extensive forests in open sunny spots where they flit about and rest on the herbage. [Found in open pasture-fields on the mountains of Cambria County. *Editor.*]

834. **Eubaphe aurantiaca** Hübner.

May 25–June 19; July 26–August 30. Common and very variable. The several named varieties occur with the typical form.

836. **Utetheisa bella** Linnæus.

July 12–29. Locally common in waste lands where it flies about in daytime.

Var. **venusta** Dalman.

New Brighton, August 4 (Merrick); Pittsburgh (Krautwurm).

838. **Haploa clymene** Brown.

July 17–28. Common in open woods. The young larvæ were observed on white snakeroot, *Eupatorium ageratoides* Linnæus, during late fall; and larvæ were brought to maturity on wild cherry after hibernating (Engel).

840. **Haploa lecontei** Boisduval.

Specimens approaching the typical form are rare. The various named varieties and intergrades are common and very interesting series are contained in local collections. They are on the wing June 5–July 18.

842. **Haploa contigua** Walker.

New Brighton, July 6–27 (Merrick); Rock Point, July 25 (Friday); Coraopolis (Meyer).

846. **Ecpantheria deflorata** Fabricius.

June 10–28. Rarely taken except by breeding. The Messrs. Krautwurm have collected and reared several hundred larvæ found on wild hydrangea. They hide among the leaves at the base of the bushes during the daytime. [The larvæ have been found also on various common compositæ by the Editor.]

851. **Estigmene acræa** Drury.

May 26–July 4; July 27–September 1. Common. The larva feeds on grasses and low vegetation generally.

854. **Estigmene congrua** Walker.

May 6–June 2; August 6–20. Common. The handsome larva of this species feeds on plantain, *Plantago major* Linnæus, and pupate under leaves upon the ground.

855. **Hyphantria cunea** Drury.

May 4–June 2; August 2–13. Common. The larva of this species has a broad greenish-yellow shade along the sides below the subdorsal line.

856. **Hyphantria textor** Harris.

June 14–July 7. Common. This and the preceding species are difficult to separate in the imago; the larvæ, however, differ and *textor* appears much later in the season, and is apparently single brooded.

859. **Isia isabella** Smith & Abbot.

May 14–July 3; July 22–August 23. Common. The larva feeds promiscuously on low vegetation.

860. **Phragmatobia fuliginosa** Linnæus.

July 3–August 15. Rare.

862. **Diacrisia virginica** Fabricius.

April 28–June 8; July 28–August 7. Common. The larva feeds promiscuously on grasses and herbaceous plants.

863. **Diacrisia latipennis** Stretch.

June 10–July 4. Common in wooded lands where it is freely taken at light.

874. **Apantesis virgo** Linnæus.

Pittsburgh, July 12–30 (Engel); New Brighton, July 5–29 (Merrick).

876. **Apantesis michabo** Grote.

May 2–19; August 6–28. Rare, but well distributed in this vicinity.

877. **Apantesis intermedia** Stretch.

Pittsburgh, August 25–September 11 (Engel & Marloff); New Brighton, August 25–September 8 (Merrick).. Larva on grasses and plantain.

880. **Apantesis anna** Grote.

Pittsburgh, June (Engel); New Brighton, June 25 (Merrick).

Var. **persephone** Grote.

June 2–18. Rather rare. Mr. B. Krautwurm has reared several specimens. Foodplant: plantain.

882. **Apantesis arge** Drury.

May 2–24; August 3–October 24. Common. Foodplants: grasses and plantain.

892. **Apantesis figurata** Drury.

Jeanette, May 25 (Klages); Charleroi (Ehrman); Pittsburgh, August 15 (Engel).

895. **Apantesis vittata** Fabricius.

May 6–13; August 27–September 13. Common. Foodplant: plantain.

——. **Apantesis phalerata** Harris.

May 18–June 10; July 31–September 25. The larvæ and adults of this species can be easily separated from *vittata*, and it should be listed as distinct. Foodplant: plantain.

905. **Ammalo tenera** Hübner.

June 5–26. Common.

910. **Euchætias egle** Drury.

June 28–July 20. Common. The larva is abundant on milk-weed.

911. **Euchætias oregonensis** Stretch.

Pittsburgh, June 11 (Marloff); May 28 (Krautwurm); Allegheny (Meyer).

919. **Halisidota tessellaris** Smith & Abbot.

June 4–July 23. Common. The moth in its season occurs abundantly on the blossoms of milkweed in the early evening, and the larva is a general feeder on deciduous plants.

922. **Halisidota maculata** Harris.

Pittsburgh, June 1, 1896 (Friday).

923. **Halisidota caryæ** Harris.

May 18–June 20. Common at light in extensive forests. The larvæ prefer hickory and walnut, but occur on numerous other plants.

Family AGARISTIDÆ.

949. **Alypia octomaculata** Fabricius.

May 25–June 19; July 2–August 5. Common. Foodplants: Virginia-creeper, wild and cultivated grape, and very common on Boston ivy (*Ampelopsis veitchi*).

Family NOCTUIDÆ.

Subfamily NOCTUINÆ.

961. **Demas propinquilinea** Grote.

New Brighton, April 12–24 (Merrick); Pittsburgh, April 20–26 (Krautwurm).

962. **Demas flavicornis** Smith.

New Brighton, April 24–May 6; July 23 (Merrick).

964. **Charadra deridens** Guenée.

April 29–May 20; July 4–August 5. Well distributed, but not abundant.

968. **Raphia frater** Grote.

New Brighton, July 6–August 6 (Merrick).

971. **Apatela rubricoma** Guenée.

May 13–22; July 18–26. Rare. Mr. Krautwurm has reared the larva on elm.

972. **Apatela americana** Harris.

May 18–June 17; July 19–27. Common. Foodplants: maple, linden, witch-hazel, oak, locust.

983. **Apatela populi** Riley.

May 24–June 12. Common. Larva feeds on species of poplar.

984. **Apatela lepusculina** Guenée.

July 23–August 14. Common. This form is very close to the preceding species, and may, if carefully worked out, prove to be the second brood of the same.

980. **Apatela morula** Grote.

New Brighton, July 26 (Merrick).

991. **Apatela interrupta** Guenée.

April 30–May 23; July 20–August 12. Common. Foodplant: hawthorn.

993. **Apatela lobeliæ** Guenée.

May 3–30; July, August. Common.

994. **Apatela furcifera** Guenée.

May 9–19; July 19–August 16. Common. The larva occurs on wild cherry.

995. **Apatela hasta** Guenée.

New Brighton, April 29–May 31 (Merrick).

999. **Apatela radcliffei** Harvey.

April 30–June 12; July 4–August 25. Rare.

1001. **Apatela spinigera** Guenée.

New Brighton, August 1 (Merrick); Pittsburgh (Krautwurm).

1002. **Apatela clarescens** Guenée.

May 5–30; July 19–27. Common.

1003. **Apatela hamamelis** Guenée.

May 25–July 26. Rare. Larva on witch-hazel.

1004. **Apatela superans** Guenée.

Pittsburgh, June 21 (Friday).

1005. **Apatela lithospila** Grote.

Pittsburgh, May 12–20 (Marloff & Krautwurm); Allegheny (Overbeck); New Brighton, May 5–25; August 27 (Merrick).

1008. **Apatela funeralis** Grote.

New Brighton, May 9; August 1 (Merrick); Allegheny (Meyer); Wilmerding (Zahrobsky).

1018. **Apatela afflicta** Grote.

May 6–June 19; August 18–25. Rare.

1025. **Apatela ovata** Grote.

June 6–26; August 1–19. Rare about Pittsburgh, but quite common at New Brighton.

1026. **Apatela brumosa** Guenée.

Allegheny (Lippold); New Brighton, July 13–26 (Merrick). Mr. Lippold bred his specimens from larvæ found on witch-hazel.

1027. **Apatela hæsitata** Grote.

Pittsburgh, May 14–22; July 10 (Engel & Marloff); New Brighton, May 4–June 3; July 7–9 (Merrick).

1028. **Apatela retardata** Walker.

Pittsburgh, July 23 (Krautwurm); New Brighton, May 5; July 5–14 (Merrick). Mr. Krautwurm reared the larva on maple.

1029. **Apatela sperata** Grote.

New Brighton, August 5, 1907 (Merrick).

1037. **Apatela xyliniformis** Guenée.

May 12–28; July 17–August 21. Common.

1039. **Apatela impleta** Walker.

New Brighton, April 24–May 8 (Merrick); Pittsburgh, May 2–10; July 20 (Engel & Marloff).

1041. **Apatela oblinita** Smith & Abbot.

April 30–June 1; July 21–August 19. Common. Foodplants: willow, smartweed.

1049. **Arsilonche albovenosa** Goeze.

April 28–May 19; July 25–August 18. Common. Foodplant: willow.

1054a. **Micrococelia obliterata** Grote.

May 15–June 25; August 1–15. Common.

1059. **Jaspidia teratophora** Herrich-Schaeffer.

May 19–June 27; July 18–August 7. Common.

1061. **Polygrammate hebraicum** Hübner.

May 20–July 29. Rare, but generally distributed.

1067. **Chytonix palliatricula** Guenée.

New Brighton, May 24–June 18 (Merrick); Pittsburgh, May 25 (Engel & Krautwurm).

1073. **Baileya ophthalmica** Guenée.

May 4–June 20. Common at rest on twigs of bushes in the forest.

1075. **Baileya doubledayi** Guenée.

New Brighton, May 6; July 5 (Merrick); Jeanette, July 30 (Klages).

1076. **Baileya dormitans** Guenée.

New Brighton, May 18–June 17 (Merrick). Rare.

1084. **Catabena lineolata** Walker.

Pittsburgh, May 28–June 6; August 23 (Engel).

1087. **Crambodes talidiformis** Guenée.

May 6–June 2; July 26–August 9. Common.

1088. **Platysenta videns** Guenée.

May 10–June 1; August 25–September 2. Common. At light and sugar.

1092. **Balsa malana** Fitch.

May 5–31; June 25–July 8. Common.

1093. **Balsa tristrigella** Walker.

May 24–June 20. Common in thickets at rest on saplings and wild grape-vines.

1094. **Balsa labecula** Grote.

New Brighton, May 18–June 3 (Merrick); Pittsburgh, May 12–29 (Engel & Marloff).

1100. **Anorthodes prima** Smith.

New Brighton, June 2, 1901 (Merrick); Swissvale (Knechtel). Prof. Smith determined this species and remarked it might probably prove to be *Caradrina tarda* Guenée.

1109. **Caradrina miranda** Grote.

May 12–June 7; July 23–August 17. Common. The larva probably feeds on grasses. I have found the cocoon attached to fence-rails lying about in pasture-fields.

1115. **Perigea xanthioides** Guenée.

May 26–July 26; August 16–October 20. Common.

1117. **Perigea vecors** Guenée.

April 30–May 23; July 20–October 20. Common.

1119. **Perigea sutor** Guenée.

Pittsburgh, October 12–20 (Engel & Marloff).

1136. **Oligia festivoides** Guenée.

May 24–July 17. Common locally.

1138. **Oligia versicolor** Grote.

New Brighton, June 6–July 19 (Merrick & Engel).

1141. **Oligia grata** Hübner.

May 2–June 15; August 2–October 17. Common.

1158. **Hadena modica** Guenée.

June 3–25; July 28–August 12. Common.

1159. **Hadena hausta** Grote.

June 1–July 7. Rare, but represented in nearly all local collections. Prof. Smith determined this species for Mr. Merrick. It is very similar to *Hadenella subjuncta* Smith, figured by Dr. Holland in his Moth Book, Plate XIX, fig. 25.

1165. **Hadena diversicolor** Morrison.

Pittsburgh, August 25–September 11 (Engel); New Brighton, September 23 (Merrick).

1166. **Hadena mactata** Guenée.

August 22–October 19. Rarely found at rest on the trees, but quite common at sugar.

1167. **Hadena turbulenta** Hübner.

Pittsburgh, July 14, 1907 (Friday).

1202. **Hadena miselioides** Guenée.

Ohio Pyle, August 25, 1907 (Kahl); Panther Hollow, Schenley Park, Pittsburgh (Holland).

1205a. **Hadena fractilinea** Grote.

July 17–August 25. Common and very variable.

1206. **Hadena misera** Grote.

Pittsburgh, July 11–August 3 (Marloff & Krautwurm); New Brighton, July 14–August 14 (Merrick); Swissvale (Knechtel).

1212. **Hadena passer** Guenée.

May 17–June 10; August 6–October 1. Common.

1217. **Hadena remissa** Hübner.

Pittsburgh, June 22, 1904 (Krautwurm); Wilmerding (Zahrobsky).

1220. **Hadena vultuosa** Grote.

Pittsburgh, July 12, 1905 (Marloff).

1221. **Hadena apamiformis** Guenée.

Pittsburgh, May 24–June 12 (Marloff, Engel, and Friday).

1224. **Hadena finitima** Guenée.

Pittsburgh, May 26–June 8, 1905 (Marloff).

1227. **Hadena dubitans** Walker.

June 4–8; August 20–31. Common.

1228. **Hadena plutonia** Grote.

Pittsburgh, May 30–June 10; July 18–24 (Engel, Marloff, Krautwurm). Rare. At sugar and occasionally at light.

1231. **Hadena impulsa** Guenée.

Pittsburgh (Krautwurm).

1232. **Hadena devastatrix** Brace.

July 27–August 29. Common. At sugar.

1235. **Hadena arctica** Boisduval.

June 20–August 3. Rare in late years.

1241. **Hadena verbascoides** Guenée.

Pittsburgh, June 13, 1905 (Engel).

1242. **Hadena nigrior** Smith.

Pittsburgh, June 13, 15 (Engel); New Brighton, June 6–24 (Merrick). Rare. A figure of this species appears in the Moth Book, Plate XIX, fig. 42. Dr. Dyar determined it as *sectilis* Guenée.

1243. **Hadena cariosa** Guenée.

Pittsburgh, June 6–21; August 7 (Marloff, Engel, Krautwurm); New Brighton, June 13–July 10 (Merrick). Rare. A boldly marked specimen in the Merrick collection was determined as *nigrior* by Prof. Smith, but it is a fine specimen of *cariosa*.

1250. **Hadena lignicolor** Guenée.

June 12–July 8; August 14–23. Common at sugar and at rest under stumps, loose boards, and fence-rails.

1278. **Hyppa xylinoides** Guenée.

May 6–June 8; August 11–September 12. Common.

1282. **Feralia jocosa** Guenée.

Pittsburgh, March 2–29 (Krautwurm, Engel); New Brighton, March 15–April 9 (Merrick, Engel). Rare. Under hemlock trees.

1288. **Euplexia lucipara** Linnæus.

April 27–May 30; July 19–27. Common. At light and sugar.

1290. **Dipterygia scabriuscula** Linnæus.

May 10–June 10; July 10–September 2. Common.

1291. **Actinotia ramosula** Guenée.

April 14–May 20; July 6–September 6. Common.

1295. **Pyrophila pyramidoides** Guenée.

July 19–28; August 27–October 29. Common. The larva feeds on various deciduous plants [and on rhododendron, to which it is very destructive, as I have found to my grief, *Editor*].

1297. **Heliotropha reniformis** Grote.

Pittsburgh, August 17 (Krautwurm).

1299. **Prodenia commelinæ** Smith & Abbot.

Pittsburgh, October 18–November 27 (Engel, Marloff, Krautwurm); Allegheny (Meyer).

1300. **Prodenia ornithogalli** Guenée.

August 7–November 1. Quite common in some years at sugar [and after dark on flowers of Compositæ, *Editor*].

Var. **eudiopta** Guenée.

Occurs with the typical form.

1302. **Laphygma frugiperda** Smith & Abbot.

August 20–October 28. The typical form, as well as the varieties, occurs at sugar and is quite common in some years.

1305. **Magusa dissidens** Felder.

Pittsburgh, October 10–17 (Marloff); New Brighton, October 20 (Merrick); Jeanette, October 11 (Klages). Rare at sugar and light.

1370. **Adita chionanthi** Smith & Abbot.

New Brighton, August 24 (Merrick); Coraopolis (Knechtel); Pittsburgh (Krautwurm).

1372. **Copipanolis cubilis** Grote.

March 27–April 23. Not rare in favorable seasons. The moth may be found clinging to dead weeds and twigs of bushes in the woods. It is a remarkably variable species, which it will be interesting to breed.

1375. **Eutolype rolandi** Grote.

Coraopolis (Knechtel); Allegheny, (Overbeck); New Brighton, May 8 (Merrick).

1376. **Eutolype bombyciformis** Smith.

New Brighton, April 18–May 3 (Merrick, Engel); Wilmerding (Foerster); Coraopolis (Knechtel). This species has been reared by the writer from the ova. Foodplant: hickory.

1377. **Eutolype grandis** Smith.

New Brighton, March 15–April 25, three specimens (Merrick); Coraopolis, (Knechtel).

1380. **Psaphidia grotei** Morrison.

Pittsburgh, April 16–26 (Krautwurm, Engel); New Brighton, April (Merrick, Engel). Newly emerged specimens are frequently found on ash, which may be its foodplant.

1381. **Psaphidia resumens** Walker.

April 15–May 7. Rare, but generally distributed in this vicinity. The larva probably feeds on maple.

1383. **Psaphidia thaxterianus** Grote.

March 12–27. Rare. Like the preceding species it occurs in the several localities covered by this list. The moth may be found on or near oak trees, which are its foodplant. Dr. Dyar reared the larva, and published a description of it. Jour. N. Y. Ent. Soc., IX, 84, 1901.

1391. **Rhynchagrotis brunneicollis** Grote.

New Brighton, June 25–July 8 (Merrick); Pittsburgh, June 25–July 17 (Engel, Marloff); Jeanette, October 2 (Knechtel).

1393. **Rhynchagrotis anchocelioides** Guenée.

Pittsburgh, July 5–September 2 (Marloff, Engel); New Brighton, July 10–August 6 (Merrick). Rare. At sugar and light.

1393a. Var. **brunneipennis** Grote.
Pittsburgh, September 10 (Marloff).

1397. **Rhynchagrotis alternata** Grote.
July 6–September 22. Common. At sugar and light.

1415. **Adelphagrotis prasina** Fabricius.
Pittsburgh, July 6 (Krautwurm); New Brighton, July 31 (Merrick); Jeanette, June (Klages); Wilmerding, two specimens (Zahrobsky).

1422. **Eueretagrotis sigmoides** Guenée.
New Brighton, June 26–July 11; August 3–17 (Merrick); Pittsburgh, July 28 (Krautwurm).

1428. **Semiophora tenebrifera** Walker.
Pittsburgh, April 19–29 (Engel, Marloff); Jeanette, April 16 (Klages); Coraopolis (Knechtel). Rare. At light and occasionally at sap of sugar maple.

1451. **Agrotis badinodis** Grote.
August 6–October 20. Common. At light and sugar.

1454. **Agrotis ypsilon** Rottemburg.
May 4–July 10; October 7–November 29. Common.

1455. **Agrotis geniculata** Grote & Robinson.
New Brighton, August 19–September 11 (Merrick); Pittsburgh, October 2 (Engel & Krautwurm); Swissvale, September 3 (Knechtel).

1467. **Peridroma margaritosa** Haworth.
October 3–29. Common and very variable.

1468. **Peridroma incivis** Guenée.
Pittsburgh, June 17; August 12–October 20 (Marloff, Krautwurm); New Brighton, July 8 (Merrick).

1475. **Noctua smithi** Snellen.
August 15–September 20. Common.

1476. **Noctua normaniana** Grote.
August 17–September 7. Common.

1478. **Noctua bicarnea** Guenée.
June 5–27; August 14–September 1. Common.

1481. **Noctua c-nigrum** Linnæus.
May 30–June 12; August 7–September 25. Common.

1489. **Noctua fennica** Tauscher.
Pittsburgh, August 12–September 11 (Marloff). Rare. At sugar.

1490. **Noctua plecta** Linnæus.
May 13–June 27; July 20–September 9. Common.

1496. **Noctua unicolor** Walker (*clandestina* Harris).
June 5–29; July 12–September 24. Common.

1514. **Noctua lubricans** Guenée.
August 16–October 2. Rare.

1558. **Feltia subgothica** Haworth.
August 22–September 15. Common.

1540. **Feltia jaculifera** Guenée.
August 2–September 8. Common.

1540a. Var. (?) **herilis** Grote.
July 26–September 16. Common. This form is very constant and classifying it as a variety of the preceding species appears erroneous to the writer.

1544. **Feltia gladiaria** Morrison.
Pittsburgh, September 10–27 (Engel, Marloff); New Brighton, September 22–27 (Merrick). In common with many other interesting moths this species may be collected at rest on the under side of the leaves of swaying lower branches along the margin of the woods during the evening hours. The writer has wondered on many occasions when lure was plentifully provided why these moths sit motionless for hours and were not tempted to partake of the repast provided for them. No doubt many collectors have waited in vain for their quarry and may find it profitable to investigate the branches of the trees within reach during the autumn evenings.

1545. **Feltia venerabilis** Walker.
September 12–29. Common.

1550. **Feltia annexa** Treitschke.
Pittsburgh, August 14–October 25 (Marloff, Krautwurm).

1552. **Porosagrotis vetusta** Walker.
New Brighton, September 29–October 3 (Merrick).

1599. **Paragrotis fumalis** Grote.
New Brighton, August 26–September 2; two specimens (Merrick).

1603. **Paragrotis velleripennis** Grote.
Pittsburgh, September 2–11 (Marloff, Engel, Krautwurm); New Brighton, September 5, 6 (Merrick).

1631. **Paragrotis bostoniensis** Grote.
September 3–October 17. Rare, but represented from all the localities.

1649. **Paragrotis messoria** Harris.
July 22–September 3. Well distributed, but not common.

1711. **Paragrotis tessellata** Harris.

New Brighton, July 12, 1903 (Merrick); Pittsburgh (Krautwurm, Marloff).

1753. **Anytus privatus** Walker.

New Brighton, September 18, 1907 (Engel). In Merrick Museum collection.

1781. **Mamestra meditata** Grote.

August 27–September 20. Common.

1783. **Mamestra detracta** Walker.

May 18–June 30. Common.

1785. **Mamestra distincta** Hübner.

April 21–May 18. Common. At rest on the trees in extensive forests.

1796. **Mamestra subjuncta** Grote & Robinson.

May 25–June 13; July 23–August 12. Common.

1800. **Mamestra grandis** Boisduval.

May 30–June 15. Local captures of this handsome species are in most of the collections, but it is rare.

1801. **Mamestra trifolii** Rottemburg.

New Brighton, May 17–September 29 (Merrick).

1803. **Mamestra rosea** Harvey.

May 16–July 1; August 17–22. Rare.

1805. **Mamestra congermana** Morrison.

New Brighton, May 30–June 13 (Merrick); Pittsburgh, June 28 (Engel). In Engel collection, Carnegie Museum.

This form was determined by Prof. Smith for Mr. Merrick. In the writer's opinion it is not *congermana*. The three specimens seen are constant, smaller in expanse and of a much deeper color than in the last-named species.

1807. **Mamestra picta** Harris.

May 2–June 8; August 12–28. Common. The larva feeds promiscuously on low vegetation.

1810. **Mamestra latex** Guenée.

May 18–June 25. Common.

1812. **Mamestra adjuncta** Boisduval.

May 6–June 2; July 19–August 22. Common. The larva is abundant on the white snake-root and feeds on other herbaceous plants.

1822. **Mamestra legitima** Grote.

June 20–August 7. Rare, but well distributed.

1825. **Mamestra goodelli** Grote.

New Brighton, May 31–July 24 (Merrick); Pittsburgh, August 22 (Marloff). Rare.

1828. **Mamestra ectypa** Morrison.

New Brighton, July 11–August 30 (Merrick). Rare.

1829. **Mamestra renigera** Stephens.

May 19–July 2; August 14–October 5. Common.

1837. **Mamestra laudabilis** Guenée.

New Brighton, September 1–26 (Merrick); Wilmerding (Zahrobsky).

1842. **Mamestra lorea** Guenée.

June 2–25; July 20–August 18. Common.

1845. **Mamestra anguina** Grote.

New Brighton, May 18–June 2 (Merrick). Rare.

1850. **Mamestra vicina** Grote.

Pittsburgh, September 1–22 (Marloff, Engel). Rare.

1885. **Morrisonia sectilis** Guenée.

April 30–May 11. Rare. The variety **vomerina** Grote occurs with the typical form.

1890. **Morrisonia confusa** Hübner.

April 27–May 20. Common in forests at rest on the trees and hiding under stumps.

1950. **Nephelodes minians** Guenée.

August 28–September 26. Common.

1953. **Heliophila unipuncta** Haworth.

May 20–June 30; August 6–October 20. Common.

1954. **Heliophila pseudargyria** Guenée.

May 15–June 18; August 6–17; September 23–October 20. Common. The form occurring in midsummer is much larger, more robust, and generally darker, the primaries being obscurely brownish.

1963. **Heliophila albilinea** Hübner.

May 6–June 7; July 23–August 18. Common.

1978. **Heliophila multilinea** Walker.

Pittsburgh, May 25–June 17; August 18–November 4 (Engel, Marloff); New Brighton, June 4, August 24 (Merrick).

1979. **Heliophila commoides** Guenée.

Pittsburgh, August 17–26. Several specimens (Engel, Marloff).

1980. **Heliophila phragmitidicola** Guenée.

June 4–28; August 2–October 7. Common.

1996. **Orthodes crenulata** Butler.

May 10–June 18; August 10–October 2. Common.

1997. **Orthodes cynica** Guenée.

May 20–June 27; July 25–August 17. Common.

1998. **Orthodes vecors** Guenée.

May 10–27; August 7–21. Common.

2007. **Himella intractata** Morrison.

Pittsburgh, April 25 (Marloff); New Brighton, April 30 (Merrick).

2009. **Crocigrapha normani** Grote.

April 11–May. Common at sugar and at rest under stumps and fence-rails.

2012. **Graphiphora culea** Guenée.

May 11–June 15. Rare, but local specimens are in all the collections examined.

2015. **Graphiphora oviduca** Guenée.

Pittsburgh, May 29–June 8 (Marloff, Engel); New Brighton, May 18, 1907 (Merrick).

2040. **Graphiphora alia** Guenée.

March 15–April 30. Common.

2042. **Graphiphora rubrescens** Walker.

New Brighton, April 20–May 2. Two specimens (Merrick).

2043. **Graphiphora subterminata** Smith.

Wilmerding (Zahrobsky). One specimen presented to the Carnegie Museum.

2044. **Graphiphora garmani** Grote.

April 12–29. Rare, but generally distributed in this vicinity.

2060. **Tricholita signata** Walker.

August 9–28. Occasionally taken at flowers, and very common at light in forests.

2078. **Xylina disposita** Morrison.

Pittsburgh, October 20–25 (Engel, Marloff, Krautwurm). Three specimens.

2090. **Xylina antennata** Walker.

October 4–January 2; March, April. Common.

2091. **Xylina laticinerea** Grote.

Pittsburgh, October 16–January 2; March, April (Engel, Marloff, Krautwurm).

2092. **Xylina grotei** Riley.

Pittsburgh, October 19–November 20; April (Engel & Marloff). Rare.

2093. **Xylina ferrealis** Grote.

Pittsburgh, October 4–November 20 (Marloff, Engel, Krautwurm). Rare.

2094. **Xylina signosa** Walker.

Pittsburgh, October 2–November 20 (Marloff). Rare.

2095. **Xylina innominata** Smith.

Pittsburgh, October 20–November 20; March, April (Engel, Marloff). Rare. New Brighton, October 3–November 15 (Merrick).

2097. **Xylina bethunei** Grote & Robinson.

October 1–January 2; March, April. Rare, but taken by nearly all the collectors.

2098. **Xylina oriunda** Grote.

Pittsburgh, October 8. One fine specimen (Engel).

2105. **Xylina viridipallens** Grote.

Pittsburgh, November 14, 1902 (Marloff); March 29, 1905 (Engel); New Brighton, October 8, 1905 (Merrick).

——. **Xylina nigrescens** Engel.

Pittsburgh, October 18–November 20 (Engel, Marloff); New Brighton, October 19 (Merrick).

2106. **Xylina unimoda** Lintner.

October 16–January 2; March, April. Common.

2107. **Xylina tepida** Grote.

Pittsburgh, October 17. One specimen (Engel).

2109. **Xylina querquera** Grote.

Pittsburgh, October 20 (Engel); New Brighton, April 12 (Merrick).

2112. **Xylina pexata** Grote.

Pittsburgh, October 2–November 8 (Engel & Marloff).

2121. **Calocampa curvimacula** Morrison.

Pittsburgh, October 12–November 2; March 25 (Marloff, Engel, Krautwurm); Allegheny, October (Meyer).

2122. **Cucullia convexipennis** Grote & Robinson.

July 26–September 5. Fairly common some years on blossoms of *Saponaria* during the evening hours. Mr. Krautwurm and the writer have reared the larva on wild aster.

2127. **Cucullia asteroides** Guenée.

May 10–17; July 21–August 31. Common. The early specimens frequent lilac, and the summer brood is abundant on *Saponaria*.

2131. **Cucullia speyeri** Lintner.

Pittsburgh, May 31–June 10; July 20–August 10 (Engel & Marloff). The imago is quite common some years and has the same habits as the preceding species.

2133. **Cucullia cinderella** Smith.

Pittsburgh, July 20, 1899, taken on *Saponaria* (Engel). In Engel Collection, Carnegie Museum.

2149. **Sphida obliqua** Walker.

New Brighton, May 29 (Merrick).

2150. **Nonagria oblonga** Grote.

New Brighton, September 26 (Merrick).

2158. **Achatodes zeæ** Harris.

July 3–August 2. Common. The larva is common in the new growth of elder.

2161. **Gortyna velata** Walker.

June 12–July 17. Common. The moth frequents the blossoms of milkweed after dusk.

2162. **Gortyna nictitans** Borkhausen.

August 12–September 14. Common and variable.

2166. **Gortyna stramentosa** Guenée.

New Brighton, September 19–23. Two specimens (Merrick).

2172. **Papaipema inquæsita** Grote & Robinson.

New Brighton, September 3–October 6 (Merrick); Wilmerding (Zahrobsky).

2174. **Papaipema rigida** Grote.

New Brighton, September 26–October 10 (Merrick); Pittsburgh, October 6 (Friday); Wilmerding, two specimens (Foerster).

——. **Papaipema merriccata** Bird.

September 15–October 19. Common. The larva feeds in the roots of May-apple.

2178. **Papaipema purpurifascia** Grote & Robinson.

September 16–October 11. Rare. Foodplant: columbine. A smaller form, bred from loosestrife (*Ludwigia*) by Mr. Bird, is commoner. Mr. Krautwurm reared this form from branches of burdock.

2179. **Papaipema nitela** Guenée.

September 3–October 24. This and the form **nebris** Guenée are very common. The preferred foodplant is *Ambrosia trifida* Linnæus, but it infests numerous other plants. The writer has observed the larva in new growth of ornamental shrubs.

——. **Papaipema eupatorii** Lyman.

New Brighton, September 15–October 5 (Merrick, Bird, Engel).

A few specimens occurred at light and several dozen were bred from *Eupatorium purpureum*. The moth is variable in expanse of wings.

2180. **Papaipema nelita** Strecker.

New Brighton, September 11–22 (Merrick, Bird, Engel); Pitts burgh September 19 (Engel). Foodplant: cone-flower (*Rudbeckia*).

2181. **Papaipema necopina** Grote.

New Brighton, September 27 (Merrick); Jeannette, October 11 (Klages).

——. **Papaipema imperturbata** Bird.

Pittsburgh, September 29–October 18 (Engel). Foodplant: sunflower.

2183. **Papaipema cerrusata** Grote & Robinson.

September 1–October 7. Common. The larva is plentiful in ironweed, and is exceptionally free from parasites. Two specimens in the Merrick Museum Collection with concolorous stigmata were reared by the writer.

2184. **Papaipema frigida** Smith.

New Brighton, September 20–October 9 (Merrick, Bird, Engel). A few specimens taken at light and several dozen bred from the roots of meadow rue, *Thalictrum polygamum* Muhl. The form *thalictri* Lyman occurs in about equal proportion with the typical form.

2187. **Papaipema cataphracta** Grote.

September 27–October 23. Common. Foodplants: burdock and numerous other plants.

2188. **Papaipema impecuniosa** Grote.

September 3–October 10. Common.

2189. **Papaipema circumlucens** Smith.

New Brighton, August 4–September 25 (Merrick); Pittsburgh, September 1–3 (Friday, Marloff).

2192. **Papaipema marginidens** Guenée.

September 27–October 9. Not common, but generally distributed. Foodplant: wild parsnips.

2193. **Papaipema furcata** Smith.

New Brighton, October 23 (Merrick); Pittsburgh (Marloff); Jeannette, September 2 (Klages).

2197. **Pyrrhia umbra** Hüfnagel.

May 23–June 15; August 10–September 12. Rather rare, but represented in most of the collections.

2202. **Jodia rufago** Hübner.

Pittsburgh, November 20–October 20 (Marloff) at sugar; New Brighton, March 27 (Merrick).

2203. **Brotolomia iris** Guenée.

Pittsburgh, May 23–June 5 (Engel, Marloff); New Brighton, May 24–June 18 (Merrick).

2204. **Trigonaphora periculosa** Guenée.

August 26–31.

Var. **v-brunneum** Grote.

August 22–September 11. Both forms are rare in this vicinity.

2206. **Eucirrœdia pampina** Guenée.

September 16–October 10. Common at sugar and clinging to dead weeds.

2207. **Scoliopteryx libatrix** Linnæus.

July 24–August 20. Common. Mr. Lippold reared the larva on willow. Hibernating specimens were collected during the winter in the entrance to a coal-mine by Mr. Marloff and the writer.

2208. **Chœphora fungorum** Grote & Robinson.

September 4–October 5. Rare, but well distributed.

2211. **Anchocelis digitalis** Grote.

New Brighton, October 9 (Merrick).

2221. **Orthosia ralla** Grote & Robinson.

September 12–22. Rare, but represented from the different localities covered by this list. The moth occurs at sugar, and clinging to dead leaves of weeds in forests.

2222. **Orthosia bicolorago** Guenée.

October 3 – November 20. Common.

2230. **Orthosia helva** Grote.

August 25–September 9. Fairly common.

2231. **Orthosia lutosa** Andrews.

Pittsburgh, July 3–18 (Marloff & Engel).

2236. **Scopelosoma indirecta** Walker.

Pittsburgh, October 21–November 14; March 19–April 7 (Engel & Marloff); New Brighton, October 15–28 (Merrick). The moth may be found clinging to, or hiding in the dead leaves of weeds, a habit common to the species of the genus. It occurs at sugar, but is quite rare in this vicinity.

2237. **Scopelosoma moffatiana** Grote.

October 12–December 2; March, April. Common. The larva feeds on witch-hazel, and may be found on the lower branches of these shrubs.

2238. **Scopelosoma pettiti** Grote.

Pittsburgh, October 26–November 8 ; April 20–24 (Engel, Marloff) ; Swissvale (Knechtel) ; New Brighton, April (Merrick). Rare. At sugar.

2240. **Scopelosoma tristigmata** Grote.

October 16–December 2 ; March, April. Fairly common and generally distributed. The writer has reared the larva on wild cherry.

2241. **Scopelosoma walkeri** Grote.

October 4 to the end of April. Fairly common.. This form is figured in the Proc. Ent. Soc. Philad., Vol. II, Plate IX, fig. 5, and *vinulenta* Grote, same Plate, fig. 6. The figure of *walkeri* evidently was drawn from a specimen taken after hibernation when its color had faded. This is a common characteristic of the genus. Specimens captured in April would scarcely be recognized when placed with perfectly fresh material. In fresh specimens of *walkeri* the ground is as deep reddish-brown as in *sidus*, although variable in both forms. The structure and distinctness of the transverse lines is variable, while the reniform in *walkeri* is always centered by a large round spot ranging from pale ochreous to pure white. In *sidus* Guenée (*vinulenta* Grote) a semicircular white spot appears in the reniform in most specimens, while in others this spot is orange or ochreous.

2242. **Scopelosoma sidus** Guenée.

October 12–April. Common at sugar. The larva has been reared by the writer on wild cherry.

2243. **Scopelosoma morrisoni** Grote.

October 10–April. Common. Foodplants: oak, elm, wild cherry.

2244. **Scopelosoma devia** Grote.

Pittsburgh, October 5–January 2 ; March, April (Engel, Marloff, Krautwurm). Fairly common at sugar and the sap of the sugar-maple.

2246. **Glæa viatica** Grote.

Pittsburgh, October 12–23, three specimens (Marloff, Engel).

2247. **Glæa inulta** Grote.

October 4–29. Not common, but taken generally in this locality.

2248. **Glæa olivata** Harvey.

Pittsburgh, October 19–November 20 ; March 31–April 2 (Engel, Marloff). Rare. At sugar.

2249. **Glæa sericea** Morrison.

September 25–October 25. Local captures of this species are represented in all the collections, but it is quite rare.

2250. **Glæa signata** French.

Pittsburgh, November 14 (Marloff). This species is figured in the Moth Book, Plate XXVI, fig. 40, under *Epiglæa decliva* Grote. The true *decliva* determined for me by Prof. Smith and Dr. Dyar is quite different. A number of specimens of *signata* have the subterminal space overlaid with pale ochreous.

2255. **Epiglæa decliva** Grote.

Pittsburgh, October 8–29 (Engel, Marloff). Rare. At sugar.

2259. **Calymnia orina** Guenée.

July 7–27. This and the form *calami* Harvey occur in the several localities, but are quite rare.

2261. **Ipimorpha pleonectusa** Grote.

Pittsburgh, July 20 (Marloff), one specimen; New Brighton, August 10–September 5, two specimens (Merrick).

2267. **Atethmia rectifascia** Grote.

New Brighton, July 29 (Merrick).

2296. **Chloridea virescens** Fabricius.

Pittsburgh, July 7–21 (Engel); New Brighton, June 20–October 12 (Merrick); Wilmerding (Foerster). Bred from larva feeding on the green seed-capsules of columbine (Engel).

2300. **Heliothis armiger** Hübner.

August 24–October 18. Common in some years. The larva is quite injurious to the green ears of corn, and to tomatoes.

2307. **Rhodophora florida** Guenée.

June 10–July 30; August 16. Generally distributed, but not abundant. The moth occurs in the blossoms of evening primrose.

2332. **Schinia trifascia** Hübner.

Pittsburgh, August 12–18 (Engel); New Brighton, July 31–August 26 (Merrick). Rare.

2339. **Schinia nundina** Drury.

Pittsburgh, August 15–27 (Engel); New Brighton, August 21 (Merrick).

2346. **Schinia lynx** Guenée.

June 4–13; August 5–17. Rare, but generally distributed.

2354. **Schinia arcigera** Guenée.

July 30–August 30. Fairly common.

2360. **Schinia thoreaui** Grote & Robinson.
August 8–September 26. Common at light.
2361. **Schinia marginata** Haworth.
July 23–September 6. Very common at light, and flying about in pasture-fields in the daytime.
2366. **Schinia brevis** Grote.
Allegheny, October 20, 1902 (Overbeck).
2427. **Psychomorpha epimenis** Drury.
April 18–24. Occasionally found on the wing or at blossoms on warm spring days. The Messrs. Krautwurm and Lippold have reared the larvæ on wild grape.
2428. **Euthisanotia unio** Hübner.
July 3–20. Rare at light.
2430. **Euthisanotia grata** Fabricius.
June 25–July 25. Common at light in forests. Foodplant: wild grape.
2437. **Cirrhophanus triangulifer** Grote.
New Brighton, August 23–30, three specimens (Merrick).
2443. **Basilodes pepita** Guenée.
June 1–August 22. Represented in nearly all collections, very rare.
2448. **Stiria rugifrons** Grote.
Ohio Pyle, July 31–August 3, two specimens (Kahl & Klages).
2456. **Plagiomimicus pityochromus** Grote.
August 1–24. Generally distributed and common at light in pasture-lands.
2464. **Plusiodonta compressipalpis** Guenée.
May 24–30; August 21–September 23. Common. At sugar and light.
2467. **Calpe canadensis** Bethune.
June 20–29; August 3–30. Generally distributed, but rare in this vicinity.
2469. **Panchrysia purpurigera** Walker.
New Brighton, July 10–28 (Merrick).
2474. **Plusia ærea** Hübner.
June 13–29; July 23–September 13. Common at various flowers.
3476. **Plusia balluca** Geyer.
July 26–August 12. Rare. At flowers of *Saponaria*.
2481. **Eosphoropteryx thyatyroides** Guenée.
June 15–July 8; August 24–October 3. This beautiful moth is

represented in nearly all the collections. It is rare about Pittsburgh, but has occurred quite freely in the traps set by Mr. Merrick in a forest near New Brighton.

2485. **Autographa biloba** Stephens.

Pittsburgh, May 20 (Marloff); New Brighton, October 2 (Merrick); Wildmerding (Zahrobsky); Jeannette (Klages).

2487. **Autographa rogationis** Guenée.

New Brighton, September 28–August 12 (Merrick); Jeannette, October 11 (Klages); Pittsburgh, September 27 (Marloff).

2488. **Autographa precationis** Guenée.

April 30–June 28; July 24–September 6. Common.

2496. **Autographa brassicæ** Riley.

July 1–7; September 15–25. Generally distributed, but rare. Mr. Knechtel reared the larvæ on cabbage and lettuce.

2498. **Autographa oxygramma** Geyer.

Swissvale, September 3 (Knechtel); New Brighton, September 27 (Merrick).

2505. **Autographa rectangula** Kirby.

Jeannette, one specimen (Knechtel).

2517. **Autographa ampla** Walker.

Ohio Pyle, July 31, 1905 (Kahl & Klages).

2518. **Autographa basigera** Walker.

Pittsburgh, July 27 (Engel); New Brighton, September 27 (Merrick); Wilmerding (Zahrobsky).

2519. **Autographa falcifera** Kirby.

May 11–23. Common.

Var. **simplex** Guenée.

July 24–September 13. Common at various flowers.

2536. **Abrostola urentis** Guenée.

New Brighton, June 7; August 9–27 (Merrick).

2540. **Ogdoconta cinereola** Guenée.

May 26–June 22; July 23–August 13. Common.

2545. **Pæctes abrostoloides** Guenée.

Pittsburgh, June 13–20 (Marloff, Engel).

2548. **Pæctes oculatrix** Guenée.

New Brighton, July 25 (Merrick); Pittsburgh, August 8 (Marloff); Swissvale (Knechtel).

2551. **Marasmalus inficita** Walker.

Pittsburgh, June 23; July 27–September 27 (Marloff, Engel); New Brighton, August 5 (Merrick).

2552. **Marasmalus ventilator** Grote.

Pittsburgh, May 10–20 (Marloff, Krautwurm). Rare. At sugar.

2553. **Amyna octo** Guenée (*orbica* Morrison).

Jeannette, October 11 (Klages). A variable species. Seven specimens in Carnegie Museum.

2554. **Pteraetholix bullula** Grote.

Jeannette, October 11 (Klages). In Carnegie Museum Collection.

2555. **Alabama argillacea** Hübner.

September 29–October 17. Common at sugar and light.

2556. **Anomis erosa** Hübner.

Pittsburgh, September 29–October 18 (Marloff, Engel, Krautwurm); New Brighton, September 28–October 12 (Merrick); Jeannette, October 11 (Klages).

2560. **Scolecocampa liburna** Geyer.

July 3–August 23. Rare, but generally distributed.

2567. **Amolita fessa** Grote.

Pittsburgh, July 12 (Engel); New Brighton, July 3–20 (Merrick).

2568. **Rivula propinqualis** Guenée.

June 6–26; August 12–23. Common at light and among the herbage in waste lands.

2600. **Eustrotia malaca** Grote.

Pittsburgh, September 6, 1907 (Kahl). One specimen in Carnegie Museum Collection.

2601. **Eustrotia albidula** Guenée.

Pittsburgh, July 1 (Engel); New Brighton, June 16–July 15 (Merrick & Engel). Rare. At light and among the herbage in forests.

2604. **Eustrotia concinnimacula** Guenée.

Pittsburgh, April 24–May 17 (Marloff, Krautwurm); New Brighton, May 14 (Merrick).

2605. **Eustrotia synochitis** Grote & Robinson.

May 5–June 29. Fairly common at light and at rest on saplings in thickets.

2606. **Eustrotia musta** Grote & Robinson.

July 10; August 14–29. Generally distributed, but rare.

2607. **Eustrotia muscosula** Guenée.

May 19–June 24; August 16–October 24. Common.

2612. **Eustrotia apicosa** Haworth.

May 12–July 4; July 24–September 2. Common.

2613. **Eustrotia carneola** Guenée.

May 12–June 28; July 14–September 7. Common.

2616. **Eustrotia æria** Grote.

New Brighton, June 22–July 15 (Merrick); Jeannette, August 6 (Klages); Coraopolis, July 9, 1902 (H. H. Smith).

——. **Eustrotia immuna** Smith.

New Brighton, July 21–August 18 (Merrick). Rare in traps in forest.

——. **Eustrotia puncticosta** Smith.

New Brighton, July 20–August 27 (Merrick); Pittsburgh, July 10–August 15 (Marloff).

——. **Eustrotia humerata** Smith.

New Brighon, July 1–August 25 (Merrick); Ohio Pyle, July 22–August 7 (Kahl & Klages).

2618. **Galgula hepara** Guenée.

May 5–12; July 27–October 20. Common. The variety **partita** Guenée occurs with the typical form.

2624. **Prothymia semipurpurea** Walker.

Pittsburgh, May 18–25 (Marloff, Engel); New Brighton, May 19–28; July 24 (Merrick).

——. **Thalpochares fractilinea** Smith.

New Brighton, June 12–19; July 29–August 20 (Merrick); Pittsburgh, June 12, September 23 (Engel); Jeannette, May 29 (Klages).

2653. **Metoponia obtusa** Herrich-Schaeffer.

Pittsburgh, June 13–July 11; July 23–August 17 (Engel, Marloff); New Brighton, June 20–July 9 (Merrick).

2656. **Chamyris cerintha** Treitschke.

May 5–June 16; July 6–19. Common.

2674. **Tarache aprica** Hübner.

Pittsburgh, June 1, August 4 (Engel, Marloff), several specimens. [Used to be very common in the Allegheny Cemetery, Pittsburgh. *Editor.*]

2676. **Tarache erastrioides** Guenée.

May 4–June 6; July 9–August 23. Common.

2691. **Tarache candefacta** Hübner.

May 12–June 4; July 17–August 27. Common.

2702. **Spragueia onagrus** Guenée.

Pittsburgh, June 4–24; July 24–September 1. Fairly common at light. [Have found it abundant on flowers of golden-rod (*Solidago*) in the daytime. *Editor.*]

2715. **Metathorasa monetifera** Guenée.

Allegheny, July 1, 1899 (Glasser). In Merrick collection.

2716. **Euherrichia mollissima** Guenée.

New Brighton, May 18, August 6 (Merrick); Wilmerding, two specimens (Zahrobsky, Foerster).

2724. **Phalænostola larentioides** Grote.

June 10–28; August 11–September 19. Generally distributed, but not common.

2725. **Pangrapta decoralis** Hübner.

May 22–June 20; October 11. Rare about Pittsburgh, but commoner at New Brighton.

2727. **Hyamia sexpunctata** Grote.

Pittsburgh, June 8–15 (Engel, Marloff); New Brighton, June 4–July 18 (Merrick); Jeannette, August 6 (Klages).

2728. **Hyamia perditalis** Walker.

New Brighton, July 3–12 (Merrick).

2730. **Melanomma auricinctaria** Grote.

New Brighton, August 12–18 (Merrick); Swissvale (Knechtel).

2733. **Homopyralis discalis** Grote.

May 29–June 17; August 7–23. Generally distributed, but rare.

2734. **Homopyralis contracta** Walker.

May 20–June 7; July 19–August 25. Common at light and sugar.

2739. **Isogona natatrix** Guenée.

Pittsburgh, May 22–June 8 (Engel, Friday, Krautwurm). Rare at sugar.

2740. **Hypsoropha monilis** Fabricius.

Pittsburgh, July 5 (Krautwurm).

2741. **Hypsoropha hormos** Hübner.

Pittsburgh, June 10.

2743. **Cissura spadix** Cramer.

Pittsburgh, March 26, 27, three specimens at sugar (Marloff).

Subfamily CATOCALINÆ.

2754. **Drasteria erechtea** Cramer.

April 23–May 7; June 30–September 12. Common.

2755. **Drasteria crassiuscula** Haworth.

June 18–July 12; August 25–30. Rare.

2758. **Cænurgia convalescens** Guenée.

Pittsburgh, October 15 (Marloff). One male at sugar.

2760. **Euclidia cuspidea** Hübner.

May 19–June 10; July 14–22. Rather rare, but represented in most of the collections.

2766. **Melipotis nigrescens** Grote & Robinson.

Pittsburgh, June 5 (Marloff).

2769. **Melipotis limbolaris** Geyer.

New Brighton, July 11–August 11, three specimens (Merrick); Pittsburgh, July (Krautwurm).

2806. **Catocala epione** Drury.

June 28–August 30. Common. At rest on the branches and trunks of crab-apple-trees and large hawthorn bushes.

2810. **Catocala lacrymosa** Guenée.

Pittsburgh, July 18–24 (Marloff); Wilmerding (Zahrobsky); New Brighton, July 6–September 23 (Merrick). The varieties **ulalume, paulina,** and **zelica** are represented among the New Brighton material.

2811. **Catocala viduata** Guenée.

New Brighton, July 7 (Merrick).

2813. **Catocala vidua** Smith & Abbot.

August 23–October 5. Common.

2814. **Catocala dejecta** Strecker.

Pittsburgh, July, two specimens (Engel); New Brighton, July 20 (Merrick).

2815. **Catocala retecta** Grote.

July 24–August 18. Rare.

Var. **luctuosa** Hulst.

New Brighton, August 20 (Merrick).

2816. **Catocala flebilis** Grote.

July 22–August 23. Common.

2817. **Catocala robinsoni** Grote.

August 27–September 23. Common.

2819. **Catocala obscura** Strecker.

July 15–August 3. Common.

Var. **simulatilis** Grote.

August 4–14. Rare.

2820. **Catocala residua** Grote.

July 28–August 10. Rare.

2821. **Catocala insolabilis** Guenée.

July 9–22. Rare.

2822. **Catocala angusi** Grote.

Pittsburgh, June 13–August 7 (Engel & Marloff).

Var. **lucetta** Hy. Edwards.

New Brighton, August 11–September 13 (Merrick).

2823. **Catocala judith** Strecker.
July 18–27. Rare.

2824. **Catocala tristis** Edwards.
New Brighton, August 4 (Merrick), one specimen.

2826. **Catocala relicta** Walker.
August 26–September 21. Rare.

2827. **Catocala cara** Guenée.
July 25–October 12. Common.

2828. **Catocala amatrix** Hübner.
August 10–30. Common. The variety **nurus** Walker occurs equally commonly.

2829. **Catocala marmorata** Edwards.
New Brighton, August 20 (Merrick), one specimen.

2830. **Catocala concumbens** Walker.
Pittsburgh, August 10–15, three specimens (Friday); Aspinwall (Lippold).

2848. **Catocala unijuga** Walker.
August 7–September 12. Rare.

2857. **Catocala parta** Guenée.
July 4–28. Rare.

2858. **Catocala coccinata** Grote.
Pittsburgh, July 5, 6 (Engel); New Brighton, July 3–18 (Merrick). Rare.

2864. **Catocala ultronia** Hübner.
July 4–29. Common.
Var. **celia** Hy. Edwards.
New Brighton, August 2 (Merrick).
Var. **mopsa** Hy. Edwards.
New Brighton, August 21–27 (Merrick).

2865. **Catocala ilia** Cramer.
July 3–28. Common.
Var. **uxor** Guenée.
June 29–July 17. Rare.

2866. **Catocala innubens** Guenée.
July 8–27. Rare.
Var. **hinda** French.
New Brighton, July 22, August 1 (Merrick).
Var. **scintillans** Grote.
New Brighton, August (Merrick); Pittsburgh, July 7–August 4 (Friday, Krautwurm).

2867. **Catocala nebulosa** Edwards.
July 2–August 16. Rare.

2868. **Catocala piatrix** Grote.
August 20–October 20. Common. The larva occurs on walnut.

2870. **Catocala neogama** Smith & Abbot.
July 12–August 19. Common.

2871. **Catocala subnata** Grote.
Pittsburgh, July 6–August 2 (Engel, Marloff); New Brighton, July 9–August 7 (Merrick).

2872. **Catocala cerogama** Guenée.
July 23–October 8. Common.

2873. **Catocala palæogama** Guenée.
July 5–August 6. Common.
Var. **phalanga** Grote.
Occurs with the typical form.

2882. **Catocala serene** Edwards.
July 18–August 1. Rare.

2884. **Catocala antinympha** Hübner.
Pittsburgh, August (Krautwurm, Friday).

2887. **Catocala habilis** Grote.
August 4–October 10. Common.

2892. **Catocala polygama** Guenée.
July 10–29. Rare.

2894. **Catocala amasia** Smith & Abbot.
Pittsburgh, May (Krautwurm); New Brighton, July 28 (Merrick).

2902. **Catocala grynea** Cramer.
July 9–August 13. Common.

2907. **Catocala amica** Hübner.
June 28–July 21. Common and variable.

2909. **Allotria elonympha** Hübner.
May 17–June 23; July 3–August 13. Rare but generally distributed.

2911. **Euparthenos nubilis** Hübner.
May 14–June 23; July 3–August 13. Common.

2912. **Hypocala andremona** Cramer.
Pittsburgh, August 4–October 10 (Marloff, Engel, Krautwurm); Allegheny, October (Meyer). Rare at sugar and one specimen taken on flowers of *Saponaria*.

2915. **Phoberia atomaria** Hübner.
April 17–May 14. Common in forests.

2919. **Palindia merricki** Holland.

New Brighton, August 5, 1900 (Merrick).

2920. **Panapoda rufimargo** Hübner.

June 6–July 16.

Var. **carneicosta** Guenée.

June 5–August 3.

Var. **roseicosta** Guenée.

June 17–August 25. The several forms occur at sugar and are quite common.

2921. **Parallelia bistriaris** Hübner.

May 10–26; July 12–September 4. Common.

2922. **Agnomonia anilis** Drury.

Pittsburgh, July 2–15 (Engel, Marloff, Krautwurm); Allegheny (Lippold); New Brighton, July 15–18 (Merrick).

2923. **Remigia repanda** Fabricius.

October 4–20. Common.

2943. **Phurys lima** Guenée.

New Brighton, July 13 (Merrick); Aspinwall, August 5 (Lippold).

2946. **Celiptera frustulum** Guenée.

May 15–June 5; July 6–September 6. Common.

2948. **Anticarsia gemmatilis** Hübner.

Pittsburgh, October 2–21 (Engel, Marloff); New Brighton, September 30–October 22 (Merrick); Jeannette, October 11 (Klages). A very variable species.

2950. **Antiblemma inexacta** Walker.

Pittsburgh, June 19 (Friday); New Brighton, June 23 (Merrick).

——. **Massala obvertens** Walker.

Pittsburgh, August 3, 1904 (Geo. Krautwurm).

2953. **Strenoloma lunilinea** Grote.

July 17–29; August 9–September 25. Rather rare in this vicinity.

2977. **Zale horrida** Hübner.

May 4–18. Rare.

2979. **Phæocyma lunifera** Hübner.

Pittsburgh, April 12–May 14 (Marloff, Engel); New Brighton, April 19–May 4 (Merrick).

2983. **Ypsia undularis** Drury.

May 3–June 12; July 5–31. Common and variable.

2986. **Homoptera lunata** Drury.

April 2–May; July, August, October 5–29. Common and very variable.

2987. **Homoptera nigricans** Bethune.

New Brighton, May 17 (Merrick); A variety of 2983 with the transverse lines edged with greenish-blue.

2991. **Homoptera calycanthata** Smith & Abbot.

April 14–May 10. Rare. This form is very similar to 2979.

2992. **Homoptera cingulifera** Walker.

Pittsburgh, April 10–May 7 (Engel, Marloff, Krautwurm); New Brighton, April 7–20 (Merrick).

2994. **Homoptera albofasciata** Bethune.

April 29–May 16. Rare. This form is similar to the banded variety of *lunata*, but much smaller. The late Dr. Strecker determined the species.

3000. **Homoptera unilineata** Grote.

Pittsburgh, April 23–May 1 (Engel, Marloff); Jeannette (Knechtel); New Brighton, May 3–June 5 (Merrick).

3006. **Erebus odora** Linnæus.

Allegheny, two specimens (Meyer); New Brighton, September 24 (Merrick); Jeannette, October 11 (Klages); and two specimens in coll. W. J. Holland, taken in Pittsburgh.

3007. **Thysania zenobia** Cramer.

Allegheny, September 22, 1899 (Glasser). In Merrick Museum Collection.

Subfamily HYPENINÆ.

3008. **Epizeuxis americalis** Guenée.

May 20–June 12; September 21–October 10. Common.

3009. **Epizeuxis æmula** Hübner.

June 26–July 24; August 17–September 27. Common.

3012. **Epizeuxis lubricalis** Geyer.

June 7–27; July 12–August 25. Common.

3013. **Epizeuxis denticulalis** Harvey.

July 8–20; August 8–September 4. Rare.

3014. **Epizeuxis scobialis** Grote.

New Brighton, July 8–31 (Merrick); Ohio Pyle, July 13–August 9 (Kahl & Klages).

——. **Epizeuxis diminuendis** Smith.

New Brighton, July 5–August 24 (Merrick); Pittsburgh, July 24–30 (Engel & Marloff).

3016. **Epizeuxis rotundalis** Walker.

New Brighton, June 11–July 31 (Merrick); Pittsburgh, July 4–7 (Engel).

——. **Epizeuxis julialis** Smith.

New Brighton, July 2–28 (Merrick).

——. **Epizeuxis merricki** Smith.

New Brighton, July 2–August 2 (Merrick); Pittsburgh, July (Marloff).

3019. **Zanclognatha lævigata** Grote.

July 6–August 15. Common in forests.

Var. **modestalis** Fitch.

July 11–August 17. Rarely entirely brown in median space, partly obscured intergrades are numerous.

Var. **reversata** Dyar.

July 17–August 27. Rare.

3020. **Zanclognatha pedipilalis** Guenée.

May 25–June 8; July 25–August 28. Common.

3021. **Zanclognatha cruralis** Guenée.

Pittsburgh, July 2–September 15 (Marloff, Engel); New Brighton, June 11–14 (Merrick).

3024. **Zanclognatha ochreipennis** Grote.

June 26–August 10. Common.

3025. **Zanclognatha marcidilinea** Grote.

May 28, August 23–September 25. Rare.

3026. **Zanclognatha lituralis** Hübner.

May 19–July 13. Rare.

3031. **Hormisa absorptalis** Walker.

Pittsburgh, July 1 (Engel); New Brighton, July 5, 6 (Merrick).

3032. **Hormisa litophora** Grote.

Pittsburgh, July 6–August 23 (Engel, Marloff); New Brighton, July 16–August 1 (Merrick).

3036. **Philometra metonalis** Walker.

May 28–June 23; July 24–August 17. Common.

3037. **Philometra eumelusalis** Walker.

June 6–28; August 8–25. Common.

3039. **Chytolita morbidalis** Guenée.

May 15–June 28. Common.

3041. **Renia salusalis** Walker.

New Brighton, June 22–July 19 (Merrick).

3042. **Renia discoloralis** Guenée.

July 12–August 5. Rare, but represented in most of the collections.

3046. **Renia factiosalis** Walker.
July 6–August 24. Common.
3048. **Renia flavipunctalis** Geyer.
June 17–July 24. Common.
3049. **Bleptina caradrinalis** Guenée.
July 2–August 24. Common.
3051. **Tetanolita floridana** Smith.
Pittsburgh, May 30 (Engel); New Brighton, July 24–September 17 (Merrick).
3054. **Heterogramma pyramusalis** Walker.
May 12–27; July 20–August 15. Common.
3055. **Gaberasa ambigualis** Walker.
May 12–June 24; July 18–September 30. Common.
3056. **Dircetis vitrea** Grote.
New Brighton, July 1–August 28 (Merrick). Fairly common at light in extensive forests.
3058. **Palthis angulalis** Hübner.
May 10–June 4; Angust 18–September 10. Common.
3059. **Palthis asopialis** Guenée.
May 16–June 19; August 1–September 9. Rare.
3063. **Lomanaltes eductalis** Walker.
New Brighton, June 5; August 2–11 (Merrick); Ohio Pyle, August 22–25 (Kahl & Klages).
3064. **Bomolocha manalis** Walker.
Pittsburgh, May 30–June 3; September 5 (Engel); New Brighton, August 16–September 3 (Merrick).
3065. **Bomolocha baltimoralis** Guenée.
May 13–June 16. Common.
——. **Bomolocha chicagonis** Dyar.
New Brighton, August 5 (Engel).
3066. **Bomolocha bijugalis** Walker.
May 10–June 6. Rare.
3067. **Bomolocha scutellaris** Grote.
May 12–June 12. Rare.
3068. **Bomolocha abalinealis** Walker.
May 27–June 19; August 17–23. Common.
3069. **Bomolocha madefactalis** Guenée.
New Brighton, May 21–June 5; July 7–22 (Merrick); Pittsburgh, May 16; July 31–August 3 (Marloff, Engel).

3070. **Bomolocha sordidula** Grote.

May 17–June 1; August 6–21. Common.

3072. **Bomolocha toreuta** Grote.

Pittsburgh, May 27–June 6; August 7 (Marloff, Engel, Krautwurm); New Brighton, August 16–September 9 (Merrick).

3073. **Bomolocha deceptalis** Walker.

May 18–June 9; August 5. Rare.

3074. **Bomolocha edictalis** Walker.

Ohio Pyle, July 12–31 (Marloff, Krautwurm, Kahl, Klages); New Brighton, July 24 (Merrick); Pittsburgh, July 21 (Engel).

3075. **Bomolocha citata** Grote.

Pittsburgh, August 29–October 19 (Marloff, Krautwurm); New Brighton, August 24–September 12 (Merrick); Jeannette, October 11 (Klages).

3079. **Plathypena scabra** Fabricius.

July 1–August 5; September 1–December 27, March. Common.

3080. **Hypena humuli** Harris.

April 1–June 13; July 24–28; October 17–November 19. Common.

Family NYCTEOLIDÆ.

3083a. **Nycteola lintnerana** Speyer.

Pittsburgh, May 31–June 12, September 3 (Engel); New Brighton, July 31–August 2 (Merrick).

3084. **Nycteola proteella** Dyar.

New Brighton, July 5–September 3 (Merrick); Pittsburgh, July 15 (Carnegie Museum Acc. 2733); Jeannette, July 6–19, three specimens (Klages); Pittsburgh, June 29–July 22 (Engel), three specimens.

Family NOTODONTIDÆ.

3090. **Apatelodes torrefacta** Smith & Abbot.

June 17–July 20. Common. Foodplant: wild cherry.

3091. **Apatelodes angelica** Grote.

New Brighton, July 8–29 (Merrick); Pittsburgh (Krautwurm); Wilmerding, July 6 (Zahrobsky). Mr. Krautwurm reared the larva on lilac and ash.

3094. **Melalopha inclusa** Hübner.

April 29–May 8; August 20–28. The larvæ live in small colonies in a web on the branches of willows and poplars.

3096. **Melalopha albosigma** Fitch.

Pittsburgh, April 25–May 17; August 23 (Marloff, Engel); New Brighton, April 23–June 27, August 31–September 2 (Merrick). Foodplant: willow.

3098. **Datana ministra** Drury.

June 13–July 20. Common. The larvæ are abundant in colonies on many deciduous plants, but seem to prefer hawthorn.

3100. **Datana angusi** Grote & Robinson.

June 15–July 13. Common. The larvæ are common on hickory in small colonies.

3101. **Datana drexeli** Hy. Edwards.

New Brighton, June 26–July 22 (Merrick); Pittsburgh, June (Krautwurm); Ohio Pyle, July 1 (Marloff). Mr. Krautwurm and the writer reared the larvæ, which are common, on witch-hazel.

3102. **Datana major** Grote & Robinson.

Pittsburgh (Krautwurm).

3106. **Datana perspicua** Grote & Robinson.

Pittsburgh, June, July (Krautwurm); Wilmerding, (Zahrobsky). Mr. Krautwurm has observed the larvæ in colonies on sumac.

3108. **Datana integerrima** Grote & Robinson.

June 12–27. Common. The larvæ are abundant in large colonies on walnut.

3110. **Datana contracta** Walker.

June 20–July 9. Rare. The writer and Mr. Marloff have bred large series of this species which when flown is easily confused with 3108. The larvæ live on different kinds of oaks.

3112. **Hyperæschra georgica** Herrich-Schæffer.

New Brighton, July 31 (Merrick).

3116. **Notodonta basitriens** Walker.

Ohio Pyle, July 17 (Engel); Pittsburgh, July (Krautwurm); New Brighton, July 27–August 18 (Merrick). Mr. Krautwurm has reared the larva on maple.

3118. **Pheosia dimidiata** Herrich-Schæffer.

New Brighton, August 2–24 (Merrick); Allegheny (Lippold); Ohio Pyle, July 31 (Kahl & Klages).

3121. **Lophodonta angulosa** Smith & Abbot.

New Brighton, July 2–20 (Merrick).

3123. **Nadata gibbosa** Smith & Abbot.

April 27–May 26; July 4–August 24. Common. The larvæ are common on oak and maple.

3124. **Nerice bidentata** Walker.

May 25–June 20. Rare. The larva feeds on elm and hackberry.

3125. **Symmerista albifrons** Smith & Abbot.

June 2–27. Common. Foodplants: oak, maple.

3127. **Dasylophia anguina** Smith & Abbot.

May 24–June 21; July 22–September 8. Rare. The larva feeds on locust, and has been reared by Mr. Krautwurm and the writer.

3128. **Dasylophia thyatiroides** Walker.

New Brighton, May 10–June 5; July 28–August 6 (Merrick); Pittsburgh (Krautwurm); Swissvale (Knechtel). Rare.

3133. **Heterocampa obliqua** Packard.

New Brighton, July 18–25 (Merrick); Coraopolis, one female (Knechtel); Wilmerding, one female (Foerster).

3136. **Heterocampa umbrata** Walker.

June 7–August 20. Generally distributed, but rare. The larva feeds on oak.

3137. **Heterocampa manteo** Doubleday.

July 10–August 12. Common. The larvæ are common on oak, maple, and beech.

3140. **Heterocampa biundata** Walker.

May 20–July 25. Rare. The larvæ occur on oak, linden, and maple.

3141. **Heterocampa guttivitta** Walker.

May 18–June 16; July 26–August 12. Common. Foodplants: oak, maple.

3142. **Heterocampa bilineata** Packard.

April 28–June 27; July 24–August 19. Rare. The larva feeds on elm.

3143. **Misogada unicolor** Packard.

May 5–June 25; August 2–September 8. Rare. Foodplant: sycamore.

3145. **Ianassa lignicolor** Walker.

June 6–12; July 7–August 23. Rare. The larva has been reared by the writer on oak.

3148. **Schizura ipomϾ** Doubleday.

June 12–22; July 8–August 8. Rare.

Var. **telifer** Grote.

New Brighton, July 24–30. Rare.

Var. **cinereofrons** Packard.

May 15–June 11; July 18–August 16. Common. The larvæ feed on numerous deciduous plants.

3149. **Schizura concinna** Smith & Abbot.

May 28–June 12. Common. Foodplants: apple, hawthorn, wild cherry.

3150. **Schizura semirufescens** Walker.

Pittsburgh, July 31 (Marloff), two specimens; New Brighton, July 14–August 12 (Merrick). The larvæ were found on locust.

3151. **Schizura unicornis** Smith & Abbot.

May 12–28; July 22–31. Rare. Foodplants: oak, hickory, wild cherry.

3153. **Schizura badia** Packard.

Pittsburgh, July 5 (Engel, Krautwurm).

3154. **Schizura leptinoides** Grote.

New Brighton, May 13–July 27 (Merrick); Pittsburgh, July 12 (Marloff, Krautwurm). Rare. The larva feeds on walnut.

3155. **Hyparpax aurora** Smith & Abbot.

June 30–July 12. Rare. It is represented in most of the collections.

3160. **Cerura occidentalis** Lintner.

New Brighton, August 2 (Merrick).

3161. **Harpyia borealis** Boisduval.

April 29–June 25; July 24–August 11. Common. Foodplant: wild cherry.

3162. **Harpyia cinerea** Walker.

May 15; July 4–17. Rare, but generally distributed. Foodplants: willow, poplar.

3165. **Fentonia marthesia** Cramer.

New Brighton, June 27–July 18 (Merrick); Pittsburgh, June 14–25; July 16 (Marloff, Engel, Krautwurm). Foodplant: oak.

3166. **Gluphisia septentrionalis** Walker.

May 13–June 24; August 7–24. Common. Foodplant: poplar.

3170. **Ellida caniplaga** Walker.

April 24–May 4; July 1–12. Rare. Mr. Krautwurm has reared the larva on linden.

Family THYATIRIDÆ.

3173. **Habrosyne scripta** Gosse.

New Brighton, June 5, August 16, two specimens (Merrick).

3175. **Habrosyne rectangulata** Ottolengui.

Pittsburgh, May 20–June 24; August 12 (Engel, Marloff, Friday);

Allegheny (Lippold); New Brighton, July 1, August 16 (Merrick). Mr. Lippold has reared many specimens.

3176. **Pseudothyatira cymatophoroides** Guenée.

May 20–June 13; August 8–September 10. Rare. At sugar.

3177. **Pseudothyatira expultrix** Grote.

May 18–June 5; August 28–November 2. Common.

3180. **Euthyatira pudens** Guenée.

April 19–May 3. Common in forests where dogwood (*Cornus florida*) abounds.

Var. **pennsylvanica** Smith.

This occurs with the typical form, but is rare. The moth is found at rest on the twigs of bushes and often on dead brush. Mr. Krautwurm reared the larva, which lives in a folded leaf on dogwood.

Family LIPARIDÆ.

3190. **Hemerocampa leucostigma** Smith & Abbot.

June 28–July 31; September 8–October 18. Common.

3192. **Hemerocampa definita** Packard.

New Brighton, July 5–September 10 (Merrick); Aspinwall, September 6 (Krautwurm); Ohio Pyle, August (Kahl). The writer has bred this species from ova. Foodplant: wild cherry.

3193. **Olene achatina** Smith & Abbot.

New Brighton, July 5–August 4 (Merrick); Rock Point, July 25 (Friday, Overbeck). There is much variation in the imagines.

3195. **Olene plagiata** Walker.

New Brighton, June 30–July 20 (Merrick); Ohio Pyle, July, August (Kahl, Klages).

Family LASIOCAMPIDÆ.

3208. **Tolype velleda** Stoll.

August 14–September 24. Common. The larvæ occur on apple, wild plum, and lilac.

3211. **Tolype laricis** Fitch.

New Brighton, September 25; October 5, one pair (Merrick); Pittsburgh, August 26 (Friday).

3214. **Malacosoma americana** Fabricius.

Cherry Run, Armstrong County, June 20–July 5 (Krautwurm).

3223. **Epicnaptera americana** Harris.

April 30–July 27. Rare.

Var. **ferruginea** Packard.

June 27–July 29. Rare. Both forms are represented in most of the collections.

Family PLATYPTERYGIDÆ.

3225. **Eudeilinea hermineata** Guenée.

May 10–June 11; July 21–29. Generally distributed, but rare in all localities except New Brighton.

3226. **Oreta rosea** Walker.

May 29–June 25; July 21–August 12. Common.

3227. **Oreta irrorata** Packard.

New Brighton, July 14–17; September 4, four specimens (Merrick). Taken at light in dense forest.

3229. **Drepana arcuata** Walker.

April 29–May 31.

Var. **genicula** Grote.

August 12–30. Both forms occur generally in this section, but are quite rare.

Family GEOMETRIDÆ.

Subfamily DYSPTERIDINÆ.

3232. **Dyspteris abortivaria** Herrich-Schæffer.

May 12–June 15; July 9–August 12. Common.

3234. **Nyctobia limitata** Walker.

March 25–April 26. Common, but local and usually near hemlock. It is a very variable species.

——. **Nyctobia viridata** Packard.

Pittsburgh, April (Marloff); New Brighton, April 20–May 19; July 26–August 11 (Merrck, Engel). A rare species, which was formerly listed as *Agia eborata* Hulst.

3237. **Cladara atroliturata** Walker.

April 12–29. Generally distributed, rare about Pittsburgh. Common at New Brighton. A very variable species.

3240. **Rachela bruceata** Hulst.

Espyville, November 15, 1901 (B. Krautwurm). Mr. Krautwurm observed a number of specimens in the locality mentioned, but mistook them for one of our common species and neglected to take more specimens.

Subfamily HYDRIOMENINÆ.

3245. **Paleacrita vernata** Peck.

March 18–April 17. Common.

——. **Paleacrita merriccata** Dyar.

March 10–27. Rare about Pittsburgh, but commoner at New Brighton. The female has not thus far been observed.

3247. **Alsophile pometaria** Harris.

November–December 25; March 14–April 28. Common.

3248. **Eudule mendica** Walker.

May 23–June 14; August 2–September 7. Common.

3260. **Nannia rufaria** Walker. (*Refusata* Walker, in Dyar's List.)

May 6–26; July 9–27. Common.

3262. **Heterophleps triguttaria** Herrich-Schæffer.

June 1–22; July 19–August 25. Common.

——. **Eupithecia palpata** Packard.

New Brighton, April 18–27 (Merrick); Pittsburgh, April 30 (Engel).

——. **Eupithecia packardata** Taylor.

July 27–September 4. Occurs generally, but is rather rare. This is the form which has been regarded as *absinthiata* Clerck.

——. **Eupithecia coagulata** Guenée.

Pittsburgh, May 20–June 21 (Engel).

——. **Eupithecia swetti** Grossbeck.

New Brighton, April 19, 1902 (Merrick).

——. **Eupithecia grossbeckiata** Swett.

Pittsburgh, July 2–30 (Engel).

3327. **Eucymatoge intestinata** Guenée.

May 28–June 29; August 3–17. Common.

3331. **Venusia comptaria** Walker.

April 15–May 12. Common. This is the species which has long been known as *duodecemlineata* Packard in local collections.

——. **Venusia perlineata** Packard.

May 22–July 17. Common. This species stands as *comptaria* Walker in local collections.

3332. **Euchœca albovittata** Guenée.

April 25–May 30; July 2–August 17. Common.

3335. **Euchœca lucata** Guenée.

New Brighton, May 28–June 17 (Merrick). Fairly common at rest on trees and at light.

3336. **Euchœca albifera** Walker.

Pittsburgh, August 4 (Marloff); New Brighton, May 30–August 21 (Merrick). At light in forest.

3337. **Epirrita dilutata** Denis & Schiffermüller.

New Brighton, October 19–28 (Merrick). Rare.

3340. **Hydria undulata** Linnæus.

April 25–May 29; July 25–August 7. Common. The larvæ live in colonies on wild cherry in a web.

3348. **Eustroma diversilineata** Hübner.

June 20–July 24; August 5–September 16. Common. The form **gracilineata** Guenée is equally common.

3350. **Eustroma populata** Linnæus.

New Brighton, June 25, 1901, one specimen (Merrick).

Var. **remotata** Walker.

New Brighton, July 4–20 (Merrick); Pittsburgh, June 28, 1899 (Engel); Millvale (Lippold). Some of these specimens have a yellow ground while others are brown. Probably two of the listed varieties are represented.

3354. **Eustroma atrocolorata** Grote.

June 3–29; July 8–August 17. Common. Mr. Krautwurm has reared this species on wild hydrangea.

3359. **Rheumaptera hastata** Linnæus.

Pittsburgh, June 29 (Krautwurm, Marloff); New Brighton, July 12, 13 (Merrick, Engel).

3361. **Rheumaptera sociata** Borkhausen.

New Brighton, May 29–August 25 (Merrick); Pittsburgh, May 27–29 (Engel). Rare in Pittsburgh, but very common at New Brighton.

3370. **Percnoptilota fluviata** Hübner.

May 18–June 7; July 4–August 17. Common.

3371. **Mesoleuca ruficillata** Guenée.

May 20–June 7; July 19–27. Common.

3374. **Mesoleuca lacustrata** Guenée.

May 5–June 27; July 30–August 17. Common.

3376. **Mesoleuca intermediata** Guenée.

April 17–May 10; July 24–August 29. Common.

3383. **Mesoleuca persiliata** Guenée.

New Brighton, June 4–18; Pittsburgh, June 24 (Marloff, Krautwurm).

3386. **Mesoleuca vasiliata** Guenée.

April 10–May 6. Well distributed, but rare. It occurs in forests, where it may be flushed from the dead leaves.

3388. **Hydriomena autumnalis** Strömeyer.

Pittsburgh, April 18–May 4 (Engel, Marloff, Friday); New Brighton, April 30–May 19 (Merrick); Allegheny (Lippold).

3401. **Hydriomene multiferata** Walker.

May 17–June 9. Rare, but represented in most of the collections.

3402. **Hydriomene latirupta** Walker.

May 19–June 27; July 18–September 7. Common.

3426. **Cœnocalpe gibbicostata** Walker.

September 11–27. Common, but very local.

3438. **Gypsochroa designata** Hufnagel.

New Brighton, August 11–31 (Merrick); Pittsburgh, June 13 (Engel); several specimens without date of capture (Krautwurm).

3457. **Petrophora ferrugata** Clerck.

May 5–July 2; August 2–September 7. Common.

3463. **Petrophora fluctuata** Linnæus.

May 19–June 5; July 26–August 7. Common.

Subfamily MONOCTENIINÆ.

3468. **Hæmatopis grataria** Fabricius.

May 1–June 23; August 2–September 4. Common.

Subfamily STERRHINÆ.

3469. **Erastria amaturaria** Walker.

June 1–July 12; August 2–September 6. Common.

3477. **Deptalia insulsaria** Guenée.

July 16–August 15; October 16. Common.

3479. **Cosymbia myrtaria** Guenée.

New Brighton, May 8–18, September 2 (Merrick); Pittsburgh, May 11, September 25 (Engel, Friday).

3480. **Cosymbia lumenaria** Hübner.

Pittsburgh, May 19 (Engel); New Brighton, May 1–22 (Merrick).

3487. **Synelys enucleata** Guenée.

May 26–June 8; August 7–23. Common.

Var. **restrictata** Walker.

Occurs with the typical form.

3521. **Eois demissaria** Hübner.

Pittsburgh, August 12, two specimens (Engel).

3530. **Eois ossularia** Hübner.
New Brighton, September 9–22 (Merrick); Pittsburgh, August 20 (Engel).

3546. **Eois inductata** Guenée.
June 2–24; July 22–August 19. Common.

3548. **Eois productata** Packard.
New Brighton, May 31–June 4 (Merrick).

Subfamily GEOMETRINÆ.

3561. **Chlorochlamys chloroleucaria** Guenée.
May 12–June 9; July 4–31. Common.

3564. **Nemoria subcroceata** Walker.
New Brighton, May 21–July 7 (Merrick); Pittsburgh (Krautwurm).

3571. **Racheospila lixaria** Guenée.
New Brighton, July 24, 1902 (Merrick).

3578. **Synchlora ærata** Fabricius.
May 28–June 16; August 5–18. Common.

3583. **Synchlora rubrifrontaria** Packard.
New Brighton, June 25, 1901 (Merrick).

3587. **Aplodes mimosaria** Guenée.
May 21–29; July 7–27. Common.

3589. **Aplodes rubrifrontaria** Packard.
New Brighton, April 19–May 1 (Merrick); Pittsburgh, July 11 (Engel, Krautwurm); Allegheny (Meyer).

3590. **Aplodes bistriaria** Hübner.
Pittsburgh, May 3–11 (Marloff, Krautwurm); New Brighton, April 18–May 17 (Merrick).

3599. **Anaplodes iridaria** Guenée.
June 3–July 29. This handsome species is represented in most of the collections, but is quite rare.

Subfamily ENNOMINÆ.

3604. **Eufidonia notataria** Walker.
May 28–June 20. Widely distributed, but rare.

3606. **Orthofidonia semiclarata** Walker.
New Brighton, May 2–19 (Merrick, Engel). Not rare in favorable seasons.

3608. **Orthofidonia vestaliata** Guenée.
May 2–June 4. Very common.

3611. **Heliomata infulata** Grote.

June 18–July 16. Very rare, but represented in nearly all collections.

3613. **Heliomata cycladata** Grote.

May 29–June 21. Very common in locust thickets and at flowers.

3614a. **Mellilla xanthometata** Walker.

July 10–August 24. Rare on, or in vicinity of, honey-locust.

3618. **Physostegania pustularia** Guenée.

June 20–August 6. Common.

3619. **Gueneria basiaria** Walker.

May 19–26; July 27–August 16. Rare in the vicinity of Pittsburgh, but quite common at New Brighton.

3623. **Deilinia variolaria** Guenée.

New Brighton, June 6 (Merrick); Pittsburgh, June 8–12; August 12 (Engel, Marloff).

3636. **Deilinea liberaria** Walker.

Pittsburgh, September 22–27 (Engel, Marloff); New Brighton, August 30–September 11 (Merrick); Jeannette, September 20–26 (Klages).

3647. **Sciagraphia granitata** Guenée.

Pittsburgh, June (Krautwurm); New Brighton, June 9–14 (Merrick).

3651. **Sciagraphia heliothidata** Guenée.

May 8–July 18; August 5–September 1. Common.

3667. **Philobia enotata** Guenée.

May 5–16; July 12–30. Common.

3668. **Macaria infimata** Guenée.

Pittsburgh, August 7–10 (Engel); New Brighton and Rock Point, June 26–31; August 11–September 3 (Merrick, Engel). All were found at rest on willow trees.

3680. **Macaria simulata** Hulst.

Pittsburgh, October 4 (Marloff); Jeannette, October 11 (Klages). At sugar and light.

3683. **Macaria glomeraria** Grote.

April 12–May 10. Common in forests.

3689. **Cymatophora virginalis** Hulst.

New Brighton, May 12; August 10–15 (Merrick); Pittsburgh, August 12 (Marloff).

3690. **Cymatophora ribearia** Fitch.

New Brighton, June 25, July 8, two specimens (Merrick).

3703. **Cymatophora inceptaria** Walker.

New Brighton, June 3–27 (Merrick). Common at light and among the herbage in woods.

3705. **Cymatophora subcessaria** Walker.

July 6–August 16. Widely distributed, but rare.

Var. **coörtaria** Hulst.

New Brighton, June 24–July 23 (Merrick); Pittsburgh, June 25 (Marloff).

3744. **Sympherta julia** Hulst.

New Brighton, June 29–July 30 (Merrick). Fairly common at light in woods.

3755. **Apæcasia defluata** Walker.

Swissvale (Knechtel); New Brighton, May 17 (Merrick).

3780. **Nepytia semiclusaria** Walker.

New Brighton, September 28–October 19 (Merrick); Pittsburgh, (Krautwurm); Jeannette, September 29 (Klages).

3803. **Paraphia subatomaria** Wood.

May 26–June 7; July 17–August 19. Common.

Var. **unipunctata** Haworth.

July 31–August 17. Rare.

Var. **deplanaria** Guenée.

June 1–17; July 31–August 10.

The last form is always represented by small males, otherwise like the typical form.

3807. **Lytrosis unitaria** Herrich-Schæffer.

Wilmerding, one specimen, Fœrster.

3815. **Tornos abjectarius** Hulst.

Pittsburgh, July 29; August 25, two males (Engel).

3838. **Selidosema humaria** Guenée.

April 12–May 10; August 12–September 2. Generally taken, but scarce.

3848. **Cleora indicataria** Walker (?).

New Brighton, June 4–July 14 (Merrick); Ohio Pyle, July 17 (Marloff, Friday). This form was determined by Dr. Dyar for Mr. Merrick. It does not agree with the figure of *polygrammaria*, Packard's Monograph, Plate XI, fig. 19, and the determination has been questioned. It is similar to *larvaria* but much darker, smaller, and constant.

3850. **Cleora pampinaria** Guenée.

April 3–May 25; July 17–August 24. Common.

3855. **Cleora larvaria** Guenée.

May 20–June 14; August 6–17. Rather scarce.

3858. **Melanolophia canadaria** Guenée.

April 20–May 15; July 6–27. Common, and very variable.

3859. **Æthaloptera anticaria** Walker.

April 12–28; July 16–22. Rare.

3862. **Ectropis crepuscularia** Denis & Schiffermüller.

April 12–May 19; June 19–28. Common.

3864. **Epimecis virginaria** Cramer.

Pittsburgh, April 25–May 10 (Krautwurm); New Brighton, May 5 (Merrick); Wilmerding, July 4 (Zahrobsky); Ohio Pyle, July 24 (Kahl, Klages).

3865. **Lycia ursaria** Walker.

New Brighton, April 15, 1899 (Merrick).

3867. **Lycia cognataria** Guenée.

April 20–June 2; July 16–August 6. Common. The writer has reared the larvæ on wild cherry and they occur on many other plants.

3873. **Nacophora quernaria** Smith & Abbot.

April 30–June 28. Local specimens of this interesting species are in most of the collections, but it is rare. The writer reared a large brood from ova. Foodplant: oak. In several collections dark males of this species stand under *cupidaria* Grote, but these are all males of *quernaria*.

3880. **Phigalia olivacearia** Morrison.

March 18–April 25. Rare in forests at rest on the trees, and occasionally taken at light.

3881. **Phigalia titea** Cramer.

March 22–April 27. Very common in some years.

3884. **Erannis tiliaria** Harris.

October 27–December 5. Common in forests. The females are abundant during the middle of November, and deposit eggs in the crevices of the bark of the trees. The writer bred this species from ova and numerous larvæ were observed feeding on various deciduous plants.

3886. **Cingilia catenaria** Drury.

New Brighton, September 27 (Merrick); Wilmerding, September 28 (Zahrobsky); Allegheny (Lippold, Meyer).

3898a. **Anagoga occiduaria** Walker.

New Brighton, May 2–June 7; August 2–16 (Merrick). This species is found in the woods at rest on the dead leaves. When disturbed it rises high in the air and settles again near its former resting place.

3902. **Sicya macularia** Harris.

June 10–22. Rare, but generally distributed.

3907. **Therina pellucidaria** Grote & Robinson.

New Brighton, May 7–June 12 (Merrick); Pittsburgh, April 12 (Marloff); four specimens without date (Krautwurm).

3908. **Therina endropiaria** Grote & Robinson.

New Brighton, June 11–17 (Merrick).

3909. **Therina athasaria** Walker.

New Brighton, April 6–May 8 (Merrick); Sharpsburg, May 30 (Lucock); Pittsburgh (Krautwurm).

3911. **Therina fervidaria** Hübner.

New Brighton, September 21–October 19 (Merrick); Ohio Pyle, August 2 (Kahl & Klages); Pittsburgh, September 19 (Krautwurm). The several species of *Therina* are quite rare in the Pittsburgh district. At New Brighton, where extensive forests still exist, they are commoner, and may be found at rest on the trees.

3913. **Metrocampa prægrandaria** Guenée.

New Brighton, July 27–August 21 (Merrick); Pittsburgh, June 20 (Friday).

3916. **Eugonobapta nivosaria** Guenée.

June 2–July 3. Common in forests among the herbage.

3922. **Ennomos subsignarius** Hübner.

June 30–August 5. Rare but taken by nearly all the collectors.

3923. **Ennomos magnarius** Guenée.

August 13–October 11. Common. The larvæ were reared on ash and hickory (Engel, Friday).

3925. **Xanthotype crocataria** Fabricius.

May 19–June 17; July 21–August 23. Common.

3927. **Plagodis serinaria** Herrich-Schæffer.

May 1–June 13. Generally distributed, but rare.

3928. **Plagodis keutzingi** Grote.

Pittsburgh, May 17–28; July 2–12 (Marloff, Engel, Friday). Rare.

——. **Plagodis altruaria** Pearsall. (*Keutzingaria* Packard.)

April 27–June 2. Rare, but represented in most of the collections.

3929. **Plagodis fervidaria** Herrich-Schæffer.

April 30–May 29. Rare, but generally distributed.

3930. **Plagodis alcoolaria** Guenée.

New Brighton, June 4–19 (Merrick); Pittsburgh, June (Engel).

Var. **kempi** Hulst (3926 Dyar's List).

New Brighton (Merrick). The type of this form was taken at New Brighton.

3931. **Plagodis phlogosaria** Guenée.

New Brighton, July 11–August 8 (Merrick); Pittsburgh, July 28 (Marloff); July 12 (Engel).

3932. **Plagodis emargataria** Guenée.

New Brighton, July 20–27 (Merrick); Pittsburgh, April 30–May 4 (Krautwurm).

3934. **Hyperetus amicaria** Herrich-Schæffer.

July 16–August 12. Rare in Pittsburgh, but common in a forest near New Brighton.

Var. **alienaria** Herrich-Schæffer.

April 19–May 31. Common.

Var. **nepiasaria** Walker.

May 17–June 10. Common.

3939. **Ania limbata** Haworth.

June 5–July 30. Common among herbage in woods.

3941. **Gonodontis hypochraria** Herrich-Schæffer.

May 20–June 30; July 26–August 10. Common.

3944. **Gonodontis duaria** Guenée.

May 13–June 24. Common.

3947. **Gonodontis obfirmaria** Hübner.

New Brighton, May 9–30 (Merrick); Pittsburgh, May 28–June 2 (Engel).

3954. **Euchlæna serrata** Drury.

June 15–July 22. Scarce, but generally distributed.

3956. **Euchlæna obtusaria** Hübner.

May 24–June 16; August 12–20. Common.

3957. **Euchlæna effectaria** Walker.

New Brighton, July 8–11 (Merrick). Rare.

3960. **Euchlæna johnsonaria** Fitch.

Pittsburgh, August 14 (Engel); New Brighton, Pa., June 17–July 2; September 4–9 (Merrick). A variable species, quite common at light in forests.

3964. **Euchlæna marginata** Minot.

New Brighton, May 16–20, two specimens (Merrick).

3965. **Euchlæna pectinaria** Denis & Schiffermüller.

May 22–June 24. Common.

3971. **Eutrapela kentaria** Grote.

Pittsburgh, April 22–29 (Krautwurm); New Brighton, April 13–27 (Merrick). Rare, clinging to weeds or twigs in forests with its wings reversed when at rest.

3981. **Metanema inatomaria** Guenée.

May 8–21; July 12–31. Common in vicinity of poplar, on which the larva feeds.

3982. **Metanema determinata** Walker.

May 12–26; August 6–19. Scarce, but generally distributed.

3986. **Metanema quercivoraria** Guenée.

April 29–June 9. *M. textrinaria* Grote & Robinson, is the male of this species, and both sexes are rather variable. Fairly common in woods of hard timber.

3990. **Priocycla armataria** Herrich-Schæffer.

May 29–June 21; July 17–August 7. Not rare, and generally distributed.

4001. **Azelina ancetaria** Hübner.

May 6–June 2; July 26–August 14. Common at light and the summer brood at flowers of *Saponaria*.

4005. **Syssaura infensata** Guenée.

Jeannette, September 7 (Klages). One specimen in Carnegie Museum collection.

4007. **Caberodes confusaria** Hübner.

May 24–June 18; August 20–September 17. Common and variable.

4008. **Caberodes majoraria** Guenée.

New Brighton, June 15–July 7 (Merrick). Rare.

4011. **Tetracis crocallata** Guenée.

May 14–June 17; August 4–27. Common.

4014. **Sabulodes arcasaria** Walker.

July 12–26. Rare at light and flowers of *Saponaria*. *S. sulphurata* Packard is the female of this species.

4016. **Sabulodes lorata** Grote.

May 14–June 11; July 16–27. Common among herbage in woods.

4025. **Sabulodes furciferata** Packard.

May 14–June 3. Rare. While I have not bred the species, I am confident this form is the spring brood of *S. arcasaria* Walker.

4026. **Sabulodes transversata** Drury.

June 14–July 7; August 21–October 25. Common.

4028. **Abbottana clemataria** Smith & Abbot.

April 17–May 4; June 30–August 1. Common. Foodplants: oak, wild cherry.

Family EPIPLEMIDÆ.

4044. **Calledapteryx dryopterata** Grote.

May 21–June 27; August 3–17. Widely distributed, but scarce. This curious little species assumes a rather unique posture when at rest. It folds the secondaries over the abdomen and expands the primaries and rests on top of the leaves among the herbage in the woods [and vibrates its primaries after alighting. *Editor.*]

Family NOLIDÆ.

4046. **Celama triquetrana** Fitch.

April 17–May 5. Fairly common in forests, where witch-hazel grows. Mr. Krautwurm found the larvæ on this plant.

4053. **Nola ovilla** Grote.

Pittsburgh, April 26–28 (Engel, Krautwurm); New Brighton, April 29–May 9; July 27–August 3 (Merrick).

4055. **Rœselia minuscula** Zeller.

New Brighton, May 25 (Merrick); Pittsburgh, May 13 (Engel).

4058. **Nigetia formosalis** Walker.

Panther Hollow, Schenley Park. Scarce. A specimen taken at sugar by Holland in Schenley Park is figured in the "Moth Book."

Family LACOSOMIDÆ.

4059. **Cicinnus melsheimeri** Harris.

Pittsburgh, June 11 (Engel); New Brighton, June 5–23 (Merrick); Wilmerding (Zahrobsky).

4060. **Lacosoma chiridota** Grote.

New Brighton, June 13 (Merrick, Hope); Wilmerding, June 18, two specimens (Zahrobsky).

Family PSYCHIDÆ.

4065. **Thyridopteryx ephemeræformis** Haworth.

Dr. Holland found the larval case on a shrub in his garden. [Probably an imported specimen. *Editor.*] The moth has not been observed here to the writer's knowledge. [But it is very abundant in various localities in West Virginia, below Pittsburgh. *Editor.*]

4068. **Eurycyttarus confederata** Grote & Robinson.

June 25–July 7. Common. The larval cases are numerous on the trunks of trees and on fence-posts during June.

4072. **Solenobia walshella** Clemens.

Pittsburgh, April 20–May 6 (Engel & Marloff); New Brighton, April 18–30 (Merrick). The larval case of this species occurs in the crevices of the bark of trees.

Family COCHLIDIIDÆ.

4075. **Sibine stimulea** Clemens.

Jeannette, July 7. (Klages, Knechtel); Pittsburgh (Krautwurm). Mr. Krautwurm collected the larva on oak and maple. [Numerous specimens of the larva have been sent to the Carnegie Museum from various places in Western Pennsylvania, with requests for information, and though scarce, it is widely distributed. *Editor.*]

4077. **Euclea delphinii** Boisduval.

June 19–July 24. Common. It is a variable species. The larva feeds on many deciduous plants.

4080. **Euclea chloris** Herrich-Schaeffer.

June 17–July 12. Common. The larva is abundant on hickory and wild cherry.

4085. **Adoneta spinuloides** Herrich-Schaeffer.

June 13–July 28. Common. The larva feeds promiscuously on deciduous plants.

4087. **Sisyrosea textula** Herrich-Schaeffer.

June 13–27. Generally distributed, but scarce. The larva occurs on oak, hickory, wild cherry, and other plants.

4089. **Phobetron pithecium** Smith & Abbot.

June 15–July 18. Scarce but well represented in the several collections. The larva mostly occurs on wild cherry.

4092. **Prolimacodes scapha** Harris.

June 20–July 15. Common. The larva is very abundant on cultivated and wild cherry, hickory, and many other plants.

4094. **Cochlidion biguttata** Packard.

New Brighton (Hope); Wilmerding, (Foerster).

4096. **Cochlidion y-inversa** Packard.

Pittsburgh, July 3–12 (Engel, Marloff); Ohio Pyle, July 17 (Marloff); New Brighton, June 19–August 2 (Merrick).

4097. **Lithacodes fasciola** Herrich-Schaeffer.

June 14–July 20. Common. The larva is abundant on oak, hickory, maple, and cherry.

4098. **Packardia elegans** Packard.

Pittsburgh, June 19–July 1 (Engel, Marloff); New Brighton, June 16–July 10 (Merrick).

4099. **Packardia geminata** Packard.

June 7–22 (Marloff, Engel, Krautwurm); New Brighton, June 14–22 (Merrick). Foodplants: wild cherry, oak, sycamore.

4100. **Packadia albipunctata** Packard.

Pittsburgh, May 31–June 9 (Engel). Rare.

4105. **Tortricidia flexuosa** Grote.

June 6–July 19. Common.

Var. **cæsonia** Grote.

New Brighton, July 10–23 (Merrick); Pittsburgh, July 31 (Engel). Mr. Krautwurm has bred a number of this form but they were all forced and emerged during the winter. The larva occurs freely on wild cherry and many other plants.

4106. **Tortricidia testacea** Packard.

June 5–24. Taken in the several localities, but rather scarce.

Family PYROMORPHIDÆ.

4115. **Acoloithus falsarius** Clemens.

Pittsburgh, July 12–20 (Engel, Marloff, Ehrman). The larva feeds on wild grape and the moth frequents the blossoms of yarrow or sneeze-wort during the day time.

4117. **Pyromorpha dimidiata** Herrich-Schæffer.

Pittsburgh (Krautwurm); Allegheny (Meyer). The specimens were taken flying during the day time.

4129. **Harrisina americana** Guérin-Ménéville.

Pittsburgh, July 1–10 (Engel). Taken at light. Mr. Krautwurm has reared many specimens from larvæ found on wild grape.

Family THYRIDÆ.

4131. **Thyris maculata** Harris.

June 27–August 11. Common. The moth frequents the blossoms of blackberry, dewberry, and yarrow on sunny days.

4132. **Thyris lugubris** Boisduval.

May 30–June 27. Scarce, but widely distributed. The moth occurs on berry blossoms and the writer observed it feasting on the cadaver of a cow. Mr. Link took several specimens feeding on the remains of a snake at Ohio Pyle, Pa.

4134. **Dysodia oculatana** Clemens.

June 24–July 19. Common. The moth is crepuscular in its habits and frequents the blossoms of the milkweed and the horse-chestnut (*Æsculus*). The larva lives on the white snakeroot (*Eupatorium ageratoides* Linn.). It partly severs the midrib of the leaf, causing it to droop, when it is drawn into cone-shape and forms the abode of the larva.

Family COSSIDÆ.

4147. **Prionoxystus robiniæ** Peck.

June 6–20. Common.

4148. **Prionoxystus macmurtrei** Guérin-Méneville.

Pittsburgh, June 4–8 (Krautwurm); New Brighton, May 30, June 3 (Merrick); Wilmerding, June 2 (Zahrobsky).

Family SESIIDÆ.

4162. **Melittia satyriniformis** Hübner.

July 11–29. Common. The larva is injurious to pumpkin vines.

4170. **Alcothoe caudata** Harris.

Pittsburgh, July 24–August 5, 1908 (Engel). The specimens were bred from the roots of *Clematis*. Mature larvæ and one cocoon were collected on June 21. A female emerged July 24 from the cocoon found on June 21. The pupal state ranges from 30–35 days.

4173. **Podosesia syringæ** Harris.

May 25–June 30. Common. The larvæ occur in lilac and ash.

4175. **Memythrus tricinctus** Harris.

Wilmerding, one specimen (Foerster).

4183. **Memythrus asilipennis** Boisduval.

Millvale, May, one specimen (B. Krautwurm).

4191. **Bembecia marginata** Harris.

August 8–September 12. Common. The variety *albicoma* Hulst occurs with the typical form, but is less frequent. Larva in the roots of blackberry.

4194. **Sanninoidea exitiosa** Say.

June 30–August 14. Common. The larvæ are destructive in the base of peach, cultivated and wild cherry trees, and pupate under the hardened sap which oozes from their borings.

Var. **edwardsi** Beutenmüller.

Pittsburgh, August 5 (Marloff).

4203. **Sesia rutilans** Hy. Edwards (?).

New Brighton, August 10, 1907 (Bird). This specimen is near to *rutilans* but may prove different when more material is obtained. The specimen was bred from sneezeweed.

4207. **Sesia bassiformis** Walker.

August 13–September 14. Common. Larvæ abundant in roots of ironweed.

4208. **Sesia tipuliformis** Clerck.

May 15–June 18. Common in currant fields.

4216. **Sesia pictipes** Grote & Robinson.

May 5–June 2. Common. The larva lives in the trunk and branches of plum, and cultivated and wild cherry trees.

4221. **Sesia acerni** Clemens.

May 15–June 12. Common on swamp maple.

4222. **Sesia corni** Hy. Edwards.

Pittsburgh, August 5, 1907 (Kahl); one specimen without date (Krautwurm).

4224. **Sesia pyri** Harris.

June 7–30. Common in old apple orchards where hundreds of specimens emerge from some of the trees.

4225. **Sesia scitula** Harris.

Pittsburgh (Krautwurm).

4250. **Sesia pyralidiformis** Walker.

August 7–September 13. Common in waste land where boneset grows. The larva feeds in the roots of this plant.

Family PYRALIDÆ.

Subfamily PYRAUSTINÆ.

4263. **Glaphria glaphyralis** Guenée.

June 21–July 15. Common.

4264. **Glaphria sesquistrialis** Hübner.

June 24–July 29; August 3–7. Common.

4266. **Glaphria psychicalis** Hulst.

New Brighton, June 11–August 26 (Merrick).

4269. **Glaphria peremptalis** Grote.

New Brighton, July 10, 14, two specimens (Merrick).

4273. **Lipocosma sicalis** Walker.
June 13–July 15. Common.

4274. **Lipocosma fuliginosalis** Fernald.
June 10–26; July 16–August 11. Common.

4275. **Hymenia perspectalis** Hübner.
Pittsburgh, June 23–25; August 5–18 (Engel, Marloff, Friday); New Brighton, September 30–October 26 (Merrick); Charleroi, October 1 (Ehrman); Jeannette, October 11 (Klages).

4276. **Hymenia fascialis** Cramer.
New Brighton, October 2, 1903 (Merrick); Jeannette, October 11 (Klages).

4277. **Desmia funeralis** Hübner.
June 8–July 24; August 8–September 3. Common. *Subdivisalis* Grote is the female of *funeralis*.

4285. **Samea ecclesialis** Guenée.
New Brighton, July 14–August 13 (Merrick); Pittsburgh (Holland).

4287. **Diastictis argyralis** Hübner.
Pittsburgh, May 1–30 (Engel, Marloff).

4291. **Pilocrocis ramentalis** Lederer.
Pittsburgh, October 19 (Engel); New Brighton, October 4–12 (Merrick), Jeannette, October 11 (Klages).

4302. **Blepharomastix ranalis** Guenée.
June 2–27. Common among low herbage in the woods.

4304. **Blepharomastix stenialis** Guenée.
Pittsburgh, June 20, 1908 (Engel).

4307. **Pantographa limata** Grote & Robinson.
June 22–July 26. Common.

4316. **Diaphania nitidalis** Stoll.
Jeannette, October 11 (Klages). Three specimens in Carnegie Museum.

4320. **Diaphania hyalinata** Linnæus.
Pittsburgh, September 21–October 6 (Marloff, Friday, Kahl, Klages). New Brighton, September 30–October 12 (Merrick).

4321. **Diaphania quadristigmalis** Guenée.
Jeannette, June 15–29; September (Ehrman) in Coll. W. J. Holland; New Brighton, September 5 (Merrick).

4323. **Metrea ostreonalis** Grote.
New Brighton, July 17, 1901 (Merrick).

4336. **Evergestis straminalis** Hübner.
May 1–June 10; August 13–23. Common.

4337. **Crocidophora serratissimalis** Zeller.
June 11–27; August 17–September 28. Common.

4339. **Crocidophora tuberculalis** Lederer.
New Brighton, June 7–July 5 (Merrick); Pittsburgh, July 7–26 (Marloff); Jeannette, July 18 (Klages).

4342. **Nomophila noctuella** Denis & Schiffermüller.
June 13–July 30; August 7–October 1. Common.

4349. **Loxostege obliteralis** Walker.
June 16–July 30; August 9. Common.

4351. **Loxostege helvialis** Walker.
Pittsburgh, May 28, August 14 (Engel); New Brighton, May 25, 1903 (Merrick).

4369. **Loxostege macluræ** Riley.
Pittsburgh, May 26–June 30; August 11–September 28 (Engel, Marloff); New Brighton, July 2–September 18 (Merrick).

4381. **Diasemia roseopennalis** Hulst.
New Brighton, September 3, 1905 (Merrick). One specimen.

4385. **Condylorrhiza vestigialis** Guenée.
Jeannette, October 11 (Klages); New Brighton, August 12–October 12, three specimens (Merrick).

4386. **Thaleria reversalis** Guenée.
New Brighton, August 1–September 8 (Merrick); Pittsburgh, June 23–24 (Engel); July 28 (Marloff).

4400. **Perispasta cæculalis** Zeller.
New Brighton, May 30–June 20; July 31–August 24 (Merrick); Pittsburgh, June 3–6 (Engel, Marloff). Scarce.

4401. **Phlyctænia ferrugalis** Hübner.
March 20–May 13; July 12–August 24; September 28–November 5. Common.

4410. **Phlyctænia terrealis** Treitschke.
Pittsburgh, May 30–June 14 (Engel); New Brighton, June 1–3; August 15–28 (Merrick). Rare.

4413. **Phlyctænia tertialis** Guenée.
May 24–June 29; August 15–September 2. Common.

4414. **Cindaphia bicoloralis** Guenée.
May 27–June 19; August 5–September 23. Common.

4417. **Pyrausta pertextalis** Lederer.
May 12–July 1; August 11–September 14. Common.

4418. **Pyrausta fissalis** Grote.

New Brighton, July 15–28 (Merrick); Pittsburgh, July 9–17 (Engel).

4419. **Pyrausta æglealis** Walker.

New Brighton, July 10–26 (Merrick); Pittsburgh, June 11–July 23; August 24 (Engel).

4420. **Pyrausta thestealis** Walker.

New Brighton, June 25–July 29 (Merrick).

4423. **Pyrausta oxydalis** Guenée.

July 2–August 10. Common.

4426. **Pyrausta orphisalis** Walker.

New Brighton, July 12, 1905, one specimen (Merrick).

4436. **Pyrausta fumalis** Guenée.

August 4–27. Rare at light and among low herbage in the woods.

4437. **Pyrausta illibalis** Hübner.

April 23–May 6. Common at rest on the trees in extensive forests.

4439. **Pyrausta penitalis** Grote.

May 14–July 30. Common.

4441. **Pyrausta futilalis** Lederer.

Pittsburgh, June 14–28; September 2 (Engel, Marloff); New Brighton, June 21–July 1; August 19–September 22 (Merrick). Scarce.

4442. **Pyrausta fumoferalis** Hulst.

New Brighton, July 16, 1907, one specimen (Merrick).

4443. **Pyrausta unifascialis** Packard.

New Brighton, June 3–18, 1907 (Merrick, Engel).

4450. **Pyrausta acrionalis** Walker.

May 13–June 22; July 2–August 23. Common in waste land.

4451. **Pyrausta rubricalis** Hübner.

Var.?, Pittsburgh, May 2–June 23; August 12–26 (Engel, Marloff); New Brighton, June 2 (Merrick); Dr. Dyar determined this form as *rubricalis* var. It is nearest to *acrionalis*.

4454. **Pyrausta insequalis** Guenée.

Pittsburgh, April 29–May 14; July 2 (Engel). Rare. Flying in waste lands.

——. **Pyrausta ochosalis** Dyar.

Pittsburgh, May 3–July 5; August 24 (Engel, Marloff). Common in peppermint patches in moist places.

4455. **Pyrausta generosa** Grote & Robinson.

June 12–23; July 15–August 16. Rare.

4458. **Pyrausta tyralis** Guenée.

Pittsburgh, June 14 (Engel). A specimen in the Carnegie Museum collection compared by Dr. Holland with the U. S. Nat. Mus. material.

4461.1. **Pyrausta signatalis** Walker.

Pittsburgh, June 27–July 2; August 25–September 18 (Engel, Marloff); New Brighton, May 21, July 8–August 16 (Merrick). Rare.

4469. **Pyrausta unimacula** Grote & Robinson.

May 13–June 23; August 14–September 30. Common.

4472. **Pyrausta funebris** Ström.

June 1–28; July 29–August 20. Common in waste land.

4473. **Pyrausta niveicilialis** Grote.

June 8–13; July 6–August 30. Common. The larva lives on a small variety of *Eupatorium purpureum* growing in shady woods, in a rolled leaf.

——. **Pyrausta chalybealis** Fernald.

July 15–29; August 12–September 17. Common among the herbage in the woods.

4474. **Eustixia pupula** Hübner.

June 25--July 22; August 4–September 20. Common.

4484. **Lineodes integra** Zeller.

Pittsburgh, August 17. Collection of Carnegie Museum.

Subfamily NYMPHULINÆ.

4487. **Nymphula icciusalis** Walker.

New Brighton, May 23–July 26 (Merrick).

4491. **Nymphula allionealis** Walker.

July 26, 1903, New Brighton (Merrick).

4498. **Elophila claudialis** Walker.

July 2–20; August 12. Rare. On flowers in waste land and at light.

4500. **Elophila fulicalis** Clemens.

New Brighton, June 8–July 6; August 15–27 (Merrick, Engel). Very common along the margins of water courses.

4503. **Diathrausta reconditalis** Walker.

May 31–June 27; July 28–August 25. Common.

Subfamily SCOPARIINÆ.

4507. **Scoparia basalis** Walker.

June 11–30; August 25–September 15. Common.

——. **Scoparia penumbralis** Dyar.

New Brighton, June 28–July 1 (Merrick); Ohio Pyle, June 10 (Engel).

——. **Scoparia cinereomedia** Dyar.

New Brighton, June 26–July 21 (Merrick, Engel); Coraopolis, July 13; Ohio Pyle, July 16–21 (Kahl, Klages).

——. **Scoparia strigalis** Dyar.

Pittsburgh, June 6–July 14 (Marloff, Engel).

Subfamily PYRALINÆ.

4511. **Aglossa cuprealis** Hübner.

June 3–27; August 4. Common.

4513. **Hypsopygia costalis** Fabricius. July 7–18. Rare at light.

4514. **Pyralis cuprina** Zeller.

June 26–August 1. Common. At light in forests.

4514.1. **Pyralis costiferalis** Walker.

New Brighton, June 21–July 10 (Merrick); Ohio Pyle, July 28–August 1 (Kahl & Klages).

4516. **Pyralis farinalis** Linnæus.

June 4–July 19; September 9–28. Common.

4520. **Herculia intermedialis** Walker.

Pittsburgh, June 26–July 27 (Engel, Marloff); New Brighton, June 26–July 27 (Merrick).

4521. **Herculia olinalis** Guenée.

June 11–July 12. Rare at light.

4523. **Herculia himonialis** Zeller.

June 13–July 10. Rare. Taken at light.

4524. **Omphalocera cariosa** Lederer.

Pittsburgh, July 3, 1903, one specimen (Engel).

Subfamily CHRYSAUGINÆ.

4528. **Tosale oviplagalis** Walker.

June 5–July 29. Generally distributed, but scarce. The sexes are very dissimilar in this species.

4532. **Condylolomia participialis** Grote.

June 5–July 29. Common among herbage in woods.

4533. **Galasa rubidana** Walker.

Pittsburgh, June 24–July 12 (Engel, Marloff); New Brighton, July 8–August 1 (Merrick). Rare. At light.

Subfamily SCHŒNOBINÆ.

4543. **Schœnobius unipunctellus** Robinson.

Pittsburgh, June 2–28 (Engel, Marloff); New Brighton, June 19–July 17 (Merrick).

4545. **Schœnobius melinellus** Clemens.

Pittsburgh, June 15–25; September 12 (Engel); New Brighton, June 27–July 2 (Merrick).

Subfamily CRAMBINÆ.

4564. **Crambus girardellus** Clemens.

Pittsburgh, June 26–July 13 (Engel); New Brighton, June 25–July 18 (Merrick). Rare. At light in wooded sections.

4567. **Crambus præfectellus** Zincken.

May 24–June 8; August 19. Scarce. Occurring in waste lands and at light.

4573. **Crambus laqueatellus** Clemens.

May 23–June 17. Very common.

4574. **Crambus alboclavellus** Zeller.

May 30–July 2; July 20–August 2. Common.

4575. **Crambus agitatellus** Clemens.

June 11–July 9. Scarce, but generally distributed.

4577. **Crambus albellus** Clemens.

New Brighton, May 30–July 3; Pittsburgh, June 28–July 7 (Marloff). Rare in the vicinity of Pittsburgh, but common at New Brighton among low herbage in the woods.

4579. **Crambus hortuellus** Hübner.

Pittsburgh, May 27; July 4–29 (Engel, Marloff); New Brighton, July 29 (Merrick). Rare.

4581. **Crambus turbatellus** Walker.

July 2–August 5. Scarce, but generally distributed.

4582. **Crambus elegans** Clemens.

June 9–July 12; August 3–September 17. Common in waste land, especially along the margin of woods.

4585. **Crambus vulgivagellus** Clemens.

August 20–September 23. Common at light.

4587. **Crambus ruricolellus** Zeller.

August 14–September 23. Common.

4589. **Crambus teterrellus** Zincken.

Pittsburgh, June 10–30; August 6–September 14 (Engel, Marloff);

New Brighton, June 10–July 8; September 5 (Merrick). Rare. Taken at light.

4590. **Crambus decorellus** Zincken.

Pittsburgh, July 14–25 (Marloff); New Brighton, June 17–July 10 (Merrick). Rare. Taken at light. Mr. Marloff took his specimens in a hilly pasture field.

4601. **Crambus mutabilis** Clemens.

Pittsburgh, June 2–July 5; August 8–September 4 (Engel, Marloff); New Brighton, June 13 (Merrick). This species has occurred quite commonly in my traps on waste land.

4604. **Crambus trisectus** Walker.

May 29–June 20; August 4–September 5. Common.

4607. **Crambus caliginosellus** Clemens.

Pittsburgh, July 2–August 8 (Engel, Marloff); New Brighton, July 8–August 17 (Merrick). Rare. At light.

4608. **Crambus zeëllus** Fernald.

Pittsburgh, June 17–July 12; August 7 (Engel); New Brighton, June 26 (Merrick). Rare.

4609. **Crambus luteolellus** Clemens.

Pittsburgh, July 1–30 (Engel); New Brighton, July 5–August 17 (Merrick). Rare.

4620. **Argyria nivalis** Drury.

June 9–26; July 9–August 31. Common among low herbage in woods.

4622. **Argyria auratella** Clemens.

New Brighton, July 11–27. Rare. At light in the woods (Merrick).

4634. **Dicymolomia julianalis** Walker.

Pittsburgh, May 29–July 3 (Engel); New Brighton, July 9–11 (Merrick). Rare. At light.

Subfamily GALLERIINÆ.

4636.2. **Galleria mellonella** Linnæus.

Pittsburgh, August 9–October 12 (Marloff, Engel). A bee-hive greatly infested by this pest furnished several hundred specimens.

4636.3. **Paralipsa fulminalis** Zeller (?).

June 10–July 5. Rare. Dr. Dyar determined this species as probably *fulminalis*. It is much smaller and lighter in color than *furellus*.

4636.4. **Paralipsa furellus** Zeller.

Pittsburgh, May 19–July 2 (Engel); New Brighton, May 2–June 26; July 3–August 14 (Merrick). Rare. At light.

Subfamily EPIPASCHIINÆ.

4637. **Epipaschia superatalis** Clemens.

Pittsburgh, June 1–July 8 (Marloff, Engel); New Brighton, July 4, August 1 (Merrick).

4639. **Epipaschia zelleri** Grote.

Pittsburgh, July 2–6 (Marloff, Engel); New Brighton, August 9 (Merrick). This and the preceding species are very rare.

4644. **Oneida lunulalis** Hulst.

Pittsburgh, June 19–August 7 (Marloff & Ehrman); New Brighton, June 5, one specimen (Merrick). Rare.

4648. **Benta asperatella** Clemens.

May 18–June 30; August 3. Common.

4656. **Tetralopha nephelotella** Hulst.

Pittsburgh, May 29–June 16; August 16 (Marloff, Engel). Scarce.

4658. **Tetralopha militella** Zeller.

New Brighton, June 13–August 23 (Merrick); Pittsburgh, June 1–30 (Marloff, Engel).

Subfamily PHYCITINÆ.

4671. **Myelois obnupsella** Hulst.

May 8–June 21. Common at rest on twigs in thickets.

4675. **Myelois leucophæella** Hulst.

New Brighton, May 2–July 3 (Merrick); Pittsburgh, July 10, 11 (Marloff, Engel).

4676. **Myelois bistriatella** Hulst.

Pittsburgh, June 12, 1905, one specimen (Engel).

4686. **Acrobasis demotella** Grote.

Pittsburgh, July 12–13 (Engel); New Brighton, June 3–July 21, rare at rest on trees and at light in woods (Merrick); Ohio Pyle, August 23, 1907 (Kahl); Jeannette, June 25 (Ehrman).

4687. **Acrobasis angusella** Grote.

Pittsburgh, August 4 (Marloff); New Brighton, July 11–August 18 (Merrick). Rare. At light in the forest.

4689. **Acrobasis nigrosignella** Hulst.

Pittsburgh, July 1–16 (Marloff). Rare.

4693. **Acrobasis betulella** Hulst.
New Brighton, July 5–8 (Merrick). Rare at light.

——. **Acrobasis nebulella** Riley.
Pittsburgh, July 19–August 16 (Engel & Marloff); New Brighton, June 30–August 16 (Merrick). Rare. At light in the woods.

——. **Acrobasis Kearfottella** Dyar.
New Brighton, July 12 (Merrick). One specimen.

4704. **Mineola indigenella** Zeller.
June 2–29; July 2–22. Common.

——. **Tacoma nyssæcolella** Dyar.
Pittsburgh, May 29 (Marloff); New Brighton, July 10–August 20 (Merrick). Rare. At light in woods.

——. **Ambesa busckella** Dyar.
May 24–July 12. Scarce, but generally distributed.

4739. **Nephopteryx crassifasciella** Ragonot.
New Brighton, July 3, 1906. One specimen (Merrick).

4746. **Meroptera pravella** Grote.
New Brighton, May 31–July 5 (Merrick). Rare. At light.

4748. **Meroptera unicolorella** Hulst.
New Brighton, July 5–August 18 (Merrick). Rare. In woods.

4751. **Salebria nubiferella** Ragonot.
Pittsburgh, May 15–24, two specimens (Marloff).

4759. **Salebria contatella** Grote.
May 25–June 30; August 13–27. Common and very variable.

4760. **Salebria celtidella** Hulst.
Pittsburgh, June 22–27, two specimens (Marloff).

——. **Salebria engeli** Dyar.
Pittsburgh, July 10 (Marloff); New Brighton, July 31, 1907 (Merrick).

——. **Salebria vetustatella** Dyar.
Pittsburgh, May 3–June 12; July 9 (Engel, Marloff). Rare at light.

——. **Immyrla nigrovittella** Dyar.
Pittsburgh, May 12–June 2 (Engel); New Brighton, June 17 (Merrick). Rare at light.

——. **Cacotherapia flexilinealis** Dyar.
New Brighton, June 22–July 29 (Merrick); Pittsburgh, July 2 (Marloff). Rare.

4781. **Elasmopalpus lignosellus** Zeller.

Pittsburgh, August, one specimen (Marloff); August 2–September 5, several specimens in the Carnegie Museum.

4832. **Euzophera semifuneralis** Walker.

Pittsburgh, May 13–18; July 13–29 (Marloff, Engel); New Brighton, July 31 (Merrick). Rare. At light.

4835. **Euzophera ochrifrontella** Zeller.

May 7–June 30; August 8–September 8. Generally distributed and fairly common.

4838. **Vitula edmandsi** Packard.

June 8–July 4; August 5–October 12. Common.

4843. **Canarsia ulmiarrosorella** Clemens.

May 13–June 30; July 10–August 11. Common.

4868. **Homœosoma uncanale** Hulst.

New Brighton, August 5–September 5 (Merrick). Rare at light in woods.

4871. **Homœosoma mucidellum** Ragonot.

May 18–June 27; July 29–September 9. Common.

——. **Homœosoma reliquellum** Dyar.

Pittsburgh, May 23, August 23–September 3 (Engel); New Brighton, June 25–July 5 (Merrick). Rare. At light.

4879. **Ephestia elutella** Hübner.

July 3–29. Common in barns and stables.

4881. **Ephestiodes infimella** Ragonot.

Pittsburgh, August 20–29 (Engel). Rare. At light.

4886. **Manhatta ostrinella** Clemens.

Pittsburgh, May 25–July 21; August 11–September 21 (Marloff).

4890. **Plodia interpunctella** Hübner.

May 8–June 21; July 9–September 9. Generally distributed, but not common.

Subfamily ANERASTINÆ.

4911. **Peoria approximella** Walker.

June 23–July 11. Common at light.

4915. **Wekiva nodosella** Hulst (?).

May 3–July 20. Rare. At light. Dr. Dyar determined this form as probably Hulst's *nodosella*. It is smaller and of brighter color on the forewings, otherwise similar to the preceding species.

Family PTEROPHORIDÆ.

4931. **Trichoptilus lobidactylus** Fitch.

Pittsburgh, June 7–July 9 (Marloff, Engel). Flying in waste lands.

4932. **Oxyptilus periscelidactylus** Fitch.

New Brighton, June 17–July 15 (Merrick). At light and among low herbage in woods.

4935. **Oxyptilus tenuidactylus** Fitch.

June 13–July 7. Common on waste lands and at light.

4937. **Platyptilia cosmodactyla** Hübner.

New Brighton, May 7–18. Rare at light in woods (Merrick).

4941. **Platyptilia carduidactyla** Riley.

Pittsburgh, June 29–July 28 (Engel, Marloff).

4956. **Platyptilia marginidactyla** Fitch.

Pittsburgh, May 31–June 26 (Engel, Marloff); New Brighton, May 21–June 9 (Merrick). Common.

4962. **Pterophorus homodactylus** Walker.

June 15–July 25. Rare. At light.

4973. **Pterophorus paleaceus** Zeller.

May 5–24; August 6–16. Common on waste lands and at light.

4977. **Pterophorus Kellicotti** Fish.

Pittsburgh, May 26–June 27 (Engel, Marloff); New Brighton, June 20 (Merrick).

4981. **Pterophorus monodactylus** Linnæus.

August 31–December 12, March, April. A common species. Hibernating specimens may be taken, during warm spells in the winter.

4983. **Pterophorus eupatorii** Fernald.

New Brighton, July 10–August 2. Rare at light in woods (Merrick); Pittsburgh, July 5, one specimen at light (Engel).

4990. **Pterophorus inquinatus** Zeller.

May 27–June 18; July 8–August 19. Common on waste lands and at light.

Family TORTRICIDÆ.

Subfamily OLETHREUTINÆ.

——. **Polychrosis viteana** Clemens.

May 16–June 17; July, August, September. Common in the vicinity of wild grape vines in thickets.

——. **Polychrosis yaracana** Kearfott.

Pittsburgh, June 10, a specimen in the Carnegie Museum.

——. **Polychrosis slingerlandana** Kearfott.

New Brighton, August 25, 1905 (Merrick).

5007. **Bactra furfurana** Haworth.

Pittsburg, June 9 (Engel); Ohio Pyle, August 3; Jeannette, September 8 (Kahl & Klages). Carnegie Museum, Acc. No. 2723.

5010. **Exartema nitidanum** Clemens.

Ohio Pyle, August 4, 1905 (Kahl & Klages).

5012. **Exartema monetiferanum** Riley.

Pittsburgh, May 29 (Engel); May 31 (Marloff); New Brighton, June 1–13 (Merrick); Coraopolis, July 13. One specimen in the Carnegie Museum.

5015. **Exartema permundanum** Clemens.

June 9–24; July 28–August 23. Common.

5017. **Exartema concinnanum** Clemens.

June 9–24; July 28–August 23. Common.

——. **Exartema doxcanum** Kearfott.

June 8–July 21; August 4–18. This form occurs with the preceding species and appears to be an obscured variety of it.

5018. **Exartema versicoloranum** Clemens.

Pittsburgh, June 3–July 9 (Engel, Marloff); New Brighton, June 26–July 3 (Merrick).

5020. **Exartema atrodentanum** Fernald.

Pittsburgh, August 2–4 (Marloff); New Brighton, August 19 (Merrick). Rare.

5021. **Exartema fasciatanum** Clemens.

June 17–July 4. Common among herbage in woods.

——. **Exartema merrickanum** Kearfott.

June 3–August 13. Generally distributed, but rare and rather variable.

5023. **Exartema exoletum** Zeller.

June 11–July 9; August 1–30. Rare. At light and in sunny places in the woods.

5024. **Exartema inornatanum** Clemens.

July 2–August 12. Common in extensive forests.

——. **Exartema nigrilineanum** Kearfott.

Pittsburgh, Coraopolis, Ohio Pyle, July 13–29 (Kahl & Klages).

5025. **Exartema malanum** Fernald.

Ohio Pyle, July 25, 1905. Carnegie Museum, Acc. No. 2840.

——. **Exartema nigridorsanum** Kearfott.

Pittsburgh, June 23–July 3 (Engel, Marloff); Ohio Pyle, July 31 (Marloff); Pittsburgh, June 7–July 27 (Kahl & Klages).

——. **Exartema ochrixigranum** Kearfott.

Ohio Pyle, August 1, 1905. Paratype in Carnegie Museum.

——. **Exartema sciotoanum** Kearfott.

Coraopolis, July 13. Paratype in Carnegie Museum.

5027. **Exartema ferriferanum** Walker.

Pittsburgh, June 17–July 28 (Engel, Marloff); New Brighton, June 26–July 1 (Merrick). Rare.

5031. **Olethreutes nimbatana** Clemens.

June 7–19; July 13–28. Rare but generally distributed.

——. **Olethreutes separatana** Kearfott.

Pittsburgh, May 13–June 8; July 28–September 2 (Marloff, Engel); New Brighton, June 2, August 28 (Merrick).

5038. **Olethreutes hebesana** Walker.

May 14–June 14; August 18–September 20. Common.

5041. **Olethreutes hemidesma** Zeller.

New Brighton, September 25, one specimen (Merrick).

——. **Olethreutes removana** Kearfott.

Pittsburgh, July 1, 1908; August 30, 1905 (Engel); New Brighton, August 21 (Merrick).

5047. **Olethreutes chionosema** Zeller.

Pittsburgh, June 26–July 6, three specimens (Marloff, Engel); Jeannette, June 11 (Ehrman), in collection of W. J. Holland.

5050. **Olethreutes nubilana** Clemens.

Pittsburgh, June 2–July 21 (Engel, Marloff); New Brighton, June 15–22; August 16–September 3 (Merrick). Rare. At light.

5054. **Olethreutes albiciliana** Fernald.

May 29–June 24; July 2–September 19. Common.

5056. **Olethreutes coruscana** Clemens.

May 31–June 29. Fairly common and generally distributed.

5057. **Olethreutes constellatana** Zeller.

May 31–June 25. Very common in waste lands.

5064. **Olethreutes instrutana** Clemens.

June 16–28; August 11–September 9. Common.

5071. **Olethreutes bipartitana** Clemens.

May 7–28; July 29–August 24. Common in bottom lands.

5073. **Olethreutes impudens** Walsingham.

June 1–9; August 17–September 18. Common in waste lands and thickets.

5077. **Phæcasiophora confixana** Walker.

May 17–June 16. Very common in forests of hard timber.

5078. **Pseudogalleria inimicella** Zeller.

New Brighton, May 31, 1903, one specimen (Merrick).

5079. **Eucosma circulana** Hübner.

Pittsburgh, June 1–July 13. Rare. At light (Engel, Marloff).

5096. **Eucosma cataclystiana** Walker.

June 19–July 2; August 16–30. Rare. At light.

——. **Eucosma pergandeana** Fernald.

Pittsburgh, June 6–July 20 (Engel, Marloff); Jeannette, August 6 (Klages); New Brighton, July 16 (Merrick). Rare. At light.

——. **Eucosma sombreana** Kearfott.

Pittsburgh, July 19–August 26 (Engel, Marloff); New Brighton, July 21–August 17 (Merrick). Rare. At light.

——. **Eucosma gonomana** Kearfott.

Pittsburgh, July 14 (Marloff). One specimen.

——. **Eucosma wandana** Kearfott.

Pittsburgh, June 29–August 8 (Engel, Marloff); New Brighton, June 19–August 17 (Merrick); Pittsburgh and Ohio Pyle, August (Kahl & Klages).

——. **Eucosma zomonana** Kearfott.

Pittsburgh, August 12–15 (Engel); Jeannette, August 13 (Klages); New Brighton, May 22–June 6; August 23–September 14 (Merrick). Rare. At light.

——. **Eucosma yandana** Kearfott.

New Brighton, March 26–April 11 (Merrick). Recorded by Mr. Kearfott in the description, the species is not now represented in the local collections.

——. **Eucosma tandana** Kearfott.

Pittsburgh, June 16 (Engel); Mr. Kearfott in his description notes a specimen from New Brighton, taken July 18 (Merrick).

5121. **Eucosma juncticiliana** Walsingham.

Pittsburgh, July 19–August 24 (Engel, Marloff); New Brighton, July 21–August 23 (Merrick). Rare in the woods and at light.

5124. **Eucosma abbreviatana** Walsingham.

Pittsburgh, May 14 (Marloff); New Brighton, May 31 (Merrick).

5127. **Eucosma solicitana** Walker.
Pittsburgh, May 21 (Marloff).
5128. **Eucosma transmissana** Walker.
Pittsburgh, June 18–July 12 (Engel, Marloff). Rare.
——. **Eucosma tomonana** Kearfott.
Pittsburgh, August 20–September 7 (Engel); New Brighton, August 23 (Merrick). Rare. At light.
——. **Eucosma minuatana** Kearfott.
May 26–July 1; August 16–October 2. Common. This species is labelled *strenuana* Walker in most of the collections.
5130. **Eucosma perplexana** Fernald.
Pittsburgh, July 2–11 (Engel). Rare. At light.
——. **Eucosma walkerana** Kearfott.
New Brighton, August 10, 1905 (Merrick).
——. **Eucosma dorsisuffusana** Kearfott.
Pittsburgh, July 3 (Engel).
——. **Eucosma medioviridana** Kearfott.
New Brighton, August 25–September 11 (Merrick, Engel).
——. **Eucosma engelana** Kearfott.
Pittsburgh, August 20–September 3 (Engel).
——. **Eucosma brightonana** Kearfott.
New Brighton, July 29–September 5 (Merrick); Pittsburgh, July 13 (Engel). The New Brighton data are partly copied from the description.
5131. **Eucosma nisella** Clerck.
New Brighton, August 11, 1905 (Merrick).
——. **Eucosma medioviridana** Kearfott.
New Brighton, August 25–September 16. Rare, at light in a forest (Merrick).
5138. **Eucosma illotana** Walsingham.
Pittsburgh, May 20–June 18 (Engel). Rare.
5140. **Eucosma desertana** Zeller.
New Brighton, May 22–July 17 (Merrick); Pittsburgh, June 3 (Engel). Rare.
5140.1. **Eucosma obfuscana** Riley.
Pittsburgh, June 4–18 (Engel, Marloff); Jeannette, May 23 (Klages).
5142. **Eucosma otiosana** Clemens.
May 30–June 20; August 2–29. Common.

——. **Eucosma dorsisuffusana** Kearfott.

Pittsburgh, June 20–July 6 (Engel). Rare among herbage in woods.

——. **Eucosma engelana** Kearfott.

Pittsburgh, August 21–September 2. Rare. At light (Engel).

5144. **Eucosma dorsisignatana** Clemens.

August 5–September 24. Common. A variable species; the named varieties are represented among the local material.

5150. **Eucosma carolinana** Walsingham.

New Brighton, July 31–August 14 (Merrick, Engel); Pittsburgh, July 4 (Engel); August 4, 1907, one specimen (Marloff). This species was bred by the writer from *Eupatorium purpureum*. The pupæ were found in the stems at the crown of the roots.

5163. **Thiodia radiatana** Walsingham.

New Brighton, May 19–June 10 (Merrick, Engel). Rare in hilly pasture lands.

——. **Thiodia roseoterminana** Kearfott.

May 20–June 21. Common in waste lands.

——. **Thiodia umbrastriatana** Kearfott.

New Brighton, May 23–July 1 (Merrick). Rare. At light and in waste lands.

5164. **Thiodia olivaceana** Riley.

New Brighton, July 2–19 (Merrick). Rare. At light in the woods.

——. **Thiodia imbridana** Fernald.

Pittsburgh, August 16–September 1 (Engel); New Brighton, August 5–17 (Merrick); Jeannette, August 6–24 (Klages). Rare.

5165. **Thiodia formosana** Clemens.

May 25–June 25. Rare in pastures and waste lands.

——. **Thiodia ochrotermenana** Kearfott.

Ohio Pyle, August, Carnegie Museum; New Brighton, August 6–10 (Merrick); Pittsburgh, August 19–23 (Marloff). Rare. At light.

5177. **Thiodia striatana** Clemens.

Pittsburgh, May 24–June 20 (Engel, Marloff); New Brighton, May 3 (Merrick). Rare. At light and in pasture lands.

5189. **Thiodia signatana** Clemens.

May 14–June 13. Generally distributed, but not common.

5196. **Thiodia refusana** Walker.

New Brighton, May 8–14 (Merrick, Engel); Pittsburgh, May 15 (Marloff); Jeannette, May 5 (Klages). Rare. In waste lands.

5207. **Episimus argutanus** Clemens.

May 26–July 3; August 12–September 16. Common in the vicinity of sumac.

——. **Steganoptycha bolliana** Slingerland.

Pittsburgh, August 19–September 29 (Engel); Oak Station, June 12–24, September 7 (Marloff); New Brighton, September 5–17 (Merrick).

5212. **Proteopteryx cressoniana** Clemens.

March 26–May 9. Rather rare, but represented from the several localities.

——. **Proteopteryx laracana** Kearfott.

New Brighton, April 15–May 10 (Merrick); Pittsburgh, April 22 (Marloff). Rare. At rest on trees in forests.

5213. **Proteopteryx deludana** Clemens.

April 30–June 7. Common.

5214. **Proteopteryx spoliana** Clemens.

March 23–April 25. This very variable species is abundant in extensive forests.

5215. **Proteopteryx resuptana** Walker.

New Brighton, March 14–May 8 (Merrick). Rare. Found in woods resting on trees.

5216. **Proteopteryx virginiana** Clemens.

Pittsburgh, March 28–April 26 (Engel); New Brighton, March 26–April 28 (Merrick). Common in large woods.

5217. **Proteopteryx costomaculana** Clemens.

April 24–June 17. Common in woods, especially in the neighborhood of witch-hazel.

——. **Proteopteryx albicapitana** Kearfott.

New Brighton, March 22 (Merrick). Mr. Kearfott notes this specimen in the description. It is not represented at present in the local collections.

5219. **Proteoteras æsculanum** Riley.

April 2–June 19. Rare, but represented from the various localities. It occurs at rest on trees in thickets and dense forests.

——. **Proteoteras moffatiana** Fernald.

Pittsburgh, June 25–July 31 (Engel, Klages, Krautwurm); July 4, Carnegie Museum (Acc. 2733); New Brighton, July 27 (Merrick). Very rare. At rest on trees in woods.

——. **Proteoteras naracana** Kearfott.

Pittsburgh, May 11–June 19 (Kahl, Klages, Engel). New Brighton, May 31–July 7 (Merrick, Engel). Rare. At rest on trees in woods.

5227. **Epinotia crispana** Clemens.

June 3–12, August 2–31. Common at light and in waste lands.

——. **Epinotia haimbachiana** Kearfott.

Pittsburgh, June 14–July 26 (Marloff, Engel). Common on waste lands.

——. **Epinotia watchungana** Kearfott.

Pittsburgh, April 29–May 14 (Marloff, Engel); New Brighton, March 22–May 16 (Merrick). Rare. In woods.

——. **Epinotia pseudotsugana** Kearfott.

Jeannette, August 6 (Klages); Pittsburgh, August 14 (Marloff).

5235. **Epinotia lindana** Fernald.

New Brighton, September 16–October 19 (Merrick, Engel). At light and at rest in the woods.

5237. **Tmetocera ocellana** Schiffermüller.

Pittsburgh, June 8–July 7; August 3–6 (Marloff, Engel). Common, resting on the trees in apple-orchards.

5238. **Eudemis vacciniana** Packard.

Ohio Pyle, July 16 (Kahl, Klages).

5240. **Ancylis nubeculana** Clemens.

May 14–June 10. This species is quite common on hawthorn.

5243. **Ancylis semiovana** Zeller.

New Brighton, June 5–July 22 (Merrick, Engel). Rare. Occurring in hilly pasture-lands.

5244. **Ancylis murtfeldtiana** Riley.

May 6–27; July 2–18. Common in pasture-lands.

5246. **Ancylis spiræifoliana** Clemens.

Pittsburgh, June 13. Carnegie Museum (Acc. 2960).

5248. **Ancylis burgessiana** Zeller.

May 27–June 10. Common and generally distributed.

5249. **Ancylis dubiana** Clemens.

May 25–June 19. Common along the margins of woods.

5252. **Ancylis comptana** Frölich.

Pittsburgh, May 9–27; August 16 (Marloff); New Brighton, May 29–June 6 (Merrick, Engel). Common in strawberry-fields.

5253. **Ancylis angulifasciana** Zeller.

Pittsburgh, July 15. Carnegie Museum (Acc. 2723). Determined by Mr. Kearfott. It is similar to if not the same as 5244, which was determined at the U. S. National Museum.

5254. **Ancylis platanana** Clemens.

May 21–June 15; August 15. Common on bushes in sunny glens.

5255. **Ancylis divisana** Walker.

Pittsburgh, May 20–June 21; August 30 (Marloff, Engel); New Brighton, June 7–July 9 (Merrick). Rare. Occurring in sunny places in woods.

5256. **Ancylis apicana** Walker.

Pittsburgh, May 20, August 12 (Engel, Marloff); New Brighton, June 1–July 7 (Merrick). Rare.

5258. **Ancylis muricana** Walsingham.

May 27–June 14. Common on waste lands on blackberry bushes.

——. **Ancylis diminutana** Kearfott.

Pittsburgh, May 14–24; July 6–27 (Engel). Rare. Taken at light. The larva occurs on willow.

5269. **Enarmonia prunivora** Walsh.

May 30–June 21; August 12–September 9. Fairly common on hawthorn.

5270. **Enarmonia interstinctana** Clemens.

May 29–June 24; July 27–August 25. Common on waste lands.

——. **Enarmonia eclipsana** Zeller.

Pittsburgh, April 27–May 17 (Marloff, Engel). Fairly common in locust thickets.

——. **Enarmonia dana** Kearfott.

Pittsburgh, May 20 (Kahl & Klages).

——. **Enarmonia nigricana** Stephens.

May 27–June 17. Common on waste lands.

5279. **Enarmonia lautana** Clemens.

Pittsburgh, April 13 (Engel); New Brighton, April 14 (Merrick). Very rare. Found at rest on trees in woodlands.

5280. **Enarmonia gallæsaliciana** Riley.

Pittsburgh, June 19–July 10; August 27 (Engel, Marloff); New Brighton, July 20 (Merrick). Rare. Among the herbage in woods.

——. **Enarmonia articulatana** Kearfott.

New Brighton, June 5 (Merrick).

5287. **Ecdytolopha insiticiana** Zeller.

Pittsburgh, May 10–June 2; August 6–13 (Engel, Marloff); New Brighton, June 5 (Merrick). Rare. At light.

——. **Gymnandrosoma punctidiscanum** Dyar.

Pittsburgh, July 21–August 29 (Marloff, Engel); New Brighton, June 14, September 27 (Merrick).

5288. **Hemimene incanana** Clemens.

May 26–June 22; August 12–25. Common among herbage in woods. This species was determined by Mr. Kearfott. Mr. Busck has described it as *leopardana*.

5289. **Hemimene simulana** Clemens.

June 22–July 7; August 15–September 3. Common on waste lands among berry-bushes.

——. **Hemimene bittana** Busck.

May 29–June 27; July 13–August 3. Common at light and among herbage in the woods.

5295. **Melissopus latiferreanus** Walsingham.

Pittsburgh, July 28–September 6 (Marloff); Ohio Pyle and Jeannette, June 15; August 10–September 19 (Kahl, Klages); New Brighton, July 11–August 22 (Merrick).

5296. **Carpocapsa pomonella** Linnæus.

May 20–June 18; August 7–26. Common in orchards.

Subfamily TORTRICINÆ.

5300. **Acleris peculiana** Zeller.

November 1–April. Rare. This form is similar to *subnivana* Walker, but has the primaries densely spotted with dark brown.

5301. **Acleris subnivana** Walker.

October 2–December; March, April. Rare. In thickets.

5302. **Acleris trisignana** Robinson.

New Brighton, November 1 (Merrick).

5305. **Acleris nigrolinea** Robinson.

Pittsburgh, March 20, 1905 (Marloff).

5309. **Acleris hastiana** Linnæus.

November 4–January 6; July 7–August 3. Common in thickets among wild grape-vines. This is a most remarkable species of which nine distinct forms have been collected in this vicinity by Mr. Marloff and the writer. They all remain to be determined.

5309d. Var. **maculidorsana** Clemens.

New Brighton, August 24–September 5; March 11 (Merrick); Ohio Pyle, August 1 (Carnegie Museum, Acc. 2840).

5312. **Acleris logiana** Schiffermüller.

Pittsburgh, November 4–December 8 (Engel, Marloff); New Brighton, November 10–17 (Merrick). Rare.

5314. **Acleris nivisellana** Walsingham.

September 9; October 16–April 9. Rare in thickets and resting on wild grape-vines.

5315. **Acleris schalleriana** Linnæus.

New Brighton, October 12–November 23 (Merrick). Rare. On saplings in thickets.

5316. **Acleris ferrugana** Schiffermüller.

New Brighton, October 11–November 5 (Merrick); Pittsburgh, October 22 (Marloff). Rare.

5319a. **Acleris cinderella** Riley.

New Brighton, May 13 (Merrick).

5322. **Acleris chalybeana** Fernald.

New Brighton, November 3; March 6–May 8 (Merrick). Rare. In thickets.

5323. **Acleris cervinana** Fernald.

Pittsburgh, November 4–January 8 (Marloff, Engel); New Brighton, November 4 (Merrick). Rare.

5331. **Epagoge sulfureana** Clemens.

June 9–28; August 18–September 2. Common on waste lands.

5336. **Cenopis pettitana** Robinson.

New Brighton, July 5, 1902 (Merrick); Pittsburgh, June 12 (Marloff).

5337. **Cenopis diluticostana** Walsingham.

Pittsburgh, July 6; Ohio Pyle, July 25 (Kahl, Klages).

5339. **Cenopis groteana** Fernald.

New Brighton, June 22–July 16 (Merrick); Pittsburgh, July 7–20 (Engel). Rare. Taken at light.

5340. **Cenopis testulana** Zeller.

Pittsburgh (H. H. Smith). In Carnegie Museum.

5344. **Cœlostathma discopunctana** Clemens.

May 30–June 11; August 7–19. Common.

5349. **Sparganothis xanthoides** Walker.

Pittsburgh, June 18–July 12 (Engel, Marloff); New Brighton, July 5–9 (Merrick). Rare. At light.

5350. **Sparganothis irrorea** Robinson.

May 2–July 12. Common among low herbage in woods.

5356. **Archips rosaceana** Harris.

June 9–July 12. Common.

5357. **Archips purpurana** Clemens.

June 10–July 17. Common.

5361. **Archips rileyana** Grote.

New Brighton, June 24–July 11 (Merrick); Charleroi, June 24 (Ehrman). Rare.

5365. **Archips argyrospila** Walker.

June 15–29. Common. Found at light, and among low herbage in woods.

Var. **mortuana** Kearfott.

New Brighton, June 20 (Merrick). Mr. Kearfott notes this specimen in his description.

5366. **Archips semiferana** Walker.

Pittsburgh, May 28–June 17 (Engel, Marloff); New Brighton, July 12 (Merrick); Jeannette, June 27 (Klages). Rare.

5371. **Archips fractivittana** Clemens.

May 29–June 25. Rare. At light.

5372. **Archips grisea** Robinson.

Pittsburgh, June 24, two specimens (Engel, Marloff); New Brighton, June 22, one specimen (Merrick).

——. **Archips brauniana** Kearfott.

Pittsburgh, June 11–17 (Engel); New Brighton, June 22–July 20 (Merrick). Rare. Taken at light in woods.

5373. **Archips afflictana** Walker.

New Brighton, May 7–23 (Merrick, Engel). Rare. Found at light, and at rest on trees in woods.

5375. **Archips virescana** Clemens.

Pittsburgh, May 21–25; July 26 (Engel, Marloff); May 24 (Carnegie Museum, Acc. 2960). Rare.

5377. **Archips clemensiana** Fernald.

June 2–18; July 6–15. Common at light and among low herbage in woods.

5379. **Archips persicana** Fitch.

One specimen in the Holland Collection in the Carnegie Museum, bearing label, "Pa." [Taken in Schenley Park, Pittsburgh. *Editor.*]

5380. **Archips melaleucana** Walker.

May 20–June 18. Common in forests.

5382. **Platynota flavedana** Clemens.

June 9–30; August 13–24. Common on ironweed in pasture-lands.

5387. **Platynota sentana** Clemens.

June 2–27; July 23–August 2. Common on saplings in thickets.

5391. **Pandemis limitata** Robinson.

June 10–27; August 31–September 13. Common among herbage in woodlands.

5392. **Pandemis lamprosana** Robinson.

Pittsburgh, June 11–July 14 (Engel, Marloff); New Brighton, July 9; September 2–16 (Merrick). Rare. Taken at light. Larva on witch-hazel.

5396. **Tortrix pallorana** Robinson.

Pittsburgh, May 28–June 20; August 8–September 2 (Engel, Marloff). Rare.

5399. **Tortrix quercifoliana** Fitch.

June 10–July 19. Rare. At light.

5400. **Tortrix albicomana** Clemens.

June 10–July 26. Common in forests. More than 60 specimens of this variable species were collected by the writer on June 10 at Ohio Pyle, representing the different forms to which varietal names have been applied.

5401. **Tortrix bergmanniana** Linnæus.

New Brighton, June 20–July 19 (Merrick); Jeannette, June 24 (Klages). Rare. Found at light in forests.

5402. **Tortrix peritana** Clemens.

May 24–June 12; August 16–31. Common in waste lands and in woods.

5412. **Tortrix basiplagana** Walsingham.

New Brighton, September 23, 1905, two specimens (Merrick).

5419. **Eulia quadrifasciana** Fernald.

Pittsburgh, June 18–July 4 (Engel, Marloff). Rare.

5420. **Eulia juglandana** Fernald.

Ohio Pyle, August 3 (Kahl, Klages); New Brighton, June 17–August 5 (Merrick). Fairly common at light in the woods.

5421. **Eulia triferana** Walker.

April 12–May 29; August 10–26. Common.

5424. **Eulia velutinana** Walker.

April 18–30; July 3–August 30. Common.

5427. **Eulia mariana** Fernald.

New Brighton, April 27–May 29 (Merrick, Engel). Rare. Found at rest on trees in forests.

5428. **Eulia alisellana** Robinson.

Pittsburgh, June 17–27 (Marloff); New Brighton, June 9–July 3 (Merrick); Ohio Pyle, June 10 (Engel). Rare.

5429. **Amorbia humerosana** Clemens.

May 20–June 18. Common in thickets.

Subfamily Phaloniinæ.

5431. **Phalonia floccosana** Walker.

May 21–June 20. Common at light and among low herbage in woods.

——. **Phalonia atomosana** Busck.

Pittsburgh, August 2–September 17 (Engel); New Brighton, August 26–September 13 (Merrick, Engel). The writer has bred this species from the roots of boneset, *Eupatorium perfoliatum.*

——. **Phalonia biscana** Kearfott.

Pittsburgh, August 2 (Engel); Ohio Pyle and Jeannette, August 11–20 (Kahl, Klages); New Brighton, August 24–September 8 (Merrick).

5440. **Phalonia dorsimaculana** Robinson.

June 4–July 2; August 13–September 16. Common in forests.

——. **Phalonia ednana** Kearfott. Pittsburgh, July 8, 1906 (Engel). One specimen.

5445. **Phalonia angulatana** Robinson.

June 5–27; August 12–September 17. Common.

5446. **Phalonia argentilimitana** Robinson.

May 18–June 16; July 8–September 14. Rare. In pasture-fields.

5449. **Phalonia labeculana** Robinson.

May 5–July 7; August 20–September 19. Common in pasture-lands.

5451. **Phalonia interruptofasciata** Robinson.

Pittsburgh, June 23–July 31 (Engel, Marloff); New Brighton, July 1–14 (Merrick). Rare. Found at light and among low herbage in forests.

——. **Phalonia aureana** Busck.

Pittsburg, June 20–July 4; August 4 (Engel, Marloff). Rare. Occurs in patches of wild aster.

5452. **Phalonia bunteana** Robinson.

June 8–20; August 3–September 9. Common on waste lands.

——. **Phalonia hollandana** Kearfott.

August 18–September 21. Fairly common on waste lands and resting on fences.

——. **Phalonia zaracana** Kearfott.

Pittsburgh, July 14 (Carnegie Museum, Acc. 2723), a specimen determined by Mr. Kearfott. It is very close to *hollandana*.

5453. **Phalonia œnotherana** Riley.

Pittsburgh, August 11 (Engel); New Brighton, May 29–June 6 (Merrick, Engel). Rare. On waste lands.

5455. **Phalonia hospes** Walsingham.

Pittsburgh, August 18–September 4 (Marloff, Kahl, Klages); Ohio Pyle, August (Klages).

——. **Phalonia schwarziana** Busck.

Pittsburg, July 17, 1906 (Marloff). One specimen.

——. **Phalonia marloffiana** Busck.

Pittsburgh, May 27–July 4 (Marloff, Engel); New Brighton, June 20 (Merrick). Rare. Occurs on waste lands.

——. **Phalonia nonlavana** Kearfott.

Pittsburgh, June 4–July 6 (Marloff, Engel); New Brighton, June 17–26 (Merrick).

——. **Phalonia temerana** Busck.

Pittsburgh, May 16–June 10 (Marloff, Engel); New Brighton, May 30 (Merrick).

——. **Phalonia discana** Kearfott.

July 12–September 6. Common at light and on waste lands.

——. **Phalonia winniana** Kearfott.

New Brighton, July 8–26 (Merrick); Pittsburgh, August 3 (Engel). Rare. At light.

5460. **Phalonia parvimaculana** Walsingham.

New Brighton, June 11 (Merrick); Pittsburgh, June 8–July 21 (Engel). Rare. At light.

——. **Phalonia rana** Busck.

Pittsburgh, July 30–September 10 (Engel, Marloff, Friday); New Brighton, August 20–September 6 (Merrick); Ohio Pyle, August 2 (Kahl, Klages). The larvæ of this strikingly marked species feed in the stems and roots of ironweed, and pupate in the galleries.

——. **Phalonia punctadiscana** Kearfott.

Oak Station, Pittsburgh, July 29–August 8 (Marloff).

——. **Commophila contrastana** Kearfott.

Pittsburgh, May 23–29, three specimens (Engel, Marloff); Jeannette, May 20 (Ehrman), in coll. W. J. Holland.

——. **Hysterosia birdana** Busck.

New Brighton, July 10–August 15 (Merrick, Bird, Engel); Pittsburgh, July 23 (Engel). Bred from roots of *Rudbeckia*.

——. **Hysterosia terminana** Busck (*Merrickana* Kearfott).

Pittsburgh, August 12–27 (Engel, Marloff); New Brighton, July 25–September 11 (Merrick). Common in open woods at rest on the trees.

——. **Hysterosia cartwrightana** Kearfott.

Pittsburgh, July 21–30 (Engel); New Brighton, August 1–13 (Merrick). Rare. At light.

——. **Hysterosia modestana** Busck.

Pittsburgh, June 29–July 23; August 18 (Engel, Marloff); New Brighton, July 24–August 16 (Merrick); Ohio Pyle, August 10 (Carnegie Museum). Rare. At light.

——. **Hysterosia baracana** Busck.

Pittsburgh, July 5–August 13 (Engel); New Brighton, July 18–August 30 (Merrick). Rare. At light.

——. **Hysterosia tiscana** Kearfott.

Pittsburgh, August 24 (Carnegie Museum, Acc. 2723).

5475.1. **Carposina crescentella** Walsingham.

New Brighton, April 29–May 30 (Merrick, Engel). Rare. Found at rest on trees in the woods.

——. **Carposina fernaldana** Busck.

Pittsburgh, June 21; August 11–26 (Engel, Marloff); New Brighton, June 28; August 13–September 29 (Merrick). Common on hawthorn.

Family YPONOMEUTIDÆ.

5476. **Martyringa latipennis** Walsingham.

New Brighton, July 1–30 (Merrick); Ohio Pyle, August 23 (Kahl); Pittsburgh, June 31–July 15 (Engel, Marloff).

5477. **Yponomeuta multipunctella** Clemens.

Pittsburgh, June 24–July 3 (Engel, Krautwurm); New Brighton, July 16 (Merrick). Rare. At light.

5503. **Plutella maculipennis** Curtis.

Pittsburgh, May 29–June 15; July 19–September 17 (Engel, Marloff); New Brighton, June 2–July 18 (Merrick).

5513. **Glyphipteryx impigritella** Clemens.
New Brighton, June 14 (Engel); Jeannette, July 20 (Klages).

——. **Tinagma crenulellum** Engel.
Pittsbugh, June 24–July 12; New Brighton, May 31–June 4 (Engel). Rare. On waste lands.

5519. **Choreutis inflatella** Clemens.
Pittsburgh, June 3–8; August 10–20 (Kahl, Klages, Marloff); New Brighton, June 27–July 5 (Merrick, Engel). In sunny places in the woods.

5522. **Choreutis gnaphaliella** Kearfott.
Pittsburgh, May 27, September 8–October 17 (Kahl, Klages, Marloff, Engel); New Brighton, June 3–July 13 (Merrick, Engel). Rare. On blossoms of yarrow.

5528. **Choreutis extrincicella** Dyar.
Pittsburgh, June 4–27 (Engel, Marloff). Rare. On flowers on waste lands.

5532. **Brenthia pavonacella** Clemens.
Pittsburgh, May 16–June 1; July 20–August 18 (Engel, Marloff); Ohio Pyle and Pittsburgh, July 25–August 4 (Kahl, Klages).

Family GELECHIIDÆ.

5539. **Metzneria lappella** Linnæus.
Pittsburgh, June 20–29 (Engel, Marloff); New Brighton, July 10–31 (Merrick). Rare. At light in the woods.

5540. **Paltodora striatella** Hübner.
New Brighton, August 26–September 1 (Merrick).

5546. **Paltodora anteliella** Busck.
Pittsburgh, August 23–September 11 (Engel, Marloff); New Brighton, August 26–September 11 (Merrick, Engel). Common.

5552. **Sitotroga cerealella** Olivier.
Pittsburgh, June 6 (Carnegie Museum, Acc. 2723).

5554. **Telphusa longifasciella** Clemens.
New Brighton, April 26, 1903, one specimen (Merrick).

——. **Telphusa fuscopunctella** Clemens.
Pittsburgh, June 12–July 7 (Marloff); New Brighton, July 11–12 (Merrick, Engel). Rare. On trees in woods.

5558. **Telphusa palliderosacella** Chambers.
May 2–30. Common in forests.

5561. **Telphusa basifasciella** Zeller.
Pittsburgh, June 1–27 (Marloff).

5572. **Chrysopora lingulacella** Clemens.
Pittsburgh, May 20, July 8 (Engel). Two specimens.

5575. **Aristotelia roseosuffusella** Clemens.
June 7–July 15; August 12–19. Common at light and on low herbage on waste lands.

5578. **Aristotelia rubidella** Clemens.
Pittsburgh, June 20; August 2–28 (Engel, Marloff). Common.

5579. **Aristotelia fungivorella** Clemens.
Pittsburgh, July 1, 2 (Engel, Marloff); July 11 (Carnegie Museum).

5586. **Aristotelia minimella** Chambers.
Pittsburgh, July 15–August 26 (Engel). Rare. At light.

5589. **Aristotelia gilvolinella** Clemens.
Pittsburgh, July 1–21 (Engel, Marloff). Rare. Among low herbage in woods.

5590. **Aristotelia angustipennella** Clemens (*kearfottella* Busck).
June 27–August 6. Common in forests.

5591. **Aristotelia quinquepunctella** Busck.
New Brighton, June 14–July 12 (Merrick); Pittsburgh, July 10 (Carnegie Museum).

5593. **Evippe prunifoliella** Chambers.
Pittsburgh, May 16–June 5; August 9 (Marloff).

5599. **Recurvaria obliquestrigella** Chambers.
New Brighton, March 18–April 29 (Merrick, Engel).

5600. **Recurvaria cratægella** Busck.
Pittsburgh, June 8–July 30 (Engel, Marloff); New Brighton, July 16 (Merrick). Common in orchards.

5601. **Recurvaria robiniella** Fitch.
June 3–July 22; August 1–15. Common in locust thickets.

5602. **Recurvaria quercivorella** Chambers.
March 22–May 16. Common on oak.

5608. **Epithectis attributella** Walker.
June 21–July 27. Common in forests.

5615. **Paralechia cristifasciella** Chambers.
March 28–May 1; July 1–20. Common.

5617. **Phthorimæa glochinella** Zeller.
New Brighton, May 16 (Merrick).

5620. **Gnorimoschema gallæsolidaginis** Riley.
September 12–29. Common.

5621. **Gnorimoschema gallæasteriella** Kellicott.
Pittsburgh, September 1 (Engel).

——. **Gnorimoschema henshawiella** Busck.

Pittsburgh, June 7–July 16; August 9 (Marloff).

——. **Gnorimoschema artemisiella** Kearfott.

Pittsburgh, April 12–May 6 (Engel); New Brighton, May 6–June 14 (Merrick, Engel).

5636. **Gnorimoschema banksiella** Busck.

Pittsburgh, June 7–July 10; July 30–August 9 (Marloff, Engel); New Brighton, July 5–27 (Merrick). Rare. In forests.

——. **Gnorimoschema claricella** Busck.

Pittsburgh, September 11–28 (Marloff, Engel).

5637. **Gnorimoschema batanella** Busck.

Pittsburgh, June 10–July 14 (Engel, Marloff); New Brighton, July 9 (Merrick).

5650. **Menesta tortriciformella** Clemens.

Pittsburgh, June 28 (Engel); July 6–August 11 (Marloff).

5653. **Strobisia irridipennella** Clemens.

Pittsburgh, July 1–August 4 (Marloff, Kahl, Klages).

5654. **Strobisia emblemella** Clemens.

Pittsburgh, July 1–August 1 (Engel, Marloff).

5655. **Trichotaphe flavocostella** Clemens.

Pittsburgh, June 26–August 4 (Marloff, Engel); New Brighton, June 20–July 29 (Merrick).

5659. **Trichotaphe alacella** Clemens.

July 1–29. Common in patches of wild aster.

5661. **Trichotaphe nonstrigella** Chambers.

New Brighton, June 14–21, two specimens (Engel) in Merrick Museum.

5662. **Trichotaphe juncidella** Clemens.

June 7–20; July 12–August 26. Common on waste lands where aster grows.

——. **Trichotaphe washingtoniella** Busck.

Pittsburgh, June 13–July 16; August 15–24 (Engel, Marloff); New Brighton, July 13–September 3 (Merrick).

——. **Trichotaphe trinotella** Busck.

Pittsburgh, June 3; August 18–24 (Engel); New Brighton, June 28, August 18 (Merrick).

5667. **Trichotaphe chambersella** Murtfeldt.

Pittsburgh, August 18–23 (Engel). Rare. On low herbage in forests.

——. **Glyphidocera speratella** Busck.

New Brighton, June 28–July 16 (Merrick). Rare. At light in the woods.

——. **Glyphidocera aberatella** Busck.

Pittsburgh, July 2–23; August 16–September 3 (Marloff, Engel).

5675. **Anorthosia punctipennella** Clemens.

June 15–July 28. Common in forests.

5678. **Ypsolophus ligulellus** Hübner.

April 30–May 18; July 2–August 12. Common.

——. **Ypsolophus flavivittellus** Clemens.

Pittsburgh, July 2–15 (Marloff, Engel); New Brighton, July 6–August 25 (Merrick). Rare in forests. This is a constant variety and should be listed.

5679. **Ypsolophus punctidiscellus** Clemens.

May 31–June 25. Common in forests.

5685. **Ypsolophus ventrellus** Fitch.

New Brighton, March 10, October 17, two specimens (Merrick).

5686. **Ypsolophus eupatoriellus** Chambers.

May 17–June 15; July 30–August 13. Common.

5696. **Aproærema palpilineella** Chambers.

New Brighton, September 28 (Merrick).

5699. **Aproærema nigratomella** Clemens.

June 3–July 12. Rare. On low herbage in woods.

5702. **Anacampsis rhoifructella** Clemens.

New Brighton, August 11–29 (Merrick).

5711. **Anacampsis agrimoniella** Clemens.

Pittsburgh, July 21 (Marloff); New Brighton, July 17–September 3 (Merrick, Kearfott, Engel). Common.

——. **Anacampsis nonstrigella** Busck.

Pittsburgh, July (Marloff); New Brighton, July 13, August 6 (Merrick); Coraopolis, July 10 (H. H. Smith in Carnegie Museum).

5713. **Anacampsis levipedella** Clemens.

Pittsburgh, September 23–October 7 (Engel); Ohio Pyle, July 27–August 8 (Kahl, Klages).

5714. **Gelechia cercerisella** Chambers.

Pittsburgh, May 31–July 2; July 16–August 25 (Marloff, Engel). Rare in thickets.

5718. **Gelechia trialbamaculella** Chambers.

New Brighton, May 25; July 9–September 13 (Merrick). Pittsburgh, June 3 (Marloff).

5720. **Gelechia bimaculella** Chambers.

Pittsburgh, June 6 (Marloff); June 20 (Engel).

——. **Gelechia fluvialella** Busck.

Pittsburgh, June 26–July 6 (Marloff, Engel).

5744. **Gelechia discoocellella** Chambers.

June 12–27; August 25–October 24. Rare. At light.

5750. **Gelechia albisparsella** Chambers (?).

June 20–July 1. Rare, but generally distributed. Mr. Busck determined this species as probably *albisparsella*. It is the largest species of the genus taken about Pittsburgh.

5755. **Gelechia bicostomaculella** Chambers.

New Brighton, June 30–July 18 (Merrick). Rare.

5756. **Gelechia nigrimaculella** Busck.

July 1–October 3. Common on hard-wood timber.

5757. **Gelechia maculimarginella** Chambers.

Pittsburgh, July 6 (Engel).

5758. **Gelechia biminimaculella** Chambers.

New Brighton, July 29–September 28 (Merrick). Rare.

5759. **Gelechia pseudoacaciella** Chambers.

May 8–31. Common on locust.

5761. **Gelechia vernella** Murtfeldt.

New Brighton, July 31–August 28 (Merrick). Rare.

5764. **Gelechia mediofuscella** Clemens. May 2–June 1. Common.

——. **Gelechia fondella** Busck.

Pittsburgh, June 5–July 12 (Engel); New Brighton, June 20 (Merrick). Rare.

——. **Gelechia pseudofondella** Busck.

New Brighton, June 26–July 7. Rare. Taken at light in dense forests (Merrick).

5765. **Gelechia walsinghami** Dietz.

Pittsburgh, June 9–July 1 (Engel, Marloff); New Brighton, June 26–July 23 (Merrick). Rare. At light and at rest on saplings in thickets.

5768. **Gelechia conclusella** Walker.

June 12–July 14. Common.

5824. **Gelechia punctiferella** Clemens.

New Brighton, July 17, 1904 (Merrick). One worn specimen determined by Mr. Busck.

Family STENOMIDÆ.

5834. **Stenoma schlægeri** Zeller.

Pittsburgh, May 23–June 8 (Engel); New Brighton, April 25–June 5 (Merrick). Rare.

5835. **Stenoma leucillana** Zeller.

May 13–22; July 29–August 20. Common.

——. **Stenoma mistrella** Busck.

Pittsburgh, June 28, July 25 (Kahl, Engel).

5840. **Brachiloma osseella** Walsingham.

New Brighton, July 4–August 4 (Merrick); Ohio Pyle, July 23–August 11 (Kahl, Klages). Rare. Taken at light in the woods.

Family ŒCOPHORIDÆ.

5843. **Eumeyrickia trimaculella** Fitch.

June 2–July 2. Rare. Found at rest in shady woods.

5851. **Psilocorsis quercicella** Clemens.

May 18–June 5; August 17–28. Rare. In dense forests.

5852. **Psilocorsis reflexella** Clemens.

April 5–June 11; July 8–22. Common in forests.

5853. **Machimia tentoriferella** Clemens.

September 10–October 16. Common and generally distributed.

5854. **Depressaria atrodorsella** Clemens.

New Brighton, May 25; September 7–29 (Merrick); Pittsburgh, April 22 (Engel); July 1, Carnegie Museum. Rare.

5858. **Depressaria pulvipennella** Clemens.

Pittsburgh, September 20–November 5; April 9–May 14 (Engel, Marloff); New Brighton, September 9–October 23 (Merrick). Rare.

5864. **Depressaria walsinghamella** Busck.

July 17–28; September to May. A common species which frequents the sap on sugar maples and in common with most of the species of the genus may be collected in out-houses, under loose boards, and in brush piles in the forests during the winter.

5870. **Depressaria nebulosa** Zeller.

Pittsburgh, September 30–November 8; April 20–May 20 (Engel, Marloff). Rare.

5874. **Depressaria curvilineella** Beutenmüller.

July 3–30; October 4 to May. Common.

——. **Depressaria flavicomella** Engel.

New Brighton, June 13–July 1 (Merrick, Engel); Pittsburgh, June 11–25 (Marloff); Jeannette, June 14 (Ehrman) in collection W. J. Holland. Rare at light on the trees in forests.

5882. **Depressaria robiniella** Packard.

July 11–August 22. Generally distributed, but rare.

5886. **Depressaria betulella** Busck.

New Brighton, July 7–August 30 (Merrick). Rare. At light in forests.

——. **Depressaria maculatella** Busck.

New Brighton, July 26–September 30 (Merrick). At light in forests.

5889. **Depressaria heracliana** DeGeer.

July 17–August 12; October to May. Common. The larvæ are abundant on wild parsnips feeding on the green seeds and later in the stems and branches.

5893. **Semioscopsis packardella** Clemens.

April 12–May 19. Common in thickets.

——. **Semioscopsis merriccella** Dyar.

New Brighton, March 15–April 19. Common in forests (Merrick, Engel).

——. **Semioscopsis megamicrella** Dyar.

New Brighton, March 11–April 29 (Merrick, Engel); Pittsburgh, March 17–April 17 (Marloff). Common.

——. **Semioscopsis aurorella** Dyar.

New Brighton, March 9–April 13 (Merrick, Engel); Pittsburgh, March 10–April 5 (Marloff). Common.

5894. **Semioscapsis allenella** Walsingham.

New Brighton, May 26–July 13 (Merrick, Engel). Fairly common in wooded ravines.

5913. **Ethmia zelleriella** Chambers.

Pittsburgh, May 31–June 20 (Engel, Marloff).

5918. **Euclemensia bassettella** Clemens.

New Brighton, July 30, 1903. One specimen (Merrick).

5920. **Epicallima argenticinctella** Clemens.

June 6–July 28. Fairly common in sunny places along the margin of woods.

5922. **Borkhausenia borkhauseni** Zeller.

Pittsburgh, June 27, several specimens (Marloff).

5923. **Borkhausenia coloradella** Walsingham.

Pittsburgh, June 7–10. Several specimens in the Carnegie Museum.

——. **Borkhausenia ascriptella** Busck.

Pittsburgh, June 14–29 (Marloff, Engel); New Brighton, July 12 (Merrick).

5928. **Borkhausenia shalleriella** Chambers.

Pittsburgh, New Brighton, and Ohio Pyle, June 10–26 (Engel). Quite common at Ohio Pyle resting on moss-covered rocks in the woods.

5932. **Œcophora newmanella** Clemens.

May 30–June 20. Rare, but generally distributed. Found on the wing, or resting on shrubbery in the woods.

Family BLASTOBASIDÆ.

5941. **Pigritia laticapitella** Clemens.

May 30–June 23; August 5. Common at light and resting on twigs in thickets.

5956. **Dryope ochrocomella** Clemens.

Pittsburgh, August 18–25 (Engel). Rare. At light.

5970. **Holcocera chalcofrontella** Clemens.

June 16–July 12. Common. Found at rest on twigs and trees in thickets.

5973. **Holcocera gilbociliella** Clemens.

Ohio Pyle, June 10 (Engel).

5975. **Holcocera modestella** Clemens.

Pittsburgh, May 13 (Engel).

5976. **Holcocera purpurocomella** Clemens.

May 23–June 20. Common at light.

5979. **Holcocera glandulella** Riley.

New Brighton, June 22–July 26 (Merrick, Engel). Several specimens were bred from acorns. This species appears to be identical with *modestella*. The latter was determined by Mr. Busck.

Family ELACHISTIDÆ.

6003. **Coleophora caryæfoliella** Clemens.

Pittsburgh, June 12 (Marloff); June 19–July 19 (Engel). Rare.

6010. **Coleophora corruscipennella** Clemens.

April 20–June 19; August 5–October 2. Common.

6029. **Coleophora luteocostella** Chambers.

Ohio Pyle, June 28 (Engel). Two specimens.

——. **Batrachetra placendiella** Busck.

Pittsburgh, June 24–28 (Marloff). At rest on small twigs of hawthorn.

——. **Batrachetra trichella** Busck.

Pittsburgh, June 23–July 14; August 3 (Marloff, Engel).

6066. **Cosmopteryx gemmiferella** Clemens.

June 20–July 9; August 8–16. Rare, but generally distributed.

6088. **Elachista præmaturella** Clemens.

May 15–27; July 6–8 (Marloff, Engel).

——. **Elachista albicapitella** Engel.

Pittsburgh, June 12–17 (Engel, Marloff); New Brighton, June 24 (Merrick); Pittsburgh, June 7, 1905, Carnegie Museum.

——. **Elachista orestella** Busck.

Pittsburgh, June 11–14 (Marloff).

6094. **Blastodacna (Elachista) bicristatella** Chambers.

Pittsburgh, May 24–June 6 (Engel, Marloff). Common at rest on large hawthorn bushes.

6107. **Scythris basilaris** Zeller.

June 24–July 12. Fairly common. Found on the wing or resting on low vegetation on waste lands.

6108. **Scythris eboracensis** Zeller.

June 8–July 10. Common on waste lands.

6110. **Scythris impositella** Zeller.

Pittsburgh, May 26–June 24 (Engel, Marloff); New Brighton, June 27–July 5 (Merrick, Engel). Rare. On flowers in meadows and waste lands.

6117. **Heliozela æsella** Chambers.

Pittsburgh, May 5–14 (Engel); New Brighton, May 13–18 (Merrick, Engel). Common at rest on trees in forests.

6125. **Antispila nyssæfoliella** Clemens.

May 27–June 23. Common on and near sour gum trees.

6127. **Stilbosis tesquella** Clemens.

June 19–July 29. Common in sunny places in the forests.

6130. **Theisoa constrictella** Zeller.

Pittsburgh, June 12–July 16 (Engel, Marloff).

——. **Epermenia imperialella** Busck.

Pittsburgh, May 30–June 20 (Engel, Marloff); New Brighton, May 30–June 13 (Merrick). Found at light and among herbage in shady woods.

——. **Epermenia albapunctella** Busck.

Pittsburgh, January 3–6 (Marloff). A hibernating species found at rest on a wild grape-vine.

6152. **Mompha brevivittella** Clemens.

May 16–July 2; October 20–December. Generally distributed. Several specimens were bred from the seed capsules of evening primrose (Merrick, Engel).

——. **Mompha stellella** Busck.

May 24–June 28; October 6–April. Generally distributed. It occurs like the preceding species in the primrose, and the hibernating imagines may be taken in brush-piles in the woods.

6157. **Mompha eloisella** Clemens.

June 9–July 12. Common. The larvæ hibernate in the stems of primrose.

6158. **Perimede (Mompha) erransella** Chambers.

Pittsburgh, June 19–August 12 (Engel). Rare at light.

6162. **Mompha luciferella** Clemens.

Pittsburgh, June 20–29 (Engel, Kahl, Klages).

——. **Mompha engelella** Busck.

May 24–June 29; July 6–August 2. Generally distributed and fairly common in sunny spots in the woods, also at light.

——. **Synallagma busckiella** Engel.

Pittsburgh, June 28–July 6; August 1–September 29 (Engel, Marloff). Common at light.

6177. **Schreckensteinia erythriella** Clemens.

Pittsburgh, June 15–August 11 (Engel, Marloff). Common, flying in waste lands.

6178. **Schreckensteinia festaliella** Hübner.

March 28–April 21; July 5–27. Fairly common in woods and on waste lands.

6179. **Walshia amorphella** Clemens.

New Brighton, August 13 (Merrick).

Family TINEIDÆ.

6209. **Nepticula platanella** Clemens.

Pittsburgh, June 12–July 28 (Engel). Rare at rest on trees in forests.

6226. **Nepticula obrutella** Zeller.

June 12–27. Common in open woods at rest on the trees.

6228. **Opostega albogallierella** Clemens.
June 12–July 20; August 7–21. Common at rest on trees in forests.

6233. **Bucculatrix ambrosiæfoliella** Chambers.
May 24–July 20; August 12–September 23. Common.

6238. **Bucculatrix coronatella** Clemens.
Pittsburgh, May 20 (Engel); New Brighton, May 29–June 16 (Merrick, Engel). Rare.

6243. **Bucculatrix magnella** Chambers.
Pittsburgh, July 11–29 (Marloff, Engel).

6246. **Bucculatrix pomifoliella** Clemens.
Pittsburgh, May 5–20; July 20–September 29 (Engel, Marloff). Common.

6254. **Lithocolletes rileyella** Chambers.
May 5–14; July 24. Common in thickets.

6257. **Lithocolletes lucidicostella** Clemens.
Pittsburgh, May 5–20; August 12 (Engel); New Brighton, May 5–13 (Merrick, Engel).

6267. **Lithocolletes robiniella** Clemens.
April 29–May 29; August 2–November 21. Common.

6270. **Lithocolletes blancardella** Fabricius.
March 25–May 14. Common.

6287. **Lithocolletes cincinnatiella** Chambers.
Pittsburgh, May 29–August 5 (Engel); New Brighton, June 3–14 (Merrick, Engel). Rare.

6294. **Lithocolletes ulmella** Chambers.
Pittsburgh, May 27–June 17 (Engel); New Brighton, May 14–June 14 (Merrick, Engel). Rare.

6301. **Lithocolletes basistrigella** Clemens.
Pittsburgh, June 29 (Carnegie Museum).

6310. **Lithocolletes tilieacella** Chambers.
Pittsburgh, May 14–20 (Engel). Rare.

6316. **Lithocolletes tritæniella** Chambers.
Pittsburgh, May 3–22 (Marloff).

6334. **Lithocelletes hamadryella** Clemens.
May 8–27; July 20. Common.

6337. **Bedellia somnulentella** Zeller.
Pittsburgh, September 19–October 20 (Engel, Marloff). Rare.

6345. **Gracilaria astericola** Frey & Boll.
Pittsburgh, May 22–June 8; August 28 (Marloff, Engel); New Brighton, May 19–June 11 (Merrick).

6348. **Gracilaria belfrageella** Chambers.
New Brighton, May 23–June 17 (Merrick, Engel). Rare on shrubbery in the woods.

6360. **Gracilaria negundella** Chambers.
Pittsburgh, June 12 (Engel).

6362. **Gracilaria stigmatella** Fabricius.
Pittsburgh, April 10 (Engel); New Brighton, April 25; September 11–November 21 (Merrick, Engel). Rare.

6363. **Gracilaria rhoifoliella** Chambers.
June 30–August 18; November 4. Generally distributed, but rare.

6364. **Gracilaria lespedezæfoliella** Clemens.
June 10–24; August 5–18. Common and widely distributed.

——. **Gracilaria pennnsylvaniella** Engel.
Pittsburgh, May 14–24; August 2–October 20 (Engel, Marloff); New Brighton, May 30, July 31 (Merrick, Engel).

6370. **Gracilaria strigifinitella** Clemens.
May 17–June 23; July 26–August 15. Common.

——. **Gracilaria packardella** Chambers.
April 29–June 10. Generally distributed, but rare.

——. **Gracilaria superbifrontella** Clemens.
May 20–July 12; August 16–28. Common on shrubbery in sunny ravines.

6375. **Gracilaria venustella** Clemens.
Pittsburgh, May 20–June 2; August 23 (Engel, Marloff). Rare.

6378. **Gracilaria burgessiella** Zeller.
New Brighton, June 3–21; July 27–August 20 (Merrick, Engel). Rare.

6388. **Ornyx cratægifoliella** Clemens.
Pittsburgh, May 5–31 (Marloff, Engel).

6396. **Coriscium albinatella** Chambers.
Pittsburgh, August 24, 1904 (Carnegie Museum, Acc. 2723).

6397. **Coriscium paradoxum** Frey & Boll.
Pittsburgh, April 26–May 6 (Engel, Marloff); New Brighton, April 22–May 18 (Merrick, Engel). Rare in forests.

6401. **Coriscium cuculipenellum** Hübner.
Pittsburgh, August 17 (Engel).

6409. **Philonome clemensella** Chambers.
June 19–July 26. Common in forests.

6418. **Lyonetia speculella** Clemens.

Pittsburgh, August 29–October 3 (Marloff, Engel). Rare. In woods.

6421. **Phyllocnistis vitifoliella** Chambers.

Pittsburgh, September 16–October 30. Hibernating specimens November to April (Engel). Common.

6435. **Tischeria citrinipennella** Clemens.

May 18–June 14; August 7–20. Common at light.

——. **Argyresthia oreasella** Clemens.

July 4–28. Common on the foliage of hawthorn.

6456. **Argyresthia apicimaculella** Chambers.

Pittsburgh, June 15–July 16 (Marloff, Engel).

6457. **Argyresthia austerella** Zeller.

June 14–July 8. Common.

——. **Argyresthia undulatella** Chambers.

May 29–June 24. Common.

6471. **Acrolepia incertella** Chambers.

Pittsburgh, April 15–20 (Engel, Marloff); New Brighton, April 22, July 23 (Merrick, Engel). Rare. At rest on trees in forests.

6473. **Scardia tessulatella** Zeller.

Pittsburgh, June 21–July 26 (Engel, Marloff); New Brighton, July 2–August 29 (Merrick). Rare. At light in the woods.

6474. **Scardia anatomella** Grote.

May 27–July 4. Common at light in forests.

——. **Scardia approximatella** Dietz.

June 30–July 27. Common at light and at rest on trees in woods.

6476. **Xylestia pruniramiella** Clemens.

June 24–August 9. Common.

6477. **Paraclemensia acerifoliella** Fitch.

Pittsburgh, May 20–30 (Marloff, Engel). Rare. On the foliage of bushes on waste lands.

6481. **Isocorypha mediostriatella** Clemens.

Pittsburgh, July 21–August 19 (Engel, Marloff). Rare.

6484. **Incurvaria russatella** Clemens.

New Brighton, July 9–23 (Merrick, Engel); Pittsburgh, June 13–23 (Marloff). Several specimens in Carnegie Museum.

6487. **Tineola bisselliella** Hummel.

New Brighton, July 9–23 (Merrick); Pittsburgh, August 12 (Kahl).

——. **Monopis crocicapitella** Clemens.

Pittsburgh, May 19–June 12; July 26–September 12 (Marloff, Engel).

6495. **Monopis biflavimaculella** Clemens.

June 4–20; August 16. Common.

6502. **Monopis doristrigella** Clemens.

June 10–July 12. Common.

6511. **Monopis marginistrigella** Chambers.

Pittsburgh, June 10–July 11 (Engel, Marloff).

6491. **Tinea acapnopennella** Clemens.

May 14–June 15; July 6–August 23. Common.

——. **Tinea auropulvella** Chambers.

June 1–12; July 3–31. Common.

——. **Tinea multistriatella** Dietz.

Pittsburgh, June 5–July 19 (Engel, Marloff); August 17–September 1, Carnegie Museum. Rare.

6492. **Tinea apimaculella** Chambers.

Pittsburgh, June 8–17 (Engel, Marloff); New Brighton, June 15–July 3 (Merrick).

6497. **Tinea canariella** Clemens.

Pittsburgh, May 29, July 4 (Engel, Marloff); New Brighton, July 7 (Merrick).

6500. **Tinea croceoverticella** Chambers.

Pittsburgh, June 17–July 15 (Engel, Marloff); New Brighton, July 28 (Merrick).

6503. **Tinea fuscipunctella** Haworth.

Pittsburgh, July 24–August 18 (Engel, Marloff); New Brighton, June 14–July 20 (Merrick). Reared on dead leaves (Engel).

6506. **Tinea granella** Linnæus.

Pittsburgh, May 20–July 26 (Marloff); New Brighton, June 12–July 1 (Merrick).

6520. **Tinea pellionella** Linnæus.

Pittsburgh, June 4–15 (Marloff).

6525. **Tinea trimaculella** Chambers.

Pittsburgh, June 17; August 23–September 13 (Engel); New Brighton, August 15 (Merrick).

6531. **Tinea arcella** Fabricius.

July 9–August 15. Rare at light and resting on the trees in forests.

6534. **Amydria effrenatella** Clemens.

May 31–June 17; July 2–August 1. Rare, but generally distributed.

6535. **Cyane visaliella** Chambers.
June 12–July 21. Common in forests resting on trees.

6537. **Diachorisia velatella** Clemens.
July 3–27. Common resting on trees in thickets.

6540. **Hybroma servulella** Clemens.
July 7–August 11. Common in thickets and forests.

6541. **Homesetia fasciella** Chambers.
May 30–June 26; July 20–September 12. Common

6544. **Homosetia miscecristatella** Chambers.
June 17–July 12; August 12. Common.

——. **Homosetia tricingulatella** Clemens.
Pittsburgh, June 28, July 23 (Engel); New Brighton, July 13, 28 (Merrick).

6547. **Homosetia argentinotella** Chambers.
Pittsburgh, June 7–July 17 (Engel, Marloff); New Brighton, July 8–28 (Merrick). Rare.

——. **Homosetia costosignella** Clemens.
June 14–July 12. Common in forests.

——. **Leucomele miriamella** Dietz.
Pittsburgh, June 9–26 (Engel, Marloff); New Brighton, July 16 (Merrick); Pittsburgh, September 12, Carnegie Museum.

6545. **Œnoe hybromella** Chambers.
Pittsburgh, July 5–29 (Engel, Marloff); New Brighton, August 5 (Merrick).

6553. **Adela bella** Chambers.
June 4–July 6. Common in sunny places in forests.

6558. **Adela ridingsella** Clemens.
New Brighton, June 10, 1906, one specimen (Merrick).

6574. **Pronuba yuccasella** Riley.
Pittsburgh, July 16, 1903, one specimen (Marloff).

6583. **Hypocolpus mortipennellus** Grote.
Pittsburgh, June 8, two specimens (Marloff, Engel).

6584. **Acrolophus plumifrontellus** Clemens.
June 24–July 21. Common at light.

6602. **Pseudanaphora arcanella** Clemens.
Pittsburgh, July 5–15 (Marloff); New Brighton, July 2–12 (Merrick). Rare. At light.

6603. **Pseudanaphora mora** Grote.
September 20–October 25. Common in waste lands and open woods.

Family HEPIALIDÆ.

6605. **Sthenopis quadriguttatus** Grote.

New Brighton, June 6, 1903, one specimen (Merrick).

There are fourteen hundred and thirty-nine (1439) species and sixty-eight (68) varieties enumerated in the foregoing list, as has been ascertained by a count made after reading the final proofs. The total number of species and varieties is therefore fifteen hundred and seven (1507). *Editor.*

ANNALS

OF THE

CARNEGIE MUSEUM

VOLUME V. NO. 2 AND 3.

Editorial Notes.

The Sesqui-Centennial celebration of the capture of Fort Duquesne and the founding of Pittsburgh was an event memories of which will long abide. The collection of historic relics brought together upon comparatively short notice at the Carnegie Museum received a great deal of attention. The collection was arranged by Mr. Douglas Stewart. It consisted in part of objects which belonged to the Museum, and in part of objects loaned for the occasion. During the celebration we had the pleasure of placing upon exhibition a set of Sheffield plate, a china plate with the Pitt coat of arms, a cameo scarf-ring, and a fob and seal belonging to "the Great Commoner," whose name is borne by this city. All these had been brought over and loaned for the occasion by his descendant, Miss Pitt-Taylor. A catalog of the objects which were exhibited upon this occasion has been prepared by Mr. Stewart and is published in this number of the Annals.

The Carnegie Museum should be recognized more and more as the proper custodian in this city for such historic collections. It is a matter of regret that many valuable relics of the past, which, had they been conserved, would have taught important lessons, have been in the lapse of time scattered and hopelessly lost, or destroyed by fire.

Arrangements have been made for a systematic collection of the avifauna of the eastern slopes of the Andes within the State of Bolivia, and during the coming year or two the Museum may expect to add largely to its collection of South American birds. A Catalog of the Birds of Costa Rica with Notes upon their Distribution and Habits is being prepared for publication by Mr. M. A. Carriker, Jr., who spent five years in that country collecting for the Carnegie Museum, and by Mr. W. E. C. Todd. Assistance has been most kindly given these gentlemen in their work by Mr. Outram-Bangs, of Cambridge, Massachusetts, and by the authorities of the various museums in which collections of Costa Rican birds are preserved in this country.

ARRANGEMENTS have been made to undertake an ornithological collecting trip through the western States of South America by a thoroughly competent party. It is the intention of the Museum so soon as possible to complete its collection of the birds of the western hemisphere.

PROFESSOR C. H. EIGENMANN has recently returned from his expedition to British Guiana. The expenses of the expedition were borne by the Carnegie Museum, the authorities of the Indiana State University having kindly consented to give Professor Eigenmann leave of absence for this purpose. He reports most satisfactory results, the discovery of a number of undoubtedly new species of fishes, and numerous observations bearing upon the geographical distribution of characteristic South American forms.

MR. JOHN D. HASEMAN has been continuing his explorations of the rivers of Brazil and adjacent countries with great success. Large collections representing the fish fauna of Brazil have been recently received.

PRESIDENT D. STARR JORDAN is completing a paper upon the collection of Formosan fishes which belong to the Museum, and it will shortly be published in the Memoirs.

A MEMOIR upon the Entelodontidæ, based upon the remarkably perfect skeleton of Dinohyus recovered two years ago in western Nebraska, will shortly be published. It is from the pen of Mr. O. A. Peterson.

MR. H. J. HEINZ with great generosity has made a large addition to the collection of watches which he has placed in the Museum. A catalog of this collection of watches is in course of preparation by Mr. Douglas Stewart. Mr. Heinz has also kindly loaned to the Museum a very large and valuable collection of ivory carvings which will shortly be placed upon exhibition.

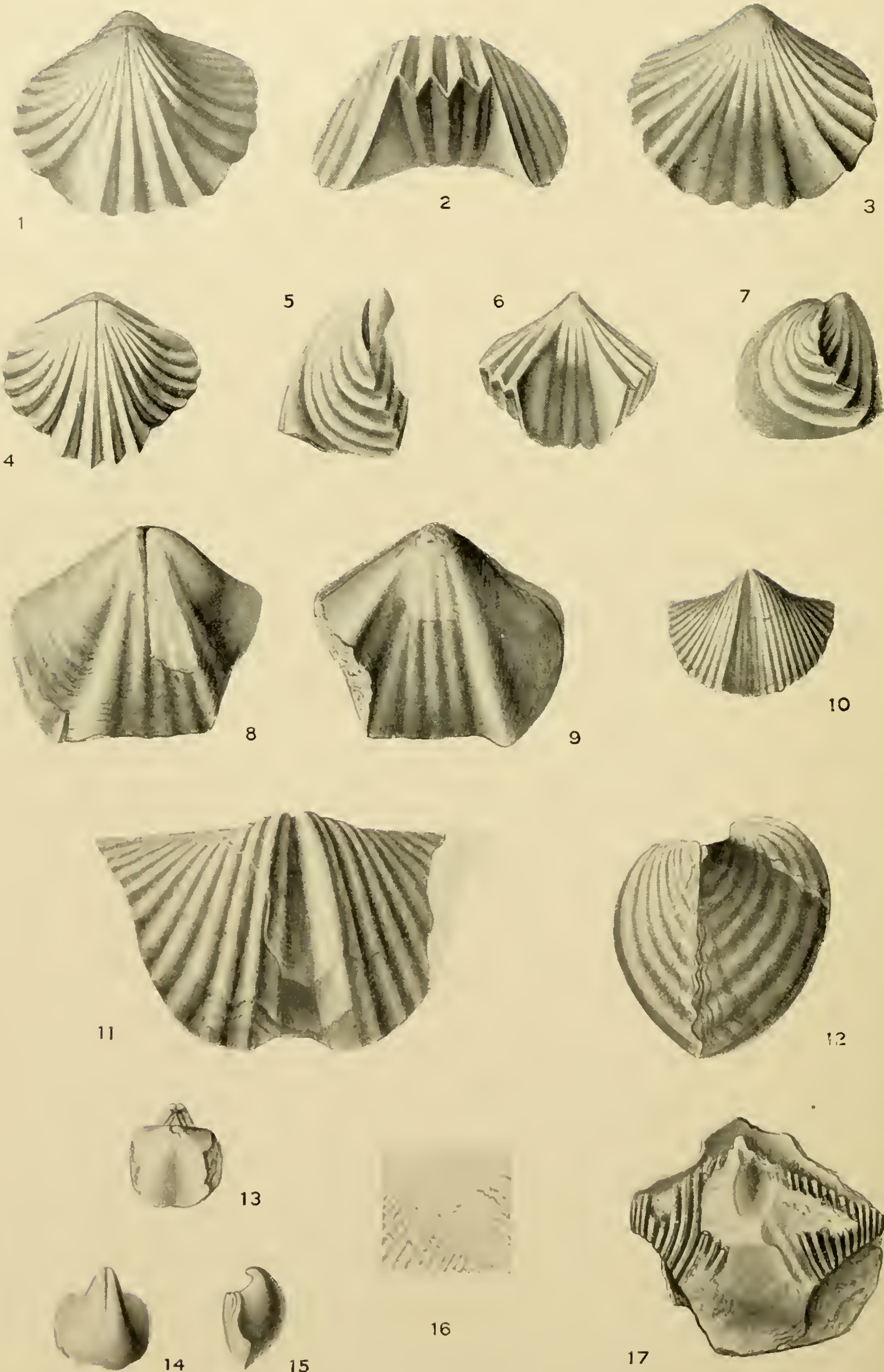
It is hoped that we may be able on the coming celebration of Founder's Day at the end of April to throw open the Gallery of Reptiles to the public. While it will be only scantily furnished, nevertheless it will contain much of interest, among other things a splendid large group representing the Diamond-back Rattlesnake in its native haunts, which has been completed by the Messrs. Santens and Mr. G. A. Link.

We are very desirous of completing our collection of the Birds of Paradise. While possessing representatives of a number of genera and species, there are many lacunæ in the collection, which we desire to fill, and all persons who have in their possession collections from which they might possibly be able either by sale or exchange to help us fill the gaps which exist in our collection, are requested to correspond with the Museum.

The celebration of Convocation Day by the University of Pittsburgh on February the 12th, Lincoln's birthday, was utilized as an occasion upon which to display to the public two important historical souvenirs of "The Great Emancipator," which are in the possession of the Museum. One is a life mask of President Lincoln, made by the sculptor Clark Mills, assisted by his son, Theodore A. Mills. This mask was made sixty days before the assassination of the President. With it was displayed a cane which has a history. The director of the Museum on placing these objects before the audience said, in speaking of the cane, "When Abraham Lincoln passed through Pittsburgh on his way to Washington to be inaugurated, he spent the night at the Monongahela House, and the Chairman of the Republican County Committee, Mr. M. McGonnigle, handed to him this cane. There are fourteen knots on the cane, corresponding in number to the letters in the name of the President, and on each one of these knots is a silver plate with a letter, spelling the words A-B-R-A-H-A-M L-I-N-C-O-L-N. Below the handle of the cane is a silver plate on which are inscribed the words 'Allegheny County, Pa. Lincoln, 16,725. Fusion, 6,725,' these numbers representing the votes which had been cast for the then President-elect. President Lincoln on receiving the cane made a brief speech, in which he expressed his gratitude to 'the

Life Mask of Abraham Lincoln, made by L. Clark Mills and Theodore A. Mills, sixty days before the assassination of the President. Cane used by President Lincoln.

citizens of the State of Allegheny' for the splendid majority they had rolled up for him. He used the cane while in Washington on his walks to and fro between the White House and the War Department, and broke the ferrule which was on it. Not very long before his death, Mr. Magee, the father of the late Christopher L. Magee, who was an old time abolitionist, called upon President Lincoln, and President Lincoln in conversation with him recalled his visit to Pittsburgh, and stepping to a corner of the room, produced the cane. After fondling it for awhile in his hands he said to Mr. Magee, 'You have sons, have you?' Mr. Magee replied, 'I have.' President Lincoln answered, 'Well, then, take this cane back to the State of Allegheny. Keep it, and hand it down to your sons.' The cane at the death of Mr. Magee was given by his wife to the late Hon. Christopher Lyman Magee, who in turn gave it to his sister, Mrs. John Fremont Steele, who last Sunday with great kindness placed it in the custody of the Carnegie Museum as a loan, to be preserved here subject to her disposition."



Sydney Prentice, del

Upper Devonian Brachiopoda.

IV. THE FAUNA OF THE UPPER DEVONIAN IN MONTANA.

Part I. — The Fossils of the Red Shales.

By Percy E. Raymond.

In a paper "On the Occurrence in the Rocky Mountains of an Upper Devonian Fauna with Clymenia" in the American Journal of Science, Series 4, Vol. XXIII, p. 116, 1907, the writer announced the discovery by Mr. Earl Douglas of a fauna very similar to that of the *Clymenia* limestone of Germany. In that paper a preliminary list of the fossils found near Logan and Three Forks in the five zones of the Three Forks shale was given. The most novel of the fossils there listed were found in the red fissile shale of Zone 1 and it is these fossils which form the subject of the present paper. In later articles the more prolific faunas of the green shale and the limestone of Zones 2 and 4 will be described.

In a paper read before the Section of Palæozoölogy at the Seventh International Zoölogical Congress, but not yet published, the age of this fauna was discussed, and an attempt was made to show that it was younger than the fauna with *Manticoceras intumescens* in New York, Michigan, and elsewhere.

In the present paper nothing further than a description of the fauna of the red shale is attempted, further remarks on correlation being deferred until the Devonian faunas of the northern Rocky Mountains are more fully known.

Class BRACHIOPODA.

Order *TELOTREMATA* Beecher.

Family RHYNCHONELLIDÆ Gray.

Genus Camarotœchia Hall and Clarke.

Camarotœchia contracta Hall.[1]

(Plate III, figures 1–7.)

Atrypa contracta Hall, 1843. "*Report of the Fourth District, Geology of New York*," p. 66, figs. 2, 3.

Rhynchonella (*Stenocisma*) *contracta* Hall, 1867. "*Paleontology of New York*," Vol. IV, p. 351, pl. 55, figs. 26–39.

[1] For a full synonymy of the brachiopods listed in this article, see Schuchert, Bull. U. S. Geol. Survey, No. 87, 1897.

The identification of this shell is not entirely satisfactory, but the *Camarotœchia* which is so abundant in the Three Forks shale is more like this than any other described species. Some of the fully grown shells agree very closely with Hall's description in volume IV, "New York State Paleontology." They have about sixteen plications on each valve, three of which are in the sinus and four on the fold. Other specimens in the collection have one, two, or four plications in the sinus and two, three, or five on the fold.

Locality. — This is a common fossil in all the zones of the Upper Devonian with the exception of the white blocky shale. Nearly all the specimens from the red fissile shale are of small size. Three Forks and Logan, Montana.

Genus LEIORHYNCHUS Hall.

Leiorhynchus mesacostale Hall.

(PLATE III, FIGURES 8, 9.)

Atrypa mesacostalis Hall, 1843. "*Report of the Fourth District, Geology of New York,*" p. 64, fig. 1.

Leiorhynchus mesacostalis Hall, 1867. "*Paleontology of New York,*" Vol. IV, p. 362, Pl. 67, figs. 18–25.

This is one of the abundant fossils in this fauna. The specimens are moderately convex, transversely elliptical in outline, and usually of somewhat smaller size than the specimens from New York. The plications are entirely obsolete on the sides of most of the specimens, and the number of plications in the fold and sinus is variable, ranging from one to four in the sinus, and two to five on the fold. Half a dozen specimens have been observed which show one or two faint plications outside the fold and sinus.

Locality. — This species is common in the same zones as the preceding at Three Forks and Logan, Montana.

Family SPIRIFERIDÆ King.

Genus SPIRIFER Sowerby.

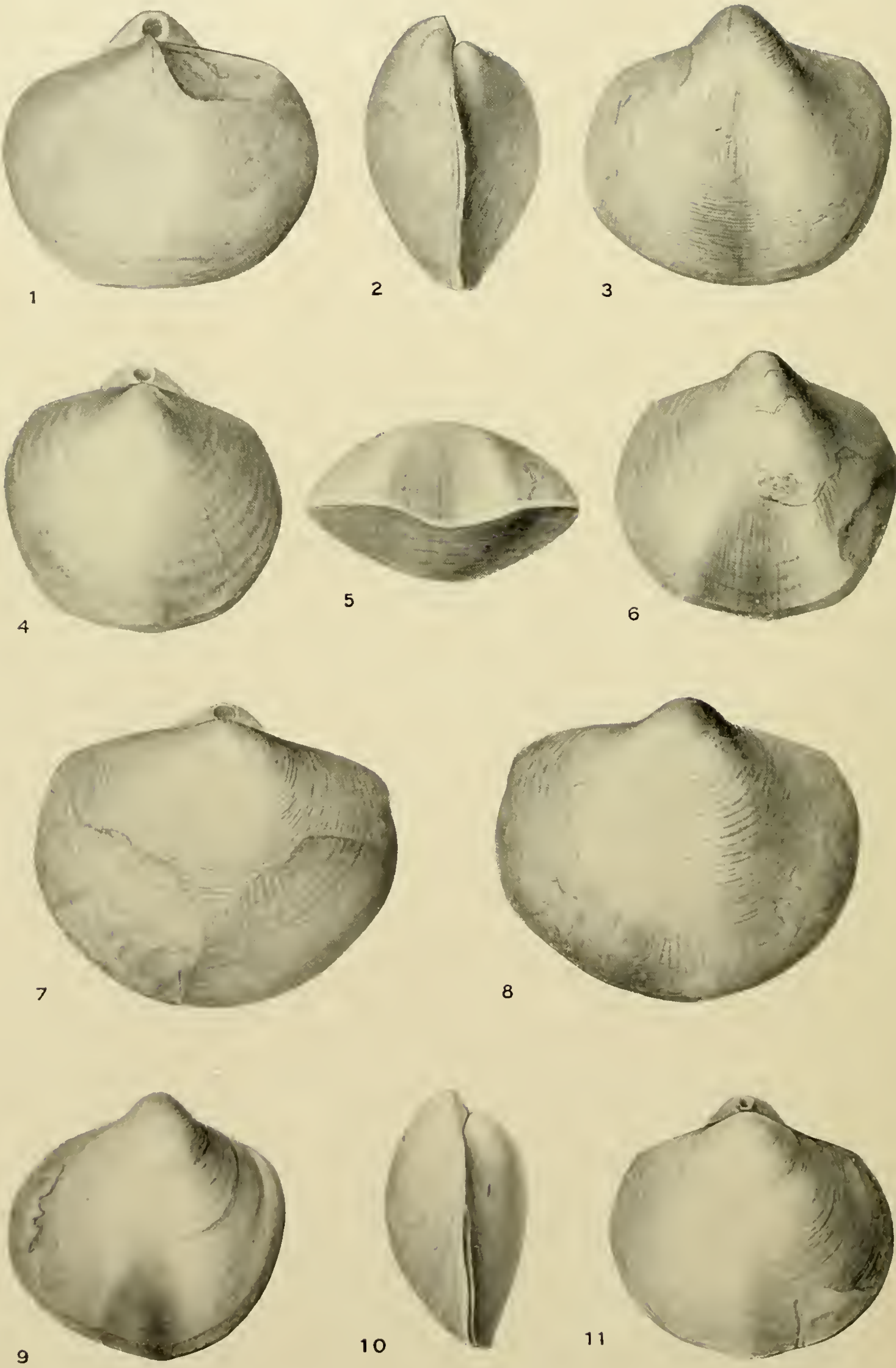
Spirifer disjunctus Sowerby.

(PLATE III, FIGURE 10.)

Spirifera disjuncta Sowerby, 1840. "*Transactions of the Geological Society,*" 2d series, Vol. V, Pl. 53, fig. 8; Pl. 54, figs. 12, 13.

Spirifer disjunctus Hall and Clarke, 1893. "*Paleontology of New York,*" Vol. VIII, pt. II, Pl. 30, figs. 14, 15, 17.

This species is quite abundant in the red fissile shales, and is note-



Sydney Prentice, del.

Cleiothyridina devonica Raymond.

worthy only for the small size of the specimens, which show all the characters of the adult.

Locality. — Logan, Three Forks, and elsewhere in Western Montana.

Spirifer pinonensis Meek.

(PLATE III, FIGURES 11, 12.)

Spirifer (*Trigonotreta*) *pinonensis* Meek, 1870. "*Proceedings Academy Natural Sciences of Philadelphia*," p. 60.

Spirifer pinonensis Walcott, 1884. "*Monograph U. S. Geological Survey*," No. VIII, p. 138, Pl. 4, figs. 1, 1*a*–1*e*.

A single well preserved specimen was found in the red fissile shale at Three Forks. The shell is robust, both valves being strongly convex. There are nine plications on each side of the fold and sinus, the first one on either side being stronger than the others. The fold shows a faint longitudinal indentation, and there is a trace of a plication in the sinus. The surface is marked by numerous fine concentric lines of growth.

Locality. — A very rare species in the red fissile shale of the Upper Devonian at Three Forks, Montana. It occurs more commonly in the limestone of the same region.

According to Walcott, this species ranges from the base to the summit of the Devonian limestone throughout the Eureka District in Nevada.

Genus AMBOCŒLIA Hall.

Ambocœlia gregaria Hall.

(PLATE III, FIGURES 13–15.)

Ambocœlia gregaria Hall, 1860. "*Thirteenth Annual Report New York State Cabinet Natural History*," p. 81.

Specimens of this species are fairly common and differ from the specimens found in New York only in their smaller size.

Locality. — Found in the Three Forks shale at Logan and Three Forks, Montana.

Family ATHYRIDÆ Phillips.

Genus CLEIOTHYRIDINA Buckman.

Cleiothyridina devonica sp. nov.

(PLATE III, FIGURES 16, 17; PLATE IV, FIGURES 1–11.)

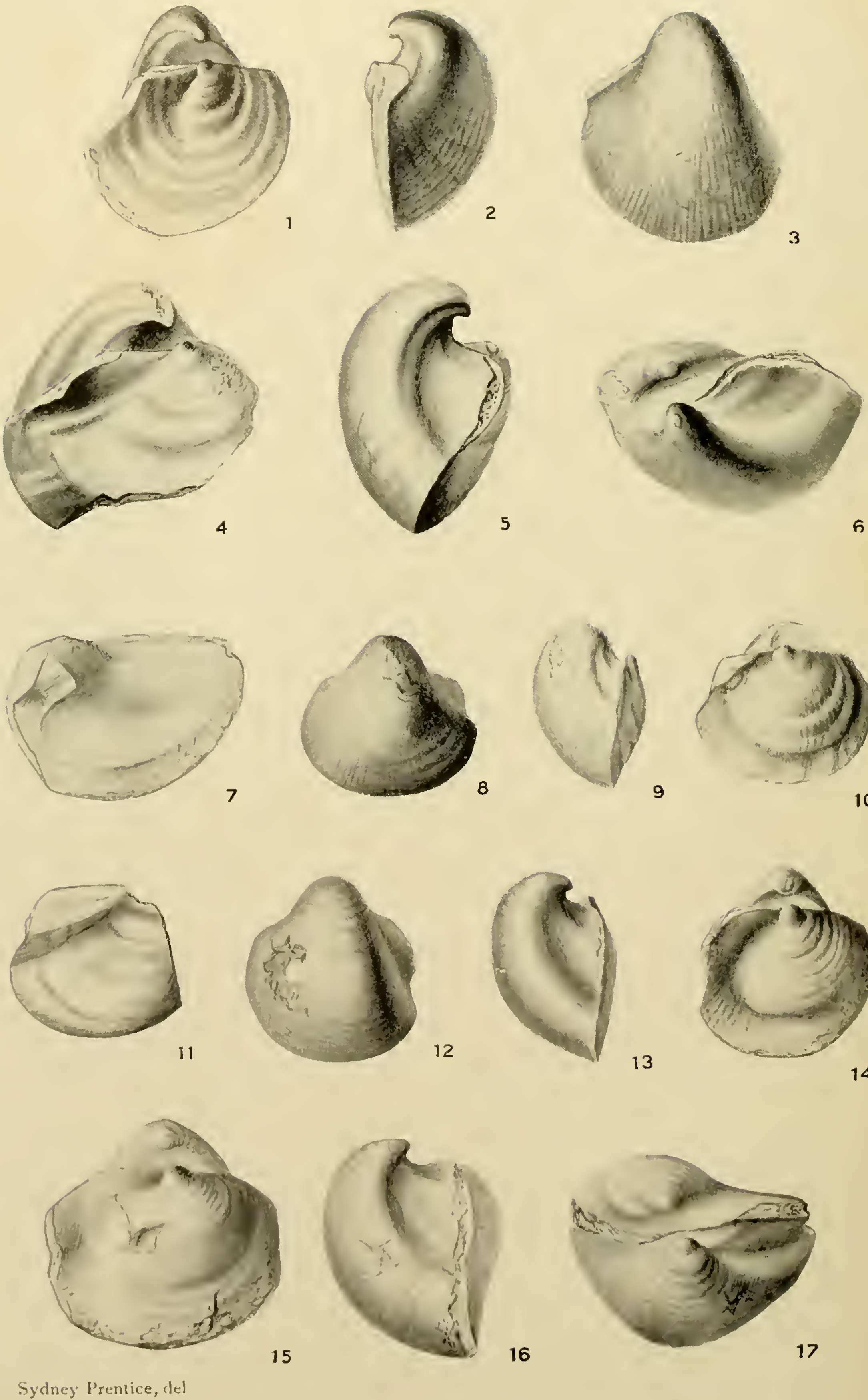
Mr. Buckman has recently shown that the name *Cleiothyris* cannot be used for the group of shells usually so designated, as it was not so used by Phillips, the author of the genus. Mr. Buckman has therefore proposed the name *Cleiothyridina* and designated as the genotype *Athyris roissyi* as figured by Davidson, in the "Monograph of Carboniferous Brachiopoda," Pl. XVIII, fig. 8. (See Annals and Magazine Natural History, Series 7, Vol. XVIII, p. 321, 1906.)

Description.— The adult shell varies in outline from subcircular to transversely elliptical. The sides and front of the shell are usually somewhat straight, which gives the shell a rather quadrate form. The valves are nearly equally convex, the pedicle valve being slightly the deeper. The pedicle valve shows a narrow sinus or a flattened area in nearly all specimens, but in a few this valve is uniformly convex. On the brachial valve there is a low fold which is not defined at the sides and can be seen only when looking at the front of the shell. The beak of the pedicle valve is small and closely incurved, but the pedicle opening remains clear throughout life, the pedicle continuing to encroach upon the umbo as the beak becomes more incurved.

The surface markings on the better preserved specimens are those characteristic of the genus. The concentric lamellæ are very numerous and the spiniform extensions of their free margins are long and slender. Partially exfoliated specimens show fine, interrupted radial striæ, and casts of the interior show very numerous radiating vascular markings.

The spirals of a single specimen have been developed. They were replaced by hematite, while the interior of the shell was filled with calcite, thus permitting the use of acid. Each of the cones was found to taper rather rapidly outward and consisted of eleven turns of the flat lamella. The lamellæ were not fimbriated as Davidson found those of *Athyris pectinifera* Sowerby to be. Unfortunately the loop of this specimen was so distorted that its form could not be made out.

No other species of this genus are known from the Devonian, but several species have been described from the Mississippian and Pennsylvanian. The shell known as *Cleiothyris roissyi* L'Eveille is the most common of the Mississippian forms. Girty states that the shell as figured by L'Eveille is 34.5 mm. wide and 22.5 mm. long, deeply folded, with the two depressions which define the fold so deep as to give the shell a trilobate appearance. The beak is not incurved, so that the round, open foramen is a noticeable characteristic of the typical specimen. (See Monograph XXXII, U. S. Geol. Survey, pt. II, p. 570.) The shell thus described is very different from the one in the Mississippian usually identified as *Cleiothyris roissyi*, and



Sydney Prentice, del

Loxopteria holzapfeli and L. clarkei.

also very different from the Devonian shell here described. The Mississippian form should probably be known as *Cleiothyridina sublamellosa* (Hall) as Schuchert has already suggested in "Bulletin U. S. Geol. Survey," No. 87, p. 183, 1897. He says: "American specimens usually referred to this species are constantly smaller and are often without sinus or fold. If these differences are of sufficient importance to distinguish American specimens from typical *Cleiothyris roissyi*, then this species should be known as *C. sublamellosa* Hall."

From this Mississippian shell our specimens differ in their more transverse form and in the deeper sinus in the ventral valve.

The specimens of *Cleiothyridina devonica* are very well preserved and the great number of specimens in our collection exhibit a wide range of variation. In young stages the shell is subcircular in outline, becoming quite transverse and somewhat quadrate in the adult, while old shells show a tendency to regain the circular form. The history of the development of the sinus of the pedicle valve is similar. In young shells it is entirely absent. In the adult it is strongly developed, but in many old individuals it is practically obliterated. Individuals are found in which the development of one or both of these characters is retarded or accelerated. Thus there are small shells, especially in the red shales, with the deep sinus of the adult and the subcircular outline of the young and other specimens with the outline of the adult, but lacking the sinus.

Locality.—This is a common shell in most of the zones of the Three Forks shale of the Upper Devonian at Three Forks and Logan, Montana.

Subkingdom MOLLUSCA.

Class PELECYPODA.

Order *PRIONODESMACEA* Dall.

Family PTERINEIDÆ Dall.

Genus LOXOPTERIA Frech.

Loxopteria holzapfeli sp. nov.

(PLATE V, FIGURES 1–7, 11.)

Cf. *Avicula dispar* Sandberger. "*Versteinerungen des reinischen Schichtensystems in Nassau*," p. 284, t. 29, fig. 14.

Cf. *Kochia* (*Loxopteria*) *dispar* Frech, 1891. "*Die devonischen Aviculiden Deutschlands; Abhandlungen zur geologischen Specialkarte von Preussen und den Thüringischen Staaten*," Band IX, Heft 3, p. 77, t. 6, figs. 4–4*h*.

Cf. *Loxopteria dispar* Clarke, 1903. "*The Naples Fauna in Western New York; Memoir of New York State Museum*," No. 6, p. 272, Pl. 13, figs. 8–17.

Description. — Shell somewhat triangular in outline, inæquivalve, the right valve nearly flat, the left valve capuliform.

The right valve is slightly convex, sometimes quite flat. A narrow sulcus extends from the beak to a notch in the posterior margin of the shell, and delimits a wing-like portion of the valve. There is no posterior gape observable in any of the shells in the collection, but the thin margins of the "ears" are frequently broken.

The left valve is strongly elevated and acute in the umbonal region, but the beak is incurved almost to the hinge. The anterior end of the valve is smoothly rounded, the length of the hinge being less than the length of the shell. From the highest point on the valve to the anterior margin the slope is gradual, but the posterior slope is abrupt and slightly concave. This concavity is broken by a ridge which extends from the posterior side of the beak to a rounded, ear-like extension of the posterior margin of the valve.

The surface of both valves is marked by numerous fine, radiating striæ. The right valve also shows a few rather strong concentric undulations.

No muscle scars have been observed on the left valves, but some of the better preserved casts of the interiors of right valves show a small but strong oval posterior scar and an apparently entire pallial line. An anterior muscle was undoubtedly present, but its scar has not been detected on any of the specimens at hand.

The prodissoconch is retained on both valves, and is set off from the remainder of the beak by a shallow groove. Its position shows a clock-wise tortion of the shell during growth.

The ligament was external. The ligamental area on the left valve is triangular, with the apex of the triangle directly beneath the beak. On the right valve the greater part of the ligamental area is posterior to the beak, and its plane is at an angle of about 45° to the remainder of the valve. No striations were observed on the ligamental area.

This species seems closely allied to *Loxopteria dispar* (Sandberger), as described by Frech, but differs from that species in having the wing of the right valve more sharply defined and in the ornamentation of the same valve by strong concentric undulations.

From *Loxopteria dispar* as described by Clarke from specimens obtained in western New York, our specimens differ in having a small ear on the posterior end of the left valve, a ligamental area under the umbos, concentric ridges on the right valve, and in the absence of broad radial ribs, and of a posterior opening between the shells. In surface markings, disregarding the concentric wrinkles on the right valve, our specimens agree best with figures 4*b* and 4*d*–4*f* of the illustrations in Frech's work cited above, while Dr. Clarke's specimens seem to agree best with figures 4*c*, 4*g* and 4*h*. *Loxopteria corrugata* Clarke and *L. rugosa* Frech are species with pronounced concentric wrinkles on the right valve, but neither of these species has a sharply defined posterior wing.

This species is named for Professor Eduard Holzapfel, of Aachen, whose researches have greatly extended our knowledge of the Upper Devonian faunas.

Locality. — This species is common in the red fissile shale of the Upper Devonian at Three Forks, Montana. It occurs more rarely in the limestone above the red shale at the same locality.

Loxopteria clarkei sp. nov.

(PLATE V, FIGURES 8–10, 12–17.)

Cf. *Kochia* (*Loxopteria*) *lævis* Frech, 1891. "*Die Devonischen Aviculiden Deutschlands; Abhandlungen zur geologischen Specialkarte von Preussen und den Thüringischen Staaten*," Band IX, Heft 3, p. 76, t. 6, figs. 3–3*e*.

Just as *Loxopteria holzapfeli* is closely related to *L. dispar*, so the other species of *Loxopteria* found in the same fauna is very similar to *L. lævis* Frech. The shell may best be described by comparing it with the species of this genus already known. Both valves are convex, there being much less disparity between them than in *L. holzapfeli*. From that species it differs also in having a less highly elevated and more rounded umbonal region, a less acute and prominent beak and in the possession of concentric undulations on both valves.

From *Loxopteria lævis* it differs in having a more pronounced posterior wing on both valves, a less depressed beak on the left valve, and in the presence of concentric undulations on both valves.

Dr. Clarke has referred to *Loxopteria lævis* specimens which, as that author remarks, differ considerably from the German specimens in having a depressed right valve and concave larval shell. None of the shells from Montana show these characters.

This shell is named for Dr. John M. Clarke, to whom we are indebted for our knowledge of the fauna of the Middle Upper Devonian of America.

Locality. — This is a rather rare species, and has been found only in the red fissile shale of the Upper Devonian at Three Forks, Montana.

Family MODIOLOPSIDÆ Fischer.

Genus GONIOPHORA Phillips.

Goniophora subrecta Hall ?

(PLATE VI, FIGURES 1–3.)

Goniophora subrecta Hall, 1885. "*Paleontology of New York*," Vol. V, pt. 2, Vol. II, p. 304, Pl. 42, figs. 14, 15; Pl. 44, figs. 19, 21.

To this species is referred with considerable doubt a shell which is very common in all but one of the zones of the Upper Devonian in the vicinity of Three Forks, Montana. The specimens differ from those described by Hall in having a somewhat longer hinge, a more nearly square posterior end, and a more rounded anterior margin. The specimens from the red shale are all much smaller than those obtained from the limestone and the green shale.

Class CEPHALOPODA.

Subclass TETRABRANCHIATA.

Order *NAUTILOIDEA*.

Family ORTHOCERATIDÆ Hyatt.

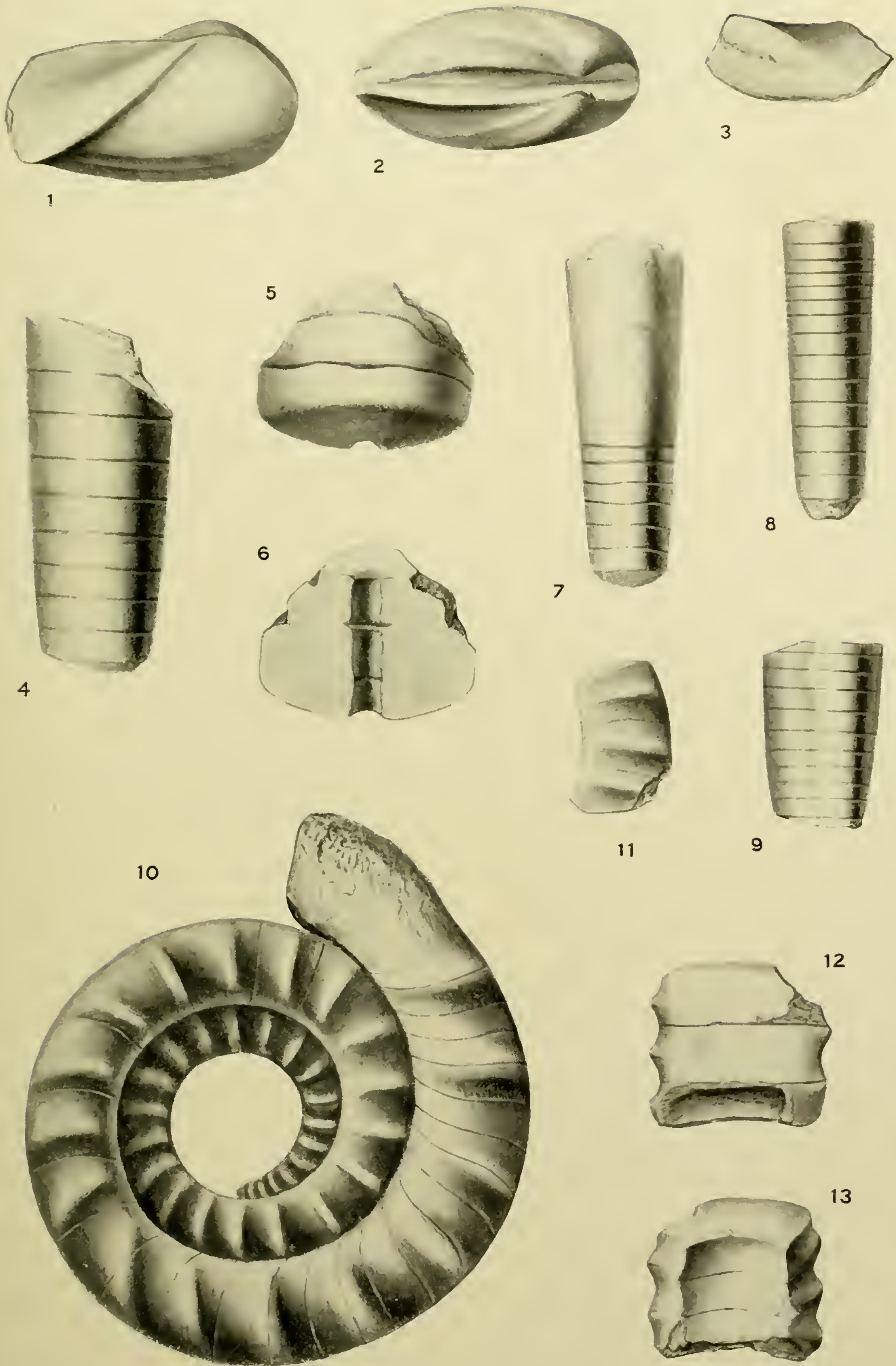
In the fauna obtained from the red shales there are several species of straight-shelled nautiloids, represented in large part by small fragments of the chambered portion of the shells. Three of these forms are sufficiently abundant and represented by enough material to make them worthy of description. All are circular in section, with smooth surface, small, slightly eccentric siphuncles, and short siphuncular collars. While the material at hand is hardly sufficient to render the generic reference certain, yet it seems very probable that they belong to the family Orthoceratidæ as defined by Hyatt, and that one of them is an *Orthoceras*, while the other two have the very small siphuncles of *Geisonoceras*.

Genus ORTHOCERAS (Breyn.) emend. Hyatt.

Orthoceras montanense sp. nov.

(PLATE VI, FIGURES 4–6.)

This species is known only from fragments, none of which are large. The shell is circular in section and tapers very gradually. The



Sydney Prentice, del.

Upper Devonian Cephalopoda and Pelecypoda.

cameras are shallow, there being seven in a length of 16 mm. The sutures are nearly straight, the septa strongly convex. The siphon tube is 1.5 mm. in diameter where the shell is 14 mm. in diameter and has the same measurement at the smaller end of another specimen where the shell is 7 mm. in diameter. The siphuncle is slightly off the center of the shell, but whether dorsad or ventrad cannot be determined. No specimen in the collection shows any part of a living chamber that can be referred to this species.

The specimens are replaced by hematite and pyrite and are not crushed. One of the specimens sectioned shows the short siphonal funnels very well as the siphuncle contained only a very soft clay which was easily removed. All the other specimens sectioned were entirely filled with the hematite and the siphon tube could not be distinguished.

Locality. — This species is rather common in the red fissile shale of the Upper Devonian at Three Forks, Montana.

Genus GEISONOCERAS Hyatt.

Geisonoceras normale sp. nov.

(PLATE VI, FIGURE 7.)

Shell small, gradually tapering, circular in section. The living chamber is preserved in one specimen, and is about as long as eight cameras and apparently comprises one third of the shell. None of the cameras are deep, but they become more shallow on approaching the living chamber. On the best specimen the three cameras nearest the living chamber together occupy a length of only 3 mm., while the next three occupy 5 mm. The sutures are almost straight, the septa moderately convex, the siphon tube very small, and the siphonal funnels very short and delicate. The position of the siphuncle seems to be somewhat variable. In some specimens it is almost central, while in others it is nearly half way between the center and the margin.

This species may be distinguished from the last by its much smaller size, shallower cameras, smaller and more eccentrically placed siphuncle.

Locality. — This species is rather common in the red shale of the Upper Devonian at Three Forks, Montana.

Geisonoceras accelerans sp. nov.

(PLATE VI, FIGURES 8, 9.)

This species is very similar to the last, differing from it principally in the shallower cameras. As may be seen by the figured specimen the older cameras are nearly as deep as those in *Geisonoceras normale*, but on approaching the living chamber they become very shallow. The siphuncle is very small, and is situated close to the center. Living chamber and siphonal funnels not seen. A few specimens show traces of faint longitudinal striæ.

A specimen of this shell was sent to Dr. Holzapfel, who compared it, on account of its very shallow cameras, with *Orthoceras gregarium* Münster (*O. angustiseptatum* Gümbel).

Locality. — This species occurs rather rarely in the red shales of the Upper Devonian at Three Forks, Montana.

Order *AMMONOIDEA*.

Suborder *GASTROCAMPYLI* Hyatt.

Family CLYMENIDÆ Gümbel.

Genus PLATYCLYMENIA Hyatt.

Platyclymenia americana Raymond.

(PLATE VI, FIGURES 10–13; PLATE VII, FIGURES 1–3.)

Clymenia (*Platyclymenia*) *americana* Raymond, 1907. "*American Journal of Science*," series 4, Vol. XXIII, p. 118, figures.

This is by far the most abundant of the cephalopods in the red fissile shale and is also quite common in the green shale. Although a great number of specimens have been collected, most of them are so poorly preserved that they are useless for study.

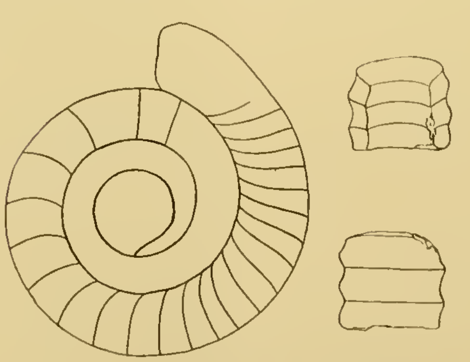
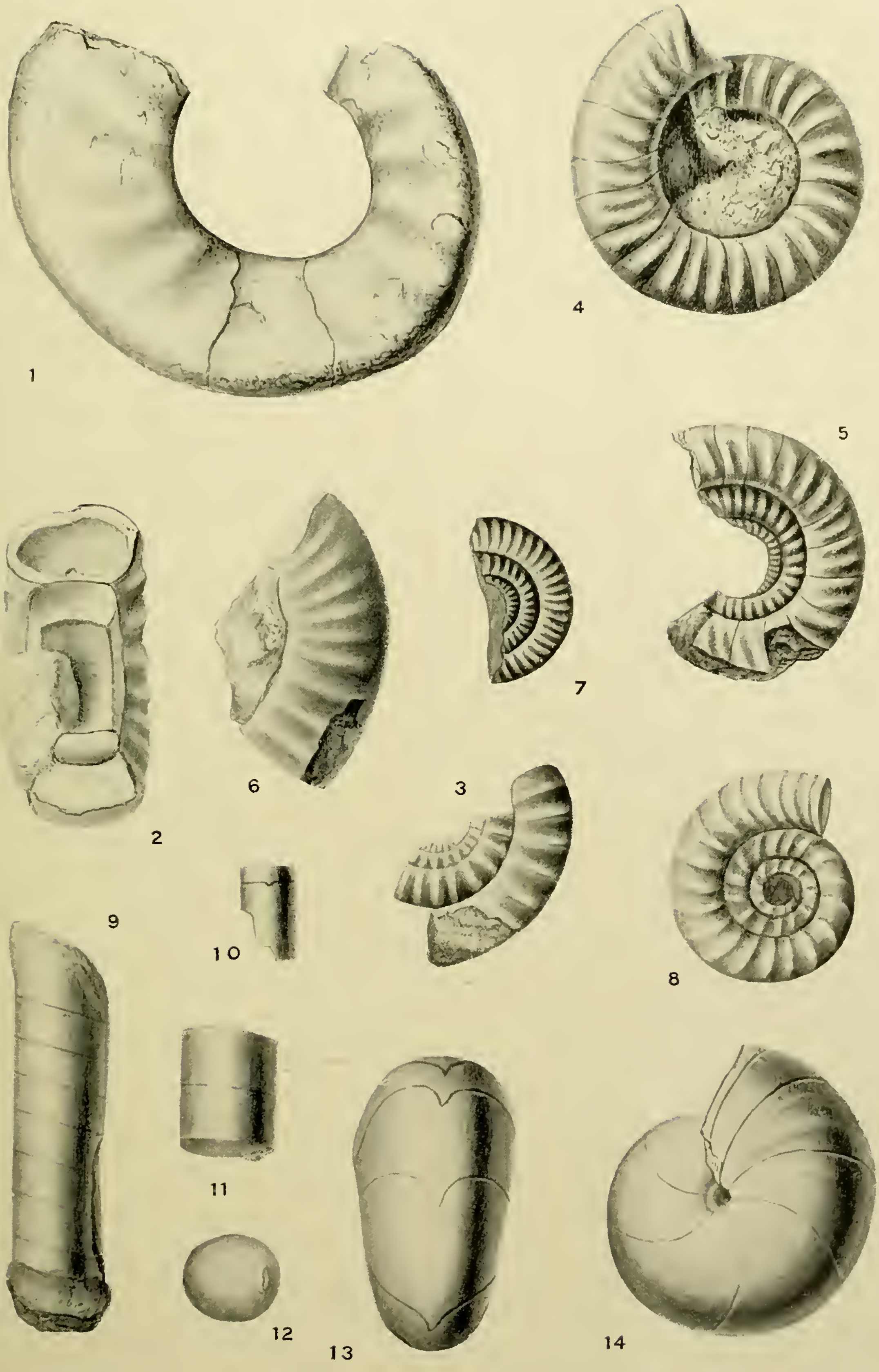


FIG. 1. *Platyclymenia americana* Raymond. Outline drawing of the type and of a fragment to show sutures. Natural size.

Description. — Shell of medium size for the genus, compactly coiled, but not involute. The whorls are depressed in section, the venter of the inner whorls flattened, that of the living chamber more convex. The living chamber is large, consisting of over half a volution. The cameras are rather shallow on the inner whorls, become deep in the adult, and then suddenly become so shallow that the septa are twice as numerous as before. The sides of the whorls are crossed by strong ridges which have a slightly diagonal trend and which die out on the umbilical margin and on the



Sydney Prentice, del.

Upper Devonian Cephalopoda.

venter. Some of these ribs point slightly forward, others a little backward. The ribs become gradually further apart on each whorl, until on the body whorl they are quite distant from each other. They do not bear any fixed relation to the cameras, for, as may be seen on the figures, a rib may be between the septa, or may be cut in any direction by a septum. The dorsum is slightly concave and is frequently marked by a revolving line showing the position of the siphuncle. As shown by the figures, the suture is very simple.

This species is more closely related to *Platyclymenia annulata* (Münster) than to any other described species, and differs from it principally in the more depressed section of the whorls and the coarser ribs. A copy of Frech's figure of *Platyclymenia annulata* from his monograph "*Über devonische Ammoneen; Beiträge zur Paläontologie und Geologie Osterreich-Ungarns und des Orients,*" Band XIV, Heft 1 und 2, 1902, t. 2, figs. *6a–6c*, is here introduced for comparison (Plate VII, figure 8).

Locality. — This species is found in the red shale, the green shale, and the limestone of the Upper Devonian at Three Forks, Montana.

Platyclymenia polypleura sp. nov.

(PLATE VII, FIGURES 4–6.)

Description. — This species may be described by saying that it differs from the preceding in its somewhat smaller size, shallower cameras, and, principally, in the much more numerous and finer ribs which ornament the surface. The ribs of the body whorl, instead of becoming very strong and distant, become weaker and more numerous, and extend further on the venter.

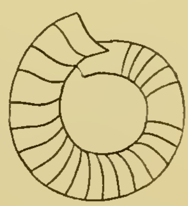


FIG. 2. *Platyclymenia polypleura* Raymond. Outline drawing of the type to show sutures. Natural size.

This species bears much the same relation to *Platyclymenia americana* that the variety *Platyclymenia annulata densicosta* Frech does to *Platyclymenia annulata* (Münster). In surface ornamentation our species is much like the German variety of *annulata* described by Frech, but the whorl section is very different. In *P. polypleura* the whorl section is depressed, with a rounded venter, while in *P. annulata densicosta* it is slightly compressed and has a distinctly flattened venter. (See figure 7, plate VII, which is copied from figure 5, plate 2, of Frech's "*Über devonische Ammoneen.*")

Locality. — This species is found rather rarely in the red shale of the Upper Devonian at Three Forks, Montana.

Suborder *MICROCAMPYLI* Hyatt.

Family BACTRITIDÆ Hyatt.

Genus BACTRITES Sandberger.

Bactrites nitidus sp. nov.

(PLATE VII, FIGURES 9–12.)

The collection contains considerable fragmentary material of a species of *Bactrites* which appears to be much like *Bactrites gracilis* Sandberger and *B. gracilior* Clarke. None of the specimens from Montana retain the shell or show any trace of surface markings, and for that reason, as well as because there are minor differences in the casts, it has been thought wiser not to refer these forms to any established species.

Description. — The shell is subcircular in section, uncrushed specimens being only slightly elliptical. The diameter of the shell diminishes so slowly that the tapering is hardly noticeable on the longest specimens in the collection. The septa are oblique, sloping toward the dorsum, and are gently convex. The cameras become more shallow as the living chamber is approached. The largest fragment shows eight cameras in a length of 18 mm. Another specimen with about the same diameter has two cameras in a length of 7 mm. The sutures show a slight backward curve on the sides of the shell, but are nearly straight. There are only two fragments of living chambers in the collection. The largest is 12 mm. in length. One of the smaller specimens, 8 mm. in length, is so perfectly preserved that the cast is not broken so as to show the siphonal funnels, and, in consequence, the suture is entire. On this specimen may be seen faint traces of oblique ridges like those with which *Bactrites gracilis* and *B. gracilior* are ornamented.

Locality. — This species is fairly common in the red shale of the Upper Devonian at Three Forks, Montana.

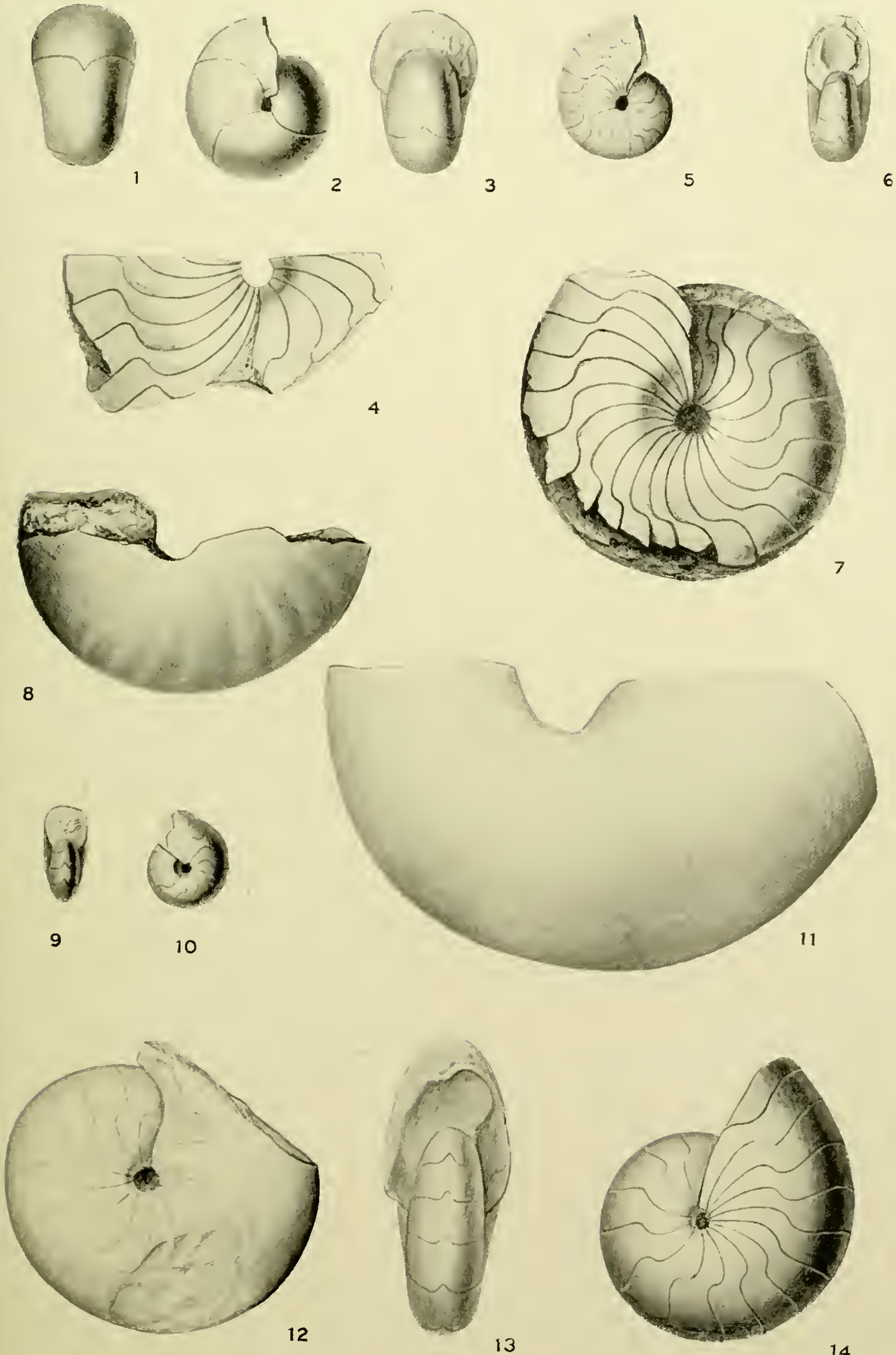
Family NAUTILINIDÆ Hyatt.

Genus PROLOBITES Karpinsky.

Prolobites simplex sp. nov.

(PLATE VII, FIGURES 13, 14; PLATE VIII, FIGURES 1–3.)

Description. — Shell plump, involute, the umbilicus becoming very



Sydney Prentice, del.

Upper Devonian Cephalopoda.

narrow in fully grown shells. Adult shells are only slightly compressed and young specimens are almost globular. None of the specimens are entire, but from the shells at hand it is evident that the living chamber occupies over half a volution. The surface markings, which consist of very faint ridges, run slightly forward from the umbilicus and turn back on the venter, forming a shallow hyponomic sinus.

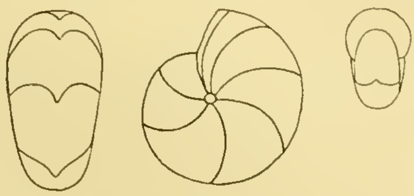


FIG. 3. Outline drawing of two specimens of *Prolobites simplex* Raymond to show sutures. Natural size.

The cameras are deep in young specimens, a specimen 10 mm. in diameter showing only three sutures in a full volution. The suture is almost straight from the umbilicus to the ventral lobe, but shows a shallow saddle near the umbilicus. This suture is much simpler than that of the adult *Prolobites delphinus* (Sandberger), but is somewhat like that of the variety *atava* described by Frech. ("*Über devonische Ammoneen*," p. 78, fig. 33.)

This genus has not been found elsewhere in the American Devonian.

Locality. — This is the most common of the goniatites found in the red shale of the Upper Devonian at Three Forks, Montana.

Suborder *EURYCAMPYLI* Hyatt.

Family MAGNOSELLARIDÆ Beyrich.

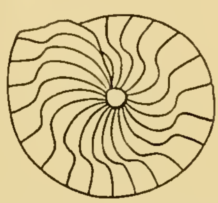
Genus TORNOCERAS Hyatt.

Tornoceras crebriseptum sp. nov.

(PLATE VIII, FIGURES 5–8.)

In my preliminary paper referred to above, this shell was spoken of as *Cheiloceras* sp. as the surface markings consist of nearly straight lines with a very shallow hyponomic sinus. The course of the suture is, however, so like that of *Tornoceras* that it must be referred to that genus. In a recent paper (Die Cephalopodenfauna des hoheren Oberdevon am Enkeberge. Neue Jahrbuch für Mineralogie, Geologie, und Paleontologie, Beilage-Band XXVI, 1908, pp. 565–634), Wedekind has shown that the internal suture of the typical *Cheiloceras* is a nearly straight line between lateral saddles, while the inner suture of *Tornoceras* shows a deep internal lobe between two saddles. Both *Tornoceras crebriseptum* and *Tornoceras douglassi* show the internal lobe, which is somewhat tongue-shaped in *T. douglassi* and rather broadly V-shaped in *T. crebriseptum*.

Description. — Shell discoidal, compressed, involute, the narrow umbilicus open at all stages of growth. The sides of the shell are flattened, the venter rounded. The surface is marked by distant, nearly straight ridges which run from the umbilicus diagonally forward across the shell and turn very slightly backward on the venter. No complete specimen has been observed, the largest portion of the living chamber



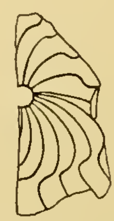


FIG. 4. *Tornoceras crebriseptum* Raymond. Outline drawing to show sutures. Natural size.

FIG. 5. *Tornoceras* sp. Outline of one of the specimens in which the normal course of the sutures is reversed. Natual size.

so far seen consisting of half a volution. The course of the suture is shown by the figure.

Locality. — This species is common in the red shale of the Upper Devonian at Three Forks, Montana.

Tornoceras sp.

(PLATE VIII, FIGURE 4.)

This species is represented by only two specimens, which indicate a shell of the same size and shape as the preceding species, but the course of the suture line is exactly reversed. Where in the previous species there were saddles, in this species there are lobes. Even the V-shaped lobe of *Tornoceras crebriseptum* is a V-shaped saddle in this species. This is a very peculiar condition among the goniatites, ventral saddles being developed only among the chloichoanitic ammonites. The small number of specimens having this peculiar form at once leads to the suspicion that this reversed position of the septa is an abnormal condition. With so little material at hand and what there is preserved in such refractory minerals, it is not possible to determine what is the cause of this reversion of the normal suture. It is very possible that material showing the ontogeny would throw some light on this perplexing form.

Locality. — A very rare shell in the red shale at Three Forks, Montana.

Tornoceras douglassi sp. nov.

(PLATE VIII, FIGURES 9–14.)

All the goniatites found in the white blocky shale, and many of those from the red shale belong to the genus *Tornoceras*. The specimens from the white shale are much larger than those from the red shale, but most of the shells in the red shale are dwarfed, so that, as there are no other differences between the shells from the two localities, they are probably the same species. One of the shells from the red shales is chosen as the holotype, to avoid any confusion in case it should at any time be found that there are really two species involved.

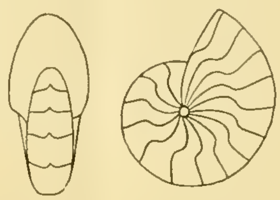


FIG. 6. *Tornoceras douglassi* Raymond. Outline drawings of the type to show sutures. Natural size.

Description. — Shell discoidal, involute, with a small umbilicus throughout life. In the best specimen from the red shales the portion of the living chamber preserved occupies about half a volution, but specimens from the white shale show that the living chamber occupies at least a volution. On these latter specimens, which are flattened casts in a fine shale, the form of the aperture is preserved. The form, as shown in the figure, is gently rounded at the sides, with a deep, rather broad hyponomic sinus. The surface markings seen on the hematite replacements found in the red shales have the same course as the outlines of the apertures on the white shale. The markings, which are very faint, sweep gently forward from the umbilicus, become stronger on the sides of the shell and turn abruptly back on the venter, forming very slight hyponomic ridges.

The cameras are shallow, but not so shallow as those of the species just described. In young stages the sutures are further apart and the whorl-section more rotund. The course of the suture is shown in the figure. The lobes and saddles are slightly deeper than those of *Tornoceras crebriseptum*.

Four species of *Tornoceras* have been described from the Devonian of New York state. From *Tornoceras uniangulare* (Conrad) the present species differs in being distinctly umbilicate in the adult stage. *Tornoceras bicostatum* (Hall) differs from *T. douglassi* in having a broad and flattened venter, and in the direction of the surface markings.

The suture of *Tornoceras peracutum* (Hall) has very much more pronounced lobes and saddles than that of *T. douglassi*, and *Tornoceras rhysum* Clarke has very much stronger surface markings than the species from Montana. These are the more striking differences, but a close comparison shows many other differences in the course of the suture, the whorl section, and the ornamentation.

This species is named for Mr. Earl Douglass, who discovered the fauna here described.

Locality.— This species is quite common in the white blocky shale and in the red fissile shale of the Upper Devonian at Three Forks, Montana.

EXPLANATION OF PLATES.

PLATE III.

1, 2, 3. *Camarotœchia contracta* Hall. Three views of an individual from the green shale. × 2.

4, 5. The same species. A cast from the red shale. × 2.

6, 7. The same species. A small specimen from the green shale. × 2.

8, 9. *Leiorhynchus mesacostale* Hall. Two views of a specimen from the red shale. × 2.

10. *Spirifer disjunctus* Sowerby. A small specimen from the red shale. × 2.

11, 12. *Spirifer pinonensis* Meek. Two views of a specimen from the red shale. × 2.

13, 14, 15. *Ambocœlia gregaria* Hall. Three views of a specimen from the red shale. × 2.

16. *Cleiothyridina devonica* Raymond. A portion of the surface enlarged to show the ragged edges of the lamellæ from which the spines have been broken, and, in one corner, the spines themselves flattened against the shell. × 4.

17. The same species. A specimen showing imperfectly the spiral supports of the brachia. × 2.

PLATE IV.

1, 2, 3. *Cleiothyridina devonica* Raymond. Three views of a specimen from the green shale. × 2.

4, 5, 6. The same species. A more nearly circular individual. × 2.

7, 8. The same species. A somewhat larger individual, with a rather small sinus. × 2.

9, 10, 11. The same species. Three views of another specimen. × 2.

PLATE V.

1, 2, 3. *Loxopteria holzapfeli* Raymond. Three views of a specimen, showing the relative convexity of the valves and the radial striations of the left valve. × 2.

4, 5, 6. The same species. Three views of a larger individual. × 2.

7. The same species. A cast of a part of a right valve, showing the posterior scar and the pallial line. × 2.

8, 9, 10. *Loxopteria clarkei* Raymond. Three views of a small specimen from the red shales. × 2.

11. *Loxopteria holzapfeli* Raymond. A fragment, showing a practically perfect posterior wing. × 2.

12, 13, 14. *Loxopteria clarkei* Raymond. Three views of a nearly complete specimen. × 2.

15, 16, 17. The same species. Three views of a large specimen. × 2.

PLATE VI.

1, 2. *Goniophora subrecta* Hall? Two views of a specimen from a nodule of limestone. × 2.

3. The same species. A small and very imperfect specimen from the red shale. × 2.

4. *Orthoceras montanense* Raymond. × 2.

5, 6. The same species. A sectioned specimen, showing the curvature of the septa and the short siphonal funnels. × 2.

7. *Geisonoceras normale* Raymond. × 2.

8, 9. *Geisonoceras accelerans* Raymond. The original of No. 9 is much flattened. × 2.

10. *Platyclymenia americana* Raymond. The type. The inner whorls are not preserved. × 2.

11, 12, 13. The same species. Three views of a fragment to show the ribs, the suture, and the form of the section. × 2.

PLATE VII.

1. *Platyclymenia americana* Raymond. Part of the body whorl of a large individual from the shale, showing how indistinct the ribs become. Natural size.

2. The same species. A fragment, showing the position of the siphuncle and the depressed section of the whorls. × 2.

3. The same species. Another fragment showing some of the inner whorls. × 2.

4. *Platyclymenia polypleura* Raymond. A large specimen with the inner whorls concealed. × 2.

5. The same species. A specimen showing a part of the inner whorls. × 2.

6. The same species. A portion of a body whorl, showing the numerous ribs. × 2.

7. *Platyclymenia annulata* var. *densicosta* Frech. A copy of Frech's figure to show similarity to *Platyclymenia polypleura*.

8. *Platclymenia annulata* (Münster). A copy of Frech's figure.

9. *Bactrites nitidus* Raymond. A large, but somewhat crushed specimen. × 2.

10, 11, 12. The same species. Fragments showing the suture, siphuncle, septa, and the shape of the section. × 2.

13, 14. *Prolobites simplex* Raymond. Two views of a rather large specimen. × 2.

PLATE VIII.

1, 2, 3. *Prolobites simplex* Raymond. Three views of a small specimen. × 2.

4. *Tornoceras* sp. ind. Compare the sutures with those of figure 7. × 2.

5, 6. *Tornoceras crebriseptum* Raymond. A young individual. × 2.

7. The same species. The type. × 2.

8. The same species. A fragment of a body whorl, showing a trace of surface markings. × 2.

9, 10. *Tornoceras douglassi* Raymond. A small specimen. × 2.

11. The same species. A portion of a body whorl, showing the outline of the lip. × 2.

12. The same species. A specimen from the white shale. × 2.

13, 14. The same species. Two views of the type. No attempt has been made to show the rather obscure surface markings which are described in the text. × 2.

V. DESCRIPTION OF A NEW SPECIES OF PROCAMELUS FROM THE UPPER MIOCENE OF MONTANA WITH NOTES UPON PROCAMELUS MADISONIUS DOUGLASS.

By Earl Douglass.

Procamelus elrodi sp. nov.

(Type No. 777, Carnegie Museum Catalogue of Vertebrate Fossils.)

(Plates IX to XI.)

The type of this species is a nearly complete skull and mandible with the greater portion of the neck. It was found by the writer in a pinkish, fine-grained stratum beneath river deposits of conglomerate and sand, which are exposed in the bluffs on the east side of the lower Madison Valley in Montana nearly east of Hyde Post-office.

The species is distinguished by its large size, the pit into which the infraorbital foramen opens and the much larger pit above it, the heavy but not deep mandible, the prominence of the postero-superior portion of the angle and the relative proportions of the cervicals which decrease in the length of the centra from the axis backwards.

Dentition. — All the teeth are more or less worn, indicating that the animal was fully mature. The teeth anterior to the molars are preserved, but are all somewhat worn, especially the last three premolars. The molars on the left side are gone and the first two on the right side are nearly destroyed.

Upper Teeth. — About 7 mm. anterior to the third incisor on the right side there is a small rudiment of a second incisor in an alveolus 2 mm. in diameter. The tooth does not appear to possess any enamel and does not project below the alveolar border.

$I^{\underline{3}}$ is a heavy caniniform tooth, nearly circular in section. The canine is a little narrower transversely and a little longer antero-posteriorly than $I^{\underline{3}}$ and is elliptical in section. It curves slightly forward like the canines of many of the carnivora. $P^{\underline{1}}$ is smaller than the canine but has nearly the same form. $P^{\underline{2}}$ is narrow transversely, but is attached by two heavy roots. $P^{\underline{3}}$ is larger and has three roots.

The length of P^4 is nearly the same as that of P^3 but it is much broader. These teeth are so worn that the exact original form of the crown cannot be made out. The last molar is longer and broader than those preceding it.

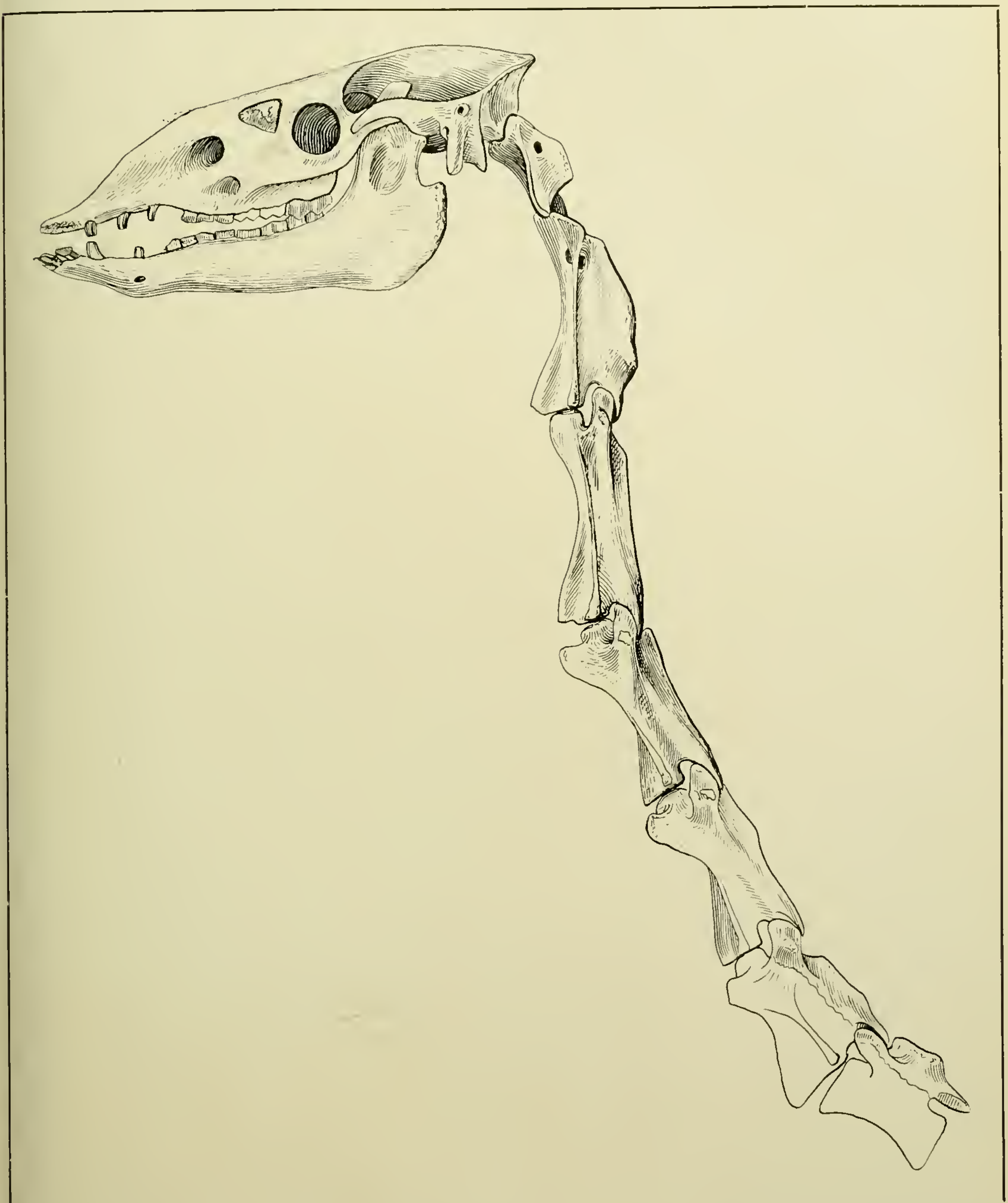
Lower Teeth. — The incisors are all large, the anterior being the largest and the posterior the smallest. I_1 though somewhat worn has a crown 25 mm. in height, and it is more nearly symmetrical than the other incisors. It is semiprocumbent. I_3 is slightly less procumbent. The canine is large, curved, and oval in horizontal section. The anterior premolar is smaller than the canine and is conical in form. Premolars two and three have each two large roots. The teeth are narrow transversely, but the three posterior premolars increase in length and width from the second to the fourth. Of the molars only the last on the right side is completely preserved. This is long antero-posteriorly.

The Skull. — The skull is long and proportionally low, the frontal plane broad, the brain-case quite large and full, the sagittal crest low and long, and the posterior portion of the zygomatic arch slender and arching upward. The lachrymal vacuities are large and oval in form. The facial pits are large.

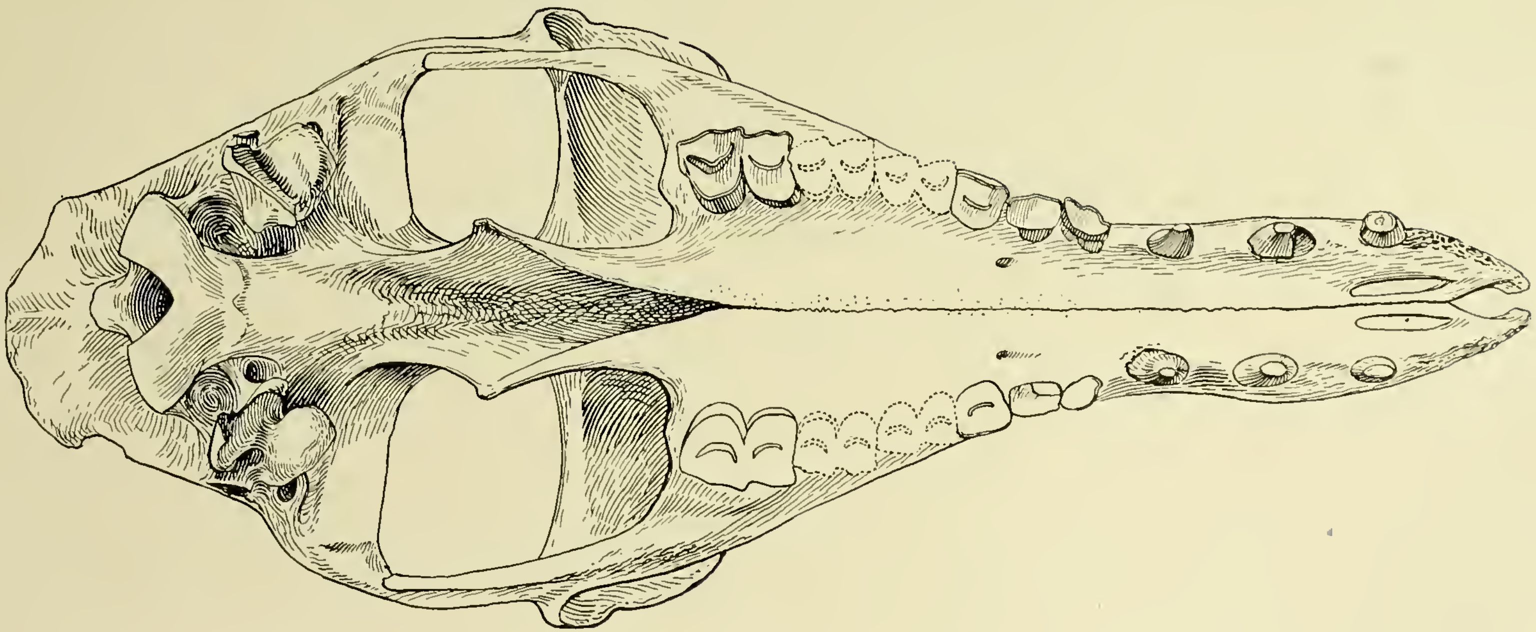
Palate View. — The alveolar borders of the premaxillaries are thick transversely and are roughened in front of I^3. The anterior tips arch upward and approach each other but are not in contact in the present specimen. The incisive alveoli are long and narrow. The palate gradually widens from before backward to the canine and then gradually narrows to P^2, but the last incisors, the canines, and the first premolar of the opposite sides are nearly the same distance apart. The lower border of the pterygoid curves downward and ends in a rounded point. The posterior border ascends steeply. The lower surfaces of the basioccipital and basisphenoid are broad, and broadly convex transversely.

Lateral View. — The infraorbital foramen opens into a fossa or depression above the anterior portion of M^1. Above this is a large concavity. The lachrymal vacuity is large and oval. The anterior border of the orbit is above the middle of the last molar. The zygomatic arch is rather slender behind the orbit and is arched upward. The postglenoid process is weak and thin antero-posteriorly, but rests against the high tympanic, from which it is partially separated on the outer side by the postglenoid foramen. The tympanic bulla is high. The inner portion is destroyed in the type specimen, but the outer

Skull of *Procamelus elrodi* Douglass. (One third natural size.)



Skull and Neck of *Procamelus elrodi* Douglass. (One eighth natural size.)



Palatal View of Skull of *Procamelus elrodi* Douglass. (A little less than one third natural size.)

portion is prismatic in form. The opening of the external auditory meatus is a short sessile tube located at the upper extremity of the tympanic, fusing behind with the mastoid process. The paroccipital processes are flattened below and are oblique being directed antero-internally and postero-externally. The outer portion terminates in a small triangular process. The paroccipital processes extend forward so that their anterior portions are partly internal to the tympanics.

Top View. — The anterior portions of the nasals are gone. The anterior processes of the frontal form a wedge between the posterior rounded lobes of the nasals. The forehead between the orbits is broad and is slightly convex transversely with a small median anterior concave area. The supraorbital foramina are about two centimeters external to the median line of the skull. The anterior margin of the temporal foramen is nearly perpendicular to the longer axis of the skull, but internally trends backward in a rapidly developing curve continuous with that of the supratemporal ridges, which unite to form the sagittal crest at a point a little less than one third of the distance from the supraorbital foramina to the occiput. The supratemporal ridges are low and obscure. The sagittal crest is long, thin, low in front and quite high behind. The lateral wings of the occiput are quite broad.

The Mandible. — The horizontal portion of the mandible is quite heavy, especially in front, but not deep, though it gradually increases in depth from $P_{\overline{2}}$ to the ascending ramus. The angle of the mandible is broadly rounded, ending behind in a hook-like process. The ascending ramus is narrow antero-posteriorly with heavy rounded anterior and posterior ridges, which bound the masseteric fossa before and behind. This fossa has the form of an inverted oval. The coronoid process is high and inclines backward.

The Neck. — The atlas is broader than long. Beginning with the axis, and including its process, each succeeding cervical is shorter than the preceding or equals it in length. In *Oxydactylus* the third cervical is the longest and the cervicals posterior to it decrease in length to the last. In *Alticamelus altus* (Marsh), according to Matthew,[1] the cervicals vary in length from the longest to the shortest in the following order: C. 3, C. 4, C. 5, axis, C. 6, C. 7, atlas.

The spine on the axis is low, thin and rounded anteriorly, but is

[1] "Fossil Mammals from Colorado," *Mem. Amer. Mus. Nat. Hist.*, Vol. I, Part VII, p. 431. See measurements.

higher and thicker posteriorly where there is a thickened heavy tubercle. The spine of the second cervical is low anteriorly and soon divides into two sessile ridges which diverge and then converge, sending backward parallel branches. The fourth and fifth cervicals resemble the third in general form, but there is a quite prominent tubercle on the fifth.

The skull of *Procamelus elrodi* is nearly as large as that of *Alticamelus altus* described by Matthew, while the neck is much shorter. The separate measurements of the vertebræ in *Procamelus elrodi* give a total of 1036 mm. while that of *Alticamelus altus* gives 1560 mm.

This species is named in honor of my friend Professor Merton J. Elrod who has done so much for scientific research in Montana, and to whom I owe a debt of gratitude.

MEASUREMENTS OF *Procamelus elrodi*.

	Mm.
Length of skull, basal	429
“ “ “ including sagittal crest	503
Width “ “ at canines	60
Length “ “ at diastema between P^{1} and P^{2}	48
Width “ “ “ posterior orbits	165
“ “ “ “ tympanics	111
Height “ “ “ M^{3}	123
“ “ “ “ “ and including tympanic bullæ	118
“ “ occiput	90
Length of mandible including incisors	380
Depth of “ at canine	19
“ “ “ “ P_{1}	33
“ “ “ “ P_{2}	40
“ “ “ “ M_{1}	50
“ “ “ “ M_{3}, posterior part	65
Anteroposterior diameter of ascending ramus of mandible at posterior angle	85
Length of upper dental series from I^{3}	223
“ “ molar-premolar series	163
“ “ premolar series	81
“ “ molar series	82
“ “ I^{3}	15
Width “ “	13
Length “ space between I^{3} and canine	19
“ “ canine	15
Width “ “	14
Length of space between canine and P^{1}	15
“ “ P^{1}	14
Width of P^{1}	10

	Mm.
Length of space between P^1 and P^2	19
" " P^2	15
Width of P^2	8
Length of P^3	18
Width of P^3	11
Length of P^4	20
Width of P^4	17
Length of M^1 and M^2	48
" " M^3	38
Width of M^3	25
Length of lower dental series	267
" " " molar-premolar series	175
" " " molar series	96
" " I_1 greatest	12
Width of I_1	9.5
Length of I_3	15
Width " I_3	8
Length of space between I_3 and canine	11
" " canine	19
Width " "	13
Length of space between canine and P_1	20
" " P_1	15.5
Width of P_1	11.5
Length of space between P_1 and P_2	20
" " P_2	12
Width of P_2	7.5
Length of P_3	16.5
Width of P_3	7
Length of M_3	43
Width of M_3	19
Length of atlas, greatest	101
Width of atlas	120
Length of centrum of axis including odontoid process	190
Width of axis, posterior	84
Height of axis, greatest	100
Length of C 3, centrum	176
" " C 3	118
Height of C 3	77
Length of C 4	171
Width of C 4	110
Length of C 5	161
Width of C 5, about	105
Height of C 5	82.5
Length of C 6, about	140
" " C 7	97
Whole length of neck articulated	1000

Procamelus madisonius Douglass.

("The Miocene Lake Beds of Western Montana." Published by the University of Montana, 1899, p. 15.)

In my first paper on the Tertiary deposits of Montana I described a skull and two portions of mandibular rami with teeth under the above name. The portions of the lower jaws were figured in outline

FIG. 1. Lateral view of skull of *Procamelus madisonius* Douglass. (One third natural size.)

in that paper. The skull which is the type of the species has never been figured; figures of the cranium are therefore given in this paper. A detailed description appeared in the original paper, but, as skulls of fossil camels were very rare at that time, its characteristic features could not well be pointed out. The statement there made that the

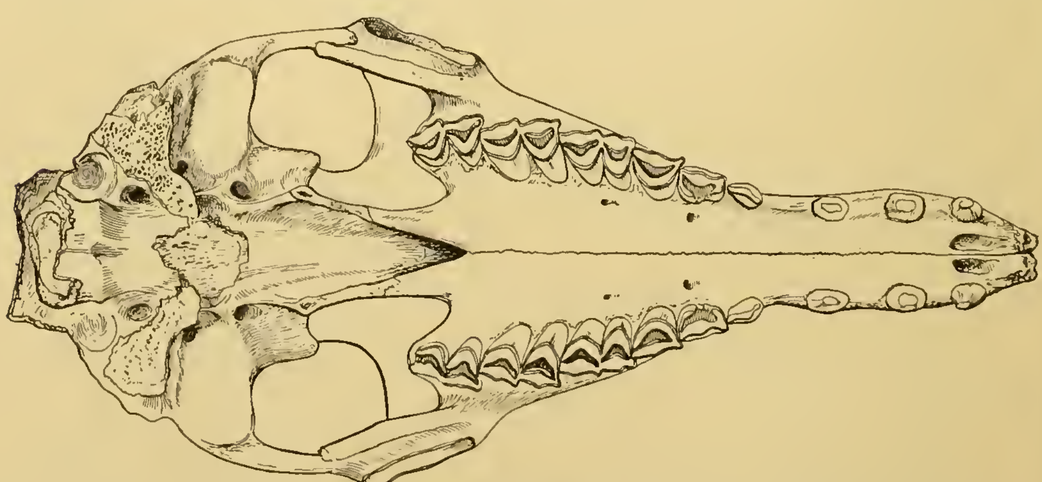


FIG. 2. Palatal view of skull of *P. madisonius* Douglass. (Considerably less than one third natural size.)

skull was about one fifth larger than that of *Camelus dromedarius* is misleading, as the only skull then available for comparison was that of a small dromedary. Many skulls of the living species are very much larger than that of *Procamelus madisonius*. The characters which now seem most striking in the skull and dentition of this species are the following:

The posterior portion of the skull is broad in proportion to the length. The posterior border of the orbit is about one third the distance from the occiput above the occipital condyles to the anterior margin of the premaxillaries; thus making the brain-case and the face shorter in proportion to the total length of the skull than is the case in *Procamelus occidentalis* as figured by Cope on Plate LXXVII of Vol. IV of the "U. S. Geological Survey of the 100th Meridian." The brain-case is still larger in *Procamelus elrodi*. The first and second incisors in the type of *P. madisonius* are gone, but none of the other teeth are greatly reduced. In $P\frac{3}{}$ the inner crescent is incomplete. The length of the molar series is a little greater than that of the premolar series. The three diastemata between $I\frac{3}{}$ and $P\frac{2}{}$ increase in length backward.

VI. SOME SECTIONS IN THE CONEMAUGH SERIES BETWEEN PITTSBURGH AND LATROBE, PENNSYLVANIA.

BY PERCY E. RAYMOND.

During the last few years the Pennsylvania Railroad has made many new cuttings in straightening and improving its main line in western Pennsylvania, and some of these excavations between Pittsburgh and Latrobe have exposed strata which could not be well seen in the exposures previously available for study. The two big cuts between Donohoe and Beatty near Latrobe in Westmoreland County are particularly interesting as they expose a nearly continuous section about 450 feet in thickness, permit the identification of the various horizons, and correct some errors into which previous workers have been led by the incomplete exposures available at the time the surveys were made.

In the Report of the Second Geological Survey of Pennsylvania, Volume KK, Dr. Stevenson gave two sections, one east from Georges Station and including the strata in the tunnel through Dry Ridge, and one west from Beatty. In neither of these sections are the horizons identified except in relation to the Pittsburgh coal, and in each there are a number of concealed intervals. The sections which are here given serve to supplement and to some extent to explain the older sections.

The big cut through Dry Ridge just east of the station at Donohoe is on the western side of the Fayette anticline, and the dip is strongly northwest. In the middle of the cut it is about 1 foot in 16. The dip becomes less as the summit of the anticline is approached, but all the strata of the Conemaugh series below the Cow Run sandstone and thirty to forty feet of the strata of the Allegheny series are brought up above the level of the railroad track before the dip changes. Just beyond the semaphore, a mile and a half east of Donohoe, the dip changes to the southeast. From that point there are no good exposures until the western end of the big cut west of Beatty is reached. There the strata from just below the Pine Creek limestone to the clay on top of the Birmingham shale are exposed. In the low cuttings east of this big cut the Morgantown sandstone and the Clarksburg limestone are exposed, but the bank is so overgrown with vegetation that it is not now possible to make satisfactory measurements. The Morgantown here is a cross-bedded sandy shale, and not a compact sandstone. At Beatty the Pittsburgh coal goes below the level of the railroad track.

The section compiled from these two large cuts is as follows, in descending order :

34.	Structureless clay, grading into residual soil at the top.		
33.	Thin-bedded clay shale, very black at the base, green and somewhat sandy above. Birmingham horizon. 49 ft.	49 ft.	
32.	Structureless red clay. 12 ft. 6 in.	61 ft.	6 in.
31.	Thin-bedded fissile shale, with small red nodules. 23 ft. 6 in.	85 ft.	
30.	Shale and limestone with abundant marine fossils. 3 ft. Black shale with a few marine fossils. 3 ft. } Ames horizon 6 ft.	91 ft.	
29.	Coal. Harlem horizon. 14 in.	92 ft.	2 in.
28.	Red structureless clay, weathering gray and yellow. 14 ft.	106 ft.	2 in.
27.	Thin-bedded red shale. 7 ft. 6 in.	113 ft.	8 in.
26.	Structureless clay, weathering red, gray, and yellow. Contains many nodules of limestone. 14 ft. 8 in.	128 ft.	4 in.
25.	Thin-bedded clay-shale. 14 ft. 6 in.	142 ft.	10 in.
24.	Red structureless clay. 9 ft.	151 ft.	10 in.
23.	Heavy-bedded sandstone. A layer of coal from 1 to 4 inches in thickness occurs near the base of this sandstone. It can be traced only about 25 feet, and is bent and contorted. Cow Run horizon. 45 ft.	196 ft.	10 in.
22.	Thin-bedded black shale. 5 ft.	201 ft.	10 in.
21.	Limestone with marine fossils. 6 in. Pine Creek horizon.	202 ft.	4 in.

The continuation of this section is taken from the big cutting east of Donohoe station. The dip here is to the northwest.

21.	Shale with marine fossils. 6 in. Pine Creek horizon.		
20.	Thin-bedded yellow sandy shale. 10 ft.	212 ft.	4 in.
19.	Yellow shaly sandstone which breaks down readily on exposure to the weather. 25 ft.	237 ft.	4 in.
18.	Light gray, very compact sandstone. At the base and 10 feet above the base there are irregular layers of conglomerate which is made up mostly of small, well-rounded quartz pebbles. 42 ft. 18, 19, 20 are the Buffalo horizon.	279 ft.	4 in.
17.	Thin-bedded dark gray and black shales with plant remains and lamellibranchs. 12 ft. 6 in.	291 ft.	10 in
16.	Thin-bedded black shales with marine fossils and small red nodules. 10 ft. Two layers of compact limestone with marine fossils. 3 ft. } Brush Creek horizon. 13 ft.	304 ft.	10 in.

15.	Dark gray and black shale. Mason horizon. 14 ft.	318 ft. 10 in.
14.	Coal. 6 in. Mason.	319 ft. 4 in.
13.	Gray clay-shale at the base, grading into a sandy clay above. In some places this bed contains a heavy-bedded sandstone. 13 ft.	332 ft. 4 in.
12.	Somewhat sandy gray clay-shale. 14 ft. 6 in.	346 ft. 10 in.
11.	Thin-bedded black shale. 16 ft.	362 ft. 10 in.
10.	Coal. Gallitzin horizon. 2 ft. The thickness is very irregular, varying from 2 to 4 ft.	364 ft. 10 in.
9.	Gray, structureless clay. 12 ft.	376 ft. 10 in.
8.	Thin-bedded sandstone, bottom not seen. 7 ft.	383 ft. 10 in.
7.	Concealed. 15 ft. ±	398 ft. 10 in.
6.	Rather thin-bedded sandstone. Top not seen. Mahoning horizon. 21 ft.	419 ft. 10 in.
5.	Coal. Upper Freeport horizon. 4 ft. 5 in.	424 ft. 3 in.
4.	Structureless green clay. 6 ft.	430 ft. 3 in.
3.	Gray, thin-bedded shale, with a layer of limestone nodules at the top. 7 ft.	437 ft. 3 in.
2.	Heavy-bedded buff limestone. 2 ft. 6 in.	439 ft. 9 in.
1.	Yellow clay shale. 5 ft.	444 ft. 9 in.

NOTES ON THE SECTION.

33. The basal layers of the Birmingham are a very black bituminous shale. This is the horizon of the Elk Lick coal. It does not occur as a coal on the eastern side of the anticline, but it may be seen in the first cut west of Donohoe on the western side of the anticline. It is there from 14 to 16 inches in thickness as stated in the Latrobe Folio of the United States Geological Survey, page 13, 1904, but it is 150 feet above the Buffalo sandstone (Saltsburg of the folio) and not 50 feet as estimated by the writers of that folio. The coal on the eastern side of Dry Ridge which in the folio is identified with the Elk Lick must be either the Gallitzin or the Upper Freeport, probably the former, as it is reported as lying above a sandstone, and 3 feet 9 inches thick.

30. The Ames limestone is well exposed in the cutting west of Beatty, is full of fossils, and of typical appearance. It is accompanied by a thin bed of coal, as often happens. In Dr. Stevenson's figure 32, page 274 of the report cited above, numbers 4 and 5 seem to be the Birmingham, 6 the Elk Lick, and the coal spoken of as probably occurring in 9, the Harlem.

23. The base of the Cow Run sandstone is very uneven, and in the section at the cut east of Donohoe is much higher above the Pine Creek than in the cut west of Beatty.

21. The Pine Creek limestone is apt to be very full of sand and clay, and is particularly so in these sections east of Pittsburgh. In the cut east of Donohoe its horizon was found only after a most careful search, and then could be identified only by its fossils, which are not common at that locality. A similar condition is seen at Trafford (formerly Stewart Station), and the other cuttings between that station and Ardara.

20, 19, 18. The Buffalo sandstone is here much thicker than usual. The lower part is massive and in places conglomeritic, while the upper part is soft and tends to become shaly. The base is irregular and the thickness variable.

16. The Brush Creek shales and limestone are full of very well preserved fossils, largely pelecypods and gastropods, and as a large amount of this material has been taken out and scattered along the dumps on either side of the cut, this is an excellent collecting ground. I am indebted to Father Wirtner, O.S.B., of Penn Station, for having called my attention to this locality.

The following are the more common species:

Euomphalus catilloides Conrad,
Bulimorpha nitidula (Meek and Worthen),
Sphærodoma primaginia (Conrad),
Worthenia tabulata (Hall),
Trepospira illinoisensis (Worthen),
Bellerophon percarinatus Conrad,
Euphemus carbonarius (Cox),
Patellostium montfortianum (Norwood and Pratten),
Astartella vera Hall,
Marginifera wabashensis (Norwood and Pratten).

This is probably No. 19 of Dr. Stevenson's section (his fig. 32), while his No. 22 would be the Mason coal.

7. The concealed interval is not readily estimated, but there are probably not much more than 15 feet of strata missing. This figure was obtained by taking the dip of the top of the Upper Freeport and the top of the Mason coal. The top of the Upper Freeport is rather irregular (is, in fact, faulted in one place), and the best measurements to be obtained gave the apparent dip as 1 foot in 29, while the dip of the Mason coal is 1 foot in 16. As the course of the railroad is here approximately perpendicular to the strike, this is nearly the true dip. As calculated with these data, the maximum

vertical distance between the two layers in question is 120 feet and the minimum is 76 feet. The strata actually exposed measure 85 feet 6 inches, thus showing that the minimum is too small, and the interval has been assumed to be slightly above the average between the two figures, and has been placed at 100 feet. Absolute accuracy is not claimed for any of the measurements on account of the varying dip and the physical difficulties of making the measurements on the steep sides of the cuts.

6. The Mahoning sandstone is rather thin-bedded and seems to yield readily to weathering. This sandstone and the Cow Run sandstone seem to have been confused with the Buffalo in previous work.

5. The Upper Freeport coal is being actively mined on the eastern side of Dry Ridge between the old and new railroad tracks. The coal is reported to be very good, but contains a couple of "binders" which have to be picked out. It has been prospected on the eastern side of the anticline, but is not being mined there at present.

SECTION AT THE GRAPEVILLE ANTICLINE.

The crest of the next anticline west of the Fayette anticline crosses the Pennsylvania Railroad between Grapeville and the cutting just east of the station at Jeannette. In the bank of Brush Creek at Oakford Park, a mile north of the railroad and northeast of Jeannette, the Upper Freeport coal, three feet thick, is exposed. Fourteen feet of sandy shale and 44 feet of heavy-bedded Mahoning sandstone rest upon it. The section in the railroad cut at Jeannette is interesting in comparison with the similar portion of the section at Donohoe. It is as follows:

SECTION AT JEANNETTE, PA.

11.	Yellow and gray sandy shale with plant remains. At the base and three feet above the base are thick layers of sandstone. Mason shale horizon. 11 ft.	11 ft.
10.	Gray clay-shale. 2 ft.	13 ft.
9.	Coal. 10 in. Mason	13 ft. 10 in
8.	Gray structureless clay. 14 ft.	27 ft. 10 in.
7.	Gray sandy shale with nodules. 21 ft.	48 ft. 10 in.
6.	Very carbonaceous shale, almost coal. May be the horizon of the Upper Gallitzin. 1 ft. 6 in.	50 ft. 4 in.
5.	Thin-bedded black shale, with great numbers of specimens of *Carbonicola* and *Spirorbis*. 1 ft.	51 ft. 4 in.
4.	Gray shale and thin layers of limestone which contain fresh-water invertebrate fossils. 4 ft. 6 in.	55 ft. 10 in.

3.	Contorted gray clay and thin-bedded gray shale with many limestone nodules. 10 ft.	65 ft 10 in.
2.	Soft gray and green clay. 6 ft.	71 ft. 10 in.
1.	Thin-bedded sandstone, bottom not seen. This is the top of the Mahoning. 3 ft.	74 ft. 10 in.

It will be noted that the distance between the top of the Mahoning and the base of the Mason coal is 68 feet in both sections. As the Mahoning is at least 50 feet thick in this locality, the estimate of 43 feet at Donohoe is probably under, rather than over the true thickness.

In this locality the Mason shale contains two layers of sandstone and is much more sandy throughout than usual.

The horizon of the Gallitzin coal would be at the top of number 3, but there is no trace of it in this section.

SECTION AT THE MURRYSVILLE ANTICLINE.

The crest of the next strong anticline west of the Grapeville crosses the Pennsylvania Railroad about half-way between Ardara and Trafford. In straightening the line several long and deep cuts have been made and the strata from a few feet below the Brush Creek limestone to the top of the Birmingham shale are well exposed. The section given here is compiled from measurements made in all the cuttings from the second one east of Ardara to the one just east of the station at Trafford.

SECTION ALONG THE PENNSYLVANIA RAILROAD FROM ARDARA TO TRAFFORD, PA.

20.	Gray sandy shale, with lenses of sandstone. Birmingham horizon. 47 ft.	47 ft.
19.	Coal. Elk Lick horizon. 6 in.	47 ft. 6 in.
18.	Gray shale. 6 in.	48 ft.
17.	Yellow structureless clay, with great numbers of limestone nodules. 12 ft.	60 ft.
16.	Thin-bedded red shale. 12 ft.	72 ft.
15.	Yellow fissile shale with marine fossils at the base. 10 ft.	82 ft.
14.	Shaly limestone with marine fossils. Ames horizon. 3 ft.	85 ft.
13.	Structureless red clay. 16 ft.	101 ft.
12.	Red fissile shale with many small nodules. 29 ft.	130 ft.
11.	Yellow sandstone and shale. 6 ft.	136 ft.
10.	Red, green, and gray clay. 8 ft.	144 ft.
9.	Red thin-bedded clay-shale. 58 ft.	202 ft.
8.	Impure sandy limestone with marine fossils and land plants. Pine Creek horizon. 6 in.	202 ft. 6 in.
7.	Yellow clay with numerous concretions. 4 ft.	206 ft. 6 in.
6.	Thin-bedded red shale. 6 ft.	212 ft. 6 in.

5. Yellow structureless clay. 5 ft. .... 217 ft. 6 in.
4. Gray and yellow shale, grading into thin-bedded sandstone. 36 ft. 6 in. .... 254 ft.
3. Gray clay-shale overlying 1 ft. 7 in. of sandy limestone, both containing numerous marine fossils. Brush Creek horizon. 4 ft. 258 ft.
2. Yellow, almost structureless clay. 9 ft. 6 in. .... 267 ft. 6 in.
1. Heavy-bedded sandstone, base not seen. 10 ft. 6 in. .... 278 ft.

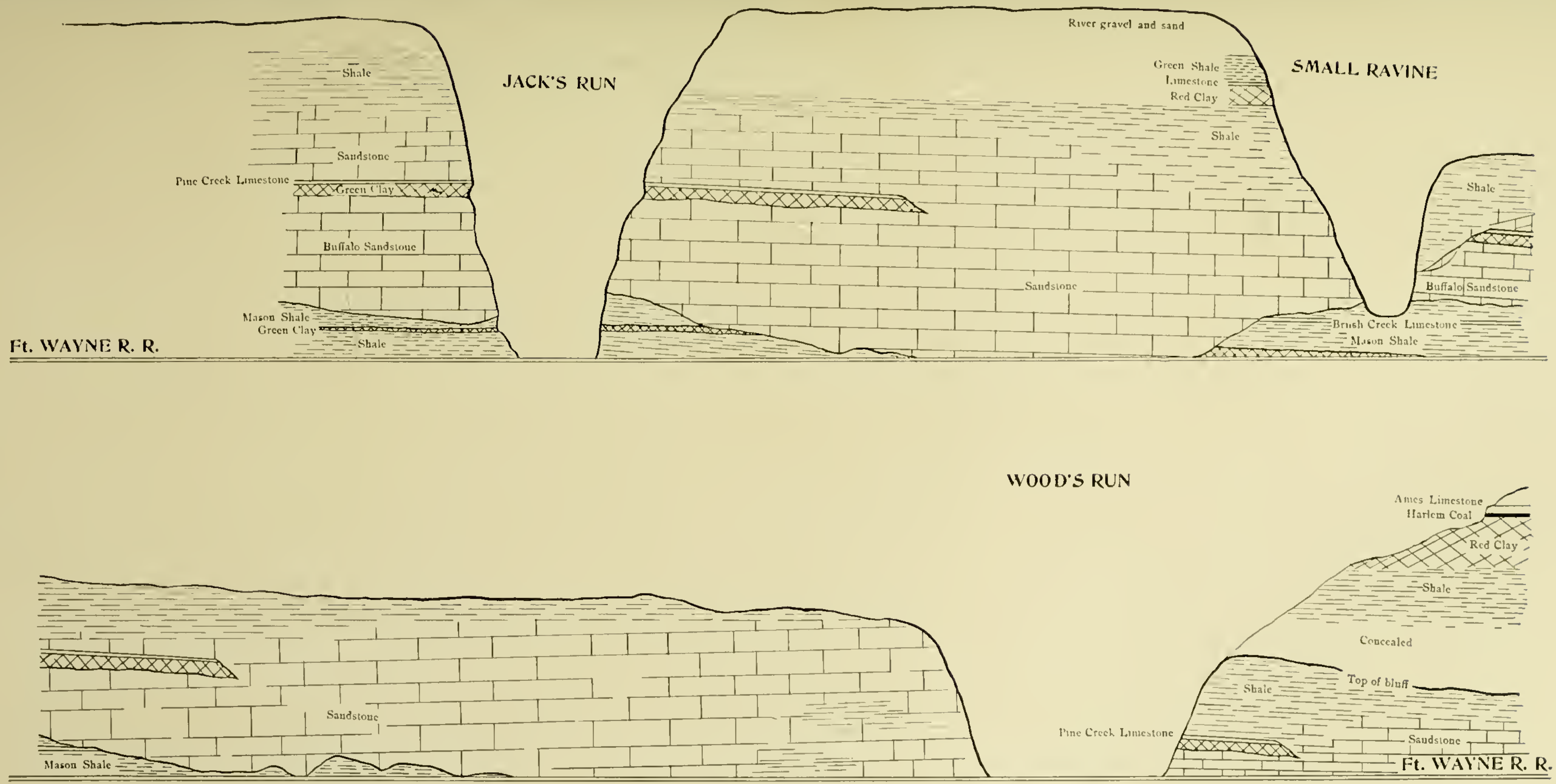
This section does not differ greatly from the one given by Professor Stevenson in Report KK, page 348, figure 48, which was measured along the old line of the Pennsylvania Railroad. His No. 15 corresponds to our No. 20 and is not the Morgantown but a sandy phase of the Birmingham. Dr. Stevenson's "coaly shale" No. 27, is the Pine Creek and No. 30 is the Brush Creek. The Pine Creek here contains very little lime and in the cuts east of the one at Trafford can hardly be distinguished except by its few marine fossils. In the cut just east of Trafford it forms a fairly solid layer, sometimes a foot thick, and contains quite a quantity of fossils, chiefly cephalopods and gastropods.

The strata between the Pine Creek and Ames limestones here measure 112 feet as compared with 110 feet at Donohoe. As shown by the sections the intervening beds are quite different at the two localities. The Cow Run sandstone is absent from this section, as is the Harlem coal. The coal may, however, be seen on the western side of this anticline along the road between Wilmerding and Pitcairn. Bed 13 of this section is the same as bed 28 of the section west of Beatty, and 10 is at the same horizon as 24.

The vertical distance between the Brush Creek and Pine Creek limestones is only 52 feet, in place of 90 feet at Donohoe, and what sandstone there is between the two limestones is not massive, but rather thin-bedded and shaly.

NOTE ON THE UNCONFORMITIES AT THE LOWER LIMITS OF THE BUFFALO AND COW RUN SANDSTONES.

The unconformities at the bases of the Cow Run and Buffalo sandstones are well shown along the bluff above the Fort Wayne Railroad tracks between Allegheny and Bellevue, Pa. This locality is mentioned by Dr. I. C. White, in Report Q, page 165, of the Second Pennsylvania Survey, but was not described in detail. It is such a good example of the unconformities by erosion which occur at these horizons that the section is here illustrated by means of a diagram and photographs. The diagram (Plate XII) is drawn to scale, the vertical



Geological Section from Jack's Run to Wood's Run.
(Vertical Scale: 1 in. = 120 ft.; Horizontal Scale: 1 in. = 600 ft.)

scale being one inch to 120 feet and the horizontal one inch to 600 feet. The upper diagram on the plate is a continuation of the lower.

The Ames limestone is exposed just about where the 900 foot contour crosses Woodlawn Avenue, near the corner of Beaver Street, Allegheny, about one-fourth of a mile from the station at Wood's Run. Descending to the station the following section is obtained:

10.	Sand and gravel in the old river bed. 27 ft.		
9.	Shaly limestone with many marine fossils. 5 ft. Ames horizon.	5 ft.	
8.	Coal. Harlem horizon. 18 in.	6 ft.	6 in.
7.	Red structureless clay. 26 ft.	32 ft.	6 in.
6.	Gray and red clay-shale with plant remains, *Estheria*, and *Leaia tricarinata*. 29 ft.	61 ft.	6 in.
5.	Concealed. 26 feet	87 ft.	6 in.
4.	Sandy shale. 41 ft. 6 in.	129 ft.	
3.	Clayey limestone with marine fossils. Pine Creek horizon. 1 ft.	130 ft.	
2.	Green clay. 8 ft	138 ft.	
1.	Sandy shale. 15 ft. 6 in.	153 ft.	6 in.
	Level of the railroad tracks.		

The Pine Creek limestone, resting on a bed of soft clay, may be seen near the eastern end of the station-platform at Wood's Run. It is there 23 feet 6 inches above the railroad track. Following the cliff along for a few hundred feet the limestone has disappeared, and the face of the bank is a solid mass of sandstone. Returning northwest along the track and crossing Wood's Run, the limestone and clay are found to be absent and the face of the cliff shows only cross-bedded sandstone and shale for about half a mile. The Pine Creek limestone and the clay then appear again, the limestone this time 65 feet above the track. A short distance south of the foot-bridge over the tracks and a quarter of a mile from Wood's Run, the base of the Buffalo sandstone appears above the track with a dark sandy shale beneath it. At the foot-bridge mentioned the section of the face of the cliff is as follows:

2.	Heavy-bedded sandstone. 90 ft.	90 ft.
1.	Thin-bedded sandy shale. 10 ft.	100 ft.

The lower photograph on Plate XIV was taken from this bridge.

A short distance north of this foot-bridge there is another bridge where the highway crosses the tracks, and 100 yards beyond this bridge is the small ravine indicated on the diagram. The section at this bridge is as follows:

7. Sandstone and sandy shale. About 50 ft.

6. Very clayey limestone with marine fossils. Pine Creek horizon. 2 ft.	2 ft.	
5. Green clay. 10 ft.	12 ft.	
4. Sandy shale. 3 ft.	15 ft.	
3. Heavy-bedded sandstone. Buffalo horizon. 41 ft. 6 in.	56 ft.	6 in.
2. Black limy shale with numerous marine fossils. Brush Creek horizon. 1 ft.	57 ft.	6 in.
1. Thin-bedded rather sandy shale. Mason horizon. 17 ft.	74 ft.	6 in.

On the opposite side of the small ravine the section is very different.

9. Thin-bedded green shale. 21 ft.	21 ft.	
8. Red, iron stained clay with marine fossils. Horizon unknown. 1 ft. 6 in.	22 ft.	6 in.
7. Red clay. 11 ft. 6 in.	34 ft.	
6. Sandy shale with lenses of sandstone toward the top. 62 ft. 6 in.	96 ft.	6 in.
5. Heavy-bedded sandstone with occasional lenses of sandy shale. 48 ft. 6 in.	145 ft.	
4. Sandy shale. 8 ft.	153 ft.	
3. Clayey limestone with marine fossils. Brush Creek horizon. 1 ft.	154 ft.	
2. Thin-bedded sandy shale with plant remains. Mason horizon. 17 ft.	171 ft.	
1. Green clay. 5 ft.	176 ft.	

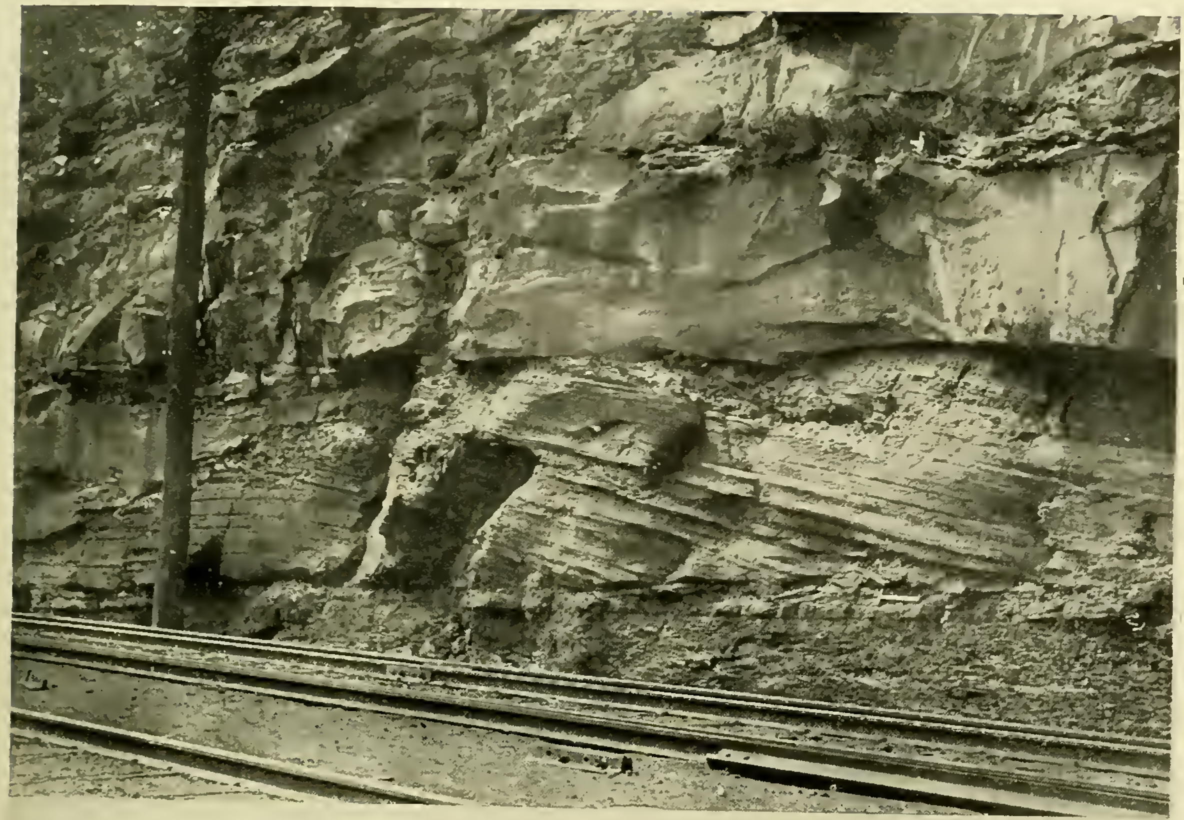
Just before the ravine is reached, the Pine Creek limestone, the clay beneath it, and the upper part of the Buffalo sandstone are cut off as indicated in the diagram and shown by the photographs (Plate XIII). A little beyond the ravine the base of the combined sandstones cuts down through the Brush Creek limestone, the Mason shale, and the clay beneath it. About half-way between this ravine and Jack's Run the Pine Creek limestone and its clay reappear in the face of the cliff and the base of the Buffalo sandstone again comes above the level of the track. On the northern side of Jack's Run the Pine Creek limestone is 100 feet above the level of the track.

From the diagram and the sections on which it is based, it is very evident that there must have been two periods of erosion, one before and one after the Pine Creek limestone was deposited. From the depth and narrowness, and the steep sides of the valleys cut during both these intervals it is evident that the land must have been raised some distance above sea-level after each marine formation had been deposited, and from the sharp truncation of the edges of the strata (see Plate XIII), it would seem that the rocks were rather firmly consolidated before the erosion took place.

The area eroded after the Brush Creek limestone was deposited was quite extensive, as is indicated by the distribution of the Buffalo sand-

L. S. Coggeshall, photo.

Unconformity near Wood's Run.



L. S. Coggeshall, photo.

Unconformities near Etna and Wood's Run.

stone, the base of which is almost always noticeably irregular. This unconformity is especially well exhibited along the north bank of the Ohio River from Wood's Run to Dixmont, and on the south bank from Fleming Park to Groveton, Pa. Another place near Pittsburgh where it may be seen and where at least a part of the beds which have been eroded may be determined is on the Baltimore and Ohio Railroad between Etna and Wittmer, Pa. At Wittmer the section in an abandoned clay pit is as follows:

10.	Light green clay-shale. Top not seen. 20 ft.	20 ft.
9.	Black and dark gray shale with marine fossils in limestone nodules, though rarely in the shale itself. 10 ft.	30 ft.
8.	Sandy limestone with numerous marine fossils. 8 and 9 are the Pine Creek horizon. 1 ft. 6 in.	31 ft. 6 in
7.	Green structureless clay. 10 ft.	41 ft. 6 in.
6.	One layer sandstone. 2 ft. 6 in.	44 ft.
5.	Sandy shales and thin-bedded sandstone. One layer contains plant remains and invertebrate fossils. 18 ft. 6 in.	62 ft. 6 in.
4.	Thin-bedded gray shale with plant remains. 35 ft. 6 in.	98 ft.
3.	Thin-bedded black shale with marine fossils. There is a thin bed of impure limestone at the base. Brush Creek horizon. 7 ft. 6 in.	105 ft. 6 in.
2.	Thin-bedded gray shale. Mason horizon. 15 ft. 6 in.	121 ft.
1.	Yellow sandstone and shale. 5 ft.	126 ft.

The only layers in this section which can be referred to the Buffalo sandstone are those in No. 6 and possibly the upper part of No. 5, certainly not more than 10 feet altogether. Three quarters of a mile south of this point the base of the Buffalo sandstone cuts through the Brush Creek limestone and disappears below the level of the railroad track. Beds 2, 3, 4, and part or all of 5, a thickness of at least 68 feet, have been eroded away before the sandstone was deposited.

The period of elevation and erosion was followed by a period of subsidence during which these troughs were filled, possibly by the rivers which cut them. This lowering reached its culmination when the sea again covered the land and the Pine Creek limestone and shale were deposited. In many places the Pine Creek limestone is covered by from 10 to 15 feet of shales containing marine fossils, these shales grading without break into shales with land plants, indicating a probable gradual silting up of the sea and the return of land conditions. There was then another elevation which brought the Pine Creek deposits above sea-level, and valleys were again carved, cutting down into the already consolidated Buffalo sandstone. In these valleys the Cow Run sandstone was deposited, probably by stream action.

There are numerous other unconformities of this same sort at different horizons in the Conemaugh series near Pittsburgh, some of which will be described and figured at another time.

NOTE ON THE NAMES BUFFALO AND SALTSBURG AS APPLIED TO THE SANDSTONE BETWEEN THE BRUSH CREEK AND THE PINE CREEK LIMESTONES.

In a number of the folios of the Geologic Atlas of the United States the name Saltsburg has been adopted for the sandstone designated as Buffalo in this paper. The latter name has been preferred by the writer, first, because it has a slight priority of publication, and secondly, because, although as first used the name Saltsburg was intended to designate the sandstone called Buffalo by Dr. White, the section from which the formation was named, and which was taken as the type, shows a sandstone which is really a combination of the Cow Run and Buffalo sandstones. The combination was effected in the same way as has just been illustrated in the section at Allegheny. Professor Stevenson gives the same explanation to the Saltsburg section in the Bulletin of the Geological Society of America, Vol. XVII, 1906.

The name Buffalo was given by Dr. I. C. White in Report Q of the Second Geological Survey of Pennsylvania, page 33, 1878. He states: "The Buffalo (Upper Mahoning) Sandstone, 450 to 510 feet below the Pittsburgh coal, is No. 19 of the section. By this name we have designated a very massive and conglomerate sandstone which comes immediately below the Pine Creek limestone, and attains its maximum development along the waters of Buffalo Creek, in Buffalo township, Butler County. In the section at Freeport it forms the upper bluff rock, and its base is 125 feet above the Freeport coal."

In Report KKK of the same survey, page 22, 1878, Dr. J. J. Stevenson applied the name Saltsburg to a sandstone which "is finely exhibited along the Conemaugh and Loyalhanna near Saltsburg." In the generalized section on page 18, Dr. Stevenson represented the sandstone with the top 53 feet below the Green Crinoidal limestone (Ames) and the base 42 feet above the Black fossiliferous limestone (Brush Creek). It is not further defined in that report, and for a fuller description it is necessary to go to the typical section, which was described by the same author in Volume KK, pages 317 and 318. The sandstone is there described as being 100 feet in thickness, with the base resting upon ten feet of black, rather sandy shale. In this shale is a discontinuous layer of limestone nodules which Professor Stevenson states (Bulletin Geological Society of America, Vol. XVII, p. 174, 1906) represents the Brush Creek limestone. That this is a correct correlation is confirmed by the discovery by the writer of specimens *Euomphalus catilloides*, *Pleurotomaria carbonaria*, and a *Nautilus* in the shale less than a foot above the limestone. The fossils were not common and were poorly preserved, but enough could be determined to show that it was a marine fauna, similar to the fauna found elsewhere in the shale above the Brush Creek. The sandstone at Saltsburg thus overlies the Brush Creek as does the Buffalo, but the Pine Creek is absent from the section at Saltsburg, its place being occupied by sandstone. The Cow Run and the Buffalo have apparently joined, as at Allegheny. The name Saltsburg was applied to the whole mass, and thus has a different meaning from the name Buffalo, which can be applied to only the lower part of the sandstone at Saltsburg.

EXPLANATION OF PLATES.

PLATE XII.

A diagrammatic section of the strata exposed in the bluff along the Ft. Wayne R. R. from Jack's Run to Wood's Run, Allegheny, Pa. The lower diagram is a continuation of the upper. Vertical scale, 1 inch equals 120 feet; horizontal scale, 1 inch equals 600 feet.

PLATE XIII.

Upper photograph. The bluff just south of the small ravine indicated in the diagram on the preceding plate. The Pine Creek limestone (just at the top of the poles in the picture) and the clay beneath it are seen to be cut out near the margin of the photograph. The soft bed beneath the limestone is the green clay of the diagram, beneath it is the Buffalo sandstone, extending a little below the fence, and in the shale beneath the sandstone is the Brush Creek limestone.

Lower photograph. A nearer view of the face of the bluff just at the left-hand margin of the upper picture, showing the shale resting on the eroded edges of the Buffalo sandstone.

PLATE XIV.

Upper photograph. Unconformity at the base of the Buffalo sandstone one mile north of Etna, Pa. The hammer rests on the Brush Creek limestone. Above it is a cross-bedded shale, followed by the Buffalo sandstone.

Lower photograph. Unconformity at the base of the Buffalo sandstone along the Pennsylvania Railroad near Wood's Run, Allegheny, Pa.

VII. A PRELIMINARY LIST OF THE UNIONIDÆ OF WESTERN PENNSYLVANIA, WITH NEW LOCALITIES FOR SPECIES FROM EASTERN PENNSYLVANIA.

By Dr. A. E. Ortmann.

Several years ago, the writer, in pursuance of his studies of the fresh-water fauna of Pennsylvania, began to collect the freshwater shells. The past summer (1908) was especially favorable for collecting Unionidæ, on account of the low stage of the rivers, and a good deal of work was done in this group, so that it is believed that the study of the mussels has progressed far enough to make it possible to give a general account of the Unionidæ of the western half of the state.

The region investigated covers not only the drainage of the upper Ohio (Monongahela and Allegheny Rivers), but also that of Lake Erie, and some of the tributaries of the Susquehanna. The latter have not, however, been as thoroughly studied as the streams lying to the west of the divide. A number of additional localities are situated in southeastern Pennsylvania.

Before we give our list of species, it seems to be well to mention and discuss the previous records of the Unionidæ of western Pennsylvania, since in many cases the nomenclature has changed, and since several incorrectly identified species have been listed.

In the older publications we have only a few records from our region. I was only able to find the four following:

Unio æsopus Green (Contr. Maclur. Lyc., I, 1827) = *Pleurobema æsopus* (Green).

Described from the "rivers in the neighborhood of Pittsburgh." Still present in the Ohio below, and in the Allegheny above Pittsburgh.

Unio circulus Lea (Observ., I, 1834) = *Obovaria circulus* (Lea).

Cited by Lea from the Monongahela River at Pittsburgh. The locality is now barren, no Unionidæ being any longer present in the immediate vicinity of Pittsburgh. Nevertheless a few years ago this species was still present in the Ohio River below Pittsburgh.

Unio coccineus Conrad (Monogr., 3, 1836, and Lea, Observ., II, 1838) = *Quadrula coccinea* (Conrad).

This species is cited by Conrad from the "Mahoning River, near Pittsburgh," while Lea says: "Mahoning River, Ohio." The point of the Mahoning River nearest to Pittsburgh is where it joins the Shenango, thus forming the Beaver, near Mahoningtown, Lawrence County, about forty-five miles from Pittsburgh. The species is still present there, and I regard this part of the Mahoning River as the *type-locality*.

Unio viridis Conrad (Monogr., 4, 1836, and **U. tappanianus** Lea, Observ., II, 1838) = *Symphynota viridis* (Conrad).

From the "Juniata River," according to Conrad, and from the "Juniata at Hollidaysburg (Blair Co.)" according to Lea. Although Unionidæ have recently been collected at Hollidaysburg, this species is not among them. Nevertheless it is present in the Raystown Branch of the Juniata River, and even farther west, in the headwaters of the West Branch of the Susquehanna in Indiana County.

In 1891, E. H. Harn published a list of shells from western Pennsylvania (Nautilus, 4, 1891, pp. 136–137). Harn was located at Blairsville, Indiana County, and apparently most of his Unionidæ were from the Kiskiminetas, or the Conemaugh drainage. It is much to be regretted that this list does not give exact localities, since at present the fauna of the Kiskiminetas and its tributaries is almost completely destroyed, only meager remains surviving in a few of the headwaters.

Harn's list is here submitted. All the species have recently been found in western Pennsylvania. The correct name according to the modern nomenclature is given.

1. **Unio æsopus** Green = *Pleurobema æsopus* (Green).
2. " **alatus** Say = *Proptera alata* (Say).
3. " **circulus** Lea = *Obovaria circulus* (Lea).
4. " **clavus** Lamarck = *Pleurobema clava* (Lamarck).
5. " **crassidens** Lam. = *Unio crassidens* Lamarck.
6. " **cylindricus** Say = *Quadrula cylindrica* (Say).
7. " **gibbosus** Barnes = *Unio gibbosus* Barnes.
8. " **fabalis** Lea = *Micromya fabalis* (Lea).
9. " **iris** Lea = *Lampsilis iris* (Lea).
10. " **kirtlandianus** Lea = *Quadrula subrotunda kirtlandiana* (Lea).
11. " **ligamentinus** Lamarck = *Lampsilis ligamentina* (Lamarck).

12. **Unio multiradiatus** Lea = *Lampsilis multiradiata* (Lea).

13. " **mytiloides** Rafinesque = *Quadrula obliqua* (Lamarck) (form: *pyramidata* (Lea)).
 " **obliquus** Lamarck = *Quadrula obliqua* (Lamarck).

14. " **occidens** Lea = *Lampsilis ventricosa* (Barnes).

15. " **parvus** Barnes = *Lampsilis parva* (Barnes).

16. " **phaseolus** Hildreth = *Ptychobranchus phaseolus* (Hildreth).

17. " **pustulosus** Lea = *Quadrula pustulosa* (Lea).

18. " **rectus** Lamarck = *Lampsilis recta* (Lamarck).

19. " **securis** Lea = *Plagiola securis* (Lea).
 " **subovatus** Lea = *Lampsilis ventricosa* (Barnes), see no. 14.

20. " **subrotundus** Lea = *Quadrula subrotunda* (Lea).

21. **Anodonta undulata** Say = *Strophitus undulatus* (Say) (incl. *edentulus* (Say)).

22. **Margaritana marginata** Say = *Alasmidonta marginata* Say.

23. " **rugosa** Barnes = *Symphynota costata* (Rafinesque).

24. " **undulata** Say. = *Alasmidonta undulata* (Say).

If the last species is correctly identified by Harn, it cannot be from the Kiskiminetas drainage, since it is positively absent from the Ohio drainage. Yet the species is found not very far from Blairsville, in the drainage of the West Branch of the Susquehanna (Clearfield Creek) in Cambria County.

Of this list of twenty-three species (disregarding the eastern form just mentioned), nine have been found recently in the Kiskiminetas drainage, although of some of them only dead shells have been secured, or seen; viz.: *Lampsilis ventricosa*, *L. multiradiata*, *L. ligamentina*, *L. recta*, *Ptychobranchus phaseolus*, *Strophitus undulatus*, *Symphynota costata*, *Alasmidonta marginata*, *Unio gibbosus*, and *Pleurobema clava*. Two additional species not enumerated by Harn have been recently found in the Kiskiminetas drainage: *Anodonta grandis* Say and *Quadrula coccinea* (Conrad).

The rest of the fauna is irreparably lost in the Kiskiminetas drainage, but most of these species still exist in the Allegheny River in Armstrong County. In order to now find *Lampsilis parva* and *Quadrula kirtlandiana*, we are compelled to go up the Allegheny River as far as French Creek and its tributaries.

The absence of *Lampsilis luteola* (Lamarck) in Harn's list is remarkable. But this species, which is common in other parts, is also at present absent from the Kiskiminetas drainage, and this makes it the more probable that Harn's shells were distinctly from this drainage system.

W. B. Marshall published (Bulletin New York Museum, 1, 1892, pp. 3 *et seq.*) a list of Unionidæ from New York. The species were "from localities within the limits of the state of New York, or from the Allegheny River at Warren, Pa., just south of the New York boundary." It is much to be regretted that Marshall did not realize the importance of indicating the exact localities, since his list covers a territory which is of the greatest interest. We do not know which species of this list were found in Warren County, Pennsylvania.

I have myself collected the following species in Warren County (Allegheny River, Connewango, and Brokenstraw Creeks):

	MARSHALL'S LIST.
Truncilla perplexa rangiana (Lea)	= **Unio perplexus** Lea.
Micromya fabalis (Lea)	= **U. fabalis** Lea.
Lampsilis ventricosa (Barnes)	= **U. occidens** Lea and **U. ventricosus** Barnes.
" *ventricosa ovata* (Say)	= **U. ovatus** Say.
" *multiradiata* (Lea)	= **U. multiradiatus** Lea.
" *luteola* (Lamarck)	= **U. luteolus** Lamarck.
" *ligamentina* (Lamarck)	= **U. ligamentinus** Lamarck.
" *recta* (Lamarck)	= **U. rectus** Lamarck.
Ptychobranchus phaseolus (Hildreth)	= **U. phaseolus** Hildreth.
Strophitus undulatus (Say)	= **Anodonta edentula** Say and **pavonia** Lea.
Anodonta grandis Say	= **Anodonta lewisi** Lea.
Symphynota compressa Lea	= **U. pressus** Lea.
" *costata* (Rafinesque)	= **Margaritana rugosa** Barnes.
Alasmidonta marginata Say	= **M. marginata** Say.
Quadrula coccinea (Conrad)	("without evidence that it inhabits New York").

We see that all, except the last species, are in Marshall's list. But in addition, the following western species are recorded from New York state:

Unio alatus Say = *Proptera alata* (Say).
" **clavus** Lamarck = *Pleurobema clava* (Lamarck).
Margaritana complanata Barnes = *Symphynota complanata* (Barnes).
Unio crassidens Lamarck.

Anodonta ferussaciana Lea = *Anodontoides ferussacianus* (Lea).
" **footiana** Lea = *Anodonta grandis footiana* Lea.
" **gigantea** Lea = *Anodonta grandis gigantea* Lea.
Unio gracilis Barnes = *Proptera gracilis* (Barnes).
" **hippopæus** Lea = *Quadrula undulata hippopæa* (Lea).
Anodonta imbecillis Say.
Unio iris Lea = *Lampsilis iris* (Lea).
" **lævissimus** Lea = *Proptera lævissima* (Lea).
" **novi-eboraci** Lea, see **U. iris.**
" **parvus** Lea = *Lampsilis parva* (Barnes).
" **patulus** Lea, see **U. clavus.**
Anodonta plana Lea, see **A. gigantea.**
Unio rubiginosus Lea = *Quadrula rubiginosa* (Lea).
Anodonta subcylindracea Lea = *Anodontoides ferussacianus subcylindraceus* (Lea).
Unio triangularis Barnes = *Truncilla triquetra* Rafinesque.
" **undulatus** Barnes = *Quadrula undulata* (Barnes).
" **verrucosus** Barnes = *Quadrula tuberculata* (Rafinesque).

The question is, whether these species have reached western New York by way of the Allegheny River, or by way of Lake Erie. Since a large number of species are found in both drainages, it remains doubtful in the case of the majority of the forms recorded by Marshall, by which way they have travelled. Only in those cases where the species is positively absent from Lake Erie and its drainage, does the way of the Allegheny River seem to be positively indicated. These are, according to our list of the Lake Erie species given below, and according to Sterki (Proceedings Ohio Academy of Sciences, 4, 1907): *Truncilla perplexa rangiana*, *Lampsilis ventricosa ovata*, *Proptera lævissima*, and *Unio crassidens*. Now it is remarkable, that *Unio crassidens* ascends in the Allegheny only as far as the northern part of Armstrong County, and is positively absent in this river above Oil City, and that *Proptera lævissima* has not been found at all in the state of Pennsylvania. Thus it is seen that Marshall's work must all be done over again.

The next list published is that by S. H. Stupakoff (Nautilus, 1894, p. 135) from Allegheny County. It contains the following species:

1. **Margaritana rugosa** Barnes = *Symphynota costata* (Rafinesque).
2. **Unio ligamentinus** Lamarck = *Lampsilis ligamentina* (Lamarck).
3. **Unio gibbosus** Barnes.

4. **Unio ellipsis** Lea = *Obovaria ellipsis* (Lea).
5. " **cariosus** Say = *Lampsilis ventricosa* (Barnes).

Lampsilis cariosa (Say) is an eastern form, and absent from the Ohio drainage, yet it has often been confounded with its western representative *L. ventricosa*, so that it is beyond doubt that *L. ventricosa* is intended.

6. **Unio pyramidatus** Lea = *Quadrula obliqua* (Lamarck) form: *pyramidata* (Lea).

Unio trigonus Lea.

This species remains doubtful. The true typical *Quadrula trigona* has never been found in the Ohio drainage in Pennsylvania, although certain individuals of *Q. rubiginosa* (Lea) incline toward it. Such specimens have recently been collected in Allegheny County.

7. **Unio alatus** Lea = *Proptera alata* (Say).

All of the foregoing seven species have been subsequently found in Allegheny County, except *Obovaria ellipsis*, which, however, exists in the Ohio in Beaver County. At the present time, only four of these forms live in Allegheny County: *Lampsilis ventricosa*, *Lampsilis ligamentina*, *Proptera alata*, *Unio gibbosus*, and only at one place; viz.: in the northeastern corner of the county in the Allegheny River. As to the rest, all the rivers in Allegheny County are so hopelessly polluted that no *Unionidæ* are any longer found.

To this list, G. H. Clapp (Nautilus, 8, 1895, p. 116) has added a supplement, namely:

1. **Unio ovatus** Say = *Lampsilis ventricosa ovata* (Say).
2. **Unio rectus** Lamarck = *Lampsilis recta* (Lamarck).
3. **Unio pilaris** Lea = *Quadrula subrotunda* (Lea) juv.

This probably is a misidentification, young specimens of *Quadrula subrotunda* being intended. *Quadrula pilaris* stands very close to *subrotunda*, and since *subrotunda* was, and is, rather abundant in our rivers, and is missing in both Stupakoff's and Clapp's list, it is more than probable that the latter species should be recorded for Allegheny County.

4. **Unio crassidens** Lamarck.
5. **Unio luteolus** Lamarck = *Lampsilis luteola* (Lamarck).
6. " **gracilis** Lea = *Proptera gracilis* (Lea).
7. " **rubiginosus** Lea = *Quadrula rubiginosa* (Lea).
8. " **orbiculatus** Hildreth = *Lampsilis orbiculata* (Hildreth).
9. " **securis** Lea = *Plagiola securis* (Lea).

10. **Unio cornutus** Barnes = *Obliquaria reflexa* Rafinesque.
11. " **undulatus** Barnes = *Quadrula undulata* (Barnes).
12. " **obliquus** Lamarck = *Quadrula obliqua* (Lamarck).

These species, as well as the seven of Stupakoff's list, are yet present in the Ohio River below Pittsburgh in Beaver County. In Allegheny County they now seem to be extinct, only *Unio crassidens* being found in the northeastern corner of the county, together with the four species mentioned above.

In 1899, S. N. Rhoads (Nautilus, 12, 1899, pp. 133 ff.) published a list of shells collected by himself in the Ohio River at Coraopolis, Allegheny County, and at Beaver, Beaver County, and in the Beaver River, at Wampum, Lawrence County. The collections were made in September, 1898. A number of the duplicate specimens were secured by the Carnegie Museum, while the main collection went to the Academy of Natural Sciences in Philadelphia. I have gone over both collections, and am able to correct certain misidentifications. The collection from Wampum is controlled by a much larger collection from the same place in the Carnegie Museum, secured in September, 1897, by G. H. Clapp and H. H. Smith.

The following species are recorded by Rhoads, and I append the necessary remarks:

1. **Anodonta edentula** Say = *Strophitus undulatus* (Say).

Three specimens from Coraopolis in the Philadelphia Academy are this species. In the same tray were several specimens of **Symphynota viridis**, which probably were put in by mistake, since this species is not found in the Ohio drainage. From Wampum in the Philadelphia Academy and Carnegie Museum. Also recorded from Beaver, but no specimens could be found in either collection.

2. **Anodonta gracilis** Lea = *Proptera gracilis* (Lea).

From Coraopolis and Beaver in the Philadelphia Academy.

3. **Anodonta marginata** Say = *Alasmidonta marginata* Say.

From Coraopolis in Philadelphia Academy, from Wampum in Philadelphia Academy and Carnegie Museum.

4. **Margaritana rugosa** Barnes = *Symphynota costata* (Rafinesque).

From Coraopolis and Beaver in Philadelphia Academy; from Wampum in Philadelphia Academy and Carnegie Museum.

5. **Unio æsopus** Green = *Pleurobema æsopus* (Green).

From Coraopolis and Wampum in Philadelphia Academy.

6. **Unio alatus** Say = *Proptera alata* (Say).

From Coraopolis in Philadelphia Academy and Carnegie Museum; from Beaver in Philadelphia Academy.

7. **Unio coccineus** Lea = *Quadrula coccinea* (Lea).

From Wampum in Philadelphia Academy and Carnegie Museum.

8. **Unio cooperianus** Lea = *Quadrula cooperiana* (Lea).

No specimens of this species could be found in the Philadelphia Academy, and none are in the Carnegie Museum. But the writer has found this species in the Ohio River in Beaver County, and thus the record is confirmed.

9. **Unio cornutus** Barnes = *Obliquaria reflexa* Rafinesque.

From Beaver in the Philadelphia Academy. Rhoads reports it also from Coraopolis, but no specimens from this locality have been seen by the writer.

10. **Unio cylindricus** Say = *Quadrula cylindrica* (Say).

From Coraopolis and Beaver in Philadelphia Academy; from Wampum in Philadelphia Academy and Carnegie Museum.

11. **Unio crassidens** Lamarck.

From Coraopolis in Philadelphia Academy and Carnegie Museum; from Beaver in Philadelphia Academy.

12. **Unio donaciformis** Lea = *Plagiola donaciformis* (Lea).

The specimens recorded from Coraopolis are in the Philadelphia Academy. This species has not been found in recent investigations.

13. **Unio elegans** Lea = *Plagiola elegans* (Lea).

From Coraopolis in Philadelphia Academy.

14. **Unio gibbosus** Barnes.

From Coraopolis in Philadelphia Academy and Carnegie Museum; from Beaver in Philadelphia Academy; from Wampum in Philadelphia Academy and Carnegie Museum.

15. **Unio irroratus** Barnes (sic!) = *Cyprogenia irrorata* (Lea).

Only one specimen from Beaver in the Philadelphia Academy.

16. **Unio kirtlandianus** Lea = *Quadrula subrotunda kirtlandiana* (Lea).

From Wampum in Philadelphia Academy and Carnegie Museum.

17. **Unio lens** Lea = *Obovaria circulus* (Lea).

From Coraopolis in Philadelphia Academy; from Wampum in Philadelphia Academy and Carnegie Museum.

18. **Unio ligamentinus** Lamarck = *Lampsilis ligamentina* (Lamarck).

From Coraopolis and Wampum in Philadelphia Academy and Carnegie Museum; from Beaver in Philadelphia Academy.

19. **Unio luteolus** Lamarck = *Lampsilis luteola* (Lamarck).

From Coraopolis and Wampum in Philadelphia Academy and Carnegie Museum.

20. **Unio metanevra** Rafinesque = *Quadrula metanevra* (Rafinesque).

From Coraopolis in Philadelphia Academy and Carnegie Museum; from Beaver in Philadelphia Academy.

21. **Unio multiradiatus** Lea = *Lampsilis multiradiata* (Lea).

From Wampum in Philadelphia Academy and Carnegie Museum.

22 and 23. **Unio obliquus** Lea (sic!) = *Quadrula obliqua* (Lamarck) and *Quadrula subrotunda* (Lea).

Specimens from Coraopolis in Philadelphia Academy and Carnegie Museum are in part *obliqua*, in part *subrotunda*. From Beaver there are only five specimens of *subrotunda* in the Philadelphia Academy. One specimen from Beaver in the Philadelphia Academy was labeled *varicosa* Lea = *Pleurobema cicatricosum* (Say), but it is an old *subrotunda*. *P. cicatricosum* is not found in western Pennsylvania.

24. **Unio ovatus** Say = *Lampsilis ventricosa ovata* (Say) and *Lampsilis ventricosa* (Barnes).

A few specimens from Coraopolis in the Philadelphia Academy and the Carnegie Museum represent the var. *ovata* the larger part the typical *ventricosa*. A specimen from Beaver in the Philadelphia Academy is var. *ovata*. The specimens from Wampum in the Philadelphia Academy and the Carnegie Museum are all *ventricosa*.

25. **Unio parvus** Barnes, probably = *Micromya fabalis* (Lea).

Rhoads reports one specimen from Wampum. It could not be found in the Philadelphia Academy. The Carnegie Museum possesses a number of specimens of *Micromya fabalis* from Wampum, and since the latter species is not mentioned by Rhoads, it is very likely that he confounded it with *Lampsilis parva*.

26. **Unio phaseolus** Hildreth = *Ptychobranchus phaseolus* (Hildreth).

From Wampum in the Philadelphia Academy and the Carnegie Museum.

27. **Unio plicatus** Lea = *Quadrula undulata* (Barnes).

A specimen from Beaver, and a number of specimens from Wampum in the Philadelphia Academy and the Carnegie Museum are all *undulata*. *Quadrula plicata* has not been found in the Ohio drainage in Pennsylvania, while *Q. undulata* is quite abundant, chiefly so in the Beaver drainage.

28. **Unio compressus** Deshayes = *Symphynota compressa* (Lea).

Specimens from Wampum are in the Carnegie Museum. In the Philadelphia Academy, of four specimens thus labeled, only one was this species, the rest young *Lampsilis ligamentina.*

29. **Unio pustulosus** Lea = *Quadrula pustulosa* (Lea).

From Coraopolis in Philadelphia Academy; from Wampum in Philadelphia Academy and Carnegie Museum.

30. **Unio rectus** Lamarck = *Lampsilis recta* (Lamarck).

From Coraopolis and Beaver in the Philadelphia Academy.

31. **Unio rubiginosus** Lea = *Quadrula rubiginosa* (Lea).

From Coraopolis in the Philadelphia Academy.

32. **Unio securis** Lea = *Plagiola securis* (Lea).

From Coraopolis in the Philadelphia Academy.

33. **Unio triangularis** Barnes = *Truncilla triquetra* Rafinesque.

From Coraopolis and Beaver in the Philadelphia Academy; from Wampum in the Philadelphia Academy and Carnegie Museum.

Unio trigonus Lea.

Doubtfully reported by Rhoads from Coraopolis. The specimens in the Philadelphia Academy under this name are young *Quadrula rubiginosa* (Lea).

34. **Unio tuberculatus** Barnes = *Tritogonia tuberculata* (Barnes).

From Coraopolis in the Philadelphia Academy; from Wampum in the Carnegie Museum.

35. **Unio verrucosus** Barnes = *Quadrula tuberculata* (Rafinesque).

From Coraopolis and Beaver in the Philadelphia Academy; from Wampum in the Philadelphia Academy and Carnegie Museum.

Finally, C. T. Simpson (Proceedings United States National Museum, 22, 1900, p. 553) records **Lampsilis fatua** (Lea) from the Beaver River, Pennsylvania. The specimen, upon which this record is founded, belongs to the Carnegie Museum, and is from Wampum, collected by Clapp and Smith, and is nothing but *Lampsilis iris* (Lea).

During his investigations, the writer has discovered a number of additional species in western Pennsylvania. A list of all known species is submitted here, giving the references to the older writers, indicating the general distribution and giving in the case of the rarer species the exact localities. Besides the material collected by the writer other material belonging to the Carnegie Museum has been used. Aside from the fine collection made at Wampum, Lawrence County, by Clapp and Smith, and the duplicates from the Rhoads collection, there is a collection made by G. A. Ehrmann in the Monongahela River at Charleroi, Washington County, acquired in 1897; a collection made by Miss Vera White in Little Beaver Creek at Cannelton, Beaver County, acquired in 1897; and a collection made by H. H. Smith at the same locality in September, 1897. Besides there are single species from various places collected by others, which need not be mentioned here.

The list is arranged according to Simpson's Synopsis (Proceedings United States National Museum 22, 1900). In a final treatise on the Unionidæ of Pennsylvania, this system will be considerably changed. The alterations introduced here relate chiefly to the nomenclature.

A. Ohio River Drainage.

1. **Truncilla triquetra** Rafinesque.

Not reported by Harn, Stupakoff, and Clapp; reported from the Ohio and Beaver Rivers by Rhoads.

Generally distributed in the Ohio, Beaver, and Allegheny drainages, and going up into the smaller tributaries: Shenango River and Pymatuning Creek in Mercer County; French Creek in Venango and Crawford Counties; Conneaut Outlet in Crawford County; Leboeuf Creek, Erie County. It has not been recently found alive in the Ohio River below Pittsburgh. It is rather abundant in the Allegheny River in Armstrong County, but never found in the Monongahela drainage.

2. **Truncilla (Pilea) perplexa rangiana** (Lea).

Not reported previously. Rather abundant in the Allegheny River from southern Armstrong County up through Venango and Forest into Warren Counties (here also in Connewango Creek), and further in French Creek in Venango and Crawford Counties. A single specimen has been found in the Shenango River in Lawrence County.

3. **Micromya fabalis** (Lea).

Reported by Harn from western Pennsylvania. Rhoads' *Unio parvus* from the Beaver at Wampum is probably this species.

Found rather sparingly in the Beaver and Allegheny drainages; in the Mahoning River in Lawrence County; in the Shenango River and Pymatuning Creek in Mercer County; in Crooked Creek in Armstrong County; French Creek in Venango and Crawford Counties; in the upper Allegheny in Venango County, as far up as Connewango Creek in Warren County. It is nowhere abundant, and is missing in the Monongahela drainage.

4. **Lampsilus ventricosa** (Barnes).

In Pennsylvania according to Call (Bull. Des Moines Acad., 1885). In Harn's list this species is given from western Pennsylvania as *U. occidens* and *subovatus*. In Stupakoff's list it is cited from Allegheny County as *U. cariosus*. It is comprised in Rhoads' *U. ovatus* from the Ohio and Beaver Rivers.

The species is very generally distributed in the larger rivers as well as in the smaller creeks. It goes up in the Monongahela drainage to Dunkard Creek in Greene County and the Cheat River in Fayette County. In the Shenango it goes to Mercer County. It is in French Creek, and in the upper Allegheny in McKean County. It is found in Little Mahoning Creek in Indiana County, and in the Kiskiminetas drainage in the upper Loyalhanna River in Westmoreland County, and in Quemahoning Creek in Somerset County. It is locally rather abundant, sometimes the prevailing species, and attains large size, as for instance, in Little Beaver Creek in Beaver County, in the Slippery-rock Creek in Lawrence County, and in the upper Shenango in Mercer County.

4*a*. **Lampsilis ventricosa ovata** (Say).

This species is reported by Clapp from Allegheny County. A specimen donated by Clapp is in the Carnegie Museum. It is also reported by Rhoads, but only specimens from Coraopolis and Beaver belong here. Call (1885) cites from "Allegheny River to Central New York."

The species is rather abundant in the Ohio in Beaver County, and formerly was abundant in Allegheny County. It occurs in the Allegheny River all the way up to Warren County, and also in French Creek in Venango and Crawford Counties. It is entirely absent in all other parts, distinctly so in the Beaver and Monogahela drainages. Wherever found, it is associated with the typical *L. ventricosa* and runs into it. Thus it should be regarded as a variety of the latter.

5. **Lampsilis multiradiata** (Lea).

Reported by Harn from western Pennsylvania, by Rhoads from the Beaver River at Wampum; not in Stupakoff's and Clapp's lists for Allegheny County.

It occurs rarely in the larger rivers (Ohio in Beaver County, Allegheny in Armstrong County); more frequently farther up, for instance all over the Beaver drainage in Lawrence and Mercer Counties. It is in the upper Allegheny as far as Warren County, in French Creek and Connewango Creek; in the upper Loyalhanna in Westmoreland County, and the Quemahoning Creek in Somerset County, and in the

Monongahela drainage it is found in the Cheat River, Fayette County. It is nowhere abundant.

6. **Lampsilis luteola** (Lamarck).

Recorded by Clapp from Allegheny County, and by Rhoads from the Ohio and Beaver Rivers. It is missing in Harn's list, and has not been found recently in any part of the Kiskiminetas drainage.

This species is rather scarce in the large rivers (Ohio and Allegheny), and absent, aside from the whole Kiskiminetas drainage, in the Cheat River, but present in Dunkard Creek in Greene County. In the Beaver drainage it is locally very abundant, becoming in some places the prevailing species. Here it goes up to Crawford County. It is also frequent in some of the tributaries of the middle and upper Allegheny: Crooked Creek in Armstrong County; Little Mahoning Creek in Indiana County; French Creek in Venango and Crawford Counties; and Connewango Creek in Warren County. It is abundant (the prevailing species) in Conneaut Lake and in Leboeuf Creek, just below the lake.

7. **Lampsilis ligamentina** (Lamarck).

It is recorded in Harn's list from western Pennsylvania, in Stupakoff's list from Allegheny County, and in Rhoads' list from the Ohio and Beaver Rivers.

This is a common species in the larger rivers, but does not go up into the smaller tributaries. It occurs everywhere in the Ohio and Allegheny as far up as Warren County, but is absent in the headwaters of the Allegheny in McKean County. In French Creek it goes at least as far as Meadville in Crawford County. In the Beaver drainage it does not go beyond Lawrence County (in Mahoning and Shenango Rivers). In the Monongahela it goes up to the Cheat in Fayette County. Wherever found, it is the prevailing species, and outnumbers all other species combined (with the exception of the Cheat River). Conditions in the Kiskiminetas drainage are unknown. It used to be there, but at present it is not any longer found there alive.

8. **Lampsilis orbiculata** (Hildreth).

Reported only by Clapp from Allegheny County.

It is found at present in the Ohio in Beaver County, and in the Allegheny River in Armstrong County. It used to be in the Monongahela at Charleroi, Washington County (Ehrmann Collection).

9. **Lampsilis recta** (Lamarck).

This species is recorded in Harn's list from western Pennsylvania, in Clapp's list from Allegheny County, and it occurs in the Ohio River according to Rhoads.

It is found in the larger rivers and is generally rather abundant. In the Allegheny it goes up as far as Warren County, where it also enters the Connewango Creek. It is in French Creek in Venango and Crawford Counties. In the Monongahela River it goes up to Dunkard Creek and the Cheat River. Its former presence in the Conemaugh River at New Florence, Westmoreland County, has also been ascertained by the writer. None of the smaller creeks contain this species, and it is absent in the whole Beaver drainage.

10. **Lampsilis iris** (Lea).

Recorded in Harn's list from western Pennsylvania. Simpson gives *L. fatua* for the Beaver River. The specimen (from Wampum), upon which this record is based, is in the Carnegie Museum, and undoubtedly is *L. iris*. The writer found additional material of this form in the Beaver drainage, not far from Wampum.

It is a rather rare species in our region, nowhere abundant, but scattered over a large area. It is most frequent in Little Beaver Creek, Beaver County, in the Mahoning and Shenango Rivers, in the Neshannock and Pymatuning Creeks in Lawrence and Mercer Counties. It is found also in Crooked Creek, Armstrong County, in French Creek, Crawford County, and in Dunkard Creek, Greene County, and the Cheat River, Fayette County.

11. **Lampsilis (Carunculina) parva** (Barnes).

Reported from western Pennsylvania by Harn. Rhoads' *U. parvus* probably is *Micromya fabalis*.

The writer has found a single dead, but well preserved shell of this species in Conneaut Outlet, Crawford County.

12. **Proptera alata** (Say).

Given in Harn's list as from western Pennsylvania; recorded by Stupakoff from Allegheny County, and by Rhoads from the Ohio River.

Abundant in the Ohio and formerly in the Monongahela. Goes up in the latter to Dunkard Creek, Greene County, but not into the Cheat. In the Allegheny River it is found in Allegheny and Armstrong Counties, but not very frequently, and does not go farther up. In addition it has been collected in the Little Beaver Creek at Cannelton, Beaver County (Miss Vera White), but not farther up. It is absent in the whole Beaver drainage.

13. **Proptera gracilis** (Barnes).

Not in Harn's list. Recorded by Clapp from Allegheny County, and by Rhoads from the Ohio River.

Abundant in the Ohio below Pittsburgh; rare in the Allegheny in southern Armstrong County. Formerly in the Monongahela at Charleroi, Washington County (Ehrmann Collection). Nowhere else.

14. **Obovaria retusa** (Lamarck).

Not reported previously from the state. A single live specimen (gravid female) was found by the writer in the Ohio at Industry, Beaver County. Subsequently a well preserved dead shell of a male was found at the same place.

15. **Obovaria circulus** (Lea).

Lea records this species from the Monongahela at Pittsburgh. It is reported by Harn from western Pennsylvania, and by Rhoads as *U. lens* from the Ohio and Beaver.

The writer has seen many dead shells from the Ohio in Allegheny County. One living specimen, taken August 1, 1906, was the last living Unionid found in the Ohio in Allegheny County. There are specimens taken from the Monongahela at Charleroi, Washington County, in the Ehrmann Collection. It is found living in the Mahoning and Shenango Rivers and in Pymatuning Creek, Lawrence and Mercer Counties. It occurs also in Crooked Creek in Armstrong and Indiana Counties. It is now rather scarce.

In the Ohio, the form *circulus* prevails, while in the smaller creeks it generally takes the more compressed shape of *O. lens* (Lea); but all manner of transitional variations between the two forms occur. *O. circulus* and *lens* are not the male and female, as Sterki believes.

16. **Obovaria (Pseudoon) ellipsis** (Lea).

Recorded by Stupakoff from Allegheny County, but in no other list.

The writer found two specimens in the Ohio at Industry, Beaver County.

17. **Plagiola securis** (Lea).

Reported in Harn's list from western Pennsylvania; in Clapp's list from Allegheny County, in Rhoads' list from the Ohio.

Rather abundant in the Ohio in Beaver County; formerly occurred in the Monongahela at Charleroi, Washington County (Ehrmann Collection). Very rare in the Allegheny in southern Armstrong County. Nowhere else.

18. **Plagiola (Amygdalonajas) elegans** (Lea).

Recorded by Rhoads from the Ohio in Allegheny County.

A dead specimen was found by the writer not far from Rhoads' locality. It is found living in the Ohio in Beaver County, but is very rare.

19. **Plagiola (Amygdalonajas) donaciformis** (Lea).

Only two specimens are recorded by Rhoads from the Ohio River at Coraopolis, Allegheny County. They are in the Philadelphia Academy, where the writer has seen them. They are both dead shells.

This is the only one of the species previously reported, which has not been found by the writer.

20. **Tritogonia tuberculata** (Barnes).

Not in Harn's, Stupakoff's, and Clapp's lists. Recorded by Rhoads from the Ohio and Beaver Rivers.

It occurred formerly in the Monongahela at Charleroi, Washington County (Ehrmann Collection). The writer found several dead specimans in Dunkard Creek, Greene County, and live ones in the Ohio in Beaver County, and at various places in the Mahoning and Shenango Rivers, and Pymatuning Creek in Lawrence and Mercer Counties.

According to Sterki (Nautilus, 21, 1907, p. 48) this species has all four gills charged in the breeding season (June 10, 1907). This will remove it, in our final arrangement, into the genus *Quadrula*, and then the name of the species must be changed, on account of the existence of the species of *Quadrula* named *tuberculata* by Rafinesque. None of the synonyms is available: *U. pustulata* Swainson (1840) being preoccupied by *U. pustulatus* Lea (1834), and *U. gigas* (Swainson) Sowerby (1867) being not this species, but equivalent to *Hyriopsis cumingi* (Lea) (see: Frierson, Nautilus, 21, 1907, p. 49). Thus we are forced to apply a new name, and **Quadrula tritogonia** nom. nov. is proposed. (See Nautilus, 22, 1909, p. 101.)

21. **Cyprogenia irrorata** (Lea).

Not mentioned in any of the previous lists, except in that of Rhoads, who reports it from the Ohio, at Beaver.

The present writer has found only dead shells in the Allegheny River in the northeastern corner of Allegheny County, and in the southern part of Armstrong County.

22. **Obliquaria reflexa** Rafinesque.

First indicated from Allegheny County by Clapp (*U. cornutus*), then by Rhoads from the Ohio River in Allegheny and Beaver Counties.

There are in the Carnegie Museum two dead specimens from the Monongahela at Charleroi, Washington County (Ehrmannn Collection), and the present writer has found four others (two of them alive) in the Ohio in Beaver County.

23. **Ptychobranchus phaseolus** (Hildreth).

Mentioned in Harn's list from western Pennsylvania; not recorded in the lists of Stupakoff and Clapp; given by Rhoads as from the Beaver at Wampum, but not from the Ohio.

The species is widely distributed in the smaller streams of western Pennsylvania, while it is lacking in the large rivers. It occurs everywhere in the Beaver drainage in Lawrence and Beaver Counties; in the little Beaver and Raccoon Creeks in Beaver County; in Dunkard Creek in Greene County, and the Cheat River, Fayette County; in the Kiskiminetas drainage in the upper Loyalhanna in Westmoreland County; and the Quemahoning Creek in Somerset County. While rare in the Allegheny in Venango and Forest Counties, and absent in the Allegheny below Oil City, it occurs practically in all its tributaries, in Connewango Creek, French Creek, and Little Mahoning Creek, Indiana County, and Buffalo Creek, Butler County. It is absent in the Ohio, but used to be found in the Monongahela at Charleroi.

24. **Strophitus undulatus** (Say).

It occurs in Harn's list as from western Pennsylvania; but is not reported by Stupakoff and Clapp. It is mentioned in Rhoads' list from the Ohio and Beaver.

In the Ohio drainage in western Pennsylvania this species is found practically everywhere, and it goes eastward into Somerset County, occurring in Quemahoning Creek and the Youghiogheny River. In the latter river, it is the only Unionid found above Confluence. Some forty individuals were collected, while there was not a trace of any other species, a very remarkable fact indeed. It is further found eastward in Indiana, Forest, and Warren Counties. This species is rather scarce in the large rivers; though Rhoads found it in the Ohio below Pittsburgh, I have never seen it there. Nevertheless it occurs in the Allegheny in Armstrong County, though the specimens are rather small. The finest and largest specimens are encountered in certain small creeks in the northwestern section of the state.

It is impossible for me to separate the western, so called, *S. edentulus* (Say) from the eastern *S. undulatus* (Say). Specimens from the Allegheny River, and young specimens from anywhere completely agree with typical eastern specimens, and generally, in the mountain streams (Cheat, Youghiogheny, Loyalhanna, Quemahoning) this species remains as small as the eastern form. On the other hand I have eastern specimens, which are larger than any western specimens (see below). Several series containing specimens of all sizes, from various localities, both in the eastern and western drainage, show that there actually is no difference whatever between the two supposed species, and I challenge anyone to identify them, when the locality is not known.

25. **Anodonta imbecillis** Say.

Not reported previously from the state. I found it only in Erie County, in Conneauttee Lake, and in the outlet of Lake Leboeuf.

26. **Anodonta grandis** Say.

This species occurs in none of the older lists, but there is a specimen in the Carnegie Museum collected in 1897 by Clapp in an artificial pond at Edgeworth, Allegheny County.

The typical form (rather heavy-shelled, elongate, dark-colored) is not rare over the western part of the state, and prefers the smaller streams, where it is sometimes found in abundance in quiet pools. It goes eastward as far as Westmoreland, Indiana, and Warren Counties. In the larger rivers it is generally absent, although single specimens (chiefly young ones) turn up here and there. In stagnant ponds a large, thin shelled, higher, and beautifully colored form (var. *gigantea* Lea) is encountered. This form is quite abundant in a pond (abandoned ox-bow of the Allegheny) at Harmarville, Allegheny County. A similar form, but with a peculiar green color (similar to var. *benedictensis* Lea!) occurs in Conneaut Lake, together with a very thin-shelled, light green, elongate form. A similar form to the latter, but of a darker color, is found in the black muck of Conneauttee Lake in Erie County. The var. *salmonia* Lea, which has been regarded as a pathological form, is rather frequent in the northwestern section of the state, and, as is quite remarkable, at certain places is found to the exclusion of the typical form.

27. **Anodontoides ferussacianus** (Lea).

Not reported previously. It is found in the northwestern corner of the state, in Mercer and Crawford Counties, in the drainage of Shenango River and French Creek. It is most abundant in the Upper Shenango at Linesville, Crawford County, and in Conneaut Lake and Conneaut Outlet. At the latter localities, the specimens very closely resemble in shape the var. *subcylindraceus* (Lea).

28. **Symphynota compressa** (Deshayes).

The only previous record is that of Rhoads from the Beaver at Wampum, Lawrence County.

In addition it has been found in Little Beaver Creek in Beaver County, in the whole Beaver drainage in Beaver, Lawrence, Mercer, and Crawford Counties, in French Creek and its tributaries in Venango, Crawford, and Erie Counties, and in Brokenstraw and Connewango Creeks in Warren County. It is entirely absent in the rest of the Allegheny drainage, in the Ohio, and in the whole Monongahela drainage.

29. **Symphynota (Lasmigona) costata** (Rafinesque).

It is cited as *Margaritana rugosa* Barnes in Harn's, Stupakoff's and Rhoads' lists from western Pennsylvania, Allegheny County, and the Ohio and Beaver Rivers.

Generally distributed over the Ohio drainage in the state, eastward as far as Fayette County (Cheat River), Somerset County (Quemahoning Creek), Indiana County (Two Lick, Crooked, and Little Mahoning Creeks), and McKean County (upper Allegheny River). It extends northward into Crawford and Erie Counties (upper Shenango River, French and Conneauttee Creeks). In some of the smaller creeks it is so abundant as to become the prevailing form (Little Beaver, Loyalhanna, Little Mahoning). On the other hand, it is rather scarce in the large rivers. I have never found it in the Ohio in Beaver County, and only a few individuals in the Allegheny in Armstrong County.

30. **Symphynota (Pterosygna) complanata** (Barnes).

Never reported before from the state. I have found a number of specimens in Conneaut Outlet, Crawford County, and a few dead ones (from a muskrat hole) in Leboeuf Creek, just below Lake Leboeuf, Erie County.

31. **Alasmidonta (Rugifera) marginata** (Say).

Reported by Harn from western Pennsylvania, and by Rhoads from the Ohio and Beaver Rivers.

It is quite generally distributed over the Ohio drainage, going up into the head-waters to Somerset, Westmoreland, Indiana, and McKean Counties. It is rare in the large rivers, but in the small streams locally abundant.

According to Pilsbry (Nautilus, 15, 1901, p. 16) and Fox (ibid., p. 47), the western form is the true *marginata* of Say (= *truncata*

Wright); while the eastern form should be called *varicosa* (Lamarck) (1819). Nevertheless I do not think that the two are specifically different. In our mountain streams forms are frequently encountered, which cannot be without doubt assigned to the western form, as in fact they closely resemble the eastern form in essential characters. Such individuals are also found in the Allegheny. The typical *marginata* (western form) does not begin to prevail till we come to the northwestern section of the state.

32. **Unio gibbosus** Barnes.

Mentioned in Harn's list as from western Pennsylvania; recorded by Stupakoff from Allegheny County, and by Rhoads from the Ohio and Beaver.

Ubiquitous all over the Ohio drainage in the state, extending eastward to Somerset, Indiana, and McKean Counties. In fact this species is so generally distributed, and so abundant, that there is hardly a stream which has mussels, in which it is missing. The most remarkable instance of its absence is in the case of Raccoon Creek in Beaver County. Other cases, in which it has not been found, occur in those creeks, the fauna of which has been more or less extirpated, as for instance Connoquenessing Creek in Butler County.

33. **Unio crassidens** Lamarck.

It is reported by Harn from western Pennsylvania, by Clapp from Allegheny County, by Rhoads from the Ohio, and by Call from the Allegheny River.

It is restricted to the larger rivers, and is abundant, where found. I have taken it in the Ohio in Beaver and Allegheny Counties; in the Allegheny in Allegheny and Armstrong Counties. It used to be found in the Monongahela at Charleroi, Washington County (Ehrmann Collection). It does not occur elsewhere.

34. **Pleurobema clava** (Lamarck).

Reported only by Call and Harn from western Pennsylvania.

It avoids the large rivers, and has never been found in the Ohio, the Monongahela, and the Allegheny as far up as southern Armstrong County. In Armstrong County it is rare in the Allegheny. It is found in the Beaver drainage in Lawrence and Mercer Counties, in Little Beaver and Raccoon Creeks in Beaver County, in the Cheat River in Fayette County, in the Loyalhanna and (formerly) in the Conemaugh in Westmoreland County, in the Upper Allegheny in Venango and Forest Counties, and in French Creek in Venango and Crawford Counties. It is nowhere abundant; the largest number from any one locality was secured in Neshannock Creek at Eastbrook, Lawrence County.

35. **Pleurobema æsopus** (Green).

The type-locality is Pittsburgh (Green). Recorded in Harn's list from western Pennsylvania; in Rhoads' list from the Ohio and Beaver.

There is a specimen in the Carnegie Museum from the Monongahela at Charleroi, Washington County (Ehrmann Collection), and the writer has found it sparingly in the Ohio in Beaver County, and more abundantly in the Allegheny in southern Armstrong County.

36. **Quadrula undulata** (Barnes).

It is not mentioned in Harn's list, but occurs in Clapp's list from Allegheny County. Rhoads' *U. plicatus* from the Ohio and Beaver is this species.

It is abundant all over the Beaver drainage, chiefly so in the Mahoning and Shenango Rivers, and formerly occurred in Connoquenessing Creek. It is rather frequent in the Ohio in Beaver County. It is unknown from the Monongahela, but a single half shell was found in the Cheat River in Fayette County. It is present in the upper Monongahela drainage in West Virginia, judging from specimens in the Carnegie Museum. In the Allegheny River in Armstrong and Venango Counties it is very rare, but becomes again abundant in French Creek in Venango and Crawford Counties, as far up as Leboeuf Creek in Erie County. It is absent from the whole Kiskiminetas drainage and the upper Allegheny above Venango County.

37. **Quadrula cylindrica** (Say).

Cited in Harn's list from western Pennsylvania and in Rhoads' list from the Ohio and Beaver.

There is a dead shell in the Carnegie Museum from the Monongahela at Charleroi, Washington County (Ehrmann Collection), and the writer has found a dead specimen in the Ohio in Beaver County. Living specimens have been found repeatedly in the Mahoning and Shenango Rivers, and in Pymatuning Creek in Lawrence and Mercer Counties, in the Allegheny in Armstrong County, and in French Creek in Venango and Crawford Counties.

38. **Quadrula metanevra** (Rafinesque).

Not mentioned in the lists of Harn, Stupakoff, and Clapp. Reported by Rhoads from the Ohio.

It is restricted to the larger rivers, occurring in the Ohio in Beaver County (formerly in Allegheny County), the Monongahela (Charleroi), and the Allegheny, Armstrong County.

39. **Quadrula lachrymosa** (Lea).

Never reported before. A single living individual was found by the writer in the Ohio River at Cook's Ferry, Beaver County.

40. **Quadrula pustulosa** (Lea).

Cited in Harn's list from western Pennsylvania. Rhoads records it from the Ohio and Beaver.

It occurs in the larger rivers, but is now rather scarce. It goes up in the Monongahela as far as the Cheat River in Fayette County, in the Allegheny to southern Armstrong County, and in the Beaver to the Mahoning River in Lawrence County.

41. **Quadrula cooperiana** (Lea).

Reported by Rhoads from the Ohio in Allegheny and Beaver Counties.

The writer has found only one living and two dead shells of this species in the Ohio in Beaver County.

42. **Quadrula rubiginosa** (Lea).

Not mentioned in Harn's list; reported by Clapp from Allegheny County, and by Rhoads from the Ohio River in Allegheny County.

Typical specimens of this species are found in the smaller creeks of the southwestern section of the state. It occurs in Raccoon Creek, Beaver County, and was formerly found in Chartiers Creek, Allegheny County. It exists in the Monongahela drainage, Ten Mile Creek, Washington and Greene Counties, Dunkard Creek, Greene County, and also in the Allegheny River in Armstrong County, and in Crooked Creek, Armstrong and Indiana Counties. Specimens from the larger rivers (Monongahela and Ohio) are not typical, and approach more or less *Q. trigona* (Lea). Nevertheless no typical *trigona* has ever been found, the specimens reported by Stupakoff as *trigona* being probably, and those reported by Rhoads surely this intermediate form.

43. **Quadrula obliqua** (Lamarck).

Call and Harn record *obliquus* and *mytiloides* from western Pennsylvania, Stupakoff gives *U. pyramidatus* from Allegheny County, Clapp *U. obliquus* from Allegheny County, and Rhoads has *U. obliquus* from the Ohio. Of Rhoads' specimens only a few belong here.

This form is quite frequent in the Ohio River in Beaver County, and it used to be abundant in the Ohio in Allegheny County, and in the Monongahela at Charleroi, Washington County (Ehrmann Collection). It is present in the Allegheny in Armstrong County, and a single specimen was found in the Beaver at Wampum, Lawrence County (Clapp & Smith Collection).

Both forms, *obliqua* (Lamarck) and *pyramidata* (Lea), are represented, and some individuals approach *plena* (Lea). They all pass gradually into each other. In fact the intergrading forms are more frequent than typical specimens, so that it is absolutely impossible to draw the line between these supposed species. A more detailed account of the various forms constituting this very variable species will be given elsewhere.

44. **Quadrula coccinea** (Conrad).

The type locality for this species is the "Mahoning River near Pittsburgh" (Conrad). It is present in the Mahoning River at Mahoningtown, Lawrence County. It does not occur in Harn's list, although present in the upper Loyalhanna in Westmoreland County, and it is not recorded by Stupakoff and Clapp. Rhoads has it from the Beaver River at Wampum, Lawrence County. Specimens from this locality are in the Carnegie Museum, collected by Clapp and Smith.

It is generally distributed in the Beaver drainage in Lawrence and Mercer Counties. It is found in Buffalo Creek, Butler County; in Little Mahoning Creek, Indiana County; in the French Creek drainage in Venango, Crawford, and Erie Counties; in Brokenstraw Creek in Warren County; and in the upper Allegheny in McKean County. In the Allegheny River from Armstrong to Warren Counties, there is a form, which inclines both toward typical *Q. obliqua*, and the form *pyramidata*. In the southwestern portion of the state (Monongahela drainage) this species seems to be absent.

This species does not belong to the genus *Quadrula*. At the breeding season, the outer gills only are used as marsupia, and thus it should be placed, according to Simpson's arrangement of the genera, with the genus *Pleurobema*. I possess a number of gravid females from Neshannock Creek in Lawrence County, and from the upper Allegheny in McKean Country.

45. **Quadrula subrotunda** (Lea).

Cited by Harn from western Pennsylvania. The *U. pilaris* of Clapp (Allegheny County) and of Rhoads (Coraopolis) are probably this form. The majority of Rhoads' *obliquus* (Coraopolis and Beaver) belong here.

It is abundant in the larger rivers: Ohio, Monongahela, and Allegheny. In the Monongahela it extends up to the Cheat River in Fayette County, in the Allegheny up to the northern part of Armstrong County.

A few individuals in the Monongahela and Allegheny represent transititons toward the var. *kirtlandiana*.

45*a*. **Quadrula subrotunda kirtlandiana** (Lea).

Given in Harn's list from western Pennsylvania; occurring in the Beaver, according to Rhoads. It is abundant in the Beaver drainage in the Mahoning and Shenango Rivers in Lawrence and Mercer Counties, and is locally the prevailing species. It also is found in French Creek in Venango and Crawford Counties, as far up as Meadville and Conneaut Outlet.

At the critical points, where the range of this form passes into that of the typical *subrotunda* (lower Beaver River, and the Allegheny in Venango County) the molluscan fauna is destroyed. No typical specimens of *kirtlandiana* have been found in the Monongahela drainage. Some specimens from Charleroi have been named by Simpson "*kirtlandiana*," but they do not represent the typical phase of this form.

46. **Quadrula (Rotundaria) tuberculata** (Rafinesque).

It does not occur in the lists of Harn, Stupakoff, and Clapp. It is reported by Rhoads from the Ohio and Beaver.

A rare species, found sparingly in the Ohio in Beaver County and (formerly) in Allegheny County. It occurs in the Monongahela drainage in Dunkard Creek, Greene County, and the Cheat River, Fayette County; in the Allegheny in Armstrong and Venango Counties; and in French Creek in Venango County. A single specimen from the Beaver in Lawrence County is contained in the Clapp & Smith Collection in the Carnegie Museum, but in quite recent years it has not been found in the Beaver drainage.

B. Lake Erie Drainage.

No freshwater mussels have been previously reported from the Pennsylvanian shores of Lake Erie, and none from the tributaries of the lake in this state. The Carnegie Museum possesses good material collected in the lake chiefly at and near Erie, in Presque Isle Bay, and upon Presque Isle. These collections were made by Dr. D. A. Atkinson in August, 1900, by O. E. Jennings in May, 1905, and September, 1906, and by the present writer in June, 1908. A few dead shells were secured by the present writer on the lake beach at Miles Grove, Erie County, and a few others in the only tributary of the lake which contains mussels, Conneaut Creek at Springboro, Crawford County.

Seventeen forms have been found. They all have been reported previously from Lake Erie and its drainage in Ohio. (See Sterki, Proceedings Ohio Academy of Sciences, 4, 1907.)

1. **Lampsilis ventricosa** (Barnes).

Miles Grove; outer beach of Presque Isle; and Presque Isle Bay.

The lake form is peculiar, being smaller and lighter in color, than the typical form of the Ohio drainage. This species has also been found in Conneaut Creek, and there represents the typical form.

2. **Lampsilis luteola** (Lamarck).

Outer beach of Presque Isle, beach pools, and Presque Isle Bay. It also is found in Conneaut Creek.

The lake form is peculiar, small and stunted. The form in Conneaut Creek agrees with the form from the Ohio drainage.

3. **Lampsilis recta** (Lamarck).

In a beach pool of Presque Isle, and in Presque Isle Bay.

4. **Lampsilis nasuta** (Say).

Miles Grove. Beach pools of Presque Isle and Presque Isle Bay.

5. **Proptera alata** (Say).

Presque Isle Bay.

Smaller than the typical form.

6. **Proptera gracilis** (Barnes).

Presque Isle Bay.

7. **Ptychobranchus phaseolus** (Hildreth).

Presque Isle Bay.

8. **Strophitus undulatus** (Say).

In Conneaut Creek (not as yet found in the lake in Pennsylvania).

9. **Anodonta imbecillis** Say.

Beach pools of Presque Isle and Presque Isle Bay.

10. **Anodonta grandis footiana** Lea.

Beach pools of Presque Isle and Presque Isle Bay.

This variety of *A. grandis* is very constant in the lake, and there are only very rare cases of individuals approaching the typical form.

11. **Anodontoides ferussacianus subcylindraceus** (Lea).

Beach pools of Presque Isle and Presque Isle Bay.

This form is extremely abundant in certain beach pools, and rather uniform in character, no intergrades toward the typical *ferussacianus* having been observed.

12. **Symphynota compressa** Lea.

A single individual was found by the writer in a beach pool on Presque sle.

13. **Unio gibbosus** Barnes.

Presque Isle Bay.

The lake form of this species is rather peculiar, being small and of lighter color than the typical form from the Ohio drainage.

14. **Quadrula undulata hippopæa** (Lea).

Presque Isle Bay.

This peculiar variety by no means belongs to *Q. plicata* under which it is placed by Simpson. It is clearly a descendant of *Q. undulata* of the Ohio drainage, and distinguished by its smaller size, and slightly more elongated form. The development of the undulations does not differ at all from the typical form, or rather, both forms show the same variations. There are many specimens of *Q. undulata* in the Ohio drainage, chiefly young ones, which come very close to the var. *hippopæa*.

15. **Quadrula rubiginosa** (Lea).

Horseshoe Pond on Presque Isle and Presque Isle Bay.

Not at all typical, but of small size, and rather swollen shape, thus closely approaching *Q. trigona;* in fact I have a specimen, which might safely be called *trigona*.

16. **Quadrula coccinea** (Conrad).

Not found in the lake, but in Conneaut Creek. I obtained a single dead shell, agreeing with the normal form of the Ohio drainage of northwestern Pennsylvania.

17. **Quadrula subrotunda** (Lea).

Presque Isle Bay.

A peculiar dwarfed form.

C. ATLANTIC DRAINAGE.

The species of the Atlantic drainage in Pennsylvania are rather well known, yet our knowledge of them is restricted mainly to the southeastern section of the state. The distribution of the single forms has never been investigated in detail, and we do not know how far they go up in the rivers. It seems that some species are rather generally distributed, while others are more or less restricted, either to the lower parts of the rivers, or to one river drainage only. The following list is intended to collect the known facts of distribution, adding new locality-records, which are represented by specimens in the Carnegie Museum. The older records are compiled from the following papers:

Gabb, A. F. "List of Mollusks inhabiting the neighborhood of Philadelphia." (Proc. Acad. Philadelphia, 1861, p. 306.)

Bruckhart, H. G. Conchology in J. I. Mombert's "An authentic History of Lancaster County." 1869, p. 518.

Hartman, W. D., & Michener, E. "Conchologia Cestrica." 1874.

Pilsbry, H. A. "Critical list of Mollusks collected in the Potomac Valley." (Proc. Acad. Philadelphia, 1894, p. 30.)

Schick, M. "Mollusk Fauna of Philadelphia and Environs." (Nautilus, 8, 1895, p. 133.)

Also a few notes by other authors scattered through the literature.

The Carnegie Museum collections of Atlantic species are chiefly from the central parts of the state (Juniata and Susquehanna drainages), and were made in 1908 by Dr. D. A. Atkinson and the present writer. To these are to be added a few records of shells collected by various persons in other parts of the state.

1. **Lampsilis cariosa** (Say).

Known from the Delaware, Schuylkill, and Susquehanna Rivers.

The Carnegie Museum possesses specimens from the Delaware, at Yardley, Bucks County (Ortmann), from the Susquehanna at York Furnace, York County (Ortmann), and from Duncannon, Perry County (Ortmann). The species is present in the Juniata River at Juniata Bridge, Perry County (Ortmann), and at Lewistown, Mifflin County (Ortmann), as far up as the Raystown Branch at Ardenheim (Ortmann), and the Frankstown Branch at Huntingdon, Huntingdon County (Atkinson). It exists also in the West Branch of the Susquehanna at Williamsport, Lycoming County (Atkinson).

2. **Lampsilis ochracea** (Say).

The Delaware, Schuylkill, and Susquehanna Rivers and Wissahickon Creek, are the known localities of this species in the southeastern section of the state. It is not represented by Pennsylvanian specimens in the Carnegie Museum.

3. **Lampsilis radiata** (Gmelin).

It occurs in the Delaware, Schuylkill, and Susquehanna Rivers and Wissahickon Creek. From the Susquehanna it has been reported as far up as Muncy, Lycoming County (Dean, Nautilus, 5, 1891, p. 78).

Specimens in the Carnegie Museum are from the Canal at Manayunk, Philadelphia County (H. J. Gera); from the Delaware at Yardley, Bucks County (Ortmann), and from the West Branch of the Susquehanna at Williamsport, Lycoming County (Atkinson).

4. **Lampsilis nasuta** (Say).

Reported from the Delaware and Schuylkill Rivers, and "Little Perkiomen Creek" (Gabb). Perkiomen Creek is a tributary of the Schuylkill in Montgomery County, but there is, as far as I can ascertain, no stream known now as "Little Perkiomen Creek." This species has not been reported from the Susquehanna drainage.

The Carnegie Museum has specimens from the Delaware at Penn's Manor and at Yardley, Bucks County (Ortmann).

5. **Strophitus undulatus** (Say).

The species has been reported from the Schuylkill (Lea); Brandywine Creek, Chester County (Hartman & Michener); Crum Creek, Delaware County (Lea); Schuylkill Canal, Philadelphia County (Schick); and from Lancaster County (Bruckhart).

In the Carnegie Museum it is represented by specimens from the following localities: Delaware River, Penn's Manor and Yardley, Bucks County (Ortmann); Little Neshaminy Creek, Grenoble, Bucks County (Ortmann); Schuylkill Canal, (H. J. Gera), and Schuylkill River, Manayunk, Philadelphia County (Ortmann); Middle Creek, Freeburg, Snyder County (Atkinson); West Branch Mahantango Creek, Richfield, Juniata County (Atkinson); Cocolamus Creek, Cocolamus, and Lost Creek, Mifflintown, Juniata County (Atkinson); Raystown Branch of the Juniata River, Everett, Bedford County (P. E. Nordgren); Beaver Dam Creek, Flinton, Cambria County (Atkinson); Swartz Run, Ashville, Cambria County (Ortmann); Cush-Cushion Creek, Green Township, Indiana County (Atkinson and Ortmann).

This species is generally small in eastern Pennsylvania, representing the typical *undulatus*. Yet locally it attains considerable size, for instance in Little Neshaminy Creek, in Beaver Dam, and in Cush-Cushion Creek. In fact specimens from the latter creek (abandoned reservoir) are the largest I possess, larger than any from western Pennsylvania. According to Simpson, both forms, *undulatus* and *edentulus*, are found in the Atlantic drainage, but my material shows that large and small individuals cannot be separated as species, because they pass gradually into each other. There are small ones from Cush-Cushion Creek, which agree perfectly with specimens of the same size from other localities farther east. Compare notes under this species in the Ohio drainage.

6. **Anodonta cataracta** Say.

Many localities are known in Philadelphia County, in the Delaware and Schuylkill Rivers, and in ponds. It is found also in Delaware, Chester, and Lancaster Counties (Bruckhart, Gabb, Schick, Hartman & Michener). It occurs also in York County, at York Furnace (Pilsbry).

There is a specimen from Crum Creek, Delaware County, in the Carnegie Museum, from the Hartman Collection, which was labeled *implicata*, but surely belongs to this species; and two others from the Schuylkill River (same collection), which were labeled *tryoni* Lea. The present writer found this species in the Delaware River at Penn's Manor, and in Little Neshaminy Creek, at Grenoble, Bucks County, and in Wissahickon Creek, at Roxboro, Philadelphia County. A dead shell was seen in the Raystown Branch of the Juniata River at Ardenheim, Huntingdon County.

Dr. Atkinson collected a splendid set of this species in Beaver Dam Creek, Flinton, Cambria County. Thus this species goes in the Susquehanna drainage far to the west in the headwaters of the West Branch of the Susquehanna, and it is here as typically developed as in the neighborhood of Philadelphia. This is the more remarkable, as *A. grandis*, which is closely allied to this species, appears right across the divide in the Ohio drainage in Indiana and Westmoreland Counties (see above, p. 195).

7. **Anodonta implicata** Say.

Delaware and Schuylkill Rivers (Lea, Gabb, Hartmann & Michener).

Typical specimens of this species were found by the writer in the Delaware River at Yardley, Bucks County. It has not yet been reported from the Susquehanna drainage.

Simpson (1900, p. 641) cites *A. grandis* as doubtfully occurring in southeastern Pennsylvania, but I do not know on what authority.

Pilsbry (Proceedings Philadelphia Academy, 1894, p. 30) gives "*Anodonta subcylindrica* Lea" (sic!) from York Furnace, York County. I do not know what this stands for. *Anodontoides ferussacianus subcylindraceus* (Lea) is not found in the Atlantic drainage in Pennsylvania.

8. **Symphynota viridis** (Conrad).

Schuylkill River, Philadelphia (Conrad, Hartman & Michener); Lancaster, Lancaster County (Conrad, Lea); Lancaster County (Bruckhart); Juniata River (Conrad); Juniata River at Hollidaysburg, Blair County (Lea).

There are specimens in the Carnegie Museum from the Schuylkill Canal at Manayunk, Philadelphia County (H. J. Gera); the Delaware River, Yardley, Bucks County (Ortmann); Raystown Branch of the Juniata River, Bedford, Bedford County (A. Koenig); Cush-Cushion Creek, Green Township, Indiana County (Atkinson).

9. **Alasmidonta undulata** (Say).

The species is reported from the Delaware and Schuylkill Rivers (Say, Gabb); and several smaller streams in Bucks, Philadelphia, Delaware, Montgomery, Chester, and Lancaster Counties (Schick, Gabb, Hartman & Michener, Bruckhart). Harn gives this species for "western Pennsylvania" (see above).

A large specimen from the Hartman collection, labeled "Kimberton Dam, Chester County" is in the Carnegie Museum. There are also specimens from the Schuykill Canal, Manayunk, Philadelphia County (H. J. Gera); Delaware River, Yardley, Bucks County (Ortmann); West Branch Mahantango Creek, Richfield, Juniata County (Atkinson); Raystown Branch of the Juniata River, Everett, Bedford County (P. E. Nordgren); Shober's Run, Bedford Springs, Bedford County (A. Koenig); Frankstown Branch of the Juniata River, Hollidaysburg, Blair County (Ortmann); Beaver Dam Creek, Flinton, Cambria County (Atkinson); Swartz Run, Ashville, Cambria County (Ortmann).

10. **Alasmidonta (Pressodonta) hetorodon** (Lea).

Schuylkill River, Darby Creek, (Lea, Gabb, Conrad, Hartman & Michener); Neshaminy Creek, Bucks County (Schick); Canal at Manayunk (Schick).

There is in the Carnegie Museum only a single individual from the last named locality (H. J. Gera coll.).

11. **Alasmidonta (Rugifera) marginata varicosa** (Lamarck).

Schuylkill River, Philadelphia (Lamarck); small creeks in Bucks, Delaware, and Chester Counties (Schick, Hartman & Michener); Lancaster County (Bruckhart).

There are specimens in the Carnegie Musuem from the following localities: Lehigh River, Bethlehem, Northampton County (Holland Collection); Delaware River, Yardley, Bucks County (Ortmann); Susquehanna River, Duncannon, Perry County (Ortmann); Juniata River, Juniata Bridge, Perry County (Ortmann); Frankstown Branch of the Juniata River, Huntingdon and Alexandria, Huntingdon County (Atkinson); Raystown Branch of the Juniata River, Ardenheim, Huntingdon County (Ortmann); Raystown Branch, Everett, Bedford County (P. E. Nordgren); Raystown Branch, Bedford, Bedford County (A. Koenig); Driftwood Branch of the Sinnamahoning Creek, Driftwood, Cameron County (Ortmann).

These represent generally the eastern variety (*varicosa*) of this species; yet there are, among a fine set collected by the writer at Ardenheim, several large individuals, which approach in the greater development of the anterior part of the shell and the sharper posterior ridge, and more distinct truncation of the posterior end, the western form (see above).

12. **Margaritana margaritifera** (Linnæus).

Lea (Observ., II, p. 56) records this species from Crum Creek, Delaware County, and Hartman & Michener from White Clay Creek, Chester County. Both records are very doubtful, and have not been confirmed. Lea (Observ., VII, p. 225) says that it goes as far south as middle Pennsylvania. The only positive record we possess is from Still Creek, Quakake, Schuylkill County (Conner, Nautilus, 18, 1904, p. 91). I have seen specimens from this locality in the Philadelphia Academy. Yet the trouble is, that I was unable to locate "Still Creek" on the topographical survey map (sheets Hazleton and Mahanoy), and also the place Quakake. There is a Quakake Junction in Schuylkill County and a Quakake Creek in Carbon County.

In the Carnegie Museum this species is not represented from Pennsylvania.

13. **Unio complanatus** (Dillwyn).

Many records are at hand from Philadelphia, Delaware, Chester, and Lancaster Counties, but none to the west of these.

In the Carnegie Museum the species is represented from the following places: Little Neshaminy Creek, Grenoble, Bucks County (Ortmann); Common Creek, Tullytown, Bucks County (Ortmann); Delaware River, Penn's Manor and Yardley, Bucks County (Ortmann); Schuylkill Canal, Manayunk, Philadelphia County (H. J. Gera); Susquehanna River, York Furnace, York County (Ortmann); Susquehanna River and Sherman's Creek, Duncannon, Perry County (Ortmann); Juniata River, Juniata Bridge, Perry County (Ortmann); Pennsylvania Canal and Lost Creek, Mifflintown, Juniata County (Atkinson); Cocolamus Creek, Cocolamus, Juniata County (Atkinson); Juniata River, Lewistown, Mifflin County (Ortmann); Raystown Branch of the Juniata River, Ardenheim, Huntingdon County

(Ortmann); Raystown Branch, Everett, Bedford County (P E. Nordgren); Shober's Run, Bedford Springs, Bedford County (A. Koenig); Frankstown Branch of the Juniata River, Huntingdon and Alexandria, Huntingdon County (Atkinson); Frankstown Branch, Hollidaysburg, Blair County (Ortmann); West Branch Mahantango Creek, Richfield, Juniata County (Atkinson); Middle Creek, Freeburg, Snyder County (Atkinson); Canal at Watsontown, Northumberland County (Atkinson); West branch of the Susquehanna, Williamsport, Lycoming County (Atkinson); Driftwood Branch of the Sinnemahoning Creek, Driftwood, Cameron County (Ortmann); Beaver Dam Creek, Flinton, Cambria County (Atkinson); Cush-Cushion Creek, Green Township, Indiana County (Atkinson).

14. **Unio fisherianus** Lea.

White Clay Creek, Chester County (Hartman & Michener); one specimen was found in the Schuylkill at Philadelphia (Gabb). It is a species belonging to the Potomac drainage, but has not yet been reported from any place in that drainage in Pennsylvania.

Not represented from the state in the Carnegie Museum.

Unio fuliginosus Lea from Cobbs Creek (a branch of Darby Creek, near Essington, Philadelphia County) is quoted twice by Simpson under *U. complanatus* (p. 723) and under *U. icterinus* Conrad (p. 727). The latter is a southern form, and it is not very likely that it is found in Pennsylvania.

The above list at least somewhat extends our knowledge of the distribution of the eastern Unionidæ.

Unio complanatus seems to be as ubiquitous in, and characteristic of, the Atlantic drainage as *U. gibbosus* is for the Ohio drainage. It goes far up into the headwaters of the Susquehanna drainage. The same is the case with *Strophitus undulatus*, *Symphynota viridis*, *Alasmidonta undulata*, and *Alasmidonta marginata varicosa*, yet it seems as if these four species are not so frequent in the larger rivers. According to the present records, *Lampsilis cariosa* and *Lampsilis radiata* seem to prefer the larger rivers, although they ascend also toward the headwaters. The distribution of *Lampsilis ochracea* remains to be investigated. It is known from the region of tidewater, but not farther up. *Lampsilis nasuta* so far is restricted to the Delaware drainage, and is absent from that of the Susquehanna and farther south. The distribution of the two *Anodontas* also should be investigated more closely. *Alasmidonta hetorodon* appears to be restricted to the southeastern corner of the state. *Margaritana margaritifera* should be looked for in the northeastern and the northern central parts of the state. The establishment of the southern boundary of distribution of the latter species is very desirable. *Unio fisherianus* is a southern form, and may be present in the Potomac drainage in southern Pennsylvania. *Unio productus* Conrad, which comes very near to *U. fisherianus*, is known from the northern tributaries of the Potomac in Maryland (Pilsbry). The occurrence of *U. fisherianus* in White Clay Creek and in the Schuylkill probably marks the northern extremity of its range. From the Susquehanna it is unknown.

Thus we see, that many questions still await final decision, and that much remains to be done in a section of the country, where collectors have been busy for almost a century. Before we know the actual distribution of each species, we cannot venture to say anything about their history; but this should be the aim of all studies in geographical distribution.

VIII. A GEOLOGICAL RECONNAISSANCE IN NORTH DAKOTA, MONTANA, AND IDAHO; WITH NOTES ON MESOZOIC AND CENOZOIC GEOLOGY.

By Earl Douglass.

In July, 1905, Dr. Percy E. Raymond and Earl Douglass were sent by the Director of the Carnegie Museum, Dr. Wm. J. Holland, to collect both vertebrate and invertebrate fossils in Minnesota, North Dakota, Montana, and Idaho, and to obtain data for the settlement of certain geological problems, which arise in the study of the various extinct faunas of that region.

Previous to starting for the field, Mr. Douglass submitted to the Director an outline of the work, which it was hoped might be accomplished, provided that the discovery of large numbers of fossils of unusual interest did not shorten the work of exploration. This plan, which in substance is given below, was approved by Dr. Holland.

1. It was proposed that collections of fossils be made from the Ordovician rocks near St. Paul and from Straight River between Faribault and Owatonna in Minnesota.

2. The bad-lands of the Little Missouri River in North Dakota, especially the section near Medora on the Northern Pacific Railroad, had been very graphically described by geologists and other observers, but the geological age of the beds of which they are composed remained doubtful. They had been referred to the Laramie, but not, so far as the author was aware, on account of the discovery in them of characteristic Laramie fossils. It was hoped that data might be obtained which would promote a settlement of the question. The region appeared to be favorable for the discovery of vertebrate fossils.

3. In the vicinity of Glendive, on the Yellowstone River in the eastern part of Montana, are bad-lands which differ in color and general aspect from those of the Little Missouri River. These, while sombre and desolate in appearance as seen from car-windows, are very alluring to the fossil-hunter, and the present writer had never seen them on his trips to and from the west without a desire to explore them. Professor Lester F. Ward had made collections of plants from

these beds, some of which were described in his paper entitled "Types of the Laramie Flora." He recognized several plant-bearing horizons, all of which he included in the Fort Union formation, but he considered the Fort Union as a part of the Laramie. It was hoped that remains of mammalia, which would settle the status of these beds, might be obtained.

4. Mr. Douglass desired to search for fossils near Columbus in Yellowstone County in Montana where he had previously found fragmentary remains of fossil reptiles.

5. It was certain that large collections of invertebrates could be secured from the various Palæozoic, and probably from the Mesozoic formations of western Montana, where Mr. Douglass had previously collected. It was much to be desired that one more familiar with the fossils and competent to judge of the relative importance of the different faunæ should visit the region in company with one who was acquainted with the country.

6. Most of the valleys of western Montana had been pretty thoroughly searched for Tertiary mammals, yet some quite large areas, including the Flathead Valley, had not been explored for this purpose. As nearly every locality and horizon from which fossil mammals had been obtained had yielded much that was new and interesting, it was important that all the localities should be carefully searched.

7. It was surmised from reading accounts of explorations in Idaho and from verbal reports that Tertiary beds, of the same age as some of those which occur in Montana, extended into contiguous portions of Idaho. This was made more probable by a knowledge of the fact that in two places at least, one north of Henry's Lake in Idaho and another south of the little railroad station of Monida in Montana, the continental divide is comparatively low, and appears o be composed of rocks of relatively modern date.

All of the localities which it was proposed to explore were visited by one or both of the members of the expedition, but circumstances prevented anything like a thorough exploration of some of them. Large collections of invertebrate fossils were obtained, many of which are of unusual importance. Remains of fossil vertebrates were collected in several localities, one or two of which had not been previously discovered, and many data of geological interest were obtained. These data, combined with observations of former years, are given in this paper with a hope that it will somewhat extend the geological knowledge of the country, and help a little toward the solution of some perplexing problems.

Some portions of the large extent of territory over which the route lay have been the subject of detailed investigations. This is especially the case with Minnesota. The geology of North Dakota is now being systematically studied by the state Geological Survey. The geology of eastern Montana is still very imperfectly known. A few expeditions in search of fossil plants and vertebrates have traversed portions of the region, and formations from the Pierre shales to the Fort Union have been recognized; but in no case is the extent of the areal distribution of the formations known. Some splendid scientific work has been done by Hatcher and Stanton in tracing the Judith and related formations, but much more work of the same kind ought to be done. In western Montana we have the work of Dr. Hayden, marvellously good for the time and circumstances under which it was executed; and some quadrangles have been mapped by the United States Geological Survey.

It is proposed in the first portion of this paper to give something of a connected report of the physical features and geology of the country which it imperfectly covers, so far as it has come under the observation of the writer, in the form of an itinerary, which, though based on the route taken in 1905, includes observations made in former years. This, it is hoped, may be of interest to inquiring residents in the regions described, as well as a guide to those who are making geological explorations. In the second part (p. 266) the geology will be treated in a more systematic manner. The geology of the western portion of Montana, with especial reference to the Tertiary deposits, furnishes the subject of a more exhaustive memoir, which is not yet completed.

FROM ST. PAUL TO NORTH DAKOTA.

In going northwestward on the Great Northern Railroad, except in a few isolated places, one sees little of the older rock in place, as the surface of the country is mainly composed of different phases of the glacial drift. The general aspect of the country is that of an undulating plain, partly wooded and partly occupied by lakes, swamps, and meadow-lands. There are moraines and glacial knolls, or hills, but no high mounds, buttes, bluffs, or mountains. The river-valleys are shallow, and there are few high cut-banks, except those made in constructing the railroad. Much of the soil is light and sandy and the region is only partly occupied by farms. The trees are not usually large enough or thick enough to form dense forests. In many places small oaks predominate; these are rather thinly scattered, or clustered in groups of various sizes, forming "oak openings." Besides oaks there are groves of poplars, elms, and many other species of hard-wood and soft-wood trees, besides various kinds of shrubs which form thickets and underbrush.

A more detailed description of the country from Detroit along the Northern Pacific Railroad to Fargo, and then of the lake region along the Great Northern Railroad, will give a fair idea of the aspect of the country and show how it differs in topography, in its flora, and in its geological conditions, from the different regions to the westward.

The Country along the Northern Pacific Railroad.

In the region of Detroit the country is what would be called, if stripped of its trees, a slightly undulating prairie. A large portion of the land is uncultivated. After leaving Detroit we pass through a flat country, a great portion of which was quite thickly wooded, but now has only small trees. Evidently much of the timber has been cut for fuel, for as we pass along we note near the railroad stations many piles of cord-wood. There are some low, gravelly hills, and interspersed with the wooded tracts are streams winding through marshy meadows, and a small, clear, placid river with low wooded or brushy banks. Among the trees seen are ashes, oaks, birches, poplars, willows, and pines. Sometimes there is not a house in sight, but, as we go westward, an occasional farm appears. The plowed land shows a mixture of black muck and whitish clay or marl. The passing stranger wonders that there are so few horses and cattle, when the country seems so favorable for stock-raising, on account of the abundance of grass and water. In places the train passes shallow cuts excavated through almost pure sand. After passing through Lake Park, which appears to be a prosperous little town, the land becomes a little more rolling with marshy tracts in the depressions. Though much of the land has a ragged appearance, the distant view of its wooded ridges and rounded hills had a very pleasing aspect as we passed through it in the early morning. Soon the proportion of cultivated land became larger, until we came to where the greater portion of the surface has been cleared of timber, leaving large groves here and there. At last we are out on a great level tract of country where the lighter green of the growing grain, almost like one vast field, is fringed, next to the western sky, by the dark green of the woods which follow the course of the Red River of the North. We are on the bed of the glacial Lake Agassiz and in one of the richest grain-regions of the world.

Along the Great Northern Railroad.

If a more southerly course is taken through the lake-region in Douglas and Otter Tail Counties, one passes through a tract of country which has great charm and beauty. When one suddenly enters it from the almost treeless plains to the westward, the change is especially delightful. Here there is a varied assemblage of lakes, meadows, forests, groves, marshes, hills, and brushland, all mingling in delightful harmony and variety. Here the great ice-sheet deposited immense quantities of debris irregularly over the country. This has been covered over with a rich soil, and plants from north, east, south, and west have mingled together giving variety and beauty to the vegetation. The cultivated hills, covered in summer with fields of wheat, oats, and corn, help to reveal and increase the splendor of the scene; yet here Nature still holds much of her possession and defies the transforming energies of man. There are bodies of water which he cannot profitably drain, and swamps and marshes overgrown with grasses, sedges, cat-tails, and rushes, where the mower and harvester cannot be used. Many of the lakes are still fringed with deciduous trees and there are wet lowlands still covered with forests. The bobolink and black-bird sing as they used to sing, and the musk-rat builds his house as of old.

Near the western portion of this region of glacial moraines is Fergus Falls, which in summer is half hidden in trees. Westward the timber is small and becomes less in quantity. The railroad-cuts show that the deposits are composed to a great extent of gravel. The hills fade away to the southward and westward; soon the great moraines are left behind, and we are gliding over the rich soil and level country of the Valley of the Red River of the North, the southern lobe of the glacial Lake Agassiz.

EASTERN NORTH DAKOTA.

Crossing the narrow river we travel for a considerable distance on the level plain, which is nearly treeless, except where crossed by some stream fringed with woods. Finally the land swells into faint undulations, resembling a slight disturbance on a quiet sea; then all is smooth again; and again it is more rolling. The country soon becomes a vast undulating grassy prairie, treeless, except by some stream, or large lake. There are many lakes and marshes, but some of them are without a tree or shrub near them. The forests of maple, oak, elm, basswood, poplar, pine, spruce, and tamarack are left behind. The shores of Minnewauken, or Devil's Lake, are, however, well timbered. The species of plants are most of them western. Though we have crossed no mountain range, desert, or large body of water, we have suddenly entered another floral region. The absence of the eastern trees and their attendants is especially noticeable. It is true that some of the trees of the Mississippi Valley ascend the Missouri River and its tributaries to various distances; but the sycamore, tulip-tree, hickory, basswood, maple, and other deciduous trees, one by one, gradually die out to the northward and westward. The oaks and elms ascend farther, and diminished in size, reach far westward on some of the smaller streams. Cottonwoods and willows, though in part of different species, extend to the mountain region and there mingle with evergreens and other western trees.

Very little of the rock older than the drift is exposed in this part of the state, but glacial material covers nearly every part of the country. If one goes westward on the Great Northern, these conditions prevail far westward into Montana. On the Northern Pacific they end at the Missouri River. Glacial drift is found west of the river, but much has been removed by erosion, and the streams expose older rocks.

From the Missouri River to the Little Missouri Bad-lands.

The Missouri River near Bismarck is a broad, muddy stream, interrupted and broken by bars of mud and sand, bordered by muddy flats, and fringed with belts of timber, or shrubbery. On one side are high bluffs of soft rock, which are of Cretaceous, or Early Tertiary age.

West of Mandan the railroad follows the valley of Heart River for a short distance and then a branch called Sweet Brier Creek. The streams are fringed with cottonwood, elm, choke-cherry, buffalo-berry, wolf-berry, and other trees and shrubs. The bluffs on the side of the valley are peculiar in shape; some are green with vegetation and some are bare. They are in places scattered over with glacial boulders. The country-rock is usually soft with occasional harder bands.

After ascending a branch of the Sweet Brier the railroad enters the valley of the Big Muddy, another branch of the Heart River. In this region the outcrops are mostly shale with bands of brownish sandstone. There are occasional dumps where coal mining or prospecting has been done. Here too are occasional patches of glacial drift. Again near Dickinson the railroad follows the course of the Heart River. In the vicinity of Dickinson, a neat and thriving city of the prairie, the country is a somewhat uneven plain with higher buttes projecting above the general level. These buttes show that the ancient level of the country has been considerably lowered by erosion, leaving only weathered monuments of its former elevation. Here we see no folds in the strata but the land was uplifted in a mass over a great area, so that the strata appear to the eye to be almost perfectly horizontal as it does until we enter Montana; then, as we go farther and farther westward, we see more and more evidences of elevation and disturbance of the strata until we enter the mountains.

The rocks in the vicinity of Dickinson represent two entirely distinct epochs, which were separated by vast periods of time, but this does not appear on a casual examination. They represent Early and Middle Tertiary. The greater portion of the rocks of this region, and probably of the larger part of western North Dakota, are of Fort Union (Early Tertiary) age, but the "Little Bad-lands," about twelve to sixteen miles southwest of Dickinson, are composed of White River deposits. These will be described later. Probably some of the surface deposits west and northwest of Dickinson are also Lower White River, but this is not yet quite certain.

At Dickinson the altitude is 2,405 feet; at Mandan near the Missouri River it is 1,664 feet; so we are now 741 feet higher than when we were at the latter place. From here the elevation increases rapidly to Fryburg which is 363 feet higher. From near that place there is a rapid descent of 500 feet to the Little Missouri River.

THE LITTLE MISSOURI BAD-LANDS.

In the vicinity of Fryburg, as the train passes through a cut, it is seen that the rock is soft, is arranged in layers, and contains hard concretions. At a little distance, on a flat sparsely covered with sage-brush and grass, are peculiar-looking bare mounds, which resemble stacks of hay. Suddenly again the train dives into a cut, and, with the eye one follows a layer of coal, which seems to glide along for a moment and then suddenly changes from black to red where the coal has been burned and the rock baked to a brick-red color.

We are now entering a region interesting to the traveller and sight-seer as well as to the geologist. There is, perhaps, nothing else just like it. When first seen it seems weird and fantastic, and it impresses one as being the wreck of a former world, or of one not yet organized. But when more perfectly understood there is no place where certain geological processes are more plainly revealed. In the near distance are low, bare, gray mounds standing on grassy flats and red hills, which look as if they had been painted. Farther away there is a wilderness of high hills, long grassy mounds and dome-shaped conical buttes. In other places there are mounds, red, green, and gray, scattered here and there over gray flats. The more level tracts, which run among the hills, sometimes for a moment seem to have their loneliness relieved by the appearance of flocks of sheep; but a more careful examination shows that what were at first supposed to be living animals are only gray bunches of sage-brush. Occasionally by a ravine with sloping sides and soft cut-banks stands a solitary cottonwood. To the southward in the distance is a vast range of gray hills, mounds, and cliffs, apparently without order, reaching to the sky in the blue distance. These are the famous Bad-lands of the Little Missouri River. This peculiar topography is the expression of the erosive forces on rocks, which are nearly horizontal, and which, though mostly soft, have different degrees of hardness and texture, in a region where the grade of the streams is steep. There are no running streams here during most of the year, but heavy rains and melting snows wash the soft bluffs; the milky water collects in streams and rushes downward to the Little Missouri River, which has cut down four hundred feet or more into the plain so dissected by the short side streams of the river that from some points of view the whole region seems a chaos.

On the north side of the railroad, after leaving Sully Springs, we see bluffs, which are nearly continuous, but appear to recede and approach as we pass along. Now they embrace bays of the more nearly level country, and project plainward apparently forming capes, headlands, and peninsulas. The disintegrating forces of the atmosphere, like the waters of the sea, have in some places worn down the ridges, which connect the promontories or buttes with the higher plateau, leaving these hills isolated, like islands near the seashore. Though the prevailing color is gray, some layers are darker, especially the seams of coal, and layer lies on layer apparently undisturbed except by atmospheric agencies. As the train glides along, if one picks out an easily distinguishable layer and tries to follow it with the eye, it appears to dodge in and out along the bluffs, now shooting in a zig-zag manner into the distance, then in the same way approaching, until it suddenly seems almost to strike the observer in the face.

Scattered over the flat at the foot of the bluffs and in nearly every position along their uneven and furrowed slopes are large petrified stumps and sections of trees. In some places these are so numerous that they look like the broken fragments of some hard stratum of rock. This region is called "the petrified forest." When one approaches the bluffs, the stratum or strata, from which these logs and stumps originally came, can be seen with the logs in the position in which they were buried countless millenniums ago. The washing away of the soft strata has left these large fragments in all sorts of positions from this stratum to the foot of the bluff. These silicified logs are almost indestructible, so, as the bluffs slowly recede, the wrecks of this ancient forest are left scattered over the arid plain at a relatively much lower level than that which the luxurious forest once occupied, though it is probably actually many hundreds of feet higher above the level of the sea.

It would be interesting to know what kinds of trees these were, what birds nested and sang in their branches, what other animals made their homes in their trunks and leafy tops and wandered or crawled in their shade, and what beings inhabited the streams, lakes, and marshes in which these layers of sand, mud, and coal were deposited ages ago. Fortunately many of the leaves of the trees have left beautiful impressions on the rocks, and roots of scouring rushes and shells of fresh-water mollusca are preserved in places; so these tell us something of the vegetable and animal life. When these beds shall have been carefully examined over a large area, other interesting things may be brought to light. Some of the names of the trees whose leaves are found here will be given later.

The descent from Sully Springs toward Medora on the Little Missouri River is very rapid. The distance is 8.2 miles and the descent 308 feet. As the beds are nearly level one descends to lower and lower strata.

At Scoria, between Sully Springs and Medora, the coal has been burned out and the clays and sandstones have been baked, making masses of red rock, which has often been broken into fragments and recemented. This "baked rock" at first sight looks much like lava, and was often mistaken for it by early travellers; but volcanic action and volcanic products are entirely absent from this region.

AT MEDORA.

We made a stop at Medora and had an opportunity to examine the rocks more carefully and at closer range. Being anxious to explore the hills, we arose early and walked a short distance to the bluffs just east of the town. Not only did the rocks and bluffs appear strange to us, but some of the living plants were unfamiliar. We noticed several species of Leguminosæ and an evening primrose in bloom. The most conspicuous flower was that of a species of *Mentzelia*. On the flat the sage-brush thrived in places, while on the sides of the bluffs *Rhus trilobata* was the principal shrub.

The beds are usually soft, except where they have been baked; yet there are some harder layers and lenses of flinty texture. The strata consist of soft shales, incoherent dust or dirt, and laminated and thick-layered sandstones. In the shales, sandstones, and even in the lenses of hard compact rock, we found impressions of plants, especially roots of *Equisetum* and leaves of deciduous trees. In one or two places we saw shells of fresh-water mollusca — gasteropods and *Unios*.

Just above Medora the river is quite rapidly cutting and undermining the bluffs on the eastern side. The banks next to the river for fifty or seventy-five feet are steep, and above the steep bank the slope is covered with masses of gray rock, which have tumbled down from above. Some of these blocks are full of the impressions of roots and tubers of *Equisetum*.

Medora stands on an alluvial flat. In places rains and melting snows have cut ravines into the recent deposits of the river bottom. These dirt-beds are either massive, banded, or locally imperfectly stratified. On the west side of the river between the railroad track and the residence built by Marquis de Mores, on a hill overlooking the Little Missouri River, is a deep steep-sided ravine, which has been carved in the alluvial deposits from the river backward to the side of the flat next to the hills. In the steep sides of this ravine, buried in the deposits of the river bottom fifteen or twenty feet below the top of the bank, the skull and bones of a bison were found. In the bottom of the cut near the head of the ravine the Fort Union beds are exposed, and in them are many fossil leaves.

Mr. Raymond and I were intending to make a trip about thirty-five miles or more south of Medora to the Little Missouri Horse Ranch. Mr. Arthur Huidekoper, the owner, had sometime previously requested Mr. Douglas Stewart of the Carnegie Museum to send a man to examine a specimen, which had been found on the ranch. The writer had long wished to search this country for remains of extinct vertebrates, and this, it was thought, would afford a good opportunity. The mail goes from Medora to Sand Creek postoffice at White Butte nearly fifty miles south by road; but we found, that, because the heavier vehicle usually employed was broken, only one of us could ride, since the only conveyance available was a light one-seated buggy. No horses or wagons could be hired at Medora. It was therefore agreed that Mr. Raymond should go on to Glendive, while I went southward.

My trip was one long to be remembered. Some have tried to correct the prevailing idea that the so-called bad lands of the west are designated as "bad" because of their unproductiveness. Some of them are bad in this sense, while others are, in part at least, good lands, especially for grazing. The bad-lands of the little Missouri are emphatically what the French voyageurs termed them, "*mauvaises terres traverser*" (bad lands to travel through); and in this day's ride the fact was being ever more and more thoroughly impressed on my mind; but "bad," in being desert-like, they certainly were not.

The area drained by the stream is long and narrow, and the grades of the short side-branches are steep. When the rains descend the surplus of water from a large area rushes down the short ravines, quickly enters the river, and renders it unfordable. So far as I could learn only one bridge, that of the Northern Pacific Railroad, spans this long river. The stage-road to Sand Creek crosses it ten times, so in times of high water it is necessary to "take to the hills," as we had to do on this trip. It was one of the roughest rides I ever experienced, yet I enjoyed it, and it gave me an opportunity to see the effects of erosion in the region between the river bottom on the one hand and the upland prairie, or plateau, on the other.

The "Bad-lands" appeared at their best. It was the fourth day of August. It had been a wet season, and the tops of the hills, the valleys, and ravines were green wherever anything could grow. The commonest plant was the rich nutritious buffalo-grass (*Bouteloua oligostachya*), now in bloom, which gave a lawn-like finish to every available spot. Though a dwarf grass, it was tall enough in some places to be cut for hay; in fact it is sometimes cut for that purpose on the prairies. Among the white or gray iron-stained buttes and along the ravines were thickets of ash, box-elder, plum, choke-cherry, and buffalo-berry, and in some places a few elms. On the edges of the thickets and on the grassy plots the scarlet horse-mint (*Monarda didyma*), with its bright, showy flowers, was in bloom, and the wild sunflower grew on the slopes. There were many species of Compositæ, a *Solanum*, and other flowers. Over the thickets of low bushes and smaller trees the white-flowered *Clematis* trailed, and an occasional hop scented the air with its wholesome odor. There are a hundred cozy nooks and picturesque miniature woodlands quietly reposing among the many-tinted hills. It is a land difficult to picture to one who has not seen it, so varied are the details of its topographic forms, so diverse its coloring; only the camera can show the former and the skillful brush of the painter the latter.

After we left the river and started through the hills the road, if it can be called a road, is one which requires a thorough knowledge of the region and experience as a horseman to traverse without mishap. Sometimes for a little distance there is an old wagon-road, or a dim trail to follow, but suddenly it "plays out" on a grassy slope by some precipitous ravine, or on a steep declivity, and one turns one way and another to see where to go in order to avoid a mishap. One must have the eye of a mechanic or a topographer to tell where to drive around a steep slope without upsetting the wagon. Now the wagon descends into a narrow ravine where one is almost above the horses, but is saved from falling on them by a sudden reversal of the relative positions of horses and wagon; and before one has time to fall out behind, the wagon is again on more level ground. Where there is a piece of road that is reasonably level and the buggy is not liable to upset, we go tearing along at a high rate of speed. Now we ascend and twist and turn, until at last we find ourselves on a grassy divide between two compound ravines, where we can gaze far over the surrounding country, a wilderness of bluffs separated by grassy valleys, or wooded ravines. We try in vain to tell whence we came, or whither we are going. To the westward we get views of the main valley of the river, with its apparently flat bottom lying between steep slopes and perpendicular bluffs. This river valley is a pretty sight, whether one travels along its course, or catches glimpses of it through the openings among the maze of hills. In places along the course of the stream there are large cottonwoods, sometimes forming groves, and sometimes scattered out on grassy lawns, thus forming pleasant parks. In other places there are thickets of ash, choke-cherry, and other trees, fringed with shrubbery, often draped with *Clematis* and bordered by weeds, grasses, and flowers. In such a place until recently stood the cabin, once occupied by the man, who is now the President of the United States, Theodore Roosevelt. The ranchers in the vicinity are proud to have known him, glad to have a President who has been among them and known the west as well as the east, and delighted to see a man in the presidential chair who gets things done. We afterward passed by the site of the cabin, in which he had lived, but which had been removed to the Portland Exposition.

From our elevated position we again descend into the ravines among the hills, following a road which leads to the river. We stop at the cabin of an old trapper, Mr. Lebo, near the bank of the stream, and partake of a dinner served in the good old style of a frontier bachelor. We change horses and again start southward, going across a flat, and ascend a little narrow wooded ravine, which winds among the hills. Previous to this we had seen some cedar trees on the steep bluffs, but here for the first time the hills are dotted with pine trees, and their northern limit is marked by a long ravine, which comes from the eastward and opens on the river valley at the ranch of Mr. Lebo. Soon we are on high grassy hills away from the river, which here comes from the westward and then suddenly turns to the northward. The road is now more level, as we are leaving the narrow steep ravines and abrupt slopes. To use a common expression, we are "getting out of the breaks." From here to Sand Creek postoffice the road is partly on the higher ground and partly in the valley of Sand Creek, a stream which rises in White, or Chalk, Butte and flows northward through a comparatively shallow valley with grassy hills and occasional cut-banks on either side to the Little Missouri River.

Leaving the stage here, I walked westward to what is called "The Logging Camp" (a part of the Little Missouri Horse Ranch), which is located on the river. The house stands near the bank of the stream and above are bluffs with baked rock, red and yellow in color, which contains many fossil leaves, and people sometimes go there to gather them. I went northward from the house to see Mr. Hanson, the overseer, and thus had an opportunity to observe an interesting phenomenon of erosion. The river here makes two ox-bow curves something like a letter S (Plate XV). As I was standing on a hill near the middle of the open part of one of the bows or curves and looking northward, I saw that the hill decreased in height to the northward and that the lower hill merged into a ridge which extended straight northward in the middle of the curve becoming gradually lower and lower until it finally became faint and died out a little before it reached the middle of the inner bend of the river. On each side of the ridge the land was nearly flat, but sloped very gently eastward and westward to the river. North of the river on the outer side of the curve was a crescent of exceptionally high bluffs, which forms a conspicuous landmark. Looking at the other ox-bow to the westward, the other portion of the compound curve, it was seen that the central ridge, diminishing in height towards the river, was like the one first observed. The first one mentioned was between one and two miles in length. Apparently these two great bends of the river had remained for a long time in approximately the same position. After the river ceased to lower its bed it slowly eroded the outer curves, and the rains gradually and evenly washed down the high tongues of the bluffs inside of the oblong curves. When the texture of the rock or soil is soft, porous, and nearly uniform, and the surface is being lowered by atmospheric agencies, the slopes are nearly uniform. River bottoms slope toward the rivers, benches slope toward the river bottoms, and plateaus slope from the middle outward. The present example shows most beautifully how the high benches have been reduced to buttes, hills, and ridges, which gradually die out into a nearly level plain.

I inferred that probably, through a large part of the deepening of the cañon, the curves of the river held approximately the same position which they now hold; yet scattered over the hills at my feet there was river gravel, showing that at some former time a river, perhaps the Little Missouri when at a much higher level, had flowed in a different course.

A part of the eastern portion of the flat had been plowed and seeded as an experiment, and Mr. Hanson was cutting oats for fodder. As yet very little farming has been done along the Little Missouri River, though one man, who has a ranch on the river-bottom south of Medora, has for several years raised oats, alfalfa, and millet. Part of the crops, when I saw them, were extremely large. This has encouraged others, and though this has been a country given over exclusively to stock-raising, it is now being rapidly settled and the government land on the upland taken as homesteads.

Upper Figure. An Ox-bow in the Little Missouri River. "Logging Camp" H.T. Ranch About Forty Miles above Medora in North Dakota. Looking South.

Lower Figure. H. T. Horse Ranch. In the Distance Hills Composed of Fort Union Beds.

The next morning Mr. Hanson loaned me a horse and saddle, and I started for the "Home Ranch" about seven miles to the southward. After ascending a narrow ravine which winds between the bluffs, I came to a rolling grassy prairie, which, in some places interrupted by buttes, stretches away to the southern and eastern horizons. To the southwest the rough land continues up the Little Missouri River. The prevailing vegetation on the upland is buffalo-grass, now in bloom, small greenish-gray prairie-sage, and other dwarf plants, among which are golden-rod and other compositæ. To the southward is what appears to be a slight depression, and beyond this, about ten miles distant, a large high butte, or mesa, which contains strata higher than those which we have previously observed. This is variously called H. T. Butte and Black Butte. Farther to the eastward, across the valley of Sand Creek, looking more like a range of hills, is White Butte.

The Little Missouri Home Ranch (Plate XV) is located in the valley of a little stream. The buildings have the appearance of a little village in the midst of a great wilderness. For miles there are no other habitations, yet here are many of the real comforts of the city, with few of its discomforts. There are dwellings, storerooms, shops, an eating-house, a spring-house, and other buildings. Here I was treated with true western hospitality, and was freely furnished everything available for the exploration of the region. Mr. Earl Huidekoper was absent when I arrived at the ranch, but when he returned, though it was a busy time and all were at work preparing for the round-up, he showed me every possible kindness and courtesy.

The valley, in which the ranch-houses are located, varies in width from about sixty to one hundred and forty rods. Through this little valley in its narrow channel between cut-banks, winds a small stream, along which are shrubbery and small ash, elder, and choke-cherry trees. Over these climb vines of the hop (*Humulus lupulus*), wild cucumber (*Echinocystis lobatum*), virgin's bower (*Clematis ligusticifolia*), and climbing polygonum (*Polygonum dumetorum ?* var. *scandens*).

The next day after our arrival, August 6, I rode over to Black Butte (Plate XVI). Near the road there is a quite high hill, at the foot of which there is a sluggish stream. On the side of this hill the fossil shell of a *Unio* was found. On the top the rock had been changed by the burning of a seam of coal, to various shades of blue, brown, and pink. Some of the rock is sugary in texture, and some hard as flint. The latter contains leaves of conifers (*Sequoia*) and deciduous trees.

Near the base of Black Butte are rather soft shales and one very thick seam of lignite. Higher up there are sands and soft clays of a brownish color. Still higher is a series of light gray sandy clays, containing brown iron-stained concretions. Near the top is a thick heavy layer of hard sandstone. As before stated, the strata of Black Butte belong to a higher level than those of the bad-lands along the Little Missouri River.

I did not measure the height of Black Butte, but I judge that it is about three hundred to four hundred feet higher than the surrounding plain. On the west side of the butte land-slides have occurred, and huge blocks of the hard sandstone, which caps the butte, have tumbled down from the cliffs, and are heaped on the terraces and scattered on the slopes in great confusion. Vegetation grows luxuriantly between the rocks. There are clumps and groves of the quaking aspen (*Populus tremuloides*), a tree not very common in this region.

From the top of this butte on a clear day a vast tract of country can be seen, extending forty miles or more in nearly every direction. Beginning about twelve or fourteen miles to the northward are the bad-lands of the Little Missouri River, the gray cliffs and slopes of which appear to be higher than the position of the spectator; but this is true in appearance only. On the west side of the Little Missouri River, overlooking the bad-lands, stands Bullion Butte, and in the further distance Sentinel Butte, which lies south of the railroad station of that name. To the westward is a peculiar prairie with lines of rounded hills, hogbacks, and ridges, and projecting above them, one lone butte, which on account of its form is called "Round Top." When the sun is low and the hills cast their deepest shadows, these elevations seem like the great waves of some mighty ocean, dwindling into faint ridges on the verge of the horizon. Toward the southwest are the Twin Buttes, two elevations which are nearly alike in form and size. Southeastward the prairie is more nearly level, but in several places long lines of flat hills (mesas) can be seen. Far away on the horizon are the Cave Hills. To the eastward across the valley of Sand Creek is a range of hills and bluffs called White Butte. Portions of this elevation are nearly bare and are light gray, weathering into bad-land forms. North of east beyond White Butte are the two Rainy Buttes. Nearly all the buttes which can be seen, except White Butte, seemed to have the same general appearance and structure as the one on which I was standing; and they are undoubtedly similar in origin. They are the scattered monuments, left by erosion, of an ancient plain, the surface of which was once higher than are the highest hill-tops at the present time.

On the north side of the Black Butte are good exposures showing the rocks of which it is composed. Near the base are shales, usually laminated, containing in many places large brown concretions, which break into angular fragments. Above these is a seam of lignite twenty feet or more in thickness. In the soft shaly clay above this seam are many dark impressions of plants. These shales, which are gray, continue upward eighty or ninety feet. They are usually laminated and soft, but some layers are a little harder, while others are very sandy and incoherent. One layer, sixty or seventy feet above the seam of lignite, is crowded with fossil ferns and leaves of deciduous trees, the lower portion being almost entirely made up of them. These were determined by Dr. Frank H. Knowlton, of the United States Geological Survey, and were found to consist of ferns (*Asplenium*), scouring rushes (*Equisetum*), poplars (*Populus*), arborvitæ (*Thuja*), bitter-sweet (*Celastrus*), and others.

Above the shales are beds which contain more sand, and there are some layers of sandstone; still higher, there are strata, about one hundred or one hundred and twenty-five feet in thickness, of sand and clay, mostly gray or white in color, and containing brown concretionary layers. These beds are not so distinctly laminated as those below. Some distance above these beds is a considerable thickness of brownish sandstone of a sugary texture. The sandstone, forming the top or "rim" of the butte, is thick, and often quite massive. It is this which protects the softer strata beneath, preserving the butte and giving it its characteristic form. The top of the butte is not so flat as it appears from the sides, but is more or less grooved by ravines.

Some of the plants which were noticed on Black Butte were ash (*Fraxinus viridis*), thorn apple (*Cratægus*), birch (*Betula*), and aspen (*Populus tremuloides*). Near it were ash (*Fraxinus viridis*), choke-cherry (*Prunus virginiana*) kinnikinnick (*Cornus ammonum ?*), wolfberry (*Symphoricarpos occidentalis ?*), rose, sage (*Artemisia*), wild sunflower, golden-rod, etc. Among the birds were grouse, brown thrushes, king-birds, and various species of sparrows and hawks.

I regret that there was not time to make a more careful study of the beds exposed here, and to obtain detailed sections with accurate measurements. Though there are vast exposures of lower beds, the higher ones appear only in the butte. I was somewhat disappointed in not finding in this whole series of beds any bones or teeth, which would settle beyond dispute the question of the age of the formation. I do not know that any one has denied that they are Fort Union, but many have regarded the Fort Union, Great Lignite, and Laramie as one formation; others have maintained the Fort Union to be only a division, or local phase, of the Laramie; while still others believe the Laramie and Fort Union to be distinct formations, the latter of considerably later age than the former. Some of the bones, which had been found on the Little Missouri Horse Ranch, had been sent to the Smithsonian Institution, and they proved to be the bones of a bison, probably an extinct species.

From what had been seen and heard it was suspected that the White Butte might represent a different formation from Black Butte. On the seventh day of August I went to examine the former. On my way I stopped at the house of Mr. T. F. Roberts, which is west of the northern portion of the butte on the stage road from Medora to Sand Creek postoffice. Looking southward from Mr. Robert's house, the valley of Sand Creek appears as an undulating prairie-land, bounded on the east by White Butte. On the west the valley is continuous with the vast rolling prairie, which opens out to the westward; but on the south, narrowing and sloping gently upward, it extends between the rudely conical, dome- and hog-back-shaped outliers of Black Butte on the right, and White Butte on the left. The greatest extent of Black Butte is nearly east and west, while that of White Butte is east of south and west of north. In some places the gray banks of the lignite beds are seen along Sand Creek, which has only a small surface flow of water in dry weather. This stream issues from near the south end of White Butte dissecting its western ridge. Partly on account of the slope of the valley to the northward, the western ridge of White Butte (Plate XVI) appears to decrease in height to the southward and merge into the grassy plain. It is not flat on top, but is irregular in outline, with low rounded prominences which are almost white. These upper white beds terminate near the northern portion of the butte east of the Robert's Ranch. Just north of this are lower flat-topped mounds. Extending northward from these are lower benches and mounds, and still farther north a large mound with a conical peak.

Upper Figure. Black Butte, Billings County, North Dakota. Looking South.

Lower Figure. White Butte, Billings County, North Dakota. Looking from the T. F. Roberts Ranch. Sand Creek is to the Right. (Photographed by Mrs. T. F. Roberts.)

Beyond these lie dome shaped hills which have not yet been reduced to the level of the prairie.

The reason why White Butte has a different appearance from the surrounding buttes, was very apparent on closer examination. On ascending the butte, the first rock examined was brownish gray sandstone. In places this contains impressions of leaves. Still higher is a layer of sandstone which has a foliate, and, in some places, a concentric structure. Above this, perhaps one hundred and fifty feet in thickness, are beds of clay and sand, the greater portion of which are almost white. In places these deposits contain much gravel. Where the fine and coarse materials are mixed and show cross-bedding, it strongly suggests a delta deposit. The principal portion of the deposit is gray and white, the pebbles are of different colors, brown prevailing. Though the color of this deposit, its texture, and the material of which it is composed are different from that which prevails in the Fort Union formation, yet I thought possibly that this formation might be the same as the gray beds which are exposed beneath the sandstone cap at Black Butte, though much thickened. But, when the vertebræ of a large mammal were found, it was apparent that the formation did not belong to the Fort Union. Later investigation showed that it is undoubtedly Lower White River. The locality is interesting, as the Tertiary is in contact with the lignite. The fact that the northern end of White Butte is composed of two formations, explains the difference which had been observed between the base and the top of the butte; the former is Lower Tertiary (Fort Union), and the latter Later Tertiary (White River). The deposits were therefore made at widely separated intervals of time, and probably under very different circumstances. In the lower portion of the White River beds there are sandstones, hard in places, which weather into irregular forms. There are also many brown ironstone concretions. The steep slopes are difficult to travel over, as, when dry, the clay hardens and the silicious sand and pebbles make the footing insecure. In places a white soapy clay has been washed out of the beds into the little gullies or ravines and has been covered with white sand. The clay holds the water and remains soft underneath. If a heavy animal, like a horse, steps on one of these places, even though there may be a dry sand-bar or gravel-bar on top, he is apt to sink in up to the body. By digging through the flat sand-bars in these little water-courses one gets water which is sweet and refreshing, and, so far as my experience goes, it does not produce any ill effects ; even the fine white sediment I did not find particularly disagreeable. The water of a spring from the top of the Fort Union beds, a little farther to the south on White Butte, was dark with alkali.

The next day Harry, the son of Mr. Roberts, and I went southward from Mr. Roberts' house about two and one half or three miles, and ascended a branch of Sand Creek which comes from the eastward, cutting through the western ridge of White Butte. The rocks along the bottom of the ravine are the gray sandstones, shales, and lignites of the Fort Union beds. These outcrop at several places on the western base of the butte. Though the lower portion of the ravine is in the Lower Tertiary, yet all along, the Later Tertiary beds appear, capping the hills or ridges. On top and part way down the sides the butte has a peculiar broken appearance. Blocks of sandstone are scattered over the surface, making it look as if ice or snow had been concerned in forming its peculiar topography. Perhaps part of this appearance is due to landslides. The slope on the south side of the ravine is thickly covered with brush, small timber, and other vegetation, well up toward the top of the butte. Near the head of the cañon, where it enters the ridge from the east, is the contact between the Fort Union and Oligocene formations. A little below the contact is a spring, the waters of which are dark, because of the presence of alkali. Apparently the spring issues from a bed of coal.

Starting from about half a mile to the east of the head of this ravine, and separated from the main ridge of the butte by grassy hills, a range of higher denuded hills (Plate XVII) or small buttes extends two or three miles to the southeastward. Between these hills and the main ridge, is an uneven grassy country, dissected by ravines and gullies, where the branches of Sand Creek unite before passing through the ravines in the western portion of the butte (Plate XXI). The eastern hills consist of four or five sub-pyramidal mounds, with broad white bases extending out in lobes and angles in every direction, and with ridges connecting the higher elevations. There are also some small outliers of the white material. These lower beds are the same as those on the top of the main butte, though in the latter place they have the appearance of reaching a greater elevation. Above the white beds there are slopes or escarpments of a creamy color, and above these are sandy beds weathering into slopes, which are interrupted by abrupt scarps of sandstone.

Upper Figure. Part of Eastern Portion of White Butte, looking Eastward. The Lower, Middle, and Upper White River Beds are here Exposed.

Lower Figure. Four Miles North of White Butte, near H. T. Road, Showing the Beginning of Ravines which Lead to the Little Missouri River. (Photographed by Mrs. T. F. Roberts.)

This region is a miniature bad-land; yet where the deposits are not washed bare, especially on the northern faces and more gentle slopes, there is a thick growth of trees, shrubs, grasses, and other vegetation. The grass is thick and heavy at the alluvial bases of these hills. The place appeared favorable for the discovery of vertebrate fossils, so it was hoped that at least enough bones might be found to fix beyond doubt the age of the deposits. The lower beds were so similar to the Lower Oligocene in other places, that there seemed little doubt that they belonged to the Titanotherium horizon, but we searched in vain for fossils. In the cream-colored beds above, which weather into cliffs or steep slopes, and contain many brown porous or cellular nodules, we found bones and teeth of various animals such as *Eumys* (a mouse), *Ischyromys*, *Gymnoptychus*, *Palæolagus* (an ancient rabbit), *Mesohippus* (a small horse), *Aceratherium* (a rhinoceros), *Merycoidodon*, *Leptomeryx*, etc., besides the shells of land turtles. The fossils show plainly that these are the Middle White River, or Oreodon beds. In the green sandy beds were many bones of the rhinoceros *Aceratherium tridactylum*.

From the top of one of the smaller buttes, as from the top of White Butte, one gets a good view of the surrounding country, and the following events in its geological history seem plainly carved on the landscape, and recorded in the rocks beneath our feet:

(1) At some time, after the deposition of the Fort Union beds, there was an increase in the grade of the streams, which in later Eocene times carved broad valleys in the strata. (2) In early Oligocene times by the partial obstruction of the drainage deposits were made in these old Eocene valleys. Probably at times there were quite large lakes and marshes. (3) There were many changes during the Oligocene, and there were apparently several stages of deposition and erosion. At several different intervals during the long period conditions were favorable in some places for the preservation of the remains of the turtles and mammals, which now lie at successive levels in the beds of White Butte. The reasons for believing that the White River (Oligocene) deposits were made in a river valley in the Eocene strata, is the fact (*a*) that they are evidently, at least in part, deposits made by streams, and in lakes and marshes. (*b*) Some of the strata apparently lie at the same level as Early Tertiary (Fort Union) strata in Black Butte. After the deposition of the White River series of strata, the beds of this age and those of the Eocene were raised together, and

a long period of erosion has reduced the greater portion of the surface to a lower level, leaving isolated buttes both of Early Tertiary and Oligocene age.[1] (4) Later the Little Missouri River has cut deeper into the strata and is now beginning to broaden its valley. If other neighboring streams were doing the same work that the Little Missouri is doing, the whole region might after a vast lapse of time be reduced to a plain on the same level as the bottom of its valley, three hundred feet or more below the present plain and six hundred feet or more below the ancient level.

The buttes are now, as they have been for ages in the past, undergoing disintegration and reduction in size. We see them now in all stages. Some are large with approximately flat tops and sides scored by ravines. Some of these ravines have worked backward until the capping-rock is dissected. In other places this rock has been worn away and has left the softer portions as isolated conical buttes, which year by year by the action of the winds and rains are vanishing away. Of the conical mounds we can see every stage, from high symmetrical buttes, through smaller, lower elevations, to low mounds or hills, which are fading away into the great plain.

During this trip I did not collect many fossils, as the time was limited, but returned to Medora by stage, and went to Dickinson by rail. Here I employed a man and team to take me to the Little Badlands (not the Little Missouri Bad-lands). From the accounts of Mr. and Mrs. T. F. Roberts and others it seemed probable that these were also composed of White River deposits. This proved to be the case, and they were found to be more fossiliferous than the beds at White Butte. In November, when returning from the trip into Idaho and Montana, I made my headquartes at Mr. Roberts' ranch while collecting at White Butte and vicinity; I then went to the Little Badlands for two weeks and made a considerable collection of fossil mammals.

Trip from White Butte to Dickinson in November.

The "H. T. Road," over which I traveled from Mr. Roberts' ranch to the Little Bad-lands, keeps outside the "breaks" of the Little Missouri River and on the undulating prairie. There are no very

[1] Dr. A. G. Leonard has written me that the Oligocene at White Butte rests on a massive sandstone, which is undoubtedly the same as that capping Black Butte, and that the sandstone at the latter butte dips sufficiently to carry it under the Oligocene at White Butte.

steep grades, but the road passes over low ridges and broad flats. The underlying rocks are Fort Union. They are mostly soft, but in places there are strata or lenses of sandstone. These on the removal of the softer rock break into blocks and remain on the surface. So different are these blocks from most of the rock of the region, that people wonder "how they get there." There are not many of these on the road to Dickinson, but on the road to Belfield, which branches off from the "H. T. Road" and takes a more northerly direction nearer the Little Missouri River, there is much of this sandstone, which in some places forms quite thick beds.

In all this distance of about forty miles from White Butte to the Little Bad-lands, I do not remember seeing more than two trees and they were far away by a small coulée. When I first drove over the road, it was the twelfth of November. It was a delightfully warm autumn day, and the ride was pleasant; yet, besides one coyote, I did not see anything animate — not even a bird or an insect. The coyote stepped a little to one side of the road as I passed, opened his mouth, ran out his tongue, and seemed to smile. He followed me for a mile or two, seeming by every act to say: "I would like to be your dog, if you fellows hadn't such a grudge against us; but anyway I know you haven't a gun now, so I am all right."

I looked carefully all along the road for signs of Oligocene deposits, but found nothing until I approached my destination. Much of the land on account of the removal of the soil is a kind of "gumbo," which is not favorable for farming purposes or exceptionally good for grazing land. In many localities, where no vegetation grows, little dark or black ironstone pebbles and fragments of petrified wood are scattered over the ground. Many of the fragments of fossil wood have a gnarled appearance, and are turned to a very hard substance much like flint.

In one place, just to the west of the road, a few miles north of White Butte, are very rough bad-lands, the beginning of the "breaks" of the Little Missouri (Plate XVII). On my return I stopped at the place, examined the strata, and made a collection of fossil plants and fresh-water mollusca. Among the plants were hickory (*Hickoria*), poplar (*Populus*) and elm (*Ulmus*). The beds, as is usually the case in the Fort Union, are composed of clay, lignite, sandy clay, and sandstone. In the beds are many brown concretions. Shells are not numerous and are usually too frail for preservation as specimens. The best of these (*Unios* and gasteropods) appeared to be in a lens or pocket. In one place near the bottom of the exposure is a seam of coal (about five feet in thickness), which is evidently superior to any I had seen in this region. It does not readily disintegrate, being hard on the weathered surface, is tough, and does not appear to contain much ash but is composed principally of pure wood turned to coal.

On approaching the vicinity of the Little Bad-lands the character of the soil is seen to change. Scattered over the prairie are many flat fragments of flinty rock, which contain impressions of rush-like plants. On a ranch, where I spent the night, the walls of a long stable and cow-shed are built of this rock, clay being used for mortar. The soil is better here, and for the first time since leaving Mr. Roberts' ranch I was near an inhabited dwelling. Here there are buttes, but they are not flat-topped mesas like Black Butte and the Rainy Buttes, which I had passed at a distance. They are in part at least of White River age.

The next day, having secured a comfortable place for myself and horse, I began collecting in the Little Bad-lands, being careful to keep distinct the fossils from the different levels. A section of the beds is given in the geological report. As at the White Butte, there are here three divisions: the lower gray beds, the middle nodular beds, and the upper beds consisting of sandstones and clays; but there are local differences. The middle beds belong to the "Oreodon" horizon, as is proven by an abundance of fossils. The deposits are quite different from those of the Fort Union. Mr. and Mrs. Roberts had noticed this difference, and it was their account of the region which induced me to visit it. The exposures of the middle and upper beds are limited, but the lower beds, which probably belong to the Titanotherium horizon, cover a quite extensive area both east and north of the Little Bad-lands. A very prominent range of hills, about five or six miles to the eastward, has the same topography and color as the White River, but I did not have time to visit it. A large portion of the road to Dickinson passes over rock of somewhat varying lithological characters, different from the Fort Union beds, but very much resembling Lower White River deposits in Montana. These deposits appear to extend through the country west and north of Dickinson.

On the Heart River, about a mile from Dickinson, is a hill where the Dickinson Pressed Brick and Fire Clay Company get the clay for its fine brick. The beds of clay are not like anything I had observed in the Fort Union deposits, nor are they exactly like the usual character of the Lower White River beds, yet I believed it to be Lower Oligocene. I procured a small collection of leaves here, among which Professor Knowlton found species of *Populus* and *Credneria* (?), and some small leaves, unknown to him, which are probably new. In a letter to me he wrote that the species found near Dickinson "thought to be of Oligocene age are Fort Union species, but it should be added that we do not know as yet a typical Oligocene flora from this country, and it may be necessary to revise the upper extension of the Fort Union." Professor A. G. Leonard, in the third biennial report of the North Dakota Geological Survey (pages 160 and 161), gives a section at this place.

Near the road between Dickinson and the Little Bad-lands are very soft beds in which there are strata of peculiar looking sandstone, forming ledges and flat-topped hills. Broken fragments of the sandstone are scattered over the surrounding country. Deposits of nearly the same character occur in the Lower White River beds of Montana.

The Little Bad-lands.

The Little Bad-lands is a strip of Tertiary exposure in a line of bluffs, terraces, flats, and bare hills, three or four miles in length, extending irregularly in a northeasterly and southwesterly direction about twelve or sixteen miles southwest of Dickinson. It is drained by a branch of the Heart River, which flows northward. East of it are grassy hills or mounds, between which are broad grassy flats. Some of the hills are comparatively high for this region. West of the bad-lands is a rolling grassy prairie. The bluffs or escarpment which form the eastern border are highest (125 feet or more in height) near the northern or northeastern portion, and they decrease in elevation to the southwestward where they merge into the plain. The face of the higher, northern portion of the bluffs does not rise in an abrupt manner from the adjoining flat land, but in peculiar terraces formed by landslides. The bluffs are composed of the Lower White River at the base, the Middle White River higher up, and what is probably Upper White River at the top. Along the foot of the steeper portion of the bluffs is a trough or depression, extending nearly the full length of the higher portion of the escarpment. This is caused by the breaking away and sliding down of large masses of strata. On the southeastern side of the depression are the cliffs, from which the large masses have been broken, and on the northwest side are the masses themselves, standing lower than the cliffs on the opposite side. The depression is thickly covered with grass, shrubs, small trees, and other vegetation. On account of the scarcity of timber here, the heaviest of it has been taken away. The trees are principally elm and ash. Outside the terrace is a belt where the nodular (Oreodon) and upper beds have literally "slidden all over" the lower beds, and the blocks and large and small masses of the former lie at nearly all angles on the latter. At first the strata have the appearance of having been greatly disturbed by orogenic movements. The dislocated masses are thickest near the bluffs, but remains of the pink nodular strata are found at a considerable distance out on the flat. In one place there is a butte, which lies at a considerable distance from the bluffs, and at a lower level than the corresponding beds in the bluffs. It is seventy feet or more in height, composed of strata of the Oreodon beds and overlying shales, which are horizontal in position. This may be in its original position, as it is difficult to see how it could have moved to this place and still retained its normal horizontal position on the lower beds. As one goes farther from the bluffs all traces of the middle beds gradually cease and only the lower beds appear. The latter form a flat, which in some places is cut by gullies, while other portions are interrupted by peculiar mounds with rounded tops and abrupt sides. Sometimes in the fading light these suggest huge mammoth-like creatures feeding on the distant plain. There are some indications that the Oreodon beds are not exactly comformable with the Titanotherium beds, but that the former sometimes occupy slight depressions in the latter; but this was not determined with certainty. In one or two places the strata appear to have a true dip. In an exposure on the north side of the Little Bad-lands the lower nodular layers of the Oreodon beds incline toward the east.

The Lower White River (*Titanotherium*) *Beds.* — The lowest exposure of the Titanotherium beds are gray sand and clay. A little higher they are more sandy and often have a peculiar cross-bedded appearance, caused by the fact that the coarser material is arranged obliquely. This condition, which suggests delta-deposits, appears in the sides of the hog-backs or dome-shaped mounds with nearly perpendicular sides, which stand on the bare flat areas. In the lower part of these beds are dark iron-stained concretions, many stream-worn quartzyte and granite pebbles, and occasional fragments of bones.

Some scutes of crocodiles were found. Toward the top the beds become less sandy and contain more clay and fine-grained "silicified rock."

The Middle White River (Oreodon) Beds. — The Oreodon beds are somewhat thicker than at White Butte, and are a little different in minor details. The color is greenish on fresh exposure, but the mass of the deposits weathers to a light buff and the nodules to a chocolate-brown. Both contain darker irregular fragments scattered through the mass. These weather out at the surface of the harder nodules and give to the latter a cellular appearance. In the lower portion of the beds are many bones, teeth, and skulls of extinct animals — insectivores, rabbits, mice, horses, rhinoceroses, merycoidodonts (oreodonts), etc. There are also turtles and a few bones of mammals near the top.

The Upper Beds. — Above the nodular beds are clays and sandstones, which in part resemble the upper beds at White Butte, and they are undoubtedly of nearly the same age. The clays contain remains of three-toed horses, merycoidodonts with large ear-capsules, lizards, turtles, etc.; and in the sandstone part of the skull of a rhinoceros (*Aceratherium*) was found.

FROM MEDORA, NORTH DAKOTA, TO GLENDIVE, MONTANA.

As we proceed on our way westward from Medora on the Northern Pacific Railroad, we ascend a branch of the Little Missouri River. It is a small winding stream, which has made cut-banks in modern alluvial deposits and in Fort Union strata. The sage-brush flats, through which it flows, are shut in on either side by hills and bluffs one hundred feet or more in height. As the road rapidly ascends, the valley becomes broadly V-shaped, the hills are relatively lower and more grassy, and are scored by shallow depressions called "buffalo-wallows." The cut-banks and other exposures of the strata become less and less numerous. Soon we are on the high rolling prairie on which are large buttes. In some of these buttes are exposed the rocks of which they are composed.

Sentinel Butte is a conspicuous landmark, which lies to the southward of the station of that name. Like Black Butte it is a remnant of higher strata, the greater portions of which have been removed by erosion. Seams of coal are still seen in the exposures of the rocks along the railroad. The general surface of the country consists of smooth, gentle slopes, which are pleasing and restful to the eye. There are some fields of grain, and, though the grass is short, large areas are mown for hay. As we proceed westward the country has much the same appearance for a long distance. The ditches and railroad cuts show no change in the strata. The houses are small and far apart, and there is an occasional "hay-corral," or a small house built on a wagon, the summer residence of a sheep-herder. The grass, when we passed through the country in August, was shorter than in the bad-lands of the Little Missouri, and deader and browner. This is the divide between the valleys of the Little Missouri River and Beaver Creek.

Near Wibaux on Beaver Creek there are gray bluffs and cottonwoods along the stream. In the distance through the broad valley to the southeastward a hilly country is seen. The rounded hills appear as if standing on a level plain. A little farther west there are exposures of rocks, which are stained with iron. Still farther are exposures of ripple-marked sandstones. Soon we again enter a rougher country. The rocks are still mostly gray and of a soft texture, nearly like those of the Little Missouri Bad-lands, but there are darker slabs of sandstone. At Hodges there still are mounds, which are red from the burning of coal, and some of the rocks on the tops of the hills have a dark, rough, and rugged appearance.

Soon we are in bad-lands again for the first time since leaving the Little Missouri River; but the rock is darker than in that region. The hills are not so high, but on the whole they are more barren than those of the bad-lands of the Little Missouri. They have a more weird, somber, and desolate appearance; though, when I saw them on this occasion, the bright sun was shining on them from a clear western sky. There are no high buttes, but some conical mounds project a little higher than the rest. The railroad follows the flat of a perennial stream, which winds its way among steep cut-banks of alluvial deposits. Occasionally the low bluffs on either side of the stream part a little, and the green of the flat winds and breaks among them, growing smaller in the distance until its branches are lost among the maze of bar en hills. The whole region has a strangely unfamiliar aspect and seems foreign to man and his works. Everything suggests an age that has long passed away. The strata, like nearly all those we have seen in our western journey thus far, are almost perfectly horizontal. In one or two places we cross the little stream, the bed of which is several rods in breadth. The deposits along the stream are as characteristic as the formation through which it passes. In its bed is sand, corrugated by the rushing water after the rains. There are reaches of angular gravel, flat bars of brown pebbles, and gray sandy levels which show the sweep of the temporary rushing current. In places there are a few cottonwood trees projecting from the bed of the stream above the cut-banks. Suddenly, as the train moves swiftly along, the hills recede to a distance, leaving a great flat, through which the stream, lined with cottonwood trees, winds its way to the Yellowstone River.

In descending from the high prairie toward the Yellowstone River, as the strata wherever seen are horizontal, it is naturally inferred that we have been descending to lower geological levels, and that the dark beds near Glendive underlie the light gray ones in the vicinity of the Little Missouri River. Glendive is about six hundred and forty feet lower than Sentinel Butte and about two hundred feet lower than Medora, which is in the bottom of the Little Missouri valley.

FROM GLENDIVE TO COLUMBUS, MONTANA.

From Glendive, Montana, to Livingstone, a distance of three hundred and forty-one miles, the railroad is in the valley of the Yellowstone River. A little distance west of Glendive, beds of nearly white sand underlie darker beds, which contain brown layers and brown concretions. There is a sharp line of contact between the two. There appears to be a slight unconformity, but this may be only apparent. At Colgate the lower beds are darker in places. Soon the rocks are seen dipping to the westward at an angle of twenty or thirty degrees, and again they are horizontal. Then, for some distance, there is not much exposure of the rocks, as the bluffs have dwindled to grassy hills; but where there are exposures they are again gray in color. Evidently we have been crossing a region where there has been a considerable disturbance of the strata, and rocks of Upper Cretaceous age (Fox Hill or Fort Pierre) have come to the surface.

It would be interesting to study these rocks in detail, as here for the first time in our western journey do we see much disturbance of the rocky strata, and for the first time since leaving Minnesota are there any considerable exposures of rocks older than the Tertiary.

The geology of the eastern portion of Montana is very imperfectly known. The country is a high plain, drained principally by the Missouri and Yellowstone rivers and their tributaries. The rocks of the

Early Tertiary and several of the horizons of the Upper Cretaceous are exposed, but the exact limits of the exposures are in all cases unknown. Some itinerary work has been done, and expeditions in search of fossils have crossed it at various places. In the northern portion of the state the exposures along the Milk River are principally of Judith River age. At Haver these beds are well exposed, and they have been traced by Hatcher and Stanton northward into the British possessions. In the eastern portion of the state the Fort Union beds undoubtedly cover an extensive territory. Farther west Mr. W. H. Utterback, while searching for extinct reptiles for the Carnegie Museum, so he has told me, orally, has traced extensive deposits of the Laramie (Ceratops) horizon. Mr. Barnum Brown of the American Museum of Natural History, has recently published a paper on "The Hell Creek Beds of the Upper Cretaceous of Montana," which is of much interest in connection with the study of the geology of this region.

This vast territory is an elevated plain, which has not only been subject to elevation in mass, but minor dislocations of the strata have occurred. These upheavals, aided by atmospheric agencies, have led to the exposure of rocks as old as the Pierre or Judith River formations in the eastern portion, and in the western portion near the mountains those as ancient as the Jurassic are brought to the surface. There are on the plains some isolated uplifts, where Paleozoic rocks are exposed.

As we proceed westward the gray-colored bad-lands can be seen north of the Yellowstone River. In them are beds of lignite, the black seams of which often suddenly give place to red strata where the lignite has been burned. They have much the appearance of the badlands of the Little Missouri River. The region is undoubtedly destined to be of much interest to the geologist and paleontologist.

THE REGION OF COLUMBUS, MONTANA.

As previously planned, I stopped at Columbus, Montana, on my western journey. Here with my friend Mr. Grant Irwin, who is a keen observer, and with Mr. Hawkins, the cashier of the bank, who has for years devoted most of his time to the study of the flora of Montana and who is interested in the geology of the country, I made some excursions in the region north of the Yellowstone in the vicinity of Columbus.

We first visited the high bluff which approaches the river west of the town. This bluff is several hundred feet in height, and it furnishes a very good exposure of a large portion of the strata nearly down to the river which washes its southern base. The grade for the road is between 100 and 200 feet above the stream. Below the road are dark shales with layers of sandstone. In the shales are fragments of bones of dinosaurs. Higher are alternating shales and sandstones, in the latter of which were found a few impressions of plants and of non-marine mollusca. The bluff is capped by gray sandstone. In the shale just beneath the sandstone are non-marine mollusca. Northeast of Columbus, the beds, though capped by gray sandstone, are somewhat different. As will be seen later, these strata extend northward to the Lake Basin, a distance of fifteen miles or more. There the beds lie above the Bearpaw shales, which contain typical Pierre fossils, though beds of the age of the Fox Hills may intervene.

North of Columbus and a little eastward, at the foot of the bluffs, are dark marine shales with bands of sandstone and some brown concretions containing marine fossils. These are undoubtedly Upper Pierre or Fox Hills. Some fossils were also found in the darker shales higher than the layers containing the concretions. These shales, as they continue upward, appear to become on the whole more arenaceous until they suddenly end, and are overlaid by heavy beds of gray sandstone, which cap the bluffs. These sandstones are in part massive and in part they have more the appearance of lamination. These and the underlying shales and sandstones, probably belong to the Fox Hills formation, though the upper sandstones may be Laramie.

In the bluffs nearly north of Columbus is a short ravine opening upon the sage-brush flat. To the right of the ravine the marine strata dip, at least at the foot of the bluffs, at a considerable angle. West of this little ravine or amphitheatre, the strata are nearly horizontal, but they consist, as on the east side of the ravine, of dark shales and thin bands of sandstone. If we follow them to the westward they appear to suddenly cease, giving place to a heavy band of sandstone, which continues to the western end of the hogback where the rock is being quarried for building stones. I did not have time to carefully investigate the matter, but it looks as if there were a fault here, and the Fox Hills or Laramie sandstone lies on a level with the marine Cretaceous. Some fossil plants were seen in the sandstone at the quarry.

One day, Mr. Irwin with team and buggy took Mr. Hawkins and myself up Keyser Creek about ten miles toward the Lake Basin. As soon as we entered the hills we saw the same dark clay, shales, and sandstones in which we had seen bones of dinosaurs in the high bluff west of Columbus. In several places — in fact wherever we examined certain layers of dark shale — we found many fragments of bones of dinosaurs, part of which belong to the *Ceratopsia*. Some fragments were also found in a quite heavy band of sandstone above the shales. Still higher were large iron-stained concretions. As the road ascends the stream the strata also ascend, so we did not reach much higher levels. In one place, about six miles from Columbus, a cliff of gray sandstone and shales has been laid bare by recent landslides and the breaking off of large blocks from the cliff. The sandstone here, like that at the quarry near Columbus, appears to be different from the surrounding rock and suggests faulting; but the difference in appearance may be due to the manner of weathering, for beds as thick, though apparently not so massive, appear in one or two other places along the stream. In the sandstones and shales are many impressions of plants, but no good fossil leaves, except those of *Lemna* and some other delicate plants, were found.

THE REGION NORTH OF BIG TIMBER.

The next stop after leaving Columbus, was at Big Timber, a distance of forty-one miles by railroad from the former place. This stop had not been planned at first, but I was extremely anxious to more fully explore the Fort Union beds east of the Crazy Mountains, where a few fossil mammals had been collected. I hired a horse and cart, and started northeastward on the road which goes from Big Timber to the Lake Basin. After leaving the river the road ascends a slope toward the higher hills. Here dark shales appear, in which there are bands and lenses of sandstone. Just below where the road ascends to the top of a stratum of sandstone, there is a layer of limestone which contains many *Unios* and gasteropods. There are also some fragments of bones. In one or two strata there are very good fossil leaves.

Extending away to the eastward to the limit of vision were partly wooded hills, or a dissected bench-land, giving the effect of a thin wood extending to the horizon. The slopes were moderately gentle, and the ravines fairly broad, but narrowing and branching as they divided among the innumerable hills. It presented a picture a little different from anything I have seen elsewhere. The strata are evidently not much disturbed. The rocks are undoubtedly of so-called Fort Union age, though they may be older than the typical Fort Union. The beds here do not look at all like the Tertiary beds in the badlands of North Dakota, as they are much darker, have more solidified material, and there is far less lignite, but they contain more fossil shells and more fragments of bones of reptiles.

From here I continued on the road which goes to the Lake Basin to within a mile or two of where it crosses Sweetgrass Creek. Here, in a little ravine on the east side of the road, some of the rocks of the Fort Union beds are nicely exposed. The ravine extends eastward opening into Sweetgrass Creek. The rocks dip at a low angle. In one place there is an exposure of fifteen feet or more of shales. On top of these are bedded sandstones several feet in thickness. At the contact between the sandstone and shales, is a layer or lens full of *Unios* and gasteropods. Layers of the sandstone above are "plastered" with fossil leaves, many of them very beautifully preserved. I saved some samples, but regretted that a large collection could not be made. Following the ravine toward Sweetgrass Creek other shales and laminated sandstones were seen, in both of which are many remains of plants. That night I stopped at the Patterson ranch and examined some bluffs just across Sweetgrass Creek opposite the house. The rocks here are different in lithological character from those which I had previously examined. There are soft shales of various tints, and the sandstones are gray, and more sugary in texture. They much resemble some beds, which occur near the middle of the series on Fish Creek, which I have provisionally referred to the Laramie; but they probably belong to the Fort Union. After this much of the country west of Sweetgrass Creek was searched. West of the lower portion of the Creek the rocks are of Tertiary age. Farther north the beds of shale and hard thin-bedded sandstones, which underlie the Fort Union, occupy a quite large strip of territory. This formation has a peculiar topography, which enables one to distinguish it from other beds in regions where the rocks are little exposed. There are ridges and hogback-shaped hills covered with grass, and between these hills and ridges are V-shaped ravines and broad flats composed of sandy clay supporting a sparse vegetation. This tract of country is nearly treeless, though in a few places along the ravines, where there are springs, there are a few cottonwood trees. I know of no permanent dwellings among these grassy hills; though they make good grazing lands, and camps of sheep-herders are occasionally found by the springs. These beds are of uppermost Cretaceous or Lower Tertiary age.

Not having seen, except perhaps at a distance, an inhabited dwelling during the day, late in the afternoon I followed a branch-road or trail which led toward Sweetgrass Creek. Descending to lower and lower elevations, I at last found myself on an alluvial flat which borders the creek. The stream is lined with cottonwoods, willows, and evergreens, the band of timber now widening into a little wooded flat — a miniature forest — and then narrowing to a mere fringe of small trees or shrubbery along the creek. Following the alluvial bench on the west side of the creek for some distance I crossed the stream and followed a trail through a luxurious growth of grasses, sedges, weeds, and shrubs, then through the shadows of large trees, and again through a high dense growth of weeds to where there were haystacks, a stable, and a log cabin. The cabin was locked and there was no one at home, but I put the horse in the stable. On ascending the hill east of the stream, I saw that the country on this side had more timber, many of the slopes and ravines being sparsely covered with evergreens. I inferred that the rocks were of Fort Union age. Returning after dark I found that the ranch belonged to a young man from Maine, Mr. Gurney, who had just returned from Big Timber. Though I had made myself at home he made me more so, as he, like nearly all the people of this country, retains the old-time western hospitality. Mr. Gurney's cabin is on the eastern border of one of the wooded flats which I have previously described. On the east side was a small field of grain reaching toward the rounded hills. South of the cabin is a cliff which is partly covered with evergreens, and which overshadowed the little woodland that extends westward to the pebbly-bottomed stream. Farther up the stream is an open space with meadows, and beyond this a little woodland and another cliff approaching the river. West of the stream are moderately high grassy hills. This is perhaps ten to fifteen miles above where the stop was made the previous night, and the rocks along the creek are very nearly the same in appearance.

The next day my course was still west of the creek among smooth rounded hills, like those traversed the previous afternoon. In this formation (lowermost Tertiary or uppermost Cretaceous) good outcrops are the exception rather than the rule. The road does not follow the stream, as the valley closes in and is rugged and rocky. After travelling for some distance the hills became relatively less elevated and the intervening flats or depressions more extensive. In some of these depressions there are beds of temporary lakes, which doubtless furnish examples of combined aqueous and æolian deposits. During heavy rains or the melting of snows, the waters which accumulate in these depressions must take considerable fine sediment with them. The dust, which in dry weather is blown from the surrounding semi-arid region, is caught by the water and remains there. One of these lake-bottoms, which at the time of the previous journey was covered with water, was now dry, hard, and sun-cracked, and I drove across it without danger. Ascending a hill or ridge from the level lake-bed, I descended to the broad valley of a little stream which flows through sage-brush flats and rather poor pasture lands. It is a feeble stream which is fed in dry weather by seeping springs. Its little cut-banks show recent superficial deposits probably of hillside- or sheet-wash and æolian dust.

East of the road from Big Timber to Melville and south of Sweetgrass Creek, which here flows eastward, some bluffs were examined. The sandstones and shales are well exposed, the latter containing some bones of a reptile (*Champsosaurus*), and the former leaves of plants. The beds are probably Fort Union. From this place to and beyond Melville the country is more level, and the greater portion of it is covered with deposits made by Sweetgrass Creek, the valley of which here broadens into a quite extensive plain. North of Melville are large meadows, and beyond these a butte (Melville Butte) which extends northward nearly to Fish Creek. This butte lies east of the much larger, mountain-like Porcupine Butte; but the latter sinks into comparative insignificance on account of its nearness to the high, sharp, abrupt peaks of the Crazy Mountains. At the lowest exposure in the south lobe of the base of Melville Butte, are alternating sandstones and dark shales. The heavier layers of sandstone, by resisting atmospheric influences, have preserved this foot-hill of the butte. Here fresh-water shells (*Unios*) and fossil leaves were found. Another higher lobe of the butte is topped by flaky shales in which there are a few bands of sandstone. In these shales were found bones of reptiles, among which were *Champsosaurus*. Above this the sandy bands in the shale are more numerous. In one band fossil leaves were found, and they appeared to be different from those below. A little higher the eruptive rock, which caps the highest portion of the butte, was seen overlying the Fort Union Beds.

On the high land between Porcupine Butte and Melville Butte the flaky shales of the Fort Union are exposed in wind-blown areas. North of Melville Butte on branches of Fish Creek are excellent exposures of the basal Tertiary. In many places fossil reptiles and plants were found, but no good mammalian remains.

Every morning during my trip I arose with hopes of finding more of the early Tertiary mammals, which, previous to the discovery of a few bones and teeth in the region northeast of Melville, had never been found outside a certain region in New Mexico. But every day I was disappointed and it was with regret that I turned my horse in the direction of Big Timber, feeling that my duty called me westward. I was sure that somewhere in these Lower Eocene beds, which cover such extensive areas in eastern Montana, someone would find, what we long have wished, more of the peculiarly interesting mammalian fauna which flourished in the dawn of the Tertiary age.[1]

The Crazy Mountains. — The region of the Crazy Mountains is interesting to the student of geology and physiography, and it is by no means without its charm to the sight-seer and the admirer of natural beauty. The mountains are the first, except the occasional glimpses of distant ones to the southward, which one sees when travelling westward on the Northern Pacific Railroad. If the time is spring, autumn, or winter, and there are no clouds, the ridges and peaks make white gashes in the cold blue sky, and all through the summer patches of snow usually remain far up among the barren summits between the sharp ridges. From these snow-fields descend streams, which dash and tumble through the deep gorges. On the sides of the steep barren ridges, it is said, are masses and sheets of loose rocks which some natural disturbances or the tread of the foot of the explorer may set in motion, and then, like a river or a moving liquid sheet, they go gliding, tumbling, leaping, plunging, and roaring down the steep and precipitous slopes with a terrifying din. Ill fares the man who cannot get out of the river of rocks which he has set in motion. Near the base of the higher portion of the mountains there is timber in the cañons, and the scene may be less desolate, but scarcely less rugged, as the mountains everywhere are scored by deep cañons.

[1] I understand that since this was written extremely interesting mammalian fossils have been found in these deposits.

The land around the base of the mountains, especially the eastern portion, forms an elevated plain, which has been carved into various forms by the streams issuing from the ranges. The different kinds of rocks are exposed, series after series, from doubtful Jurassic to Lower Tertiary, and are inclined in different directions and at various angles, so that erosion has produced a varied topography.

The streams, carving their way through rocks of different kinds and different grades of hardness, make valleys, which vary from narrow cañons to quite extensive flats or plains. Some formations, like the Eagle sandstones, and the Fox Hills or Lower Laramie sandstones, form ridges, which can be traced eastward or southeastward from the mountains to a distance of sixty miles, and I know not how much farther. Others, like the Pierre shales, form ravines or broad depressions according to the degree of dip of the rock.

FROM BIG TIMBER TO BOZEMAN.

Big Timber, which is the county-seat of Sweetgrass County, is built on a large alluvial fan, consisting principally of sand, gravel, and boulders of granite, which have been deposited by Big Boulder Creek. This stream rises in the Granite and Snow mountains, between forty and fifty miles to the soutward, and flows through a rough tract of country. Where it enters the Yellowstone valley, it has during a long period of time deposited its heavy loads of water-worn boulders.

I do not know that characteristic fossils have been found in the stratified rocks, which form the bluffs on both sides of the river above Big Timber, though I have examined them hastily. They do not differ much in appearance from those of Fort Union age to the northward and northeastward. Farther up the river is a series of beds of considerable thickness, which are in part massive and composed of volcanic breccia, and in part made up of a large series of somber looking rocks, which have the appearance of being stratified. These are the Livingstone beds of Weed, descriptions of which may be found in Bulletin No. 105, and in the Livingstone Atlas Folio, No. 1, of the United States Geological Survey.

At Livingstone the main line of the railway leaves the valley of the Yellowstone River and ascends the steep grade toward Mullen Pass in the Gallatin-Bridger range. These are the first mountains over which we pass in our westward journey on the Northern Pacific Railroad. Stretched behind us are the vast plains, elevated in the western portion, extending about two thousand miles eastward to the Allegheny Mountains, which, when compared with the Rocky Mountains, seem merely like high hills and ridges. The change here is comparatively sudden, and henceforth we shall be amidst very different scenes, the result of different geological conditions. Though we travel to the Pacific coast, there will be no more uninterrupted level horizons, but the dark silhouettes of the mountains will ever be seen against the background of the sky.

If one enters the region for the purpose of learning its history, no matter how faithfully one has studied geological literature, endless difficulties will be encountered. Until one loses child-like faith in the writers of text-books and geological theorists, one will not make much progress. Facts must be observed at first hand, the observations of others must be refuted or confirmed, and theories must be regarded as mere hypotheses to be confirmed or disproven. But the student must not, on the other hand, go to the extreme of disregarding the work of others. The geological conditions up to this point, though they have been the subject of animated discussion and difference of opinion among our best geologists and paleontologists for half a century, are simple, compared with what lies before us, where rocks of all ages have in some way gotten into all manner of positions, and hardly a step in their vast history is settled beyond a doubt. The observer must spend years in studying small phases of the great problem before his opinions can be of any great and permanent value; and even then he must expect that others will come after him and with the accumulated knowledge, which time alone brings, improve on his work.

The rocks of the eastern slope of the Bridger-Gallatin Range are principally of Cretaceous age. On the western slope the railroad descends the East Gallatin River. The walls of the cañon are of Cretaceous and Palæozoic rocks; the latter appearing for the first time since leaving Minnesota. The rocks of the massive Carboniferous limestones, weathered into peculiar forms, extend in huge monuments and rude castle-like forms high above the pine trees which surround their bases.

If we could pause for a while on the crest of the Bridger range a little farther to the northward and look eastward, we would see a wilderness of dissected ridges extending eastward and northeastward to the high sharp peaks of the Crazy Mountains. To the westward at the foot of the steep western slope of the mountains, lying stretched out like a relief-map, checkered with pastures, meadows, fallow land, and rich fields of grain, and traversed by wood-fringed streams, is one of the most productive spots in the west, the far-famed Gallatin Valley. North of this valley is a broken country, south is a maze of rugged mountains reaching to the horizon, and on the west, range beyond range of mountains gradually fade away toward the horizon until they blend with the sky. These mountains are composed of rocks, which vary in age from the gneisses of the Archæan epoch, to strata of Cretaceous times. The foot-hills are sometimes composed of older rocks, principally Cretaceous, but great portions of the valleys have been filled, sometimes to a depth of several hundreds of feet, with later Tertiary deposits, in which in some places have been imbedded the bones of a few of the many mammals, which have successively occupied this region for many hundreds of thousands of years.

After leaving Bozeman, a pleasantly located town on the East Gallatin River in the eastern part of the Gallatin Valley, the train passes for about twenty-five miles through the poorer portion of the valley to the small town of Logan, where the railroad branches, one line going through Helena and the other through Butte. Logan is situated in a narrow portion of the Gallatin Valley just before it expands into the large flat, where the streams of the Gallatin from the east, the Madison from the south, and the Jefferson from the southwestward unite to form the Missouri River.

The greater portions of the river valleys in this region have been excavated in Tertiary rocks, the remains of which form bluffs, benches, and quite large, nearly level, or undulating plains. These later Tertiary deposits in their turn occupy old river valleys, which in Eocene times had been eroded in Mesozoic and older rocks.

The Gallatin, Madison, and Jefferson rivers unite in the northern portion of the valley, and the Missouri River, which they form, starts on its northern course through a cañon in the Palæozoic rocks. This river, like other streams in western Montana, ignoring to a great extent the old valleys made by Eocene streams, carves its way through soft clays, incoherent sands, and gravel of Tertiary age, through Mesozoic sandstones, Palæozoic limestones, Algonkian shales and quartzites, and through lava-flows, with apparent indifference. It first flows northward for about twenty miles through a cañon carved in Palæozoic and Algonkian rocks, then for about sixty miles plays at "hide and seek" between the mountains and the valleys; then flows for some distance through the mountains; and finally, winding its way through a narrow cañon in the basalt twenty-five or thirty miles in length, enters the great plain. It then turns more to the eastward and takes a more nearly direct course to its destination in the Gulf of Mexico.

IN THE VICINITY OF LOGAN.

At Logan I rejoined Mr. Raymond, who, after spending a few days near Glendive, where he obtained reptilian and invertebrate fossils, had gone to Logan to make collections from the Palæozoic rocks, which are so excellently exposed in this region. Here in an hour's walk, one may travel over various horizons of Algonkian, Cambrian, Devonian, Carboniferous, Jurassic, Cretaceous, and Tertiary rocks. This was one of Mr. Raymond's principal objective points. He had been successful beyond our best expectations, and had collected large numbers of fossils from many different horizons. We continued the work of collecting with undiminished success, Mr. Raymond making some very important discoveries.

Northwest of Logan there occur Tertiary deposits, which, as in other places in the state, occupy not only the larger valleys, but the smaller depressions between the hills. A few fragmentary vertebrate fossils of Miocene age were found here. It is evident that at one time the Oligocene and Miocene deposits filled not only the broader valleys, but covered the foot-hills and bases of the mountains, and the streams flowed at a much higher level than at the present time. This accounts for the fact that the rivers and smaller streams ignore the old valleys and cut cañons in older rocks, which often rise several hundreds of feet above the bottoms of the old valleys. The conditions were perhaps similar to what they now are in Nevada, where the bases of the mountains are buried in more recent deposits and the upper portions project above the level plains. The rivers, when their beds were lowered, maintained the general course of their channels through hard and soft rocks.

It has been supposed that uplifts across the paths of drainage produced separate lakes in the various valleys among the mountains, and that these lakes were filled with sediments which were brought in by streams. But on more extended examination these imaginary barriers vanish. The Tertiary deposits, portions only of which appear to have been formed in lakes, and which were deposited at several geological stages, extend, or previous to erosion, did extend continuously over all the valleys in the region of the head-waters of the Missouri River, and covered nearly everything, except the higher mountains.

It is possible, however, that the large area of eruptive rock, through which the Missouri River has cut a cañon from near Wolf Creek to Cascade, may have formed a barrier sometime during the Oligocene; but this supposition, like that of other imagined barriers, may not bear the light of investigation. It is possible, however, that there were some isolated valleys. No connection between the Tertiary deposits in the Bitter Root and Missoula valleys with other valleys has yet been traced; but the deposits which occupy them seem to be principally composed of sediments carried by streams, the products of sheet-erosion, and rocks decomposed *in situ*.

FROM LOGAN TO VIRGINIA CITY, MONTANA.

At Logan we hired a team of cayuses and a spring-wagon and drove to the region northwest of Three Forks, where I had previously collected Devonian fossils. Here we camped for a few days and made a fine collection of fossils from the Upper Devonian shales, part of the fauna of which, according to Mr. Raymond, "seems to be much more like that of the Upper Devonian of South Devon, the Rheinland, and other localities in Europe and Asia, where the top of the Devonian is indicated by one containing numerous species of *Clymenia* and *Goniatites*."[3] In this region are many small exposures of the White River Tertiary beds, and a few fragments of bones of mammals were found.

From this place we struck westward. The next camping place was at an exposure of the Lower White River beds south of Pipestone Springs on Little Pipestone Creek west of Whitehall, where in 1899 I had collected the remains of small mammals. A few interesting specimens were found here, among which were portions of the jaws of unknown insectivores and marsupials (?), and a portion of the skeleton of an oreodont (merycoidodont) about the size of *Merycoidodon culbertsoni*. The merycoidodonts previously described from these beds are all much smaller.

The next important stop was on the Ruby River near Laurin.

[3] "On the Occurrence in the Rocky Mountains of an Upper Devonian Fauna with *Clymenia*." *Amer. Jour. Sci.*, Vol. XXIII, Feb., 1907.

From Spring Cañon in the Ruby Mountains a large collection of Carboniferous fossils was obtained. A trip of a few days was then made to "Old Baldy Mountain," south of Virginia City, where collections were obtained from many horizons in a large series of Carboniferous limestones and shales which occur there.

In the latter part of September Mr. Raymond returned to Pittsburgh, while the writer prepared for a trip to Idaho.

FROM RUBY TO MONIDA, MONTANA.

Ascending the Ruby River I passed through the lower cañon, where the Ruby cuts through Archæan gneisses and crystalline limestones, to the middle valley of the Ruby River. In the lower portion of this valley and continuing some distance up the Sweetwater to the southwestward are considerable exposures of Lower White River deposits, while overlying these on the east side of the river, and farther up on the west side reaching far up on the flanks of the Crazy Mountains, are late Miocene sands and gravels. Both formations are very sparingly fossiliferous, though enough teeth and bones of mammals have been found to determine approximately the age of the deposits. I ascended the Ruby River to where Ledford Creek enters from the northwest. This stream issues from cañons in the northern portion of the Snow Crest range, and then flows through a long narrow grassy-bottomed valley, carved through Miocene sands and gravels. Nearly the whole of the Middle Ruby Valley, in fact, is composed of Tertiary deposits, dissected by many streams and ravines and rising higher and higher toward the elevated narrow ridge of the Snow Crest Range, covering all but the higher portions in its thick mantle of sand and gravel. The road up Ledford Creek ascends quite rapidly, but the benches rise with it. My plan was to ascend this creek, and then, if possible, make my way near the foot of the mountains southwestward to one of the branches of Blacktail Deer Creek, thus getting a view of a portion of the country which I had not previously examined; but I had not yet been able to ascertain whether the route was practicable with team and wagon. I stopped at a house to inquire the way and was fortunate enough to obtain the services of a boy to guide me over the most difficult portion of the way, where there was no trail, to a road which goes to Dillon; but after ascending a long steep grade, I missed the dim trail, which I should have taken, and lost my way among the foot-hills. Turning off the road I ascended a long slope toward a bench, the top of which seemed to mount higher and higher as we toiled up its slope. Finally in the growing dusk, having gained the top of the wind-swept bench, I saw to the southward cold, dark mountains, and on all other sides desolate hills and ridges stretching many miles away. After descending a perilous hill in the gathering darkness, I reached a little stream, got a warm supper by a roaring campfire and made my bed beneath the open sky and a dense sheltering thicket of willows. All night at short intervals the wind raged furiously, roaring among the willows and lashing their tops, portending a storm, but fortunately for myself and the horses it was not yet quite due.

The next morning I climbed to the top of the high bench which I had crossed the previous evening. The bench was nearly flat, but sloped northward away from the mountains, the dark, sharp, rugged peaks of which rose into the cold sky a little distance to the southward. Far away to the westward, northward and eastward, as far as the eye could see, with a general slope to the northward, sometimes interrupted by older rocks and mountain-uplifts, were the Tertiary and more recent deposits, like those beneath my feet. At a far lower level, in the distance, toward the lower valley of the Ruby River, stretching like an irregular but comparatively low wall between the Ruby and the Tobacco Root ranges, was the ridge through which the Ruby cuts its lower cañon. Through this cañon I had passed the day before on my way to this elevated region. The Snow Crest Range gives one the impression of being a comparatively recent uplift, and of having carried upward with it in its elevation the Tertiary deposits, which now climb high on its flanks.

In viewing from this elevation the Tertiary deposits, which extend far away between mountain ranges, sometimes almost surrounding them, it was realized how at variance with the facts is the theory that during the deposition of these beds, the valleys of the mountains were occupied by separate lakes, which, like small lakes in the mountains at the present time, are gradually being filled with sediment.

Instead of deposits occupying the isolated valleys, they extend from one valley to another, so that those in the Upper Ruby, Black Tail Deer Creek, Red Rock, Grasshopper, Beaverhead, Big Hole, Deer Lodge, Madison, Gallatin, and Upper Missouri valleys were united, and the Tertiary deposits can be traced almost continuously for hundreds of miles, sometimes occupying the lowest depressions and sometimes occurring on mountain ranges seven thousand or eight thousand feet above sea level. Although the deposits are not all of the same age, this does not change the truths taught by the topography of the country. The history of these modern deposits is so complex, that its study has never been carried out into details, but our present knowledge points to the following partial outline of events as the most rational that we are able at the present time to construct.

In later Cretaceous and early Eocene times there had been upheavals and erosion of the land. This region was considerably elevated, and probably, in part at least, rugged and mountainous, traversed by swift-flowing streams. During the Eocene the streams reached their base-level of erosion and broadened their valleys. These conditions must have continued for an immense period of time reducing a large portion of the region to a plain. The streams became sluggish and drainage was obstructed, probably in part by accumulation of sediment and by volcanic dust which was wafted from no one knows exactly where. Ponds, marshes, and lakes were formed. Into these dust was carried by wind and water, depositing nearly white sediment, layer on layer, and thick masses of unstratified material. Probably unusually heavy precipitations caused the overflow of flood-plains, and deposition and rearrangement of sediment. Evidently these conditions existed for a great length of time, for the sediments are in some places thousands of feet in thickness. During portions of this immense lapse of time arid conditions prevailed. There were lakes without outlets, and evaporation of the waters caused gypsum and other minerals to be deposited. In some places fish and water-snails were imbedded in the sediments, and in other places remains of rhinoceroses, little three-toed horses, tapir-like animals, rodents, insectivores, huge titanotheres, and other animals unlike anything now living on the earth, were buried. This was the oldest White River (Oligocene) Period. It undoubtedly lasted many hundreds of thousands of years. Much the same conditions prevailed until the titanotheres became extinct. Some of the leaves of the trees are preserved in the beds and some of the logs are petrified. These have not yet been thoroughly studied, but the remains show that the flora has changed much since the Oligocene, and was more like that of the eastern portion of the United States, or of the Mississippi Valley at the present time. The evergreens were represented by the sequoia (related to the redwood of California), and among the deciduous trees are maples, dogwood, alder, poplar, etc. The drainage of the region underwent a change during or after Oligocene times, so that the courses of the rivers were different from what they had been during the Eocene.

After this there was an increase in the grade of the streams, probably caused by the elevation of the land, the streams cut down into the Lower White River deposits, and again broadened their valleys; this continued until large portions of the White River beds were removed; there were local river and terrestrial deposits, but in Lower Miocene times there was probably more erosion than deposition. In a few places bones of animals were buried.

In middle and later Miocene times there were considerable deposits made by streams in marshes and lakes. In these were sometimes buried the bones of horses, rhinoceroses, "oreodonts," camels, etc., all different from those found in the White River and Lower Miocene beds, and most of them much larger. Covering some quite large areas are Miocene deposits, composed of disintegrated granite and other rocks, which have not been transported far from their original sources.

There seems to have been, on the whole, an increase in the grade of the streams from the Oligocene, reaching its culmination at the present time. The present streams have made valleys and ravines in all the Tertiary deposits and have deposited coarse gravel and boulders along the valleys.

There is not space here to fully give the reasons for the above conclusions. These are reserved for a more complete treatise on the geology of western Montana which I hope sometime to publish. The above is only the roughest outline, and even if this outline is approximately correct, the details will require many years of patient investigation.

Descending from my bleak elevated position, I "picked up camp" and resumed my journey. I was glad to soon find a road which led to Black Tail Deer Creek, on the most eastern branch of which I reëxamined some deposits, in which several years before I had found remains of mastodons; but this time I was not successful in finding any fossils. The upper beds are late Miocene (Loup Fork) and the underlying beds probably are White River deposits. There are beds of volcanic dust, one of which is very thick. In the afternoon I camped near the house on the ranch of Professor Fenner, who was a teacher in the State Normal School at Dillon, and started to examine the mountains above the ranch.

Just above the house a little stream issues from a small cañon with steep sides, in which are many pine trees. On the north side of the cañon are outcrops of Tertiary rocks. On the south side are glacial mounds which mount up in stages toward the high mountain peaks to the southward. Between these mounds are little glacial lakes or ponds, and flat bottoms where ponds have formerly existed, but have been partly filled with sediment. Above the cañon there is a dam, which makes an artificial pond used for irrigating purposes. Above this the creek, fringed with willows, flows through meadows and among hills thickly clothed with vegetation. To the eastward and southward were the high peaks of the Snow Crest Range. There were large exposures of the "red beds" (Jurassic?), Palæozoic limestones, and other formations. Though it was getting late in the season, I determined, should the weather permit, to ascend the mountains to the south the next day, and examine some of the formations, which from a distance looked interesting and inviting. The next morning everything was covered to a depth of several inches with snow, which was still rapidly falling. I was snow-bound for about three days, then in the thaw I broke camp and resumed my journey, feeling sure that not until the next summer would the highest peaks of the Snow Crest Range be bare again.

The next night after starting I stopped on Sage Creek at the home of Mr. and Mrs. Freeman, whose acquaintance I had made on a previous expedition. They are both careful observers and I learned much about the geological conditions of the surrounding country from their intelligent and interesting descriptions. After examining the Tertiary deposits east of Sage Creek, I stopped at a place, where in 1897 I had found two or three specimens, which appeared to belong to the Middle Eocene. I did not find any more vertebrate fossils in these particular beds, but the lithological conditions are different from what I have observed elsewhere. There is little doubt that they are of Eocene age. In overlying beds I found a few fragments of bones, which probably are Lower Oligocene. This area is north of Sage Creek, where it flows eastward to empty into Red Rock Creek. Here I encountered the hard, coarse, rounded river-gravel, which according to Mr. Freeman extends in a strip a considerable distance northward and southward over benches and hills. It undoubtedly marks the course of an old post-Miocene river.

After leaving Lima I ascended Red Rock Creek, passing through the cañon into Centennial Valley. On the south side of the creek are smooth hills composed of coarse conglomerate. Hayden supposed this to be of Carboniferous age; but it would be interesting to know whether it may not be the same as the Sphinx Conglomerate in the Madison Range. If so, it is not earlier than Lower Eocene. In one place north of the stream are beds near the river, which appear to be of Oligocene age, though I did not have the opportunity of examining them closely. South of the Centennial Valley I examined some gray rocks, which are probably of Later Cretaceous age, and obtained some fossil plants, among which are some very fine ferns. The species have not been identified.

As previously stated, one of the objects of the expedition was to ascertain whether or not the Tertiary beds extend across the main divide of the Rocky Mountains at Henry's Lake and near Monida, as they do south of Silver Bow in Montana. South of Sage Creek the Tertiary deposits, though I saw no outcrops beneath the basalt, appear to "run under" the cap of lava which covers the tops of the high hills. In fact I know of no place in Montana where it is positively certain that the large basaltic flows overlie the Tertiary. Farther south than Sage Creek, on Red Rock Creek, several miles above Lima, as previously stated, there are what appears at a distance to be Oligocene deposits, along the stream. South of this I saw no outcrops.

FROM MONIDA THROUGH NORTHERN IDAHO TO HENRY'S LAKE, IDAHO.

The Continental Divide and state line, between Montana and Idaho, is only a short distance south of Monida, a little station on the Oregon Short Line. Monida has an altitude of 6,803 feet. From Lima to Monida, a distance of fifteen miles along the railroad, there is an ascent of twenty-five hundred feet, but most of the way it is very gradual, so that one does not realize that there is so much difference in the altitudes of the two places. Southeast of Monida, the wagon road ascends higher than the railroad. On the south side of the road are rounded hills or mounds, which extend to a considerably higher elevation. Immediately south of the divide streams begin, and flow through broad upland flats or valleys. These are the sources of Beaver Creek. On the eastern side of the main stream are rounded bluffs, in which there are some exposures of a gray rock, which at a little distance resembles the Tertiary rocks in Montana. But closer examination shows this to be a mistake, and there appears to be no certain evidence that deposition was continuous across the range here in later Tertiary times. The rocks mistaken for Oligocene or Miocene more resemble those of Laramie or Fort Union age in other places. Soon, in descending Beaver Creek, sedimentary rocks disappear, and only eruptive rocks are seen. The creek after flowing through two or more basins for several miles, cuts a narrow cañon through the basalt. The railroad passes through this cañon, while the wagon road goes over hills and benches. The mountains on the east and west are not high, and they decrease in height to the southward. Along the stream is a thick growth of trees and shrubbery, while on the hills and mountain slopes are sage-brush and coniferous trees. Besides these the trees common along nearly all the streams of Montana, birch (*Betula*), kinnikinick (*Cornus*), and black-fruited hawthorn (*Cratægus*) were seen.

After descending the stream about sixteen miles from the Continental Divide, the mountains ceased, and to the southward, as far as could be seen, was an arid plain, on which were comparatively few landmarks. In an embayment of this plain beside a mountain stream, nestled between the spurs of the foot-hills, is the little town of Spencer. From this point I followed the road which goes eastward south of the mountains near the northern border of the plain. Possibly some of the rock in the higher portion of the range is of sedimentary origin, but nearly all that of both plain and mountains is eruptive. Water-courses, making ravines and cañons, start away to the northward in the main divide and score the sides of the mountains to the plains, on which they sometimes continue for a short distance. Their course is marked by a fringe of trees and shrubs, but most of them soon die out on the arid waste of sage and sand. The stream (Beaver Creek), which I had followed from Montana, cuts its way out into the rock of the plain, and its course can be traced in some places by the trees, the tops of which project above the narrow gorge. Most of the streams were dry where the road crosses them, but in some there was water higher up; and there are occasional irrigated ranches between the foot-hills. When approaching the valleys, which open from the foot-hills, it looked as if the streams had their sources in the desert and cut their way into the mountains. In fact the topography of the country was so different from anything which I had previously seen, that I often could not tell which way the land sloped, or make out whether we were going on level ground or slightly up or down grade. The range of mountains is not a simple one, but spurs come from the main axis and extend southeastward into the plain fifteen or twenty miles apart. Dr. Hayden has spoken of this *en echelon* structure.

This region was entirely different geologically and topographically from any previously encountered and the change was sudden. The mountains descend southward into foot-hills, which suddenly give way to a vast arid plain. The rock is nearly all of igneous origin. Far away to the southward are some scattering buttes; beyond the plain to the southeast, the high, rugged points of the Tetons pierce the sky.

In contrast with this scene, just across the Rocky Mountain range in Montana, there are many mountain ranges of various lengths, composed of sedimentary rocks from the most ancient to the youngest, but principally of Archæan and Palæozoic age, with here and there masses of eruptive rocks. These mountains form sharp ridges and peaks, or rounded grassy or forested slopes, bordered by rugged, grassy, wooded foot-hills, which are often composed of Mesozoic rocks. Between the ranges of mountains are valleys, sometimes fertile and sometimes semi-arid, broadening and narrowing, as they make their intricate way among the mountains. These valleys are usually composed to a great extent of later Tertiary deposits, which form flats and benches, and sometimes weather into bad-lands. Besides these, and occupying in part the older valleys, are the recent river valleys. It is a land of immensely varied details of topography, a land of diversified and picturesque scenery, where every turn of the road brings new scenes to view, a region, the rocks, valleys, hills, bluffs and mountains of which are covered with inscriptions preserving for the geologist the records of its immense history, only an infinitesimal portion of which has as yet been deciphered.

The plain in Idaho is lower than the southern portion of Montana. Spencer is nine hundred and twenty feet lower than Monida and three hundred and seventy-three feet lower than Lima, but is nearly eight hundred feet higher than Dillon.

When one reaches the region of Camas Creek — it can hardly be called a valley — the scene changes. It is more level than portions of the desert, but all along this great alluvial flat are cabins, farm-houses, hay-stacks, grain-stacks, and straw-stacks, showing that the soil is productive, and, strange to say, crops are raised without irrigation. Near the streams excellent farms and fine new buildings indicate thrift and prosperity.

After leaving the Camas meadows the land is again semi-arid, but the country is not quite so smooth and level, and in some places, where the road winds through a maze of sage-brush and hillocks of lava, pleasant groves of quaking aspen are seen. These at a distance appear to be ideal camping-places, and one expects to find in their shade, cool springs of water; but not a drop is to be found. The land as one travels eastward becomes more rolling, and sage-brush more abundant.

Finally to the eastward there appears a low mountain almost completely covered with dense growths of pine. These pine forests extend to the eastern horizon. North of the mountain there is a large area of meadow-land, from which a small stream bordered by broad meadows flows to the eastward and enters Henry's Fork of the Snake River. The stream is called Shot-gun Creek. The thought occurred to me that this would be a delightful place for sport, rest, and recreation — a charming retreat for one, who for a season wishes to see less of man and more of nature. In the streams are fish and waterfowl, and in the mountains and forests grouse and larger game abound. Hundreds of fine looking cattle were feeding in the meadows. There were houses along the stream, but aside from the ranch-house in which Rea postoffice is located, they were not inhabited. I discovered the reason a little later.

Occasionally I caught views of what appeared to be a high ridge or plateau to the eastward, and along its face, at various heights, were what appeared to be exposures of light-colored rocks. I found later that this region lay inside of the Yellowstone National Park, the greater portion of which is known only to a few, and consis's of rugged forested regions far from any road or trail.

At dusk, crossing a bridge at Henry's Fork, I entered what seemed to be a little village in the open border of the great pine woods, on the river's bank. It was the summer resort of Mr. A. S. Trude, a noted criminal lawyer of Chicago, who I found owned the land on which I had been travelling for several miles. Here I spent the night, and was pleased to see in the people a harmonious blending of western freedom and genuine eastern kindness and courtesy. It is pleasant to see a man like Mr. Trude, who has the good sense to forsake for a time the crowded city and its perplexities to enjoy, like a boy, the mysterious fascination of a delightful wilderness like this.

That night it snowed again. The next morning a winding road led me through several miles of evergreen forests, where the trees and ground were covered with soft snow, and all was still and beautiful, to Elk Park Ranch, then the residence of Mr. Ulrey. Here I remained until the next day, when I rode through wind and storm to Henry's Lake. From Mr. Ulrey's house, I passed for several miles through a park region, consisting of pine forests and meadows with more brushwood than I had seen the previous day. Several miles south of Henry's Lake, the valley of Henry's Fork becomes nearly treeless, except along the streams, and the country begins to assume more of the aspect of the valleys of Montana. There are benches, which appear to be composed of Tertiary deposits, but I saw no outcrops. The same deposits appear to extend through the Raynold's Pass north of Henry's Lake. It seems quite probable that in Eocene times a river valley extended across the divide here. The altitude of the pass, according to Hayden, is 6,911 feet.

If it had been earlier in the season, I should have extended my explorations farther to the westward and southward in Idaho, and I have no doubt that I would have succeeded in finding remairs of later Tertiary deposits. They have been observed in the southwestern portion of the state. It will be interesting to know what relation the lava-flows bear to these deposits, whether they are below or above, or whether they lie between the older and the younger Tertiary beds.

HENRY'S LAKE, IDAHO, TO LOGAN, MONTANA.

Soon after crossing the Continental Divide into Montana I left the main road, which descends to the Madison River, and struck westward, as I wished to see Cliff Lake. No regular road, except a wagon-trail from the north, leads to the lake. After descending a ravine in the lava as far as driving was convenient, I unhitched and descended the narrowing gorge on horse-back. After awhile springs were seen issuing from the rocks, soon forming a clear little stream, which made the bottom green as in summer with grass and water-weeds, while all the hills around "were lying brown and bare." The stream flows for some distance through a cañon and after passing out from between rocky walls, it expanded into a long, slow-flowing, pond-like stream (really, as I found later, a long inlet of the lake) which turned from the southwestward to the northwestward and was lost behind basaltic cliffs. Ascending a long slope to the northwestward, I came to the border of a precipice, and, through openings between poplar groves, beheld one of the most picturesque sights I had ever seen. Down deep beneath me lay a narrow sheet of water (Plate XVII), winding in and out narrowing and expanding between abrupt walls and steep talus slopes on one side and steep wooded cliffs on the other. South of where I stood, near the broadest portion of the lake and nearer to the western shore, stood a high conical mound (Pyramid Island). A little farther south a high promontory projected into the lake, and a little farther south was another headland as the lake divides into three long narrow inlets which are confined between precipitous walls. The most eastern of these inlets is the one, the head of which I had previously seen.

The water is very deep except on the borders and in the narrowest portions of the lake. Here *Chara* and other water-plants grow from a white mud or ooze, which forms a terrace around the borders of the lake and covers the bottom of the shallower portions. I supposed this white ooze to be lime left by the decaying *Chara*. Undoubtedly this, together with dust and water-borne sediments, are very slowly filling the lake. Much of the Tertiary sediments of the west were supposed to have been deposited in lakes, and it would be extremely interesting if some one would study the principal types of lakes, ascertain the character of the deposits, and discover how they are actually made. This lake, and others of the same character near it, would furnish studies of the most unique and fascinating interest. On account of its having been so long isolated, Cliff Lake contains, it is said, fish and other forms of life different from any others in this region. Their study would undoubtedly throw much light on the progress and distribution of life.

Above and below are other lakes in the same gorge, which appears to be the cañon of an ancient stream that flowed between the Centennial and Madison valleys. At the lower end of the lake the cañon is filled with débris which dams the water. The surrounding country is picturesque and full of scientific interest. It ought to be a paradise for artists, geologists, and sight-seers, and yet, though many pass within a few miles of it to "see the sights" in the Yellowstone Park, comparatively few ever gaze on its hidden, though unique, grandeur and beauty. So far as natural scenery is concerned I know of nothing in the National Park which approaches it.

Near the foot of the mountains on the east side of Reynold's or Madison Pass, is what at a distance appears to be a fault. It looks as

Cliff Lake, Madison County, Montana, Looking Northward.

Terraces of the Tertiary and More Recent Deposits in the Upper Madison Valley in Montana, Looking Southward toward the Continental Divide from the Bluffs on the East Side of the River.

if the land at the foot of the mountains had fallen down, perhaps twenty-five feet or more. As I descended the valley I saw it in several places down to near the northern end of the valley, a distance of nearly fifty miles. It is always near the foot of the steep slopes of the mountains near where the Tertiary and recent deposits composing the benches abut against the older rocks. The people in the valley have noticed this phenomenon, and say that it can be traced all along the foot of the mountains to Jack Creek. Both igneous rocks and Tertiary and more recent deposits form the large benches and terraces of the Upper Madison Valley (Plate XIX), which are beautifully developed. These and the older rocks, which occupy higher altitudes, are sometimes locally covered by glacial drift. As in many of the other valleys, both Oligocene and Miocene deposits occur, but the outcrops are few and are limited in extent.

Arriving in the Lower Madison Valley, I returned the team to its owner, Mr. De Foe Merriman, and returned by rail to the Ruby Valley.

THE DEER LODGE, BITTER ROOT, AND FLATHEAD VALLEYS.

From the Lower Ruby Valley my wife and I took the train for Bitter Root Valley and the Flathead Indian reservation, stopping at Deer Lodge, from which, in company with Prof. Percy Perviance, we made several geological excursions.

East of Deer Lodge the mountains, so far as we examined them, are composed principally of igneous (basaltic) rocks, but I was surprised to find Oligocene deposits extending so high on their sides (probably to an altitude of 6,000 feet or more); though farther south they are found as high as 7,000 or 8,000 feet. West of the town we found distinguishable mammalian fossils in both White River (Oligocene) and later Miocene beds.

One day we crossed to the west side of the Deer Lodge River and followed the bench northward to near Pioneer. This bench is composed principally of Tertiary deposits, and it slopes eastward from the Powell Mountains[4] toward the river. On the surface in several places, apparently unaccompanied by any other signs of glacial action, were large granite boulders. Farther north we crossed the moraine of an old glacier which extends from high up in the rugged mountains nearly

[4] I have not been able to find that the mountain range west of the Deer Lodge valley has a name, so call it Powell Range after its most prominent peak.

to the Deer Lodge River. It has a very uneven topography. There were long lateral moraines, ridges, hogbacks, rounded hills, and correspondingly varied depressions. Granite boulders are extremely numerous, sometimes forming a very large proportion of the hills and moraines.

Near Pioneer we found quite considerable natural outcrops of White River deposits, and large areas had been uncovered by placer-mining operations. The beds are gray, nearly white, and are in part well stratified. The only fossils obtained were fresh-water mollusca (snails) and bones and scales of fishes. The excursions above mentioned were made from the 21st to the 25th of October.

We went next to the Bitter Root Valley, northeast of Stevensville, where short excursions were made. The region certainly does not abound in fossiliferous rocks, as many a fruitless tramp in the Missoula and Bitter Root valleys had previously taught me. On account of this scarcity of organic remains, the geological history of nearly all of the extreme western portion of Montana is very obscure.

In his valuable paper, "A Geological Reconnaissance across the Bitter Root-range and Clearwater Mountains in Montana and Idaho," Mr. Waldemar Lindgren says:

"An exact statement of the geological history of this region is difficult to give on account of the few exactly determinable datum planes. There are really only two determinations of time on which we may rely. The first is the date of the Columbia River lava as Miocene; the second is the Glacial epoch as early Quaternary."[5] Later in the same paper (page 30) he says: "No direct evidence of the former existence of a lake within the valley has been found. The east side, however, has not been carefully examined, and from the general configuration it would seem possible that the depression, like many other intermontane valleys of this region, was occupied by a lake in Tertiary times."

In 1889 and 1901, while living in the Bitter Root Valley, I spent much time in exploring the benches east of the Bitter Root River in the eastern portion of the valley. The deposits, which form the benches, are composed of sand, gravel, and volcanic ash, resembling some of the Tertiary beds in other portions of the state; but in all my search I succeeded in finding only a very few isolated fragments of mammalian fossils. Of these only two were determinable. One

[5] Professional Paper No. 27, U. S. Geological Survey, 1904, p. 26.

was a small piece of a tooth of a *Mastodon* and another the lower portion of the ulna-radius of a fairly large *Procamelus*. This shows that a portion at least of the upper beds belonged to the Miocene.

In 1905 on Ambrose Creek northeast of Stevensville, where the bench-land begins to slope gently upward toward the mountains, we found scattered over the loose sandy soil, a few fragments of bones and teeth, some of the latter of which belonged to the high-toothed type of later Miocene horses. Thus the observations of previous years were confirmed. There are, however, beds which lie lower and are exposed — one or two hundred feet in thickness — in a bend of the Bitter Root River, twelve or fifteen miles below Stevensville. These beds I believe to be Oligocene, though no characteristic fossils were found in them.

One day we made a trip eastward to near the mountains. The first deposits (Miocene) encountered were composed of sand, which was perhaps slightly water-worn, but not very distinctly assorted by the action of streams. Nearer the mountains were higher benches composed of sand and gravel, which were in some places slightly consolidated. On ascending the bench I saw, a mile or more distant what appeared to be good exposures of gray Tertiary deposits. On reaching the spot it was seen that what appeared to be Tertiary rocks were pure decomposing granite. The slopes were covered with grains of quartz and crystals of feldspar, which by atmospheric agencies were being moved down the hillsides toward the streams. Here then we have near the mountains sand composed of quartz and feldspar caused by the decomposition in place of granitic rock. A little farther away toward the west is the same kind of sand, little or not at all water-worn, but mixed with other material and forming the high bench-land. Still farther to the west nearer the river, are similar sands, perhaps slightly water-worn, mixed with lighter-colored material (volcanic ash?, etc), and containing remains of Miocene mammals. There are similar conditions in other portions of western Montana. A careful study of these beds would undoubtedly throw much needed light on their origin. I do not see that there is much evidence that these Miocene deposits in the Bitter Root Valley were formed to any great extent in a lake, and a large portion of them are evidently not river deposits.

On the Flathead Indian reservation, we stopped at Ravalli and examined the soft buff-colored deposits between that place and Arlee, searching it carefully for fossils, but without success. It appears to be the same kind of thinly-laminated fine sand and clay which occurs in the Missoula Valley below Missoula. It was evidently deposited in quiet waters. Whether or not it was formed at the time when the many terraces and water-lines were made on the hills and mountains on the sides of the Missoula and Bitter Root valleys is yet to be ascertained. These have suggested a lake which was dammed by a glacier in Quaternary times, but I do not know that the dam has ever been definitely located. Judging by all the other valleys of western Montana, there should be Oligocene and Miocene deposits here, though they may be mostly eroded away or covered by other deposits.

As it was getting uncomfortably near winter in the mountains, and as I had yet (should the weather permit) to collect the fossil mammals which had been found in North Dakota, there was not time for further explorations on the Flathead Indian reservation. Fortunately the weather in North Dakota remained comparatively warm and pleasant, so that a busy month was spent in collecting fossil mammals, and we returned to Pittsburgh late in December.

PART II. NOTES ON THE MESOZOIC AND CENOZOIC GEOLOGY OF NORTH DAKOTA AND MONTANA.

The extensive tract of country, to portions of which the following geological observations apply, may be divided into six distinct geological and physiographic regions.

I. *Northwestern Minnesota.* — This is an undulating, partly wooded plain. The underlying Archæan and Paleozoic rocks are overlaid by glacial deposits, and the surface shows the usual physical characters of the drift-regions, viz., low hills, moraines, marshes, ponds, lakes, and comparatively slow-flowing streams. The timber consists of evergreens and deciduous trees.

II. *Eastern and Northern North Dakota and a Small Portion of Northwestern Minnesota.* — This is a grassy prairie, which is wooded only along the streams and near the borders of some of the larger lakes. This region may be divided into two portions: (*a*) the bed of the glacial Lake Agassiz, a rich, level tract of country with timber only along the few sluggish streams; and (*b*) the remaining portion of North Dakota east and north of the Missouri River. This portion of the country is nearly covered with glacial drift, which is underlaid by rocks of Cretaceous and Tertiary age.

III. *The Southwestern Portion of North Dakota,* west of the Missouri River, consisting of bad-lands, and high prairies, over portions of which are scattered buttes, but no extensive glacial moraines. The whole region shows elevation and quite extensive erosion, but the strata are nearly horizontal. Most of the rock exposed is of Tertiary age. There is some glacial drift, but it is not a prominent feature. In places some timber grows along the streams.

IV. *The Eastern Portion of Montana.* — An elevated plain, where there has been not only extensive uplifting, but in places considerable tilting of the strata, which, combined with erosion, has brought to the surface rocks from those of Judith River age, or earlier, up to those of the Lower Eocene. Near the mountains are local outcrops of rocks reaching down to the Jurassic or Lower Cretaceous. The different formations apparently increase in thickness, and the number of their distinct divisions becomes greater as the mountains on the western boundary are approached. The timber is confined principally to the valleys of streams and to the higher portions in the vicinity of the mountains, and consists principally of cottonwoods, willows, and conifers; though in some places along the streams there are other hardy trees. There are isolated mountain-uplifts in the western portion, where Paleozoic rocks are exposed, and the conditions are similar to those in the mountainous region to the westward.

V. *The Mountainous Region of Western Montana.* — This is a region of extremely varied physical and topographic conditions, as well as of complex geological features. The rocks, representing all the geological eras from Archæan to the present time, lie in all positions from horizontal to perpendicular. The country has the appearance of having been for ages the battle-ground of geological forces, when the vast region to the eastward was comparatively quiet. On many of the mountain ranges grow forests of conifers, while along the streams and in other favorable localities are hardy deciduous trees, such as willows, cottonwoods, alders, mountain maples, hawthorns, etc.

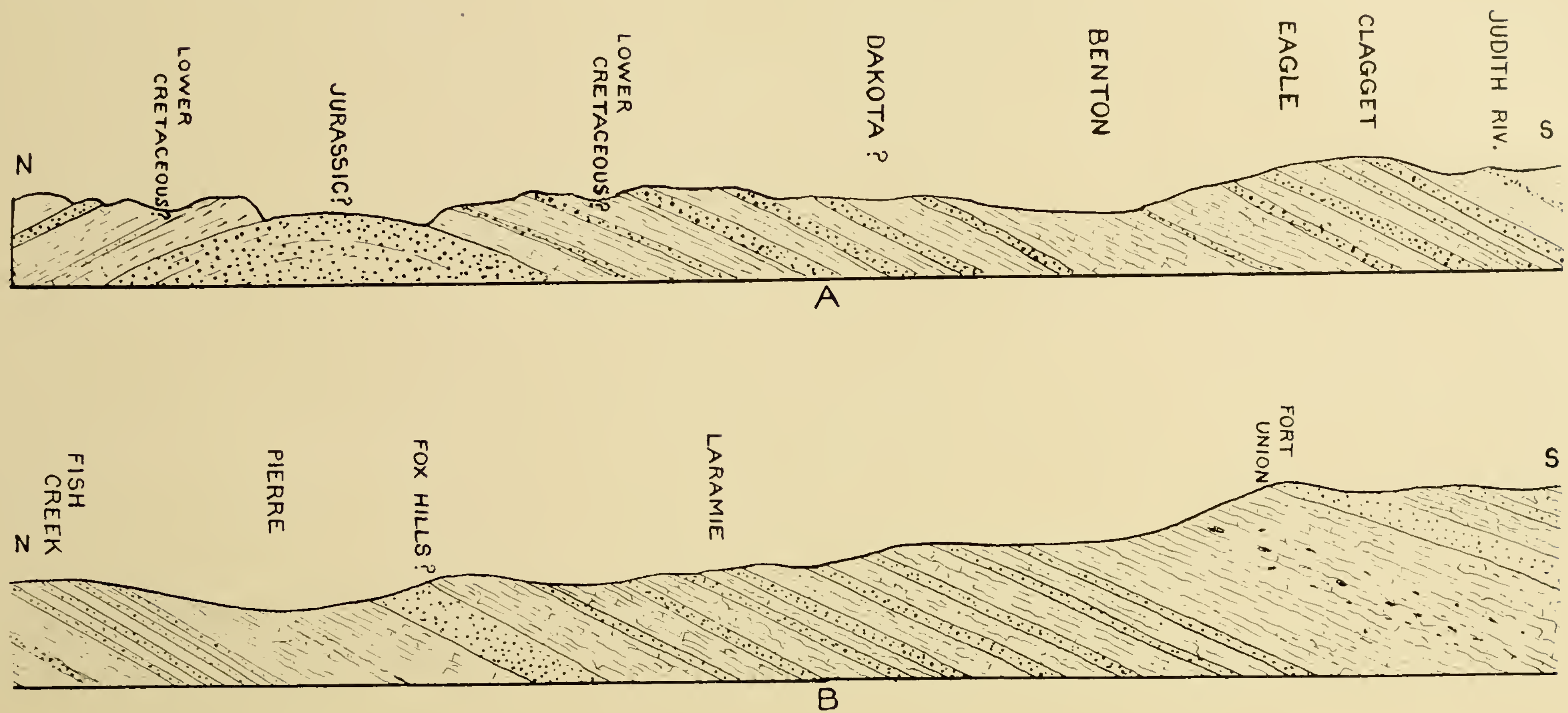
VI. *The Northern Portion of Eastern Idaho.* — A land of desert plains, bordered on the north by mountains and foot-hills, in sections of which are parks and forests of evergreens, especially in the eastern portion. The rocks are of igneous origin.

The geological conditions and physical characters of Division I. have been recorded in the splendid final reports of the Geological and Natural History Survey of Minnesota. The geology of the second division is being studied by the members of the State Geological Survey of North Dakota, and the results published in the biennial reports of that organization. This state is also fortunate in having its geological history recorded in a scientific book of unusual interest and clearness, "The Story of the Prairies," by Daniel E. Willard. The present writer, however, is able to add something to the knowledge of the geology of North Dakota.

Montana has no state geological survey, and aside from the quadrangles mapped by the United States Geological survey, the work, like that recorded in the present paper, has been of an itinerary nature. Perhaps no one who has not studied the regions through which Dr. F. V. Hayden led his geological expeditions over thirty years ago, can fully appreciate the work of that careful observer and far-seeing geologist. It is not strange that he made so many mistakes, but it is a wonder that he was so nearly right; nevertheless every year discoveries in the west modify our ideas of the past history of our continent, and enable us to approach the truth a little more nearly.

By far the best section of the Cretaceous and Lower Tertiary with which I am acquainted is that in the region of Fish and Mud Creeks northeast of Melville in T. 5 & 6 N., R 16 & 17 E., in the northern part of Sweetgrass County in Montana (Plate XX). Here series of strata which are separable into fifteen or more distinct divisions and range from doubtful Jurassic to Lower Eocene, occur in a beautiful succession of rocks several thousands of feet in thickness; and the conditions are such that nearly every minor division can be studied in detail in some portion of the area. Fossils have been found at about twenty different levels and more careful search will undoubtedly reveal many more. It is extremely desirable that a thoroughly detailed study of this section be made, as this could not fail to aid greatly in the solution of some interesting problems in the Mesozoic and Cenozoic geology of the west. This section has the additional advantage of being located in an intermediate position between the great plain and the Cordilleran region, the physical conditions of which at the present time are so dissimilar and the geological histories of which have been so very different.

A generalized section of this region, which will give some idea of the different horizons, is given here. This will furnish a convenient scale for reference in dealing with the geology of other localities. A description, intentionally brief, of the principal horizons, was given



Section from North (N) to South (S) through the Jurassic (?), Cretaceous, and Tertiary Rocks on Fish Creek, Sweetgrass County, Montana. Section B is continuous with Section A. The Drawing is not intended to show the angle of dip.

in a former paper;[6] but further observations of Stanton, Hatcher, and myself enable me to now more fully describe and to more correctly correlate some of the horizons.

In the descriptions which follow, I shall first characterize each horizon as it occurs in the Fish Creek region, when it is represented in that section.

JURASSIC (?)

Fish Creek Section. — The lower beds, which appear on the surface in the region of Fish Creek, are hard quartzites in which no good fossils were found. These are exposed in a dome-shaped uplift on the ranch of Mr. Joe Widdecombe, about eight or ten miles southeast of Harlowton, which is near the Musselshell River. The overlying rocks have been removed by erosion and left the more or less massive quartzite as a mound, or "hogback." This rock is much like the hard quartzites, which in the Three Forks section are beneath the band of limestone containing marine fossils, which were determined by Dr. P. E. Raymond as of Jurassic age. This formation is referred only provisionally to the Jurassic. The overlying red and somber clays contain bones of large dinosaurs and fresh-water mollusca. I had supposed the bones to be those of Jurassic dinosaurs, but, as these have not been studied or their species determined, and as Professor Stanton has studied the mollusca and believes the formation to be not lower than Lower Cretaceous, I shall, in this paper, refer these beds provisionally to that horizon.

The Big Hole Section. — On the lower Big Hole River about fifteen miles north and a little east of Dillon, is a Mesozoic section as finely exposed for study as that on Fish Creek, but it extends much lower in the geological scale. Unfortunately, however, characteristic fossils, which will fix beyond doubt the exact geological levels of strata in various portions of the section, have not been found, so the exact age of all the Mesozoic horizons is more or less uncertain. I made detailed measurements of the lower portion of the section, but the upper portion, which probably includes strata representing part at least of the Dakota, Montana, Colorado, Laramie, and possibly the Fort Union, was not carefully studied. The measured section undoubtedly includes the fresh-water Jurassic, the upper and lower limits of which are unknown. It begins below with the Upper Carboniferous and includes

[6] "A Cretaceous and Lower Tertiary Section in South Central Montana." *Proc. Amer. Philos. Soc.*, Vol. XLI, No. 170, 1902.

beds referred to the Permo-Carboniferous. This section was figured in a former paper,[7] but detailed measurements were not given. The more recent portion of this series of rocks is in McCarty's Mountain, and probably includes both eruptives and Upper Cretaceous and Tertiary rocks metamorphosed by heat. Below this in a descending series are many hundreds of feet of sandstones, clays, and shales. Fossils were not found in abundance, but toward the top of the series there were a few fragmentary bones and impressions of plants. Below this series are beds, which contain two or more bands of limestone interbedded with shale. These beds, on account of their position between the Jurassic and Colorado formations in other localities, have been referred to the Dakota, but their position is doubtful.

SECTION ON THE LOWER BIG HOLE RIVER IN MONTANA.

		Feet.
Fort Union? Livingston? Upper Cretaceous.	A large series of sandstones, clays and shales with metamorphic rock near the top.	
Lower portions of Upper Cretaceous, or Lower Cretaceous.	38. Sandstones	
	37. Shales.	
	36. A thin bed of limestone containing *Unio*, *Goniobasis? increbescens*, and fish teeth.	
	35. Shales.	
	34. Limestone in thin and thick layers — *Unio* (slender form of *U. douglassi* Stanton), *Corbula*, *Goniobasis?*, *Vivparus*.	
	33. Red shales, etc.	
	32. Shale and sandstone	15
	31. Limestone. Some small fossils	15
	30. Shales green and red with one or more harder bands	100
	29. Shales and red sandstone	30
	28. Gray sandstone, heavier bedded than the last below	45
Jurassic.	27. Gray and reddish-gray shaly sandstone and shale	70
	26. Red shale. Fragments of bones of reptiles	55
	25. Red shale with nodules	50
	24. Red sandstone	} 60
	23. Shale	
	22. Thin band of sandstone	
Jurassic? and Triassic?	21. Red shale	
	20. Sandy shale	
	19. Gray sandstone	

[7] "Some Notes on the Geology of Southwestern Montana," by Earl Douglass, ANNALS CARNEGIE MUSEUM, Vol. III, No. 2, 1905.

	18. Conglomerate	
	17. Gray sandstone	
	16. Gray sandstone stained brown	45
	15. Gray sandstone	
	14. Conglomerate	6
	13. Gray and greenish shale	
	12. Thin-bedded sandstones with ripple marks and shells — *Lingula*, etc.	85
	11. Greenish sandstone — *Lingula*	
Permo-Carboniferous.	10. Limestome shales and thin-bedded sandstones Fossil shells, *Lingula*, etc.	
	9. Brown thin-bedded limestones and shales. *Lingula*, *Aviculopecten*, *Myalina*	150
	8. Shales with bands of limestone	
	7. Soft shales or clay	125
	6. Quartzite, massive	
	5. Quartzite in layers with worm tracks	100
	4. Jaspery quartzite	
Carboniferous.	3. Cherty limestone impure	
	2. Cherty limestone with carboniferous fossils	120
	1. Quartzite, massive but not in section	200

There is nothing in this section very nearly like the thick-bedded limestone of the Marine Jurassic of Jack Creek cañon in the Madison Range; yet the limestone No. 31 may represent the Marine phase of this formation, though it seems quite high in the scale and overlies what appears to be non-marine Jurassic.

Other Localities. — On the west side of the North Boulder Valley, near the road from Whitehall to Boulder, are red clays and sandstones similar to a portion of those in the Big Hole section. In these some bones of turtles were found.

On the east side of the North Boulder opposite Cold Spring post-office these beds appear again; and farther to the eastward on the east side of the valley of Milligan Creek, near where the stream turns from the eastward and flows to the southward, is an outcrop of red clays, shales, and sandstones, which apparently belongs to the same formation. In the clays were found fragments of bones of large reptiles. In the two latter localities the beds lie pretty close to the Carboniferous. As the fragmentary bones have not been specifically determined, it is possible that the beds may be Triassic.

On the top of the Tobacco Root Mountains, about twenty-five miles south of Virginia City, are quite extensive outcrops of Jurassic shales, clays, and sandstones. Many bones of large dinosaurs have been eroded from a stratum of clay in one locality north of Black Butte. Above the clays containing the bones are series of clays and bedded sandstones. The sandstones occasionally contain impressions of mollusca, which are probably Jurassic. Above these shales and sandstones on the west flank of the mountains in the Ruby Valley, are the limestones which everywhere contain an abundance of gasteropods.

At a considerable distance below the Dinosaur horizon are extensive exposures of Carboniferous limestones.

These observations will, perhaps, tend to show how indefinite are the boundaries of different horizons of the Mesozoic of Montana. Not only is this true, but no two sections from different regions appear to be exactly alike. More careful study however may show that this is partly due to conditions of exposure, disturbances of strata, etc.

LOWER AND MIDDLE CRETACEOUS.

The Fish-Creek Area. — Immediately overlying the quartzite on the Joe Widdecombe ranch in the Fish-Creek section, are beds of red and somber clays. As one stands on the top of the dome-shaped exposure of quartzite, he sees on three sides of him bluffs of soft strata, which have weathered into bad-land forms. The strike of the beds is a circle or ellipse and the dip is in every direction outward from the center of the hill. These beds, which are composed of sand and sandy clay overlaid by thin-layered sandstones, contain bones of large dinosaurs. Some beautifully preserved fresh-water mollusca were found by Dr. M. S. Farr and Mr. A. C. Silberling. These constitute a new faunule which was described by Professor Stanton, who says concerning the age of the beds: "Although the evidence is not convincing, the indications are that this fresh-water horizon near Harlowton is not far from the horizon of the Bear River formation — possibly contemporaneous with it — and that it is certainly not older than Lower Cretaceous, and more probably should be assigned to about the base of the Upper Cretaceous. [8]

The following is the list given by Stanton: [9]

Unio farri.
Unio douglassi.

[8] "A New Fresh-water Molluscan Faunule from the Cretaceous of Montana," *Proc. Amer. Philos. Soc.*, Vol. XLII, No. 173, 1903, pp. 192 and 194.

[9] *Ibid.*, p. 193.

Campeloma harlowtonensis.
Viviparus montanaënsis.
Goniobasis ? ortmanni.
Goniobasis silberlingi.

I had been much inclined to refer the beds to the Jurassic, but if Professor Stanton is correct in referring them to the Lower Cretaceous, it is exceptionally desirable that collections of dinosaur bones be made from this formation, as the lower geological horizons from which these remains have previously been obtained, represent a very limited portion of dinosaurian life.

THE AMERICAN FORK BEDS.

Overlying the red and somber clays and thin-bedded sandstones above described, are clays, shales, and bedded sandstones, which, until they are satisfactorily correlated, may be called the *American Fork* formation, as they occur near the American Fork of the Musselshell River. They partly, perhaps entirely, surround the dome-shaped uplift of the underlying beds, and, of course, dip away from the center of the uplift. Here the sandstones weather into ridges and the shales into long depressions or ravines. The outcropping sandstones on some of the ledges break into long regular slabs, which are sometimes long enough for fence rails. The color of the shales comprises several dark shades. I understand that some vertebrate remains have been found in these beds. If this be true, they should be of special interest. In the upper portion of the beds sandstone predominates. The beds may or may not prove to be of Dakota age. The whole series is several hundred feet in thickness.

THE FORT BENTON FORMATION.

The Fish-Creek Region. — The Fort Benton beds are well developed in the region of Fish Creek. Immediately overlying the uppermost sandstones of the preceding formation are shales and sandstones. In the shales are brown concretions, in some of which large specimens of *Prionocyclus* were found. At a higher level in a bank of dark clay on Mud Creek, large ammonites, large specimens of *Inoceramus* (probably *I. exogyroides* Meek and Hayden), *Scaphites*, *Baculites*, and *Serpulæ* were found. In the dark clays or shales there are harder, more ferruginous bands. As the overlying Eagle sandstones are approached the deposits become more arenaceous. Here the beds weather into ravines between the sandstones below and above.

Hatcher and Stanton consider as most reasonable the view that the Benton "of the western section includes the representatives of both the so-called Fort Benton and the Niobrara of the eastern section." [10]

The Benton in Other Localities. — On the South Fork of Sixteen Mile Creek, the Benton Beds are somewhat different from those just described. They consist principally of dark shales and hard greenish-gray sandstones. There are, near the bottom, one or more bands, several feet in thickness, of rotten limestone crowded with shells of mollusca. The beds are much disturbed, sometimes standing vertically, or nearly so. Apparently they are quite thick, though no measurements were made. Fossils occur in the limestones, shales, and sandstones. This locality was visited in 1901 by the present writer and numerous fossils were obtained, among which are the following: [11]

Inoceramus undabundus Meek and Hayden.
Pinna lakesi ? White.
Pholadomya papyracea ? Meek and Hayden.
Scholenbachia shoshonensis (Meek).
Scaphites ventricosus Meek and Hayden.
Astropecten ? montanus Douglass.
Linuparus canadensis Whiteaves.
Ostrea ?
Exogyra.
Cucullæa.
Turritella.

EAGLE AND CLAGGETT BEDS.

Fish Creek Region. — The Eagle and Claggett beds have been described by Hatcher and Stanton,[12] who consider these, the Judith River, and the Bearpaw Shales as members of the Montana, but leave the question open whether, "the Pierre fills all the space corresponding to that occupied by" these four formations.

In tracing the overlying Judith River beds to the southeastward from the exposure between Fish Creek and Mud Creek, I observed, on the Big Coulee Creek, vast outcrops of sandstones lying in a nearly

[10] "Geology and Paleontology of the Judith River Beds," Bull. No. 257, U. S. Geological Survey, p. 64.

[11] "*Astropecten ? montanus* — A New Star Fish from the Fort Benton, etc.," ANNALS CARNEGIE MUSEUM, Vol. II, No. 1, pp. 5–8.

[12] "Geology and Paleontology of the Judith River Beds," U. S. Geol. Surv. Bull. No. 257.

horizontal position, and extending northeastward beyond the range of vision. These are probably, in part at least, the Eagle Sandstones, and the locality would furnish a favorable opportunity to study the deposits.

THE JUDITH RIVER BEDS.

Fish Creek Area, etc. — These have been so carefully studied and so well described by Hatcher and Stanton that I cannot add much to the observations of these gentlemen. In 1905 I observed a good exposure near the head of Fish Creek north of Melville and northeast of Porcupine Butte. This is the most western locality in which I have seen these beds in the southern portion of Montana. Like the other formations exposed here, the outcrop extends in an easterly direction, the rocks becoming less and less disturbed at greater distances from the mountains. The Judith River beds are exposed along the Great Northern Railroad, for a distance, if my memory serves me rightly, of over a hundred miles east of Havre.

THE FISH CREEK BEDS.

The Fish Creek Area. — In the region of Fish Creek, the gray beds, which are darker and contain more carbonaceous matter toward the top, are overlaid by a series of alternating dark shales and hard laminated sandstones. They are lithologically different from both the light-colored Judith River beds below and the Bearpaw shales above. The shales contain much carbonaceous matter and fragmentary plant impressions, while more perfect fossil leaves were found in the sandstones. Hatcher and Stanton do not fully describe these beds. I am not able to say whether they are marine or non-marine, but judge that they are in a sense transitional between the Judith River beds and the marine Bearpaw shales. They sometimes resemble the upper portions of the Bearpaw shales, but they contain more sandstone. They were included in what I originally denominated the "Fish Creek Beds," the lower portion of which have been correlated with the Judith River formation. Instead of giving these beds a new name to distinguish them from the Judith River below and the Bearpaw shales above, I think it better to restrict the name Fish Creek to this formation. This horizon is best exposed north of the bad-land exposure of the Judith River on the Crawford ranch between Fish Creek and Mud Creek.[13] It is also well exposed in the Lake Basin about thirty miles

[13] See Hatcher and Stanton's Bulletin on the Judith River Beds, p. 59.

to the southeast of this locality. I judge that they are nearly as thick as the Judith River deposits.

PIERRE FORMATION: BEARPAW SHALES.

Fish Creek Area. — Overlying the Fish Creek beds in the Fish Creek section, are the Pierre (Bearpaw) shales. These, according to Hatcher and Stanton, do not differ in lithological characters from the typical Pierre, but they are much thinner than in the typical locality and in the region farther south, where their deposition was probably in part contemporaneous with that of a portion of the beds, which underlie the Bearpaw shales in Montana. The invertebrate fauna is practically the same as that of the typical Pierre; but, in addition to this, the deposits contain vertebrates such as mosasaurs, *Trachodon*, and other dinosaurs. In excavating for dinosaurs, thin films of coal and plant remains, including leaves of *Sequoia*, were found. The occurrence of the reptilian remains is very different from that in the Judith River. In the latter whole bones and fragments are very numerous, sometimes a few bones of the skeleton being associated. In the Pierre shales skeletal remains are not numerous, but when found it often appears that nearly the whole animal had originally been buried. There are, however, some isolated bones in the Pierre. Several large portions of skeletons were found by Mr. Silberling and the present writer. These were secured for the Princeton Museum and the University of Montana. In searching for fossils in these beds one must violate, to a certain extent, the usual rules. The shales weather into low flats, low rounded hills and shallow ravines. The bones may be found among the grass roots on the sides or tops of the hills, or along the little ravines. Most of the country can be reached with horses and wagon, and nearly all of it on horseback, yet one may easily overlook a good skeleton which shows nothing on the surface except a few fragments of bones.

The general trend of the outcrop of the Pierre in this region is northwest and southeast. It weathers into depressions between the ridges formed by the Eagle, Claggett, and Judith River beds on the one side, and the Fox Hills (?) and Laramie on the other. In some places the depression is narrow, where the dip of the rock is greater, but it broadens into flats and undulating prairies, where it is more nearly horizontal. I have traced these beds from near the upper branches of Fish Creek to the Lake Basin, a distance of forty or fifty miles.

THE FOX HILLS (?)

Conditions are such that the upper continuation of the Bearpaw shales is not usually well exposed in the Fish Creek section. On Mr. B. Forsythe's ranch, on a branch of Big Coulee Creek, and in the bluffs northeast of Columbus they can be studied to advantage. The dark shales become more arenaceous, at least there are more layers of sandstone. Near Columbus these beds contain some brown concretions in which are marine fossils. I do not know that these have been specifically determined, but am inclined to think that they are Fox Hill species. In the two localities above mentioned the dark shales and shaly sandstones end rather abruptly and are overlaid, perhaps unconformably, by heavy gray sandstones. Near McClatchy's house on Fish Creek a few fossil mollusca were found in the sandstones.

LARAMIE AND DOUBTFUL LARAMIE.

Fish Creek Section. — The thick series of strata between the gray sandstones, just referred provisionally to the Fox Hills, and the Fort Union beds, may be divided temporarily, for convenience of description, into five lithological divisions. The total thickness must be several thousands of feet.

A. Dark shales, sandy shales, and sandstones, sometimes weathering into something like bad-land forms. They contain in almost every good exposure bones of dinosaurs, such as *Triceratops* and probably *Trachodon*. They are well exposed (*a*) northwest of the McClatchy house on Fish Creek, (*b*) south of the Lake Basin, and (*c*) north of Columbus, on the road from Columbus to the Lake Basin.

B. Sandstones and some shale. The sandstones, at least in part, are dark, sometimes iron-stained, and occur in rather thin layers. In places they are gray. A and B and the doubtful Fox Hills might be united.

The Fox Hill sandstones, and A and B of the Laramie, form a prominent ridge, which can be traced southeastward from near the American Fork, south of Harlowton, a distance of sixty miles or more into the southern part of Yellowstone County, where it forms the southern rim of the Lake Basin. The beds composing the ridge dip strongly to the southward in the more western portion near the mountains, but in the region north of Columbus they are more nearly horizontal, dipping slightly to the south.

C. Rather soft gray sandstones alternating with various colored shales (green, brown, etc.). These beds are many hundreds of feet in thickness. I do not know that any fossils have been found in them, neither am I sure that I have observed this series in any other region except near Fish Creek.

D. Gray sandstones harder than those of C, and gray clays or soft shales. In the shales, impressions of delicate plants were obtained.

E. Dark clays and soft shales, hard laminated sandstones, and two or more thin layers or lenses of limestone containing clams and fresh-water gasteropods. These are the beds, which in another portion of the present paper I have mentioned as occurring west of Sweetgrass Creek in the region northeast of Big Timber.

These beds A, B, C, D, and E are all well exposed on the road from the McClatchy ranch to Melville and Big Timber. A and B form part of the ridge through which Fish Creek cuts at the McClatchy house, C forms the first large slope toward Bear Butte, D forms the steeper slope, and E the high benches, ridges and depressions east and north of Bear Butte. The strike of the beds here changes from north of west and south of east to a more nearly northwest and south-east direction, therefore the dip changes from nearly south to a more westerly direction.

These beds, on account of their stratigraphic position, must be referred in part to the Laramie. The lower portion contains a Ceratops fauna. As is often the case, the exact upper and lower limits are uncertain. A portion of the series may have been contemporaneous in origin with the Livingston formation, but the rocks, so far as I have observed, shows no signs of volcanic activity during the deposition of the beds, unless it be the possible presence in them of volcanic ash.

CRETACEOUS IN OTHER PORTIONS OF MONTANA.

With regard to the Cretaceous of eastern Montana, my personal observations will not permit me to give any positive statements. In the western portion I have observed the Cretaceous in many places, in fact in nearly all of the larger valleys of the mountainous region except two or three of the most western, but fossils are not usually abundant, though some good collections might be made at the expense of diligent and continued search. There are excellent exposures in the following localities: (1) north of Logan extending into the Horseshoe Hills, (2) on the western flanks of the Madison and Tobacco Root Ranges, (3) at the Continental Divide east of Monida, (4) in the Frying Pan Basin northwest of Dillon, and from there northward beyond Glendale in the Bighole Valley north of Dillon, and (5) on the Hell Gate River from Garrison to Drummond, besides innumerable other smaller exposures. On the Atlas Folios of the U. S. Geological Survey the strata have been mapped as Dakota and Montana-Colorado. Some of the best exposed, and apparently the most persistent and widely distributed Cretaceous rocks, are the laminated and thick-bedded limestones which everywhere contain multitudes of fresh-water mollusca, especially gasteropods. These usually occur near the bottom of the Cretaceous series and have been referred to the Dakota. Other strata are marine, but there is apparently a considerable difference between the Cretaceous of the mountain region and that of the plains.

THE FORT UNION BEDS.

The Fort Union beds of the Fish Creek locality have been described by the author in a former paper.[14] As previously stated in the present paper, I traced them over a quite large area from northeast of Big Timber to the region north of Melville.

The beds examined apparently comprise only a part of the series and probably correspond in part to the dark shales and bands of sandstone which underlie the heavy massive sandstones at Bear Butte on the Widdecombe Brothers' "Joe and Bill Ranch" near Fish Creek. The sandstones contain impressions of plants, and there are occasional thin beds of limestone containing fresh-water mollusca. The dark shales weather into fine particles, which are sometimes flaky, and they often contain bones of reptiles, *Champsosaurus*, etc. Bones of mammals are extremely rare.

The question arises: What relations exist between the Bear Butte beds, the so-called Fort Union near Glendive, the deposits of the bad-lands of the Little Missouri, and the typical Fort Union beds near the mouth of the Yellowstone River. The Bear Butte beds differ somewhat in appearance from the deposits near Glendive, as they contain more hard material (sandstones, etc.) yet there is much similarity. Professor L. F. Ward made collections of fossil plants in the Glendive beds, and he believed that collections from various localities represented different horizons.[15] The Little Missouri beds are much

[14] "A Cretaceous and Lower Tertiary Section, etc.," *Proc. Amer. Philos. Soc.*, Vol. XLVI, No. 170.

[15] "Flora of the Laramie Group," Sixth Annual Report of the U. S. Geological Survey, p. 542.

different in appearance from those of Glendive and Bear Butte. Though I have not visited the typical locality of the Fort Union near the mouth of the Yellowstone River, I have read nearly all the descriptions of them by travellers and geologists, and these accounts lead me to infer that the lithological characters of the strata at the typical locality are nearly the same as those of the Little Missouri beds, and that parts of the same series might be traced from one locality to the other.

Fossil plants have been collected in all the above named localities and all have been pronounced by experts to be of Fort Union age ; but on account of the absence of good collections from the various horizons of the Eocene, which have been sharply distinguished by their successive mammalian faunas, it is uncertain just how many of the Eocene horizons are covered by the Fort Union. The Glendive beds apparently lie beneath the Little Missouri beds, and probably beneath the typical Fort Union. If the Bear Butte Beds — which are certainly Lower Eocene, as they contain Torrejon, and perhaps Puerco mammals — are nearly or quite contemporaneous with the Glendive beds, it is quite possible that the Little Missouri strata, and the typical Fort Union may be contemporaneous with the Wasatch, or may possibly be later. I understand that plants have been found in the Wasatch of the Big Horn Basin. If so comparisons of the fossil floras will be interesting. Remains of reptiles have been found in the Bear Butte and Glendive beds, but they have not yet been made available for determining horizons.

The subject is a large and interesting one, and will probably involve not only the collection and study of the vertebrates as well as the plants of the northern beds, but the obtaining of collections of plants, as well as animal remains, from the Eocene and supposed Eocene beds of Wyoming, Utah, New Mexico, and other regions.

As thoroughly competent paleontologists and field-parties of the U. S. Geological Survey have taken up the task of settling some of the long standing problems of Upper Cretaceous and Lower Tertiary geology, I will, for the present, refrain from further discussion of the question. There is no doubt, however, that the Fort Union is entirely distinct from the Laramie, and there are apparently several horizons of the so-called Fort Union.

OTHER EOCENE DEPOSITS.

On Sage Creek northeast of Lima are exposures of Tertiary deposits, which, judging by the fragmentary mammalian fossils, appear to be partly of Eocene, partly of Oligocene, and partly of Miocene age. Those supposed to be of Eocene age are somewhat different in appearance from any other Tertiary deposits which I have seen. They are composed of sands and clays, and are distinctly stratified and banded. They contain remains of logs, which have been replaced by calcite crystals, calcified twigs, and vertical cylindrical cavities lined with crystals of quartz and calcite. One large geode, composed of encrusted crystals of quartz, crystals of calcite, etc., which has broken in pieces and strewn the rocks below, was found in the small exposures of this formation.[16]

OLIGOCENE DEPOSITS.

The restricted areas of Oligocene deposits, which overlie the Fort Union beds in western North Dakota, have not, so far as I am aware, been fully described. Professor Cope collected some fossils in the state in 1883. In a letter written from Sulley Springs is the following:

"The beds, which are unmistakably of the White River formation, consist of greenish sandstone, and sand-beds, of a combined thickness of about 100 feet. These rest on white calcareous clay, rocks and marls, of a total thickness of 100 feet. These probably also belong to the White River epoch, but contain no fossils. Below this deposit is a third bed of drab clay, which swells and cracks on exposure to weather, which rests on a thick bed of white and gray sand, more or less mixed with gravel. This bed, with the overlying clay, probably belongs to the Laramie period, as the beds lower in the series certainly do."[17]

The following is the list of fossils given by Cope:

Rhineastes sp. nov.
Aminurus sp. nov.
Trionyx, 2 species.
Stylemys.
Castor.
Galecynus gregarius.
Hoplophoneus, 2 species.

[16] For an account of the mammals of these beds see "New Vertebrates from the Montana Tertiary," ANNALS CARNEGIE MUSEUM, Vol. II, No. 2, 1903, p. 155.
[17] *Proc. Amer. Philos. Soc.*, XXI, Oct. 30, 1883, p. 216.

Aceratherium, 3 species.
Elotherium ramosum.
Hyopotamus.
Oreodon, 3 species.
Leptomeryx sp.
Hypertragulus.
A lacertilian.

With the exception of the upper 100 feet of sand-beds and greenish sandstones, the deposits at White Butte do not seem to correspond very closely with Cope's description, neither does the list of the vertebrates which I obtained exactly agree with his, though five or six genera are probably the same. Cope's collection, however, which is now the property of the American Museum of Natural History, is labelled "White Butte, Dakota." There is a White Butte in the northern part of South Dakota, about 60 miles southeast of White Butte, North Dakota. The latter is sometimes called "Chalk Butte."

Professor A. G. Leonard[18] has described an isolated remnant of what he thinks may be Tertiary deposits on the top of Sentinel Butte. He says that "similar beds occur on top of Slim Butte and Cave Hills, not far south of the North Dakota boundary, and on account of their fossils are considered by Todd as of Miocene age."[19]

While making a collection of vertebrate fossils at White Butte, and in the Little Bad Lands (not the Little Missouri Bad Lands), in 1905, the present writer studied these deposits quite carefully, so that they might be compared with deposits of the same or nearly the same age to the southward in South Dakota, Nebraska, Colorado, etc., and to the westward in Montana. The general appearance and topography of these beds is given in another portion of the present paper.

The western portion of White Butte is a long ridge dissected in two or three places by streams which have their origin between the eastern and western portions of the butte. Its northern portion is perhaps 300 feet higher than the surrounding plain and is broken into mounds, hogbacks, and broken flat-topped ridges, but, on account of the upward slope of the land, the ridge becomes relatively lower and lower until it dies out on the plain to the southward. The northern and lower portions of the butte are composed of Fort Union deposits

[18] Third Biennial Report of the North Dakota Geological Survey, 1903 and 1904, pp. 172–173.

[19] See South Dakota Geological Survey, Bull. No. 2, p. 62.

while the upper portion is lower Oligocene. The eastern portion of the butte is a much dissected ridge or line of buttes, which begins near the middle of the eastern portion of the western ridge and trends to the southeastward, leaving a basin between the two portions. The eastern part is composed of lower, middle, and upper White River beds.

The following section is from the eastern slope of the eastern portion of the butte. I did not find the contact here between the Fort Union and the White River, but began measurement at one of the lowest Oligocene exposures. This section reaches upward only to the basal portion of the Upper White River beds.

SECTION OF WHITE RIVER BEDS AT WHITE BUTTE, NORTH DAKOTA.
(From above downward.)

	9. Gray sand probably with a mixture of volcanic ash.	6 ft.
Middle White River.	8. Clay or other fine material	3 ft.
	7. Cream-colored fine sandy clay	1 ft.
	6. Nodular Oreodon beds, clay, gray to light cream-colored on surface, darker cream-colored inside. Nodules brownish, cellular, sometimes containing bones, especially in lower portion. Beds sparingly fossiliferous from top to bottom. *Ictops*, *Ischyromys*, *Palæolagus*, *Merycoidodon culbertsoni*, *Leptomeryx evansi*, *Mesohippus*, *Hyracodon*, *Aceratherium*, etc	35 ft.
	5. A band of rock which weathers gray on the surface, becoming more nearly cream-colored toward the top at the base of the Oreodon beds. Some thin layers are very compact. Bones black. *Merycoidodon*, etc	15 ft.
	4*c*. A mixture of hard and soft rock (silicious clay) weathering into tough, compact masses.	
	4*b*. Rock tough with one seam containing nodules of barite.	
	4*a*. Rock white or gray at bottom, with imperfectly horizontal fractures or division planes	25–30 ft.
Lower White River.	3. Yellowish sand with fine and coarse grains mixed with clay and having a slightly saline (?) taste. White on weathered surfaces. When the coloring matter and the fine clay are washed out it leaves a very clean sand, composed principally of clear quartz grains, which have been imperfectly rounded by the action of wind or water..	80 ft.
	2. Thinly and horizontally laminated clay, fine grit, and gray sandstone. The lighter laminæ are	

Lower White River.

light gray, the darker of a bluish tint. These laminæ alternate irregularly on the weathered surface; they also unconformably overlie the brownish sand beneath. At the bottom of a trough-like depression there are two or three thin bands of iron-stained material about ⅛ inch in thickness. In tracing the deposit upward it was sometimes seen to be laminated and sometimes massive. Part of it is a gray sandstone, and the structure makes it appear as as if part of the mass had been deposited in an uneven surface of the other portion. Scattered over the surface of the darker gray portion are fragments of petrified wood, rounded pebbles of white quartz, granite, granitic rock without mica, gray, bluish-gray, brown, and reddish quartzite of compact texture, and gray, brown, reddish, purplish, and bluish cellular pebbles, some of which look like volcanic material, but are mostly granular rock, some of the crystals of which have been dissolved. These fragments vary in size from that of fine sand to large pebbles, some of which are six inches in diameter. There are also flat, flinty fragments, which contain impressions of plants.............. 35 ft.

1. Lowest exposure found at this place. A brownish iron-stained homogeneous sand with small, brown, concretionary masses. Upper surface not level, but having depressions filled with No. 2 .... 5 ft. +

Total thickness of section............................ 210 ft.

Another section from another locality on White Butte partly supplements the one just given, as it extends upward through the Upper White River beds. Its lowest member corresponds with No. 5 of the preceding section, beginning with the top of the Titanotherium beds and extending upward through the Oreodon and overlying beds as high as they are exposed at White Butte.

SECTION OF UPPER PORTION OF WESTERN RIDGE OF WHITE BUTTE.
(From above downward.)

13. Green sand, mostly unconsolidated, gray sand, shale, and fragments of bones........................ 18 ft.

12. Green sand. Fragments of bones of Rhinoceroses, etc. .... 8 ft.

11. Green sandstone, unequally hardened, so that it

Upper Figure. Part of the Eastern Portion of White Butte from the Eastern Side.
Lower Figure. Part of the Eastern Portion of White Butte. The Lower Rounded Slopes are Lower White River Beds, the Steeper Slopes Middle White River Beds, and the Sandstone Cap probably is the Upper White River Formation.

Upper White River.	contains irregular cavities (weathered pits) and root-like rods	8 ft.
	10. Green sand with some nodules, gray on surface near top	38 ft.
	9. Gray shale, hard in places, sometimes greenish in color. Bones of Rhinoceros	24 ft.
	8. "Rubbly" sandstone in rounded, egg-shaped forms	4 ft.
	7. Harder sandstone than No. 6	5 ft.
	6. Fine greenish sand and clay, in one stratum cracking vertically. Some imperfect horizontal parting planes	12 ft.
	5. Green sand with sandstone concretions	6 ft.
	4. Green and gray clay shales	6 in.
Middle White River "Oreodon" Beds.	3. Fine gray sand, with some clay. *Merycoidodonts*, *Hyracodonts*, *Mesohippus*, etc.	12 ft.
	2. Pinkish gray clay with brown cellular nodules. "Oreodon" Beds — *Ictops*, *Gymnoptychus*, *Eumys*, *Ischyromys*, *Palæolagus*, *Mesohippus*, *Hyracodon*, *Aceratherium*, *Merycoidodonts*, *Leptomeryx*, etc.	32 ft.
Lower White River Beds.	1. Tough sandy clay with appearance of stratification, without brown nodules, but containing a few remains of *Merycoidodonts*. Probably belongs to "Oreodon" horizon	6–8 ft.
	Total thickness of section	163 ft.
	Total thickness of Tertiary beds at White Butte about	320 ft.

The Oreodon beds have nearly the same appearance wherever exposed, but the overlying beds are more variable, and probably no two sections would be just alike. The Oreodon beds at White Butte are not rich in mammalian remains, and most of the fossils are fragmentary, though in one place three skulls with portions of skeletons of *Merycoidodon*, and a skull with part of a skeleton of *Ictops* were found. In No. 3 of the last section, portions of the skulls of *Merycoidodonts* were obtained, but probably of different species from those of the nodular beds. No. 5 contains many remains of rhinoceroses. Two good skulls were found, which have been referred to *Aceratherium tridactylum*. Some fragments of bones and teeth of reptiles and mammals, including jaws of rodents and the tooth of a crocodile, were found in No. 6. Fragments of bones were found in most of the higher horizons.

Below is given a section of the Oligocene strata in the Little Bad Lands southwest of Dickinson. It will be seen that it does not exactly correspond with the sections at White Butte.

SECTIONS OF WHITE RIVER BEDS IN THE LITTLE BAD LANDS, NORTH DAKOTA.

Upper White River.	7. Quite hard gray sandstone	10 ft.
	6. Gray clays and shales graduating vertically and horizontally into sandstones, which crack horizontally, but do not show distinct planes of stratification. Some sandy concrétions in places. Rhinoceros bones in sandstone. In clayey beds near bottom, *Merycoidodonts* with large bullæ, *Mesohippus*, lizards, etc.	40–50 ft.
	5. Pink clay, sometimes sandy, with brown nodules as in No. 2 below	5–10 ft.
	4. Stratified sandstones and sandy clays	10–15 ft.
	3. Greenish band. Character of rock much the same as No. 2, except in color	2–3 ft.
Middle White River.	2. Clays, pink on weathering, containing brown nodules, which on exposure to the atmosphere become cellular on account of the removal of softer particles; these nodules were numerous near top and bottom. In the lowest portion, in some places, are large concretionary masses of barite. The lower third is the most fossiliferous band in the series and contains many skulls and other bones of *Ictops*, *Ischyromys*, *Palæolagus*, *Mesohippus*, *Rhinoceros*, *Hyracodon*, *Merycoidodon culbertsoni*, *Leptomeryx*, *Poëbrotherium* and others. The *Merycoidodonts*, so far as observed, have small tympanic bullæ. Fossils both in nodules and clay. In the upper third are turtles and a few remains of mammals, *Rhinoceros*, *Hyracodon* (?) and *Eucrotaphus dickinsonensis* with large tympanic bullæ	50–60 ft.
Lower White River.	1. Gray to almost white sands and sandy clay containing considerable silicified material near the top and many rounded and smooth water-worn pebbles and brown iron-stained concretions in the lowest exposures. The sand grains are usually pure, clear white quartz. Exposure something like forty or fifty feet in thickness	40–50 ft.
	In the lower portion of No. 1 fragments of bone and fossil wood were found. Among the former are scutes of crocodiles.	
	Total thickness of section	nearly 200 ft.

The Lower White River deposits extend for a considerable distance east and northeast of the Little Bad Lands. On superficial examination I judged that the Lower White River beds extended northward to the region west and north of Dickinson, but I may be mistaken in this. The region has recently been more carefully examined by a member of the North Dakota Geological Survey and probably a report on this region will soon be published. East of the Little Bad Lands are clusters of hills, apparently composed of Lower White River deposits. They rise to a greater height than the exposure of the middle and upper beds. The lithological character of the beds changes in the direction of Dickinson; whether this is due to local differences at the time of deposition, or whether lower levels are exposed, is difficult to determine. I had supposed that the deposits near Dickinson, from which the Dickinson Brick Company gets its clay, to be lower Oligocene, but from the leaves which were collected there, Professor Knowlton judges them to be Eocene.

There is presumptive evidence that the White River formations in North Dakota represent the deposits made in an old river valley traversed by streams which had their origin in the region of the Black Hills. The Lower White River beds both at White Butte and in the Little Bad Lands, contain in places granite and quartzite pebbles, some of the latter of which are quite large, two or more inches in diameter. A large portion of the deposits consist of clear white quartz sand evidently derived from the decomposition of granitic rock. A very large proportion of the upper beds is also sand, but deposited under different conditions, for where the sands are consolidated into sandstone the cementing material is often green, undoubtedly on account of the presence of iron. White River deposits have now been certainly identified in the Little Bad Lands about 160 miles north of the Black Hills and at White Butte about 30 miles nearer. Professor J. E. Todd, of the South Dakota Geological Survey, has found what he believed to be "Miocene" (White River and Loup Fork) deposits on the Cave Hills nearly 40 miles, and on Slim Buttes 55 or 60 miles, nearer the mountains, also on Short Pine Hills and on Deers Ears Hills.[20] Mr. O. A. Peterson informs me that in the region north of the Black Hills there are areas of coarse sand and gravel of Lower White River age.

[20] See South Dakota Geological Survey, Bull. No. 2, p. 60. On page 17 of this bulletin Professor Todd says: "Two important geological discoveries were made: First, a development of White River and Loup Fork Formations, 300 or 400 feet in thickness about Slim Buttes, and traces of them were found in the upper portion of most of the buttes of the region."

The Lower White River beds in North Dakota, at least some of them, resemble portions of the beds of nearly the same age in Montana ; but the Middle White River is different in appearance in the two places.

It is evident that the later Tertiary deposits in Montana accumulated in various ways (as water-borne sediments and wind-blown dust accumulating in lakes, marshes, and streams, and as sheet-wash and flood-plain deposits, etc.), in large river valleys excavated in later Eocene times.

I have little doubt that the upper Tertiary deposits in North Dakota were also deposited in broad valleys of erosion. Much of the material of the deposits came from areas of granite and quartzite rock. In the region of the Black Hills are the only outcrops of these rocks for hundreds of miles ; this, connected with the fact that a series of remains of Oligocene deposits have been observed to extend from Dickinson to the Black Hills, suggests the probability that a river formerly flowed from the Black Hills northeastward through this region. If this be true, there should be coarse sediments as the mountains are approached, which is probably the case. Another thing, which tends to confirm the idea that these are river-valley deposits, is the fact that, scattered over the plains, there are buttes apparently as high as White Butte, but which are not capped by later Tertiary beds. However this may be, it will undoubtedly be possible to trace approximately the courses of some of these ancient rivers eastward from the Cordilleran region.

Apparently the Middle White River was deposited after considerable erosion of the Lower White River. I have not seen much evidence of erosion of the Middle White River (Oreodon) beds, previous to the deposition of the Upper White River, but the latter was evidently accumulated under more complex conditions, portions of the deposits being eroded and refilled with stream-deposits, etc. In the Little Bad-lands in one place what appears to be the channel of a river, or small stream, has been excavated in the clay, and afterward refilled with water-worn sand.

IX. A BOTANICAL SURVEY OF PRESQUE ISLE, ERIE COUNTY, PENNSYLVANIA.[1]

By Otto E. Jennings.

(Plates XXII–LI.)

Introductory.

The peninsula of Presque Isle at Erie, Pennsylvania, is in many respects one of the most interesting localities in the western part of that state. To the botanist it affords unexcelled opportunities for collecting and for field-studies, and, indeed, there is probably nowhere else about Lake Erie a locality, where undisturbed vegetation may be studied as at Presque Isle.

Detailed studies of the bird-life of Presque Isle having been made under the auspices of the Carnegie Museum,[2] it was determined that the plant-life of the peninsula should also be investigated. Accordingly the writer made a series of trips to the place, collecting and making field-studies on the following dates: May 15–17, June 9–11, and August 24–26, 1905; May 8–10, June 5–7, and September 20–22, 1906. The collections thus made were critically studied in the laboratory, as were also the collections in the Herbarium of the Carnegie Museum made at Presque Isle by Professor Gustave Guttenberg in 1878–1880, while connected with the Erie High School; and the collections made on Presque Isle by Dr. John A. Shafer, September 9–11, 1900, while connected with the Carnegie Museum.

The hearty thanks of the author are here due to Dr. W. J. Holland, the Director of the Carnegie Museum, for his ready approval of the plans of the author in this work and for his editorial supervision of the manuscript; to the United States War Department at Washington for permission to use certain early maps and charts of Presque Isle, and to

[1] Paper presented as one of the requirements for the degree of doctor of philosophy in the University of Pittsburgh.

[2] Todd, W. E. Clyde. "The Birds of Erie and Presque Isle, Erie County, Pennsylvania." Ann. Car. Mus., Vol. II, pp. 481–596, 1904. To the introduction of this article the reader is referred for a brief general description of Presque Isle and its larger vegetational features.

Mr. J. G. Sanders, of Washington, for having made tracings of these maps and charts; to Mr. George H. Fenkell, Engineer of the City Water Works of Erie, and to Mr. Andrew W. Shaw, Keeper of the Presque Isle Light, for many courtesies, which added to the success and pleasure of the work. For the lettering of the maps the author is indebted to Mr. Sidney Prentice, to whom also are due many thanks for suggestions and assistance in preparing the drawings and photographs, which, unless otherwise indicated, are the work of the author, assisted by Mrs. O. E. Jennings.

In matters pertaining to botanical nomenclature the author has endeavored to the best of his ability to keep this article thoroughly in accord with recent discoveries and advances, while at the same time the effort has been made to adhere consistently to the principle of priority as maintained in the amended Philadelphia Code of Botanical Nomenclature, published in 1907.

THE PHYSIOGRAPHIC ORIGIN OF PRESQUE ISLE.

Although the larger associations of plants, such as those of the desert, the prairie, open forests, and dense forests, are to be correlated with certain general climatic conditions, it is no less evident that the smaller associations of more restricted areas, such as societies and formations, and the sequence of formations in a succession, are to be correlated with local physiographic conditions.

It is thus evident that the best knowledge of the ecological associations of a locality is only to be obtained in connection with physiographic studies, including such factors as the composition of the soil, physical and chemical; moisture of the soil; topography; etc. Cowles[3] has been one of the first of a rapidly widening circle of ecologists in America to carry on extended studies of the vegetation of a region from the standpoint of "physiographic ecology," *i. e.*, considering the vegetation of a region as the natural expression of its physiography.

The topography and development of lake-shores has been the subject of very careful investigation,[4] especially in the case of the Great

[3] Cowles, H. C. "The Ecological Relations of the Vegetation of the Sand Dunes of Lake Michigan." *Bot. Gaz.*, 27: 95–117, 167–202, 281–308, and 361–391, February, March, April, and May, 1899.

[4] Gilbert, G. K. "Topographic Features of Lake Shores." U. S. Geol. Surv., Ann. Rpt., 5: 69–123, 1884. And Russell, I. C. "Lakes of North America," 1895.

Lakes, and from certain general principles thus ascertained the origin and growth of a peninsula such as Presque Isle is easily understood.

By far the most potent factors in determining the topography of lake-shores are waves and currents. In Lake Erie the amount of inflow and outflow is hardly to be considered as a factor in the production of currents, because of the relatively very broad expanse of the basin of the lake and the action of other more powerful factors, but investigations undertaken by the United States Weather Bureau[5] have shown that there is a system of currents, the general trend of which is east through the North Passage and thence southeast towards the shore from the vicinity of Lorain eastward. The currents must evidently be due to the action of the prevailing winds, especially the more severe storms. The larger axis of Lake Erie lies almost directly in the normal path of cyclonic storms[6] and, as the bed of the lake is comparatively shallow, the wave-action thus produced is particularly strong, resulting in pronounced currents.

There is also a considerable shifting of the waters from one end of the lake to the other, due to barometric pressures. The barometric pressure often varies an inch within the length of Lake Erie and, when this factor acts in conjunction with high winds, considerable fluctuations may occur in the height of the water. Fluctuations of as much as fifteen feet have been noted within the space of a few days at the eastern end of the lake.[7]

When waves from the west break upon the shelving beach of the southern shore of Lake Erie, there is near the shore a movement of water towards the beach, and, as the angle of incidence is oblique, there is a tendency for the wave to retreat as an undertow towards the northeast. The usual result is that there is formed close to the shore a current running northeastward, parallel to the shore. To such littoral currents we may in a general way attribute the formation of Presque Isle.

It has been found that in deep water the lateral movement due to a wave is very slight, but when approaching shore the friction on the bottom increases, so that the upper part of the wave finally topples over, forming a breaker. Much of the force of the wave is here ex-

[5] Russell, I. C. "Lakes of North America," pp. 32–33, 1895.

[6] United States Weather Bureau. "Climatic Charts of the United States. Chart No. 4, 1904."

[7] Russell, I. C. *l. c.*, p. 34.

pended, and during the impact of the water upon the bottom, as the wave topples over, the sand or gravel may be knocked and churned about to a considerable extent. From the breaker the water rushes quickly landward and then more slowly recedes, carrying the sand and gravel forward and backward, but, owing to the establishment of a certain equilibrium between the greater shoreward thrust and the combined weaker outward flow and the action of gravitation there results a more or less constant slope of the beach.

The ordinary littoral current unaided would not be strong enough to transport any considerable amount of coarser material, but in the line of the breakers there is a suspension of more or less of the coarser sand and gravel at the impact of each breaking wave, and the littoral current may thus cause a lateral displacement of the debris during its suspension in the water. In this manner there may occur a gradual drifting of shore debris along the line of the breakers, the material being replaced from the upper parts of the beach as fast as it is carried away.

From the mouth of the Vermilion River, Ohio, eastward to Dunkirk, New York, a total distance of about one hundred and sixty miles, the immediate shore of Lake Erie consists of the soft blue Devonian shale, named by Dr. Newberry the Erie Shale,[8] covered with a varying thickness of drift-clay, thus constituting an easily eroded shore-line favorable to the formation of a typical beach. In the vicinity of Cleveland, Ohio, "The mean recession of a line of prominent sea-cliffs in boulder clay, for a period of forty years, has been about six feet per annum."[9]

There is thus a large amount of beach debris annually taken into the waters of Lake Erie from this region and almost the entire shore of Lake Erie from Sandusky Bay eastward presents a typical beach of sand or gravel, strewn here and there with boulders from the drift-clay above. Such a beach under the action of suitable currents will develop the various beach structures, as barriers, terraces, bars, spits, hooks, loops, etc.

The littoral current, following the line of agitation of the surf-line, may deviate from this course in three ways. It may (*a*) cut across bays, etc., and join the surf-line again at the other side, forming a "spit," "hook," "bar," or "loop." It may (*b*) leave as a surface-

[8] Newberry, J. S. "Geological Survey of Ohio. Report I." Pp. 163–167, 1873.

[9] Russell, I. C. *l. c.*, p. 61.

current, or, (*c*) as a bottom-current, in either case depositing its load as a "terrace." Presque Isle has, evidently, been initially formed as a spit somewhere along the shore farther to the west and has been slowly shifting its position to the east. It is claimed[10] that at about 1800 A. D., a sand beach extended from the mouth of the run, one mile west of the present "head" of the peninsula, and from there the peninsula jutted out. A long narrow pond extended from the bay between the peninsula and the mainland and as late as 1840 scows were run in there from the bay for firewood. At that time the peninsula was said to be much wider at the western end than it is now.

As now constituted Presque Isle is to be regarded as mainly the joint product of four natural agencies somewhat modified in certain particulars by man: (1) A littoral spit-forming current deviating from the surf-line; (2) Conflicting currents tending to turn the spit inward, thus forming a recurved spit or hook; (3) The ridge-forming surf of great storms from north and northeast; (4) The soil-accumulating and soil-binding effect of the vegetation, aided by the drifting power of the wind.

Under the prevailing westerly winds there is a constant movement of the beach-debris towards the east, both in the littoral current, as before mentioned, and on the beach higher up. The breaking wave as it rushes obliquely up the beach carries many particles of sand and pebbles with it and, retreating obliquely in the other direction, leaves them often several inches to the east of their former position. During a moderate surf on one occasion, with the waves striking the beach at an angle, the writer observed rounded flat pebbles of about an inch in diameter moving eastward in this manner. The marked pebbles were not shifted with each wave but occasionally they would be shifted a foot or more at one time, the general average during some twenty minutes of observation being one and a half inches per wave. Under such conditions it thus appears that certain of the looser, more exposed pebbles would be transported the surprising distance of about fifteen hundred feet in twenty-four hours, provided, of course, that the pebbles remained in the same relative position on a uniform beach.

The general tendency during prevailing westerly winds is for this shifting beach-debris to be deposited at the extremity of the spit, as a

[10] Nelson, S. B. "Biographic Dictionary and Historical Reference Book of Erie County, Pa.," p. 426, 1896.

prolongation, but ordinarily there occur at irregular intervals conflicting currents due to northeast winds which carry the debris southward and tend to form a recurved spit or hook.

The most powerful agency, however, in the distribution of the beach-debris after it has reached this part of the peninsula is to be found in the surf of great northeast storms, which may pile the sand up in the form of beach-bars or ridges above and beyond the reach of the ordinary surf. In fact, it has been stated by Gilbert:[11] "The habit of the shore, including not only the maximum height of the beach-line and the height of its profile, but the dimensions of the wave-cut terrace and of other wave products, is determined by and adjusted to the great storms." [12]

The ridges and bars built up during the great northeastern storms will, of course, have a general direction parallel to the waves producing them, as will also necessarily be the case with the lagoons between the bars and the shore. As will be shown later, the damp banks of the newly formed lagoon may give rise to long lines of vegetation, along which, especially the woody species, the wind-driven beach-sand will accumulate, and, being held by sand-binding vegetation, will eventually form the great transverse ridges, which are topographically so characteristic a feature of Presque Isle.

THE HISTORICAL DEVELOPMENT AND PROBABLE AGE OF PRESQUE ISLE.

At the mouth of Sandusky Bay, towards the western end of Lake Erie, there is a peninsula, Cedar Point, the terminal portion of which very closely resembles Presque Isle in its general topography and mode of formation. The vegetation is also in many respects very similar. With respect to the physiographic development of the peninsula of Cedar Point, Professor E. L. Moseley has pointed out [13] that the succession of vegetational formations, taken in conjunction with certain historical records, furnishes a means of approximating

[11] Gilbert, G. K. *l. c.*, p. 89.

[12] The carrying power of the currents varies with the sixth power of the velocity, and the height of the waves is proportional to the square root of the distance through which they are propagated unimpeded. From this it may be seen that the effects produced upon the loose beach sand of the exposed outer extremity of the peninsula during the occasional great north or northeast storms may be very great indeed.

[13] Moseley, E. L. "Formation of Sandusky Bay and Cedar Point." *Proc. Ohio State Acad. Science*, 4: 179–238. (Thirteenth Ann. Rpt.) 1904.

the ages of various topographic structures, as well as of tracing their origin and development.

According to Moseley's classification the peninsula of Cedar Point consists of three portions: the bar, the dune-section, and the ridge-section. The dune or middle section represents a higher portion of the former mainland, now covered by sand, which reached farther out into the lake and formed a continuous coast-line with the mainland farther to the southeast. With the differential tilting of the lake basin, however, most of this portion of the mainland was inundated, leaving the dune-section more or less completely an island. A sand-bar soon connected this section with the mainland again to the south-east, thus constituting "the bar." This bar has been gradually shifted back over and upon the marsh behind it, as, especially, during the high water of 1858–1862.

This bar was evidently formed mainly by a swirl from the main lake current passing the islands, the rotation being from left to right and thus sweeping the beach-debris from the mainland at the mouth of the Huron River towards the dune-section. Eventually the sand accumulated sufficiently to begin the formation of a sand-spit at the northern extremity of the dune-section, the accumulating sand being heaped into long narrow ridges or bars by the exceptional action of high surf during great northeast storms, especially in periods of high water in the lake. The further growth of the ridges was due to the accumulation and retention of drifting sand by the vegetation growing upon them or along their sides.

The ridge-section of Cedar Point is about half a mile wide and in its middle portion are eight distinct ridges separated by long narrow depressions. These ridges are very similar indeed to those of Presque Isle. The latter, however, are considerably larger and wider, although scarcely higher.

The ridges of Cedar Point have been designated by Moseley by the numbers, 1 to 8, from the oldest to the most recent. Ridge No. 8 is about four feet in height above Lake Erie, and its vegetation consists of partially buried cottonwoods together with a few willows. The cottonwoods showed five rings of annual growth and the ridge is supposed to have been thrown up about 1897 or 1898. The jetty at the end of the peninsula, begun in 1896, probably offered an obstruction, and resulted in the accumulation of the sand forming this ridge. Cottonwoods under such conditions as obtain at Cedar Point or at

Presque Isle are seldom able to establish themselves around a lagoon, which has been separated from the lake for more than two or three years, so that the age of the cottonwoods will indicate very closely the age of the bar and its enclosed lagoon.

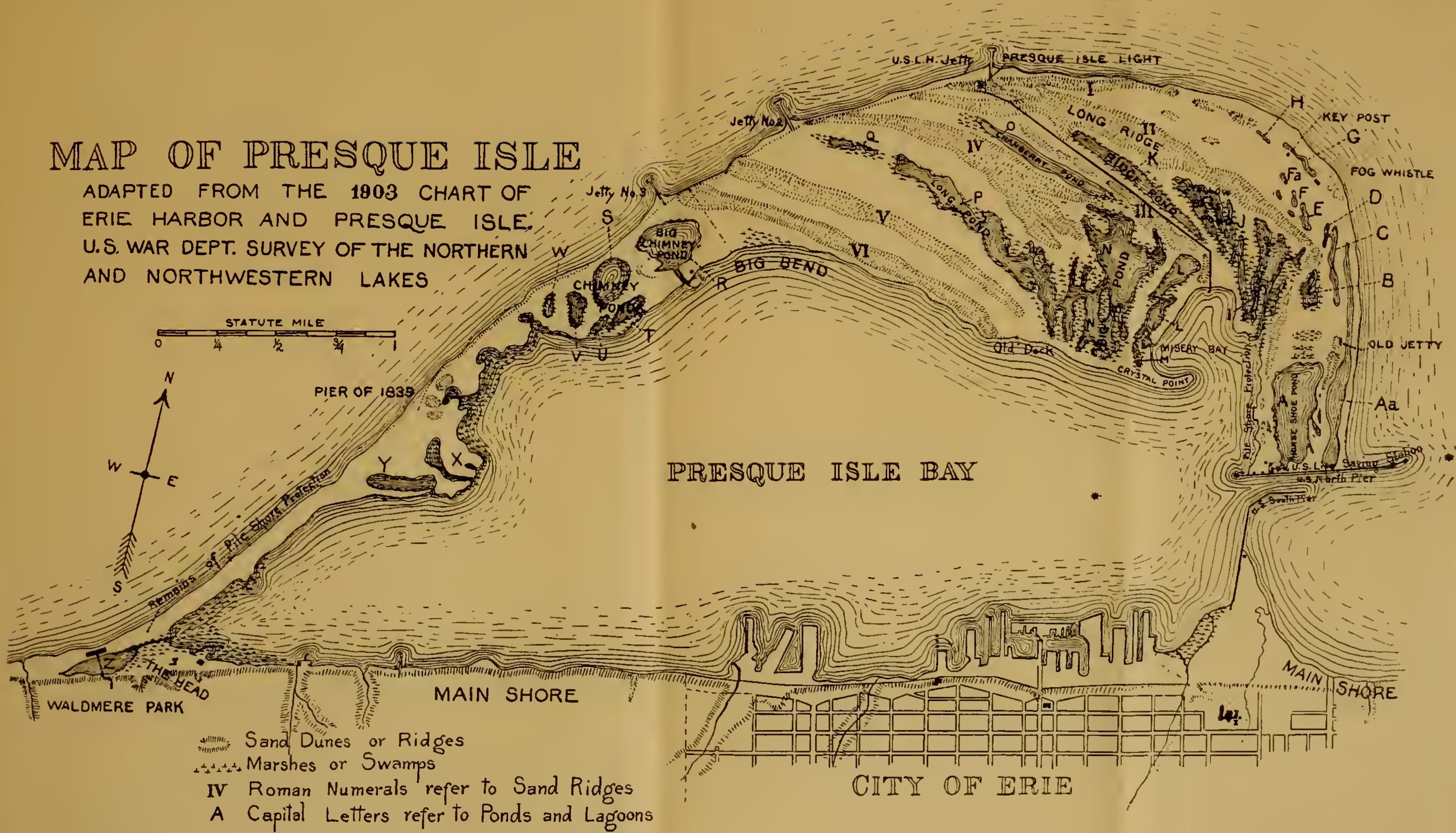
Ridge No. 7 at Cedar Point rises to a height of from twelve to sixteen feet above the lake, and from the age of the largest cottonwood Moseley concludes the ridge to have been formed by a great northeast storm, which occurred on September 11, 1878, or the one which occurred on August 15, 1879. Probably both contributed to the making of the ridge. Ridge No. 6 is also dominated by cottonwoods. It rises to a height of nineteen feet above the lake, and must have been formed by northeast storms during the very high water of 1858 to 1862. Among the other plants on this ridge were found several red cedars, ten feet or less in height, and, as the cottonwoods are short-lived trees, Moseley based his records of the age of the older ridges mainly upon the data furnished by the cedars, assuming from indications on the ridge-section, on the bar-section, and on the Marblehead spit, that the ridges were nearly or quite forty years old before cedars started to grow upon them.

Following these methods Moseley calculates the approximate dates of formation of the various older ridges as follows: Ridge No. 5, A. D. 1724; Ridge No. 4, A. D. 1684; Ridge No. 3, A. D. 1594; Ridge No. 2, A. D. 1504 (this ridge showing a cedar stump cut probably sixty-five years ago at an age of about two hundred and ninety-seven years); Ridge No. 1, A. D. 1429.

Following much the same methods for Presque Isle as did Moseley for Cedar Point, the writer found that there is considerable similarity in the probable ages of certain corresponding ridges on the two peninsulas. The probability is that most of the great northeast storms which affected Cedar Point also affected Presque Isle.

The bar between lagoon "Aa" and Lake Erie (see map of Presque Isle, Plate XXII, 218) was evidently formed about 1902–3, some of the little cottonwoods around the banks of the lagoon being in their fourth year in 1906. This structure is not shown on the Lake Survey Chart of Erie Harbor and Presque Isle, as issued in 1903.

Between "Aa" and "C," on the banks of "C," are cottonwoods which were three inches in maximum diameter in 1906. The lagoon "C" was thus likely cut off from the lake in 1894 or 1895. Between "C" and "D," along the shores of the latter, are cottonwoods with


MAP OF PRESQUE ISLE
ADAPTED FROM THE 1903 CHART OF
ERIE HARBOR AND PRESQUE ISLE.
U.S. WAR DEPT. SURVEY OF THE NORTHERN
AND NORTHWESTERN LAKES
STATUTE MILE
0 ¼ ½ ¾ 1
N
W
E
S
PIER OF 1839
U.S.L.H. Jetty
PRESQUE ISLE LIGHT
Jetty No. 2
Jetty No. 3
LONG RIDGE
LONG POND
CRANBERRY POND
RIDGE POND
BIG CHIMNEY POND
CHIMNEY POND
BIG BEND
KEY POST
FOG WHISTLE
OLD JETTY
Old Dock
MISERY BAY
CRYSTAL POINT
HORSE SHOE POND
U.S. Life Saving Station
U.S. North Pier
South Pier
Remains of Pile Shore Protection
Pile Shore Protection
PRESQUE ISLE BAY
THE HEAD
WALDMERE PARK
MAIN SHORE
MAIN SHORE
CITY OF ERIE
Sand Dunes or Ridges
Marshes or Swamps
IV Roman Numerals refer to Sand Ridges
A Capital Letters refer to Ponds and Lagoons

A SCHEMATIC CLASSIFICATION OF THE VEGETATIONAL FORMATIONS OF PRESQUE ISLE.

— PRIMARY SUCCESSIONS —

I. The Beach—Sand Plain—Heath—Forest Succession.

A.—Beach Stage.	B.—Sand Plain Stage.	C.—Heath Stage.	D.—Pine Forest Stage.	E.—Oak Forest Stage.
Chlamydomonas Formation *Cakile-Xanthium* Formation	.....*Artemisia-Panicum* Formation	.........*Arctostaphylos-Juniperus* Formation	...*Pinus Strobus* Formation	................*Quercus velutina* Formation.

II. The Beach—Sand Plain—Thicket—Forest Succession.

A.—Beach Stage.	B.—Sand Plain Stage.	C.—Thicket Stage.	D.—Cherry Forest Stage.	E.—Oak Forest Stage.
Chlamydomonas Formation *Cakile-Xanthium* Formation	.....*Artemisia-Panicum* Formation	.........*Myrica Thicket* Formation	..............*Prunus serotina* Formation	..............*Quercus velutina* Formation.

III. The Dune—Thicket—Forest Succession.

A.—Dune or Ridge Stage.	B.—Thicket or Heath Stage.	C.—Cherry or Pine Forest Stage.	D.—Oak Forest Stage.
1.—*Populus* Dune or Ridge 2.—*Ammophila* Dune 3.—*Andropogon* Dune 4.—*Prunus pumila* Dune	either *Toxicodendron* Formation................ or ..... *Arctostaphylos-Juniperus*	*Prunus serotina* Formation *Pinus Strobus* Formation	........*Quercus velutina* Formation.

IV. The Lagoon—Marsh—Thicket—Forest Succession.

Stage A.	Stage B.	Stage C.	Stage D.	Stage E.
Potamogeton Formation..............	*Potamogeton* Formation	...........*Potamogeton* Formation	................*Potamogeton* Formation	..............*Potamogeton* Formation. *Nymphæa* Formation.
			Scirpus-Typha Formation	..............*Scirpus-Typha* Formation.
	Juncus-Eleocharis Formation	*Scirpus-Typha* Formation.................	*Sabbatia-Linum* Formation	..............*Cladium-Calamagrostis* Formation.
		Sabbatia-Linum Formation	*Myrica-Salix* Formation	.. ..*Myrica-Salix* Formation.
Populus-Salix Formation	*Populus-Salix* Formation	...........*Populus-Salix* Formation	*Populus-Salix* Formation	............*Populus-Salix* Formation.

Stage F.	Stage G.	Stage H.	Stage I.
...(*Potamogeton* Formation)	...... *Potamogeton* Formation	..... *Potamogeton* Formation	.....*Potamogeton* Formation.
...(*Nymphæa* Formation)	...... *Nymphæa* Formation	..... *Castalia-Nymphæa* Formation	......*Castalia-Nymphæa* Formation.
			Decodon-Persicaria Formation.
... *Scirpus-Typha* Formation	...... *Scirpus-Typha* Formation	..... *Cephalanthus-Cornus* Formation	*Cephalanthus-Cornus* Formation.
... *Cladium-Calamagrostis* Form.:.....	*Cladium-Calamagrostis* Formation	[*Sphagnum-Oxycoccus* Formation]	
	[*Fragaria-Polytrichum* Formation]	[*Aronia-Polytrichum* Formation]	
... *Rhus-Alnus* Formation	...... *Rhus-Alnus* Formation	*Rhus-Alnus* Formation	......*Rhus-Alnus* Formation.
... *Populus-Salix* Formation	...... *Prunus-Acer* Formation	..... *Prunus-Acer* Formation	......*Ulmus-Acer* Formation.

V. The Bay—Marsh—Thicket—Forest Successions.

1. The Marsh Habitat.

Stage A.	Stage B.
Scirpus Formation *Salix discolor-lucida* Formation *Solidago-Meibomia* Formation	*Scirpus* Formation *Phragmites-Typha* Formation *Cladium-Calamagrostis* Form. *Rhus-Alnus* Formation *Ulmus-Acer* Formation

2. The Cove Habitat.

Chara Formation
Potamogeton Formation
Castalia-Nymphæa Formation
Phragmites-Typha Formation
Rhus-Alnus Formation
Ulmus-Acer Formation

3. The Driftwood Habitat.

Potamogeton Formation.
Scirpus-Typha Formation.
Sagittaria-Alisma Formation.
Salix discolor-lucida Formation.
(or *Cladium-Calamagrostis* Formation.)

Secondary Successions.

A.—The Burn Succession.

B.—The Pasture Succession.

a maximum diameter of three and a half inches, so that "D" and its ridge are little, if indeed any, older than "C" and its ridge.

Around "E" and "F" the largest of the cottonwoods are almost ten inches in diameter and we must probably regard them as having started in 1882 or 1883. Probably the bar was thrown up by the great storm of 1882 mentioned by Moseley.[14]

Immediately to the east of the Presque Isle Light, which was established in 1872, there branches off from the beginning of the "Long Ridge" a well defined ridge, which is now being washed away by the lake about half a mile from the Light House Jetty. This ridge reaches a height of about twenty-one feet above the lake at this point and from there continues for about a mile towards the Fog Whistle, becoming lower and broken towards the east. One of the largest of the cottonwoods which form the backbone of the ridge has been undermined by the lake and toppled over. Where it had been cut to free the Light House telephone wire it had twenty-six annual rings of growth. This ridge evidently was finished, as far as the work of the waves was concerned, about 1878; it was formed, perhaps, by the same storm which formed Ridge No. 5 at Cedar Point (see Plate XXXVII).

"Long Ridge" on Presque Isle begins a short distance west of the Presque Isle Light, and runs nearly due east for almost two miles. Near its middle it has a maximum width of about nine hundred feet, narrowing towards each end. At the eastern extremity it bends sharply to the south and continues somewhat brokenly for another mile. At its western end the ridge can be seen to be made up of three distinct components, which, however, immediately lose their identity towards the east, although the alignment of the cottonwoods would indicate formerly separate ridges. Long Ridge has an estimated height of twenty or more feet above the lake, and rises often to a height of seven and a half or eight feet above the neighboring sand-plain. It is everywhere covered with cottonwoods, and much red cedar and white pine at the western end. The largest of the cottonwoods, on the north side of the ridge, measured twenty-two inches in diameter, while towards the south side of the ridge the cottonwoods are older and appear to be dying out. This inner (south) side of the ridge, next to Yellow Bass Pond, has red cedars up to eight inches in maximum diameter, while, in the depression near the union of Long Ridge with the outer ridge, there is a clump of white pines reaching a maximum diameter of fourteen inches.

[14] Moseley, E. L. *l. c.*, p. 182.

A sketch of Presque Isle made by J. S. Brown, September 30, 1837, shows, (Fig. 3) the eastern boundary of the peninsula to have been situated at the present position of the eastern part of Long Ridge, including the part running south towards the old U. S. Pier. A survey made in 1817 and 1818 by Lieutenant H. W. Bayfield (Fig. 2) indicated roughly a line of dunes around the northern and northeastern

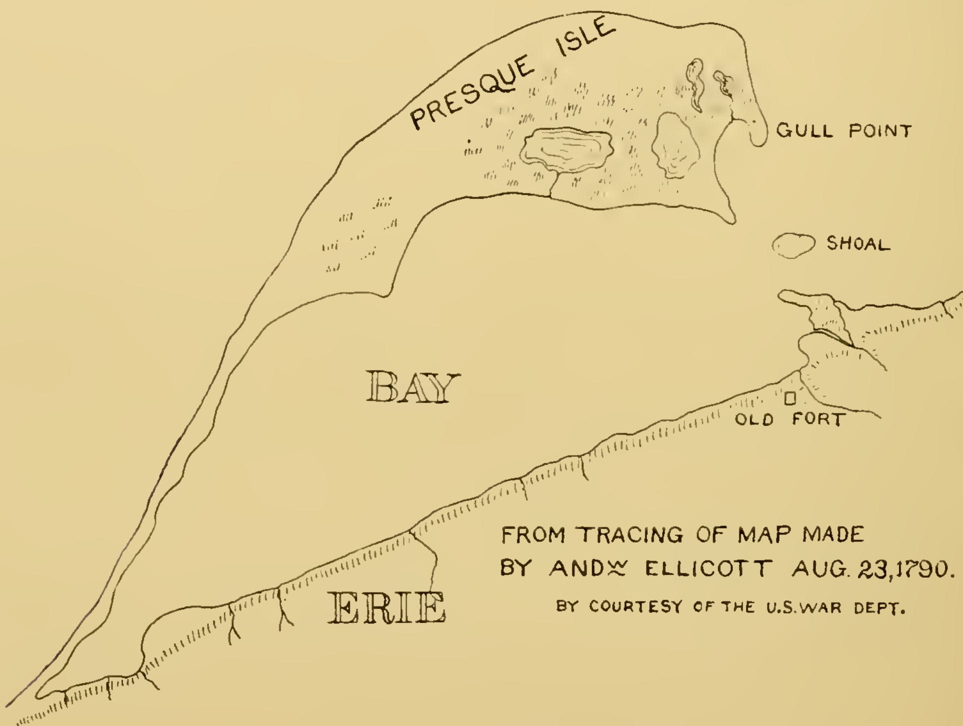


FIG. 1. Presque Isle, 1790.

shores of the peninsula, the shore-line (approximately the present inner border of Long Ridge) terminating in a small sand-spit which evidently later developed into the low ridge between Yellow Bass Pond and Niagara Pond.

Low water prevailed in Lake Erie in 1817 and 1818, but 1838 marked the climax of a period of very high water (575.11 feet above sea-level[15]) the mean water level then being 4½ feet higher than in 1808.[16] The survey of 1837 marks the sand as accumulating all along

[15] "Appendix EEE. Ann. Report Chief of Engineers, U. S. War Dept. Survey of Northern and Northwestern Lakes." 1905 : 2782.

[16] Nelson, S. B. *l. c.*, 1896. Leaving out of account an annual oscillation of about one foot in the mean water-level of Lake Erie, there have been periods of high water-level in 1812–1813, 1838, and 1858; and periods of low water in 1808, 1818, 1834, and 1895.

the eastern third of the lake shore of the peninsula so that it may be assumed that at least the interior part of Long Ridge was permanently established during the period of high water of 1838, and that the northern part was formed considerably later, probably during the high water of 1858 to 1862. A survey of the peninsula, made by John de La Camp in 1866, shows the outline of the ridge practically the same as at present, considerable sandy plain having accumulated along the western half, but towards the east it is separated from the lake by

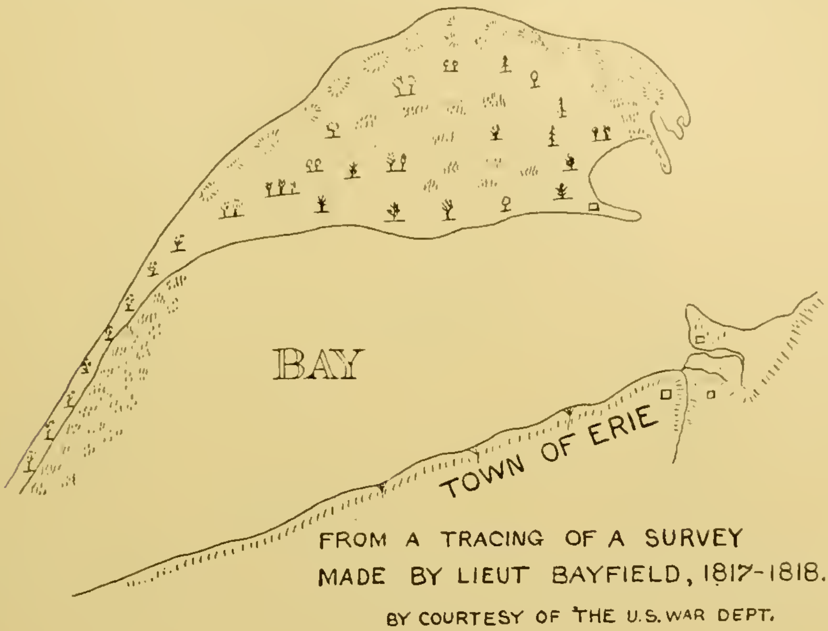


FIG. 2. Presque Isle, 1818.

merely a narrow beach. A projecting recurved spit at the point where the ridge turns abruptly to the south is evidently to be recognized to-day in the low narrow ridge which nearly divides the marsh "B." At this place are cottonwoods sixteen inches or more in diameter, thus indicating an age of at least thirty years.

The oldest of the three components of Long Ridge projects considerably to the west of Cranberry Pond and was somewhat eroded by the lake prior to the erection of the Light House Jetty. This ridge is covered by an almost pure white pine forest, the oldest of the trees having reached a diameter of seventeen to eighteen inches, breast high. This would indicate their age to be from one hundred and forty to one hundred and fifty years, and, allowing forty years for the starting of the pines, as will be explained shortly, the age of this part of the ridge would thus be about one hundred and eighty-five years, and would be thus correlated with Ridge No. 5 at Cedar Point.

The ridge formed at this time may have been the basis for the present dividing strip between Yellow Bass and Ridge Ponds, although sand did not accumulate sufficiently to form a high ridge. There are white pines here indicating a considerably greater age for this strip than is indicated by the vegetation on the narrowing part of the ridge immediately to the north of Yellow Bass Pond.

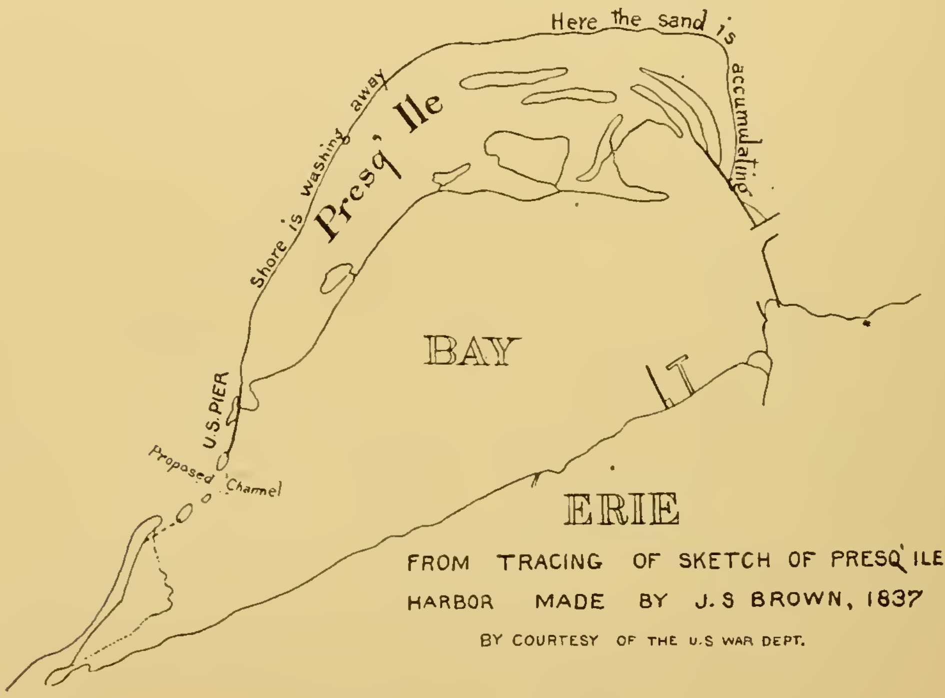


FIG. 3. Presque Isle, 1837.

According to the above considerations the younger portion, at least, of Long Ridge is to be regarded as the counterpart of Ridge No. 6 on Cedar Point. In this connection, however, it may be noted that the latter ridge consists of two more or less distinct components and it may be possible that this ridge, like Long Ridge at Presque Isle, may have been partially the product of storms during the period of high water in 1838.

Between Ridge and Cranberry Ponds there is a rather broken sand ridge showing some recent dune-formation towards its eastern end. The vegetation was evidently considerably disturbed during the building of the Board Walk, both by fire and ax, but towards the west there is considerable white pine forest mixed with black cherry and some young black oak. The largest of the pines are now losing their lower limbs and have a maximum diameter, breast high, of nearly twenty inches, thus indicating a probable age of about two hundred and twenty years for this part of the peninsula and correlating it with Ridge No. 4 at Cedar Point.

Between Cranberry and Long Ponds there is a large ridge (IV), which, beginning near Jetty No. 2, runs slightly north of east for about a mile and a quarter, widening towards the east to about eighty rods. This ridge, at least towards the eastern end, is composed of three distinct components, the identity of the individual components

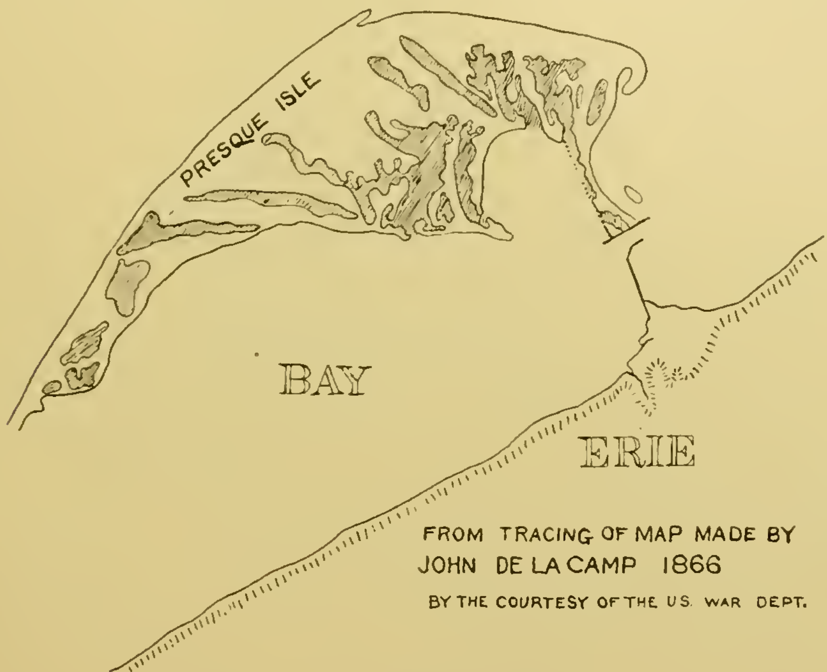


FIG. 4. Presque Isle, 1866.

having been largely obscured by the drifting of the sand and the formation of numerous dunes. The whole ridge is now covered by a dense forest consisting of black oak, white pine, cottonwood, black cherry, white ash, etc. Between Graveyard Pond (L) and Big Pond (N) there stands a cottonwood five feet and seven inches in diameter, breast high, and, comparing this with the fallen cottonwood one hundred and eleven inches in circumference which Moseley found to be about one hundred and fifty years old, the age of this tree may be estimated at approximately two hundred and seventy years. From its position and the mode of the formation of the peninsula there can be little doubt that the land between Graveyard (L) and Big Ponds is of considerably later formation than is the ridge.

Moseley found that a ridge must have been formed "nearly or quite forty years before cedars started to grow on it." On Presque Isle the sand-plain, which had accumulated outside of the western end of Long Ridge immediately prior to the survey of 1866, now supports red cedars up to two inches in diameter and at least fifteen years old. Little plants of this species from four to five years old have in several instances been found under cottonwoods having a diameter of eleven or twelve inches, and thus it appears that on Presque Isle also cedars may become established somewhere between thirty-five and forty years after the formation of the soil. White pines appear with cottonwoods but very slightly older than those under which the first cedars may appear, and they evidently may become established on soil not more than forty years old.

The dense group of white pines at the edge of the western end of Long Ridge (see Plate XXIV) occupies ground formed probably at about the same time as the older portion of the ridge, and which was not particularly disturbed during the initiation of the younger portion of the ridge. The largest of these pines are about fourteen inches in diameter, but, having grown in an open stand, are low and bushy and are probably not more than thirty-five years old,[17] so that their age corresponds quite well with the estimated age of this portion of the peninsula.

On the ridge between Cranberry and Long Ponds the dominant tree in the forest is the black oak. The white pines, mainly confined to the northern (older) side of the ridge, have mostly reached old age and are dying out, many of them having reached a diameter of twenty-six to thirty inches. One old pine was noted near Cranberry Pond with a diameter, breast high, of thirty-eight inches. Taking into consideration the porous sandy soil, the conditions of open stand prevailing during the early years of the forest, and the uniform climatic conditions, it appears probable that the trees are from two hundred and sixty to two hundred and seventy years old, and this, in turn, would indicate for the younger part of the ridge an age of about three hundred years, correlating it with Ridge No. 3, at Cedar Point, which is also apparently a compound ridge. The composition of the forest is in

[17] Spalding, V. M., and Fernow, B. E. "The White Pine." U. S. Dept. Agr., Division of Forestry, Bull. 22: 29. 1899.

Pinus Strobus invading *Panicum-Artemisia* formation near the west end of Long Ridge. Dead *Myrica* and *Alnus* under *Pinus*, and *Juniperus* under shelter of cottonwoods to the left. Photographed May 8, 1906.

Near Jetty No. 3, showing the truncated end of Ridge 6 and the *Quercus velutina* forest formation being undermined. Photographed June 10, 1906.

both cases a vigorous black oak forest with white pines, which have reached old age.

The southern side of this ridge next to Long Pond is covered with an almost pure black oak forest, many of the trees being twenty-four inches or more in diameter, although relatively low and bushy. This part of the ridge likely corresponds to Ridge No. 2, at Cedar Point, dating from approximately 1500 A. D.

The two narrow ridges between Long Pond and Big Chimney Pond are each about one and one half miles long, about one eighth of a mile apart, and run parallel to each other almost due east and west. These ridges are covered by a mature black oak forest, some of the trees having reached old age and fallen. Trees were noted with a diameter of at least forty-six inches. The shallow trough between the ridges has also a few large elms. The youngest of these ridges may correspond to the oldest ridge on Cedar Point, which Moseley notes as having "many large black oak, American elm and other trees." A rough estimate would place the age of this ridge at not far from five hundred years and the age of the oldest ridge at about fifty years more. The sandy soil is covered with about two inches of humus and there are a few clumps of hemlock trees up to five inches in diameter.

The land surrounding the Chimney Ponds is probably still older and it is not improbable that it once extended farther to the west like that portion of the peninsula immediately to the northeast. The younger ridges on the peninsula curve to the southwest, in conformity with the shore-line as the lake is approached, the middle and the eastern portions of the ridges being comparatively straight. The two ridges between Long Pond and Big Chimney Pond, however, have been washed away by the lake, their cross-sections now standing out in bold relief along the lake front. (See Plates XXV and XXXIII.) It is known that prior to the erection of the jetties this part of the peninsula was being rapidly washed away. It is stated[18] that a chart dated 1819, as compared with a map of 1878, shows a retrogression of some 1,500 feet in about three miles of the shore line of the neck of the peninsula, but that from 1865 to 1895 the shore line had been comparatively stationary. Reconstructing the curved ends of the ridges it is seen that the land now surrounding the Chimney Ponds may have extended at least half a mile out into the lake to the west. This, together with the known former attachment of the peninsula

[18] Nelson, S. B. *l. c.*, p. 417.

to the mainland farther to the southwest, would indicate a gradual shifting of the whole peninsula along the coast to the northeast. The circular Chimney Ponds have thus evidently been derived from bodies of water, like those in the vicinity of Misery Bay, created by the wearing away of the main body of the peninsula to the west, and the subsequent piling up around them of sand by the wind. The present indications are that, unless the eroding and land-building forces are kept in check by man, history will repeat itself, and that in perhaps another six hundred years, the present wider portion of the peninsula will have been washed away to form new land farther to the east, and Misery Bay and Horse Shoe Pond will have been transformed into counterparts of the present Chimney Ponds, with the main body of the peninsula stretching away to the northeast of them.

The forest covering in the vicinity of the Chimney Ponds is indicative of considerable age, as it consists of large white elms, white ashes, black oaks, cucumber trees, sassafras trees, etc., and between V and S there is considerable hemlock, one tree being fourteen inches in diameter. The sandy soil is covered with humus, in places more than three inches deep. This portion of the peninsula is surely not less than six hundred years old.

That portion of Presque Isle between the Chimney Ponds and the "Head," as the junction of the peninsula with the mainland is called, has been changed very greatly from time to time within the last century. "The neck or west side in 1812 was two or three hundred feet in width," [19] and "it is said that in 1821 the peninsula was covered with timber from the mainland, at the head, to its southeastern point." [20] During the winter of 1828–1829 the lake broke through the narrow portion near the Head, but the Government promptly closed the breach. During the winter of 1832–1833, however, another breach occurred at the same point and this widened each year till in 1835 it was nearly a mile wide. From 1836–1839 about 3,500 feet of crib-breakwater was constructed as a protection to a proposed harbor entrance at this point, but the work was finally discontinued. In 1831 vessels drawing 7½ feet of water passed through the opening. In 1844 the gap was 3,000 feet wide and some crib-work was erected. In 1853–1856 brush and stone were used, and in 1864 the gap was reported closed by the drifting sand, although exceptionally heavy seas

[19] Sanford, L. G. "History of Erie County, Pa.," p. 250, 1894.

[20] Nelson, S. B. *l. c.*, p. 415.

still broke over into the bay. During a gale in 1874 a breach occurred, but this was promptly closed and bulk-head protections built.

During the winter of 1881–1882, in 1892–1893, and again in 1905–1906, the waves have washed over the the neck but no real breach has occurred. During 1905–1906, however, there was considerable erosion of the neck, especially behind the old pile-protection (see Map, Plate XXII). In places the beach receded at least thirty feet.

The shoaling of the bay inside the neck is progressing quite rapidly and, although the outer shore may wash away, it is probable that the neck of the peninsula will be simply shifted to the east instead of being entirely swept away. It has been stated that this section of the peninsula is increasing in mass below the water's edge, although the part above the water remains about the same, the distance between the twelve and fifteen feet depth contours, outside and inside being, in 1878, about double what it was in 1839.[21]

From the above considerations it is to be seen that the main portion of the neck of the peninsula is of approximately the same age as is much of the sand-plain to the northeast of the Long Ridge and, as will be shown later, its vegetation for this reason is also very similar to that of the sand-plain.

THE ECOLOGICAL STRUCTURE AND DEVELOPMENT OF THE VEGETATION OF PRESQUE ISLE.

General Considerations.

All plants are intimately related to more or less definite conditions of environment. These conditions are not always plainly evident, but each species exists within an environment characterized by definite biological and physical features.

In nature any given area always presents more or less constant and definite conditions of environment. Such local conditions will necessarily correspond more nearly to the environment required by some species than by others, and thus there will arise in the vegetation as a whole a grouping and localization of certain species.

The unit of vegetation is the *formation*. Plants are everywhere found associated; their association being the joint result of reproduction and the conditions of environment. To quote Clements:[22] "Association in its largest expression, vegetation, is essentially

[21] Nelson, S. B. *l. c.*, p. 417.

[22] Clements, F. E. "Research Methods in Ecology," p. 202, 1905.

heterogeneous, while in those areas which possess physical or biological definiteness, habitats, and vegetation centers, it is relatively homogeneous. This fundamental peculiarity has given us the concept of the formation, an area of vegetation, or a particular association, which is homogeneous within itself, and at the same time essentially different from contiguous areas, though falling into a phylogenetic series with some and a biological series with others. From its nature, the plant-formation is to be considered the logical unit of vegetation, though it is not, of course, the simplest example of association."

In newly formed areas of soil, no formation is likely to be permanent for any considerable length of time, for there will be changes in the environment, which will render the area less suitable to the plants occupying it than to certain other plants; or, if not really rendered unsuitable for the former, the conditions may become such that other plants may occupy the area and crowd them out by *competition*. Certain recent investigations[23] have shown that certain highly toxic secretions may be given off by many species of plants, these toxic secretions being poisonous in each case to different species to a different extent.

By *succession* the ecologist refers to the successive appearance and replacement of different formations in a given area. In such a process *invasion* is followed by a *reaction* upon the habitat. This reaction may result in the replacement of one formation by another representing a later *stage* in the succession. A *normal succession* begins with a *habitat* bare of plants (*nudation*) and ends with the more or less permanent occupation of the habitat (*stabilization*) by a formation designated as the *climax-formation* of the succession. *Normal successions* begin with new soils in *primary successions*, or with *denuded* soils in *secondary successions*. In a primary succession with a new soil the conditions are evidently not suitable for a luxuriant vegetation; usually such successions consist of many stages and reach stabilization very slowly as compared with a secondary succession.[24]

In the discussion of the structure of the vegetation of a given area,

[23] Schreiner, Oswald, and Reed, Howard S. "Some Factors Influencing Soil Fertility." U. S. Dept. Agr., Bureau Soils, Bull. 40: 1–40. 1907. And Livingston, B. E. "Further Studies on the Properties of Unproductive Soils." U. S. Dept. Agr., Bureau of Soils, Bull. 36: 1–71. 1907.

[24] For a further elucidation of the ecological terms used in this article the reader is referred to Clements, F. E. "Research Methods in Ecology," Lincoln, Nebraska, 1905.

obviously the most logical method of procedure is to trace the development from the initial formation, through the successive stages to the climax-formation. By this "developmental method" the structure and the correlations of the individual associations, of whatever rank, and the continuity of the succession, as a whole, can be discussed side by side and in a logical and natural manner. Where, however, but few stages of the succession are in evidence the treatment of the vegetational associations from the standpoint of habitat is, of course, much simpler; it may be difficult or even impossible to ascertain the whole succession.

Presque Isle offers exceptional opportunities for a developmental study of the vegetation. In the course of not more than five miles there is a continuous series of formations representing stages in several different successions, the climax-stages having been reached in a couple of the successions, at least in those where the habitat represents an age of between five and six hundreds of years. For these reasons it has been deemed best to follow the developmental method in the discussion of the ecological structure of the vegetation.

Ecology, as at present understood, is largely a development of the last decade. Warming's ecological plant geography [25] was the first successful systematic classification of the ecological plant-formations of the world. His classification was based mainly upon the watery content of the soil, the "Societies" being either hydrophytic, mesophytic, xerophytic, or halophytic. Schimper in his great work [26] went a step farther and pointed out that halophytes are essentially xerophytes and that ecological associations are to be properly classified, not according to the physical watery content of the soil, but according to the physiological availability of this water for plants.

Following these classifications many workers have made detailed studies of generally more or less localized areas. Among these workers Cowles has recognized the importance of the developmental method of classification based upon physiography and has followed out this idea in his work on the sand-dunes of Lake Michigan [27] and on the

[25] Warming, E. "Plantesamfund," Copenhagen, 1895. (Knoblauch's German translation, Berlin, 1896.)

[26] Schimper, A. F. W. "Pflanzengeographie auf physiologischer Grundlage," Jena, 1898. (English translation by Fisher, Groom and Balfour, Oxford, 1903.)

[27] Cowles, H. C. "The Ecological Relations of the Vegetation of the Sand Dunes of Lake Michigan." *Bot. Gaz.*, 27: 95–117, 167–202, 281–303 and 361–391, February, March, April and May, 1899.

physiographic ecology of Chicago and vicinity.[28] More recently Clements has brought forward the idea that the ecological conditions of the habitat can be instrumentally determined, and the formation thus be designated as a definite structure.[29]

In his studies on Presque Isle the writer did not use instrumental methods, neither the time nor the instruments for such work being available. However, a season's residence on Presque Isle, following out the instrumental methods as proposed by Clements, would form the basis for a very valuable ecological contribution and it is hoped that sometime such a study may be carried on at this place. Nevertheless the ecological conditions obtaining in the various habitats on Presque Isle are so profoundly different, and these differences are so plainly apparent, the successions are so rapid, so condensed, and, at the same time, present so complete a series of stages, practically free from the destructive effects of civilization, that there seemed abundant reasons for a survey such as has been made. Such a survey, although perhaps more properly termed a reconnaissance, must, nevertheless, precede a more exact and detailed investigation, or, in the absence of further work in the near future, will stand as a valuable record of the present larger ecological structure.

Taking up now the structure of the formation, there are to be distinguished in the formation, at all times, one or more dominant species termed the *facies*. Associated with each facies are usually other prominent species, the whole group constituting a *consocies*. Areas, the appearance of which changes from one season to another, being dominated by principal species other than the facies, are termed *societies*, and the different seasonal periods *aspects*. The aggregation of parent and offspring constitutes a group termed the *family*, and the grouping of families forms a *community*.

No attempt has been made in the present contribution to use a Latin nomenclature for ecological structures. The successions have been designated by their important formations, and the formations and their minor structures by their facies or principal species respectively.

There has been, and still is, considerable confusion in ecological nomenclature, different authors having adopted the same term for

[28] Cowles, H. C. "The Physiographic Ecology of Chicago and Vicinity." *Bot. Gaz.*, 31 : 73-108, 145-182, February and March, 1901.

[29] Clements, F. E. *l. c.*

different structures, or different names for the same structures. As to synonymous terms, in recent ecological literature, *series* has often been used for *succession*, as herein defined, *society* for *formation*, and *association* for *consocies*.

Some ecologists will, perhaps, take exception to the rank of formation which has been herein accorded certain vegetational structures, especially in the Lagoon Succession, but the corresponding habitats appear, even without instrumental determination, to be so clearly distinct and their plant-life so plainly a definite and correlated structure as to merit the rank of formation.

THE BEACH-SAND PLAIN-HEATH-FOREST SUCCESSION.

A comparatively large part of the land area of Presque Isle is to be referred to this succession. It includes all of the more northern and lakeward portion of the peninsula, commencing a short distance northwest of the Key Post (see map) and extending west and southwest. This succession resembles very closely in many respects the Beach-sand Plain-Thicket-Forest Succession adjoining it immediately on the south and southeast, and probably should be regarded as a part of the same succession, which has a more xerophytic habitat, being exposed to the full force of the more violent and colder prevailing winds from the west and northwest, and on this account is invaded by certain formations from the Northern Coniferous Forest Centèr, of which more will be said later.

The Beach.

As stated in the discussion of the physiographic origin and development of the peninsula, the shore-line at the eastern end of the peninsula, within the area embraced in the succession under consideration, grows outward either by the direct accumulation of detritus upon the beach or by the formation of sandbars, behind which the shallow lagoons are often quickly filled with wind-driven sand. In either case the result is a wide stretch of beach, the sand of which when dry is readily blown about by the wind. This beach constitutes the same xerophytic structure so common along the shores of all the Great Lakes. The beach along the shores of Lake Michigan, so thoroughly studied by Cowles,[30] is practically duplicated here on Presque Isle, and, following Cowles' classification, there may be distinguished two habitats in the beach proper: the *Lower Beach* and the *Drift-Beach.*

[30] Cowles, H. C. *l. c.* *Bot. Gaz.*, 27 : 114–117, February, 1899.

The Lower Beach. — The *Chlamydomonas* Formation.

The lower beach extends from the ordinary shore-line back to the average highest point reached by the waves of the ordinary summer storms. At Presque Isle it occurs quite uniformly around the entire lake shore and much of the bay-shore. Essentially equivalent to this lower beach is MacMillan's "front strand,"[31] Schimper's "fore-shore"[32] and Cowles's "lower beach."[33]

At Presque Isle the lower beach is practically devoid of all plant-life of a permanent nature. Living fragments of *Vallisneria* and *Potamogeton* were often found half buried in the sand, and on one occasion, a rhizome of *Castalia* with living shoots, but none of these plants ever become established. During continued damp weather without high waves a motile single-celled alga, *Chlamydomonas* sp., occasionally appeared in the damp sand, causing a distinct green coloration. The same thing was observed by the writer in 1905 on the lower beach of Cedar Point, Ohio,[34] and was found also by Cowles[33] on the lower beach of Lake Michigan. As Cowles points out, the algæ being motile, can move about freely in the capillary water of the wet sand and it appears that they are really to be considered as migrants from the waters of the lake rather than as inhabitants of the beach.

The lower beach, as a habitat, offers very severe conditions for plant-life. When washed by the waves the habitat is, of course, truly hydrophytic, but when lying exposed to the sun in clear quiet weather, the sand, at least on the surface, becomes very dry and hot, extremely xerophytic, and these extreme conditions, taken together with the mechanical violence of the waves and the very unstable character of the soil, washed about by the waves when inundated, or in quiet weather becoming dry and being blown about by the wind, make establishment impossible for any of the plants of the region, aside from the alga mentioned.

[31] MacMillan, Conway. "Minnesota Botanical Studies — Observations on the Distribution of Plants along Shore of Lake of the Woods." Geol. & Nat. Hist. Survey Minn., Bull. 9: 969. 1897.

[32] Schimper, A. F. W. *l. c.*, p. 180.

[33] Cowles, H. C. *l. c.* *Bot. Gaz.*, 27: 113–115, February, 1899.

[34] Jennings, O. E. "An Ecological Classification of the Vegetation of Cedar Point." *Ohio Naturalist*, 8: 291–340, April, 1908.

Newly-formed bar between Aa and Lake Erie, looking south. This is now drift beach habitat, with *Cakile-Xanthium* formation, but the *Populus-Salix* formation is in evidence and a prominent sand-ridge may eventually form here. Photo. May 10, 1906.

The Drift-Beach. — *The Cakile-Xanthium* Formation.

The drift-beach (see Plate XXVI) extends from the upper limit of the lower beach, *i. e.*, the upper limit of the waves of summer storms, to the upper limit of the waves of winter storms. It thus comprises a zone immediately above the lower beach and differing from it in that it is not exposed to the mechanical violence of the surf during the growing season. Like the lower beach it is composed of loose, clean sand, but it is marked by a considerable accumulation of driftwood — whence its designation here as the *drift-beach*. This habitat is well developed at the eastern end of the peninsula and is quite well shown along the northern shore, except at the western end near the Head, where the shore is receding and the lower beach extends back to the base of a low vertical sand-cliff.

This drift-beach is essentially synonymous with MacMillan's "*mid-strand*,"[35] Schimper's "*mid-shore*,"[36] Cowles's "*middle beach*"[37] and Ganong's "*new beach*."[38]

The drift-beach, at least in its surface layers, constitutes an extremely xerophytic habitat. The loose white sand is exposed to the full force of wind and sun and the surface at times becomes very dry and hot, but as quickly loses its heat when insolation ceases. The water-table is but a short distance below the surface and damp sand is always to be found by digging down a few inches. If a plant can survive until its roots get down a few inches, there need be no lack of water from that source, but it seems probable that most of the plants whose disseminules may reach this habitat are unable to exist until their roots have reached the damp sand below. Following Clements this habitat may be termed *dissophytic*, being xerophytic above the surface layers of sand and mesophytic or even hydrophytic below.

The drift-beach is occupied by a formation, which from its composition will be termed the *Cakile-Xanthium* Formation. The habitat being exposed to the mechanical violence of the surf during the winter, the formation consists entirely of annuals, and in response to the dissophytic conditions the plants are xerophytic, at least in their aerial portions, most of them being more or less succulent.

[35] MacMillan, Conway. *l. c.*, pp. 969–973.

[36] Schimper, A. F. W. *l. c.*, p. 180.

[37] Cowles, H. C. *l. c.*, pp. 115–117.

[38] Ganong, W. F. "The Nascent Forest of the Miscou Beach Plain." *Bot. Gaz.*, 42: 85–87. August, 1906.

At Presque Isle this formation is characterized by *Cakile edentula* and *Xanthium commune*, together with the minor species: *Euphorbia polygonifolia*, *Strophostyles helvola* and *Cenchrus carolinianus*. The plants are scattered along here and there, in the line of driftwood, there being no particular localization of species, except that the *Xanthium* and *Strophostyles* occur more abundantly in the sheltered places, or in places where the driftwood is more abundant. This, in *Xanthium* at least, is probably due to the character of the disseminule, the burs of *Xanthium* in exposed places being liable to washing away by the waves, or blowing away by the wind. The most efficient method of dissemination in this habitat is a combination of wind and wave, the floating disseminules being cast upon the beach among the driftwood and there left buried in the sand, ready to grow the next season.

Along the drift-beach at Cedar Point, Sandusky, the habitat is characterized by *Cakile*, *Xanthium* and *Polanisia graveolens*, the last named being more abundant along the lake-beach while the *Xanthium* is more partial to the more protected bay-beach. Along Lake Michigan Cowles found the habitat characterized by *Cakile*, *Corispermum hyssopifolium* and *Euphorbia polygonifolia*, the first named species being generally the most prominent. He mentions *Strophostyles helvola* as an inhabitant of the narrow beach at the base of sea-cliffs, but it has "not been seen as yet on the beaches of the dune district."[39] Ganong finds *Salsola Kali*, *Cakile*, *Mertensia maritima* and a few other species on the drift-beach at Miscou Island, New Brunswick, *Cakile* being second in abundance to *Salsola* "though but scarce."[40]

Kearney in his studies in the Dismal Swamp region[41] and on Ocracoke Island[42] calls attention to the extremely strong insolation, the periods of intense heat, and the strong currents of air, which together constitute the xerophytic conditions, to which the plants are there exposed on the strand, and which in connection with the unstable condition of the soil are met by certain adaptations in the life-

[39] Cowles, H. C. "The Physiographic Ecology of Chicago and Vicinity." *Bot. Gaz.*, 31 : 170, March, 1901.

[40] Ganong, W. F. *l. c.*, pp. 85–87.

[41] Kearney, T. H. "Report on a Botanical Survey of the Dismal Swamp Region." Contrib. U. S. Nat. Herb., V, 367–395, 1901.

[42] Kearney, T. H. "The Plant Covering of Ocracoke Island." Contrib. U. S. Nat. Herb., V, 275–284, 1900.

Between Fog Whistle and the Lake. To the right is drift-beach with the *Cakile-Xanthium* formation. In the middle and to the left is a filled lagoon, the cottonwoods and willows still accumulating the drift-sand. Photo. May 8, 1906.

forms of the plants. Among other such adaptations are mentioned the trailing form of *Strophostyles helvola*, and the radiant form of *Cakile edentula* and of *Euphorbia polygonifolia*. On the drift-beach at Presque Isle *Xanthium*, ordinarily, and *Cenchrus*, often, shows the radiant life-form. This form is chiefly exhibited by annuals with a well defined tap-root and a stem branching immediately above the surface of the ground, the lower branches, at least, lying on the surface of the ground and spreading radiately like the spokes of a wheel.

As Kearney further suggests, the trailing and radiant forms are better fitted by their closely appressed lower branches to shade the soil, thus conserving its moisture, and also to prevent undue exposure to the heat and light reflected from the sand beneath, as well as to prevent so free a circulation of air through the foliage. In this way transpiration is probably considerably lessened, and on account of the protection afforded by the form of the plant the soil is not so readily blown away from the roots by the wind.

Succulent leaves are, of course, a further protection against excessive transpiration and the injurious effects of high insolation, and it is to be noticed that such leaf-forms are almost a universal characteristic of the plants of the *Cakile-Xanthium* formation. This leaf-form is further accompanied by light-colored, insolation-reflecting foliage in *Cakile*, *Xanthium*, *Euphorbia*, and to some extent in *Strophostyles*.

The Sand-plain. —The *Artemisia-Panicum* Formation.

At the eastern end of the peninsula, extending above and beyond the drift-beach, is an area of between two and three square miles of dry, comparatively level sand-plain, which has been gradually built up by drifting sand as the beach has been formed farther and farther lakeward. Towards the southeast this sand-plain contains a number of lagoons or ponds, and is more prominently strewn with logs and driftwood, but from the immediate vicinity of the Key Post, and extending towards the north and west, the sand has been drifted in so abundantly as to have filled the ponds and to have buried the driftwood (see Plate XXVII), the surface thus presenting here a uniformly level plain with the exception of a few small sand-ridges and dunes. It is this latter portion of the sand-plain which is to be considered in connection with the succession under discussion. The two portions of the sand-plain are, of course, essentially similar in their physiographic origin, but, as will be pointed out later, the more northern portion is characterized by different plant-formations from those of the southern portion. The northern portion of the sand-plain has a soil coarser in texture, with a greater exposure to stronger air-currents, thus constituting a habitat with a more unstable soil and more xerophytic ecological conditions.

There is no distinct line of demarcation between the drift-beach and the sand-plain, the one shading off gradually into the other, the theoretical limit of the drift-beach being, however, the extreme limit of waves during winter storms. As the beach grows outward it is being continually built up in the rear, burying the driftwood more or less completely and eventually attaining a height beyond the reach of the waves. Much of the sand-plain is very little higher than the drift-beach and in places the drift-beach appears to have been covered and again exposed by the drifting away of the sand. Such areas of beach again exposed, after having been once buried by the sand, have been termed "fossil beaches," [43] but, as they present at Presque Isle ecological conditions practically no different than those obtaining in many parts of the sand-plain proper, they will be considered as component parts of the sand-plain habitat.

Areas practically synonymous with the sand-plain, as herein recognized, have been variously denominated as the "*back strand*," MacMillan;[44] the "*upper beach*," Cowles;[45] the "*grass plain*," Ganong;[46] and in a more general sense have been included in the area of the "*dunes*," Schimper;[47] or "*middle dunes*," Kearney.[48] The North Haven Sand-plains as described by Britten,[49] are in part also typical of the sand-plain as herein described. Gleason's "*blowout association*" habitat [50] of the Illinois River Valley sand region is almost an

[43] Cowles, H. C. *l. c.* *Bot. Gaz.*, 27: 173–175, March, 1899; Whitford, H. N. "The Genetic Development of the Forests of Northern Michigan." *Bot. Gaz.*, 31: 297–298, May, 1901.

[44] MacMillan, Conway. *l. c.*, pp. 973–987.

[45] Cowles, H. C. *l. c.* *Bot. Gaz.*, 27: 167–173, March, 1899.

[46] Ganong, W. F. *l. c.*, pp. 88–94.

[47] Schimper, A. F. W. *l. c.*, pp. 654–655.

[48] Kearney, T. H. *l. c.* Contrib. U. S. Nat. Herb., 5: 367–395.

[49] Britten, W. E. "Vegetation of the North Haven Sand-Plains." *Bull. Torrey Bot. Club*, 30: 571–620, November, 1903.

[50] Gleason, H. A. "A Botanical Survey of the Illinois River Valley Sand Region." *Bull. Ill. St. Lab. Nat. Hist.*, 7: 149–194, January, 1907.

exact repetition of large parts of the Presque Isle sand-plain, especially towards the southern part.

The ecological conditions on the sand-plain are in some respects somewhat less severe than on the drift-beach. One great difference lies in the freedom of the sand-plain from wave-action ; a condition which permits the establishment of biennials or perennials, which perhaps might otherwise be able to endure the conditions obtaining in the drift-beach. Further the sand-plain, being somewhat removed from the lake, and in places being somewhat sheltered by dunes and ridges, is more or less protected from the force of the wind, and on the whole is probably less xerophytic.

The soil of the sand-plain becomes with age more compact by settling and by the sifting in and washing down by rain of the finer particles of sand. At the same time humus is gradually accumulating and so the general tendency of the soil is towards a greater capillary capacity for water and a larger supply of available plant-food. Wherever, because of certain conditions of wind- or wave-action, there has been an accumulation of coarser sand or gravel in the surface layers of the soil, the accumulation of humus and the filling up of the soil with finer particles will take a much longer period, and during this period more xerophytic conditions will prevail.

The soil of that portion of the sand-plain included in the present discussion is apparently, as a whole, of a considerably coarser texture than is the soil of that part of the plain lying to the south of the Key Post. This condition results quite naturally from the physiographic mode of formation of the peninsula ; the direction of the drift of the beach-debris being from the southwest and the coarser particles traveling more slowly, the result is that in rounding the end of the peninsula the coarser particles are left behind and so have contributed to the growth of the more northern portion, while the finer material has traveled farther and has contributed to the growth of the shore farther to the southeast.

The water of the coarser sandy or gravelly soil is more largely gravitational and escapes quickly by percolation, following which the air under the pressure of the strong winds circulates freely through the larger air spaces, thus bringing about a somewhat greater evaporation of the scant capillary water and also a rapid direct oxidation (*eremacausis*) of the little organic matter which may have accumulated. The circulation of the air of the soil and also, indirectly, the denitrification of the soil and the evaporation of the capillary water must be greatly augmented by the great extremes of temperature through which the soil often passes.[51] Such a soil on Presque Isle becomes fitted for plant-life much more slowly than does a soil of finer texture.

(The Formation.)

The ecological formation correlated with the sand-plain habitat may, from its dominant species, be called the *Artemisia-Panicum* formation. It is an open formation, the plants occupying approximately 20 per cent. of the entire area of the habitat. Towards the lake the percentage of area covered is much less than farther back, although in certain areas the plants may be considerably more aggregated, especially in the older portion of the sand-plain near Long Ridge, where the plants may even approximate closed conditions (see Plate XXVIII). In the formation as a whole, however, there is practically no competition among the component species, the biological element being of little importance in the ensemble of ecological conditions.

The facies of the formation is determined mainly by *Artemisia* — *A. canadensis* and *A. caudata* — and *Panicum virgatum*, but there is considerable alternation among these and a few other prominent species, so that several consocies are to be recognized. There is also considerable evidence of a succession among what are to be recognized as consocies, as one goes from the youngest to the oldest parts of the habitat.

In the youngest part of the habitat, that nearest the drift-beach, the formation consists essentially of the following consocies:

(*a*) *Panicum-Artemisia* Consocies.
(*b*) *Andropogon furcatus* Consocies.
(*c*) *Cladonia* Consocies.

[51] On the sand-plain at Cedar Point under almost exactly the same conditions as may be found in various places on the sand-plain at Presque Isle, the author found the temperature at a depth of one half inch below the surface of the sand, at 1:30 P. M. on a clear hot August day to be 142° Fahr. The temperature recorded at the Weather Bureau, at Sandusky, just across the Bay, was 79° Fahr., maximum for the day. The spot at which these measurements were taken was somewhat protected from the slight breeze by a few surrounding oaks.

See Jennings, O. E. "An Ecological Classification of the Vegetation of Cedar Point." *Ohio Naturalist*, 8: 291–340, April, 1908.

Looking across the sand-plain from the western part of Long Ridge. *Panicum-Artemisia* formation with a community of *Arctostaphylos* heath in left foreground, in center a *Myrica* thicket, in left background a *Juglans cinerea;* other trees *Populus deltoides.* Photographed May 8, 1906.

Each of the above mentioned consocies may occur over a certain area with the facies alone, but over much of the habitat there is more or less of a commingling of the different facies. The *Panicum-Artemisia* consocies occupies a large part of the southern and middle portion of the habitat, reaching out to the drift-beach in many places towards the south, and being replaced towards Long Ridge very largely by the *Andropogon furcatus* consocies.

In some of the most exposed parts of the habitat, and where the wind has a clear sweep, is to be found the *Cladonia* consocies. The latter consocies certainly plays a considerable part as a sand-binder and probably prepares the way for colonization by other plants. With the *Cladonia* is associated *Ceratodon purpureus*, occurring mainly as little flat concentric disks, sometimes attaining a diameter of six inches before the central portion dies and the family becomes a community. As a sand-binder the moss must also be of considerable importance, especially when abundant, as in a number of small areas. Each moss disk acts as an obstruction, behind which the sand can be seen collecting in a miniature dune.[52]

Principal Species. — The principal species to be noticed in the *Panicum-Artemisia* formation are *Lathyrus maritimus*, *Solidago nemoralis*, and *Aster ericoides*. *Lathyrus maritimus* has a mode of dissemination much different from that of the facies mentioned. Its disseminules are not readily blown about and promiscuously scattered by the wind, and the structure of the *Lathyrus* associations is more properly to be approached from the standpoint of aggregation; the groups thus being recognized as family, community, or society, according to the extent of the aggregation.

A few plants stray into the sand-plain habitat from the drift-beach, such as *Xanthium*, *Cakile* and *Strophostyles*, but they occur only in the part immediately adjoining that habitat, never in the older part of the sand-plain near Long Ridge.

Secondary Species. — Occurring apparently promiscuously in the consocies mentioned above are the following secondary species:

Euphorbia polygonifolia, *Onagra Oakesiana*,
Onagra biennis, *Gnaphalium polycephalum*,
Cenchrus carolinianus.

[52] *Cf.* Warming, E. "Lehrbuch der Oekologischen Pflanzengeographie," pp. 243-244.

One aspect, an autumnal one, is to be noticed in this formation, characterized by *Solidago nemoralis* and *Aster ericoides*, constituting together the *Solidago-Aster* Society. This society is mainly confined to the younger portion of the sand-plain, being better developed in that portion of the plain to the south and reaching its best development in the finer soil south of the Fog Whistle. As compared with the *Solidago nemoralis* growing so abundantly on the hills in the vicinity of Pittsburgh the plants referred to that species on Presque Isle are considerably smaller and have much lighter-colored leaves.

The *Arctostaphylos-Juniperus* Heath Formation.

That part of the sand-plain fronting the northern part of Long Ridge has soil of a somewhat different character from that of the corresponding part of the sand-plain, as it is being formed to-day from the beaches north of the Key Post. This older portion near Long Ridge has a less porous, more compact soil, owing probably in large part to the drifting in of finer particles of sand by the wind, and in part to the agencies of atmospheric disintegration, especially expansion and contraction during the sudden extremes of temperature, to which the sand-plain is exposed, this finally resulting in a splitting up of the gravel into finer particles and at the same time rendering more available a certain amount of mineral plant-food. There is also some humus to be seen in the upper layer of sand where the vegetation has more nearly approached a closed formation. The accumulation of humus is of necessity very slow in such a soil; the scanty plant-covering, the great porosity of the soil, the exposure to strong air currents, and the great extremes of temperature through which the soil passes, all tending to both prevent the accumulation of humus and the retention of the products of the scanty humification.

The habitat of the *Arctostaphylos-Juniperus* heath at present comprises the western portion of Long Ridge, extending east from the immediate vicinity of the Light House for approximately a mile, and also covering adjoining portions of the former sand-plain along the northern side of the Ridge. The term "heath" is here used in the sense employed by several American workers to indicate a xerophytic formation characterized by evergreen shrubs.[53] Cowles, referring to

[53] Cowles, H. C. *l. c.* *Bot. Gaz.*, 27: 367–369, May, 1899; Cowles, H. C. *l. c.* *Bot. Gaz.*, 31: 173–174, March, 1901; Brown, F. B. H. "A Botanical

On western end of Long Ridge, showing the *Arctostaphylos-Juniperus* heath formation. Ground covered with *Arctostaphylos*. *Juniperus* numerous; *Pinus Strobus* invading, as in left foreground. Photographed May 8, 1906.

the position of heaths on the windward slopes of the dunes of Lake Michigan, notes that: "The key to these facts is exposure to desiccating factors, especially heat, cold, and winds. . . . There is a vegetation carpet and a covering of humus. Both slopes have a mesophytic soil; the leeward slope has also a mesophytic air, but the windward slope has a xerophytic air." The heath at Presque Isle is characterized, as is also the northwestern portion of the sand-plain, by strong winds and extremes of heat and cold, but, as mentioned in the preceding paragraph, the conditions of the soil have become somewhat more favorable to plant-life than in the sand-plain.

The heath is a closed formation characterized by two facies — *Juniperus virginiana* and *Arctostaphylos Uva-Ursi* (see Plate XXIX). The formation has few secondary species and varies but little from season to season in general appearance. However, in a few places the *Lupinus perennis* Society becomes quite conspicuous in a June Aspect.

Secondary Species. —

Geaster hygrometricus,	*Andropogon furcatus,*
Poa pratensis,	*Lithospermum Gmelini,*
Pinus Strobus,	*Quercus velutina,*
Prunus serotina,	*Celastrus scandens,*
Toxicodendron pubescens,	*Rubus allegheniensis,*
Rubus occidentalis.	

Most of the species included in the above list are to be found most abundantly in adjoining formations, where they more properly belong. Some are to be classed as relicts of the preceding formation — *Lithospermum* and *Andropogon;* others are invaders from the thicket formation immediately along the ridge to the east —*Rubus, Rhus, Celastrus,* and *Prunus;* still others are invaders from the forest formations — *Quercus velutina* and *Pinus Strobus.*

The bearberry (*Arctostaphylos*) spreads quite rapidly in all directions over the sandy soil by means of its long prostrate vegetative shoots, and although during the winter months it usually has an abundance of bright colored berries eaten by birds, to which some of its

Survey of the Huron River Valley, III." *Bot. Gaz.*, 40: 275, October, 1905; Whitford, H. N. "The Genetic Development of the Forests of Northern Michigan." *Bot. Gaz.*, 31: 298–299, May, 1901; *and* Adams, C. C. "An Ecological Survey in Northern Michigan." Rpt. Mich. State Bd. of Geol. Survey, 1905: 24, 1906.

dissemination must be ascribed, most of the territory included each year by the plants is that taken in by the radiate enlargement of the parent plant. Isolated plants, families, or even communities, are to be found out on the sand-plain in advance of the heath, and have evidently been distributed by birds, but such occurrences are comparatively rare. Such isolated occurrences of the plant are necessary, however, for the advance of the formation sufficient to keep up with the forward march of the other formations. The vegetative method of dissemination would, at the most, advance the plant not more than two or three feet in a season.

With the red cedar (*Juniperus virginiana*) the conditions of dissemination are quite different. Occasional isolated specimens of this species occur far out on the sand-plain in such positions that they plainly indicate dispersal of the seeds by birds. On the sand-plain such specimens almost invariably stand on the leeward side (east) of a cottonwood trunk (see Plate XXX). The most abundant reproduction of the red cedar, however, occurs in the *Arctostaphylos* mats where it apparently finds conditions better suited for its ecesis. As conditions are at present in the heath, the relative predominance of *Arctostaphylos* and *Juniperus*, as to the number of individuals and as to the area occupied, is decidedly in favor of the former species in the younger stages of the formation and of the latter species in the older stages. At the climax of the formation the *Juniperus* occupies about 80 per cent of the total area.

The reaction of the heath upon the edaphic conditions of the habitat is, as compared with such effects in most formations, very rapid. This reaction consists mainly in the accumulation of humus. *Arctostaphylos* forms over the surface of the sand an entangled mat which very effectually catches and retains its own leaves when shed, as well as leaves which are blown over from the forest to the west or southwest. The soil being protected, both by the *Arctostaphylos* mat and by the dense compact *Juniperus* acting as a windbreak, humification rather than eremacausis becomes the rule, and there is an annual accumulation of humus and fine sand, blown in by northerly and northeasterly gales, finally resulting in a layer above the sand of a fine sandy loam. As compared with the soil of the almost bare sand-plain we have in the soil of the heath much better conditions of available moisture for plants (capillary and hygroscopic moisture), and excessive aeration is prevented by the vegetational covering, as well as by the fine sandy loam,

Looking east along the northern slope of the western end of Long Ridge. Vernal aspect of *Andropogon furcatus* consocies, as characterized by the *Lupinus perennis* society. *Toxicodendron* thicket on top of ridge to right. *Juniperus* to leeward of *Populus*. *Pinus* seedlings in foreground. Photographed May 15, 1905.

Geaster hygrometricus in northwestern portion of sand-plain. *Panicum Scribnerianum* in left foreground. Note accumulation of vegetable debris, *Populus* leaves and *Panicum* stems and leaves. Photographed May 8, 1906.

acting as a mulch. The temperature of the soil is much more uniform than on the exposed sand-plain; especially are the maximum temperatures much reduced. The liberation of carbon-dioxide during the process of humification also probably results, in connection with humic acids, in the formation of appreciable amounts of carbonates, humates, silicates, etc., which in solution in the capillary water of the soil are available as plant-food. The formation of the various mineral plant-foods in this manner is rendered more probable by the variety of minerals represented in the sand, feldspar, hornblende, gneiss, mica, magnetite, etc., derived mainly from the glacial till, which covers the land along the shores of Lake Erie.

There must be a considerable growth of fungal mycelium throughout the layer of sandy loam, as the *Geaster* is quite abundant and well distributed in the formation (see Plate XXXI). The presence of *Lupinus* with an abundance of root-nodules points to the fixation of atmospheric nitrogen, and the bacteria, which must accompany the humus, must finally indicate the formation of nitrates in the soil.

To briefly recapitulate: the soil of the heath as compared with the soil of the sand-plain is more stable; is more uniform in temperature and moisture; is less excessively aerated; has greater capillary and hygroscopic capacity attended by less rapid leaching; has an upper layer of sandy loam, acting as a mulch; eremacausis is very slight, if present at all; but humification and nitrification must occur, indirectly resulting in the production of various salts available as plant-food.

The *Pinus Strobus* Formation.

As stated in the preceding discussion the mature heath has reacted upon its ecological environment to a quite marked extent, and in so doing it has at the same time brought about certain conditions suitable to other species, which will thus be able to eventually replace the heath-formation. *Juniperus virginiana* and *Arctostaphylos Uva-Ursi* can accomplish ecesis and thrive in dry sandy or gravelly soils,[54] or on dry limestone hills or barren flats, in the case of *Juniperus*;[55] or in dry sands and on exposed xerophytic mountain-tops, in the case of *Arctostaphylos*.[56] So it is, also, to a less extent, with *Pinus Strobus*.

The white pine, throughout its range, whether on islands in a

[54] Britten, W. E. *l. c.*

[55] Mohr, Charles. "Notes on the Red Cedar." U. S. Dept. Agricul., Div. Forestry, Bull. 31: 28, 1901, *and* Adams, C. C. *l. c.*, pp. 24, 29, etc.

tamarack swamp, sandy soils along the Great Lakes, rocky mountains, or gravelly moraines, owes its prominence there to its ability to thrive in light, infertile, and semi-xerophytic soils. Wherever the ecological conditions are suitable for the growth of more mesophytic trees the white pine is likely to succumb to competition; even though its germination may be successful its seedlings cannot endure the dense shade of hemlock or of most hardwood forests.

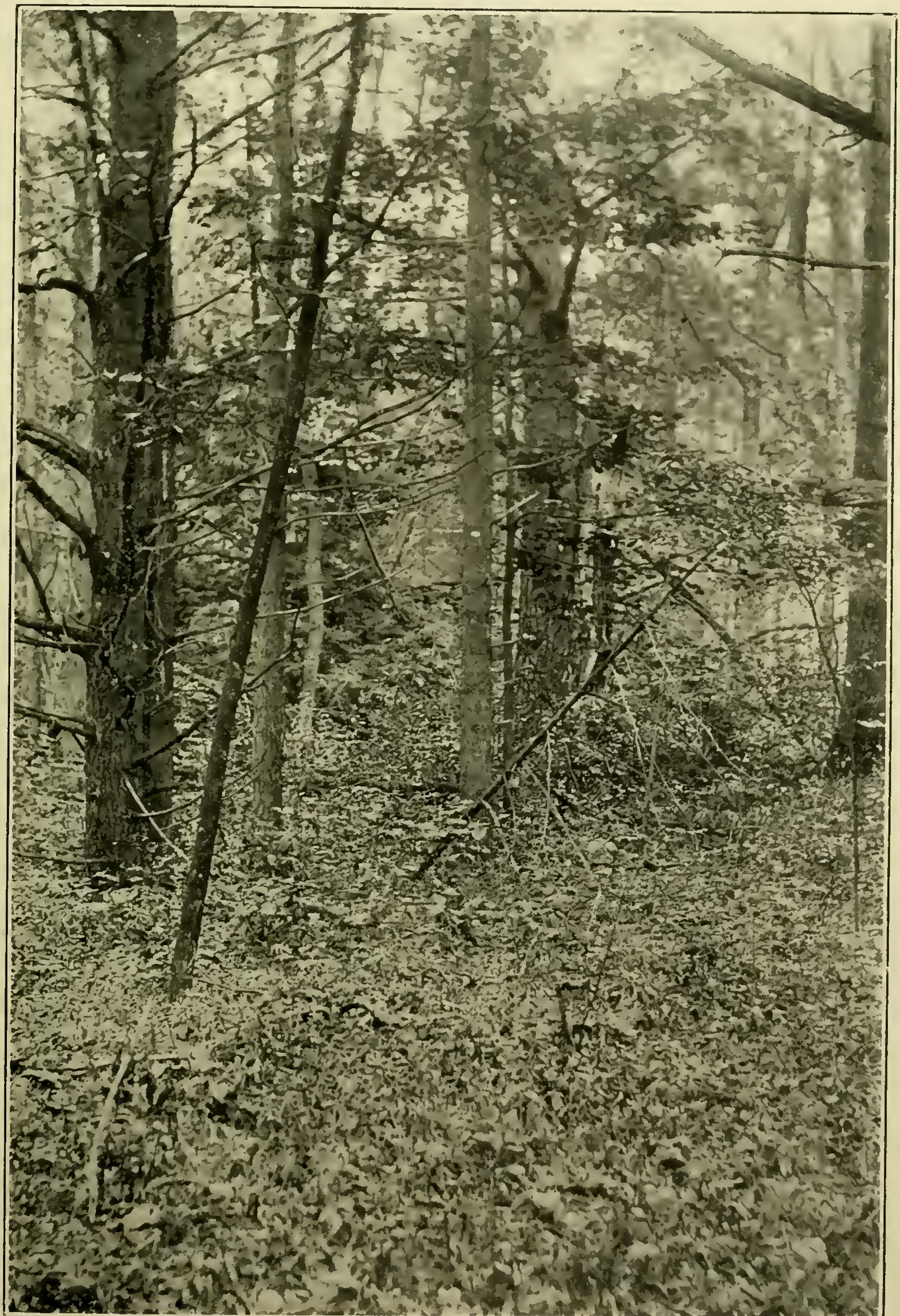
The winged seeds of the white pine are often blown for a considerable distance by strong winds and, as the white pine woods lie immediately to the southwest of the heath at Presque Isle, many white pine seeds find lodgment in the tangled mat of bearberry (see Plates XXIV, XXIX and XXX). There they find in the sandy loam the very best conditions for ecesis, viz., moderate moisture and a low open vegetational covering, which gives protection from the extremes of heat and drought, and yet lets in the rather abundant light, which is believed to be so essential for the white pine seedlings. Many seeds of the white pine undoubtedly find lodgment in the soil of the sand-plain, but although germination might be successful in certain wet periods, the seedlings could never endure the heat and drought to which they would be exposed. Certain other formations on Presque Isle, however, as the Myrica-thicket and Cranberry-formations, to be discussed later, offer conditions such that a partial occupation by white pine may take place. In no case, however, on Presque Isle does the white pine accomplish ecesis without the presence of more or less humus in the soil, and without the protection afforded by some low shrubby growth of vegetation.[57]

(The Formation.)

From what has been said it may naturally be inferred that the heath may eventually be crowded out by the ever-increasing number of white pines, and such is actually the case. A pure white pine forest (the *Pinus Strobus* formation) lies immediately to the south of the Light House (see Plate XXXII) and occupies a considerable portion of the area contiguous to the western end of Cranberry Pond. Along the shore to the southwest of the Light House this forest ex-

[56] Spring, S. N. "The Natural Replacement of White Pine on the Old Fields of New England." U. S. Dept. Agricul., Div. Forestry, Bull. 63: 11, 1905.

[57] *Cf.* Livingston, B. E. "The Relation of Soils to Natural Vegetation in Roscommon and Crawford Counties, Michigan." *Bot. Gaz.*, 39: 31, January, 1905.



Pinus Strobus forest formation southwest of Lighthouse. Young *Quercus velutina* in middle foreground. Undergrowth of *Viburnum acerifolium, unifolium, Osmunda, Vagnera*, etc. Photographed September 20, 1906.

tends out to the open slope leading directly down to the waters of the lake, and which marks the extent to which the lake had worn away the land prior to the erection of the jetties by the government. At the summit of this slope there are, in a few places, small patches of *Arctostaphylos*, and some *Juniperus*, representing remnants of the heath, but the invasion by the *Pinus Strobus* formation usually begins quite early in the life of the heath and, as a result, the pine forest presents along this part of the shore an almost unbroken front.

In the most northwesterly and xerophytic portion of the pine forest there is practically no outer shrub zone, other than the heath, but farther inland to the east, where the exposure to the lake winds is not so great, the conditions are more mesophytic and there is a gradual transition into what may be called a mixed formation in which species of *Prunus*, *Acer*, etc., are prominent. A discussion of this formation will be taken up later.

In the *Pinus Strobus* forest formation there is comparatively very little of the *layering* which is so characteristic of most hardwood forests. There are in places a very few trees of the wild black cherry, *Prunus serotina*, also *P. pennsylvanica*, which are generally of about the same height as the pines and are being gradually killed out by their dense shade. *Juniperus virginiana* occurs occasionally as a relict from the heath, but it apparently does not accomplish ecesis in the white pine forest.

There are but few seedlings of white pine in the typical part of the formation. It appears that at Presque Isle, as has been found elsewhere,[58] the seedlings of the white pine cannot endure the dense shade of the mature white pine forest. If other trees are available which can endure this shade during the seedling stages the white pine will finally be replaced by a forest of other species. At Presque Isle the black oak, *Quercus velutina*, is present very sparingly as a seedling in the heath, but it becomes more and more abundant in all sizes as the mature pine forest is approached and, upon the death of the white pine, its place is occupied by black oak. Black oak appears to be capable of accomplishing ecesis without difficulty, both in the heath and in the dense pine forest; its appearance in the latter in greater numbers being due to circumstances of dissemination rather than to its particular adaptability to the habitat. Some acorns may reach the sand-plain also, but as Britten found on the North Haven Sand-

[58] Spring, S. N. *l. c.*, p. 20.

plains,[59] the seedling fails to find there the necessary moisture and never succeeds.

In the *Pinus Strobus* formation the shrub, herbaceous, and ground-layers consist of scattering individuals of the following species :

Smilax herbacea,	*Vaccinium corymbosum,*
Cypripedium acaule,	*Lycopodium clavatum,*
Pyrola americana,	*Lycopodium complanatum,*
Pyrola elliptica,	*Lycopodium lucidulum,*
Pyrola secunda,	*Lycopodium obscurum,*
Chimaphila maculata,	*Unifolium canadense,*
Chimaphila umbellata,	*Vagnera stellata,*

Morchella esculenta.

The reaction of the *Pinus Strobus* formation upon its habitat is probably relatively greater than that of the heath, but it consumes a much longer period of time. The heath, as indicated by the relative sizes of the junipers, ordinarily occupies its habitat not more than thirty years before being replaced by the *Pinus Strobus* formation, while the latter occupies its habitat for approximately two hundred years. The soil in the pine forest is everywhere covered with a layer of pine needles and in the older portions of the forest, beneath the upper layer of undecayed needles, is a layer of more or less completely humified organic material often more than one inch in thickness. The line of demarcation between the lower part of this layer, which represents the sandy loam of the heath, is not so distinct as in the heath, owing probably to the decay of roots and fungal mycelia, and perhaps indirectly to some extent to the percolation of hydrostatic water. The action of earthworms, so important in many soils, is not indicated in this soil.

The accumulation of a mulch of forest litter, a thick layer of humus, and the gradual distribution of humus throughout the sand beneath, are processes tending directly or indirectly to increased capillarity, humification, nitrification, the formation of various acids, and the further decomposition of the grains of sand with the production of salts available in solution in the water of the soil as plant-food. The soil, as left by the *Pinus Strobus* formation, as compared with the soil as left by the *Arctostaphylos-Juniperus* heath has a more uniform supply of available (capillary) moisture and also a greater supply of mineral

[59] Britten, W. E. *l. c.*, pp. 578 and 579.

Northwest shore of Presque Isle, looking northwest from Jetty No. 3. The peninsula is here being washed away; note truncate ends of Ridges 5 and 6. The forest is here the *Quercus velutina* formation. Photographed September 20, 1906.

salts. Physically the temperatures prevailing both in the soil and in the air above the soil are more uniform, the aeration is much less, and the light is very much weaker in the *Pinus Strobus* formation.

The *Quercus velutina* Forest Formation.

The gradual invasion of the pine forest by the black oak (*Quercus velutina*) and finally the dying off of the pines, as they approach old age, eventually results in a forest characterized by one facies, the black oak, and hence to be called the *Quercus velutina* forest formation (see Plates XXV and XXXIII). The black oak constitutes usually from 85 to 95 per cent. of the primary layer in this forest and associated with it are scattering individuals of the following species:

Pinus Strobus,	*Tilia americana,*
Quercus rubra,	*Acer saccharinum,*
Quercus palustris,	*Sassafras Sassafras,*
Quercus borealis,	*Tsuga canadensis.*

The abrupt change in the character of the foliage canopy from the dense, dark, evergreen pine woods to the light, deciduous, black oak forest makes a very marked difference in the conditions of the habitat with reference to insolation in the layers below the facies of the formation, and the response to the changed environment is correspondingly very plainly evident.

Below the primary layer the four layers following are to be distinguished:

The Secondary Layer. — The secondary layer is composed of small trees and larger shrubs of varying sizes, consisting essentially of smaller individuals of the species represented in the primary layer. It is noteworthy in this connection, however, that there are relatively more white pine saplings in this formation than in the *Pinus Strobus* formation. The light conditions more nearly approximate to those of the heath formation than to those of the pine forest. The result is to a limited extent indicative of a possible alternation of formations.

The Tertiary Layer. — The tertiary layer consists of small shrubs and bushes, which owing to the presence of much *Smilax* become in places a tangled mass very difficult to traverse. The species represented in this layer are as follows:

Smilax herbacea,	*Aralia racemosa,*

Toxicodendron pubescens, *Vitis vulpina*,
Rubus allegheniensis *Celastrus scandens*,
Diervilla Diervilla.

The Herbaceous Layer. — The fourth layer consists of herbaceous plants of various species, which usually alternate to some extent with the layer next above, forming where not too much shaded a more or less dense carpet of vegetation. The species are as follows:

Corallorhiza maculata, *Chimaphila maculata*,
Aralia nudicaulis, *Galium circæzans*,
Vagnera stellata, *Hieracium scabrum*,
Vagnera racemosa, *Hieracium Gronovii*,
Unifolium canadense, *Solidago cæsia*,
Meibomia Dillenii, *Helianthus strumosus*,
Lespedeza capitata, *Tussilago Farfara*,
Osmorhiza Claytoni.

A few of the species in the herbaceous layer are of sufficient abundance to dominate during certain aspects. The *Aralia nudicaulis* society, the *Vagnera stellata* society, the *Unifolium canadense* society, and the *Osmorhiza Claytoni* society are especially to be noticed in this connection. Each of them forms over certain areas practically pure groups of one species alone. A comparatively large proportion of the species of the herbaceous layer depend more or less upon creeping stems or rhizomes for their dissemination, this method being especially favored by reason of the loose soil, in which the plant-food is largely in the upper layers. The result of this method of dissemination is, of course, a more definite alternation of different species into groups having the rank of family, community, or society.

The Ground Layer. — The ground layer is very poor as to lichens and mosses, but of the fungi, especially the Agaricaceæ, there were at times a considerable number to be seen. On account of inadequate facilities for drying the specimens during rainy weather many of the collections were lost, but the following were among the more abundant species in the habitat:

Russula virescens, *Amanitopsis vaginata*,
Russula emetica, *Armillaria mellea*,
Lactarius piperatus, *Lentinus lepidus*,
Amanita verna, *Lycoperdon gemmatum*,

Collybia radicata, *Mycena acicula*,
Boletus sp., *Scleroderma vulgare*,
Cortinarius sp.

The reaction of the *Quercus velutina* formation upon its habitat consists mainly in the addition of more humus to the surface layers, and by means of the roots to the soil for some distance below the surface. Along the lake-front there is now a recession of the shore, so that the waves of the ordinary summer storms reach to the base of a perpendicular cliff of sand which is continually being washed out below and thus undermining the oak forest and causing the trees to topple over into the lake. The side of the cliff shows the trees to be very profusely but shallowly rooted, practically the entire root-system being usually in the upper three feet of soil. The soil, however, is visibly stained with humus to a depth of a foot or more below this.

That the *Quercus velutina* formation is the climax-stage in the Beach-Sand Plain-Heath-Forest Succession is probably not the case, but it does appear that the *Quercus velutina* formation would persist as such for a long period. Owing to the physiographic changes in the northwestern shore of the peninsula, in which the land has been continually worn away by the lake, it appears that none of the *Quercus velutina* formation which can be definitely said to have followed the heath through the pine stage has attained any great age, it having been washed away. Probably in the course of time the conditions of moisture and available plant-food might become so changed through agencies of disintegration and the accumulation of humus that other more mesophytic trees might be able to compete successfully with the oaks, or to replace them altogether.

In various parts of the northeastern United States there are to be found sandy soils resembling quite closely the soil of the *Quercus velutina* habitat at Presque Isle. At Cedar Point, Sandusky, Ohio, the buildings of the Cedar Point Resort Company occupy a portion of the peninsula which is almost an exact counterpart of the *Quercus velutina* habitat at Presque Isle and the close similarity extends also to the formation. In the North Haven Sand-plains, in Connecticut, the black oak, although scattering, is yet the predominant tree.[60] Brown designates the formation occurring on the comparatively arid upper slopes of a sandy bluff at Ypsilanti, Michigan, as the "Black Oak Society,"

[60] Britten, W. E. *l. c.*, pp. 578–579.

"53 per cent of the individuals on the slope above the 760-foot contour line being black oaks."[61] Cowles finds, near Chicago, the black oak predominating on the south slopes of the established sand-dunes and on the higher sandy ridges and beaches of glacial origin.[62] Cowles further says: "The future of the vegetation on the established dunes and beaches is somewhat problematical. From analogy with other plant-societies in this region, and from established dunes in Michigan, we should expect a mesophytic forest, probably of the white oak-red oak-hickory type at first and then followed by a beech-maple forest."

The predominance of the black oak, rather than other hard woods of the region, as a successor to the white pine is, perhaps, partly to be explained by the fact that the black oak is of a more xerophytic habit and, partly, by the fact that "The percentage of ash in the wood of such trees as form the principal covering of a dune region is relatively small. As seen in the analyses reported in the volume of the Tenth Census on the forest trees of North America, the pines have an average range of .19 to .23 per cent. The two most common oaks, *Q. velutina* and *Q. coccinea*, have .28 and .19 per cent. respectively."[63] The white oak, burr oak, beech, sugar maple, basswood, and hemlock have a considerably higher per cent. and are less common or wholly absent in such sandy areas.

Livingston's conclusions with regard to the relations of soils to vegetation in certain portions of Michigan would apply also to the distribution of the plant-formations on Presque Isle. Livingston's conclusions are briefly that "the main factor in determining the distribution of forests on the uplands of this region is that of the size of the soil particles."[64] This factor determines directly the amount of air in the soil, and thus indirectly the extent of formation of humus, nitrates, and other soluble salts.

THE BEACH-SAND PLAIN-THICKET-FOREST SUCCESSION.

The Beach-Sand Plain-Thicket-Forest Succession is very closely related to the Beach-Sand Plain-Heath-Forest Succession just de-

[61] Brown, F. B. H. "A Botanical Survey of the Huron River Valley, III." *Bot. Gaz.*, 40: 274–275, October, 1905.

[62] Cowles, H. C. *l. c.* *Bot. Gaz.*, 31: 174–177, March, 1901.

[63] Hill, E. J. "Flora of the White Lake Region, Michigan, and its Ecological Relations." *Bot. Gaz.*, 29: 434, June, 1900.

[64] Livingston, B. E. *l. c.*, p. 40.

scribed, but it nevertheless differs from the latter so radically, that it seems best to give it a distinct rank.

This succession comprises a total area about equal to the succession just described, but it is considerably broken up by ponds and lagoons, so that it is scattered over a region much larger. Beginning near the Key Post it extends to the east and southeast of the Beach-Sand Plain-Heath-Forest Succession, reaching in the one direction to the U. S. North Pier and in the other direction to Presque Isle Bay, extending southwestward to the Chimney Ponds.

The initial and final stages in the two successions are much more similar than are the intermediate stages. As will be discussed farther on, the intermediate stages represented by the heath and the white pine forest are really formations derived from a distinct forest center, and therefore representing altogether another succession than the intermediate stages in the succession under discussion. The presence of stages of another succession, belonging to a distinct forest center, indicates some considerable difference in the ecological conditions obtaining in the habitat, and this difference is probably that of different conditions of soil moisture. The amount of soil moisture depends mainly upon the physical texture of the soil, particularly the size of the soil particles, and also upon the amount of humus present. The more northern and lakeward portion of the peninsula is built up of the coarser deposits of the eastward running littoral current, thus a coarser soil occurs here with less capillary moisture and more xerophytic conditions.

The amount of moisture in the soil being different in the two habitats, there might be expected to occur a corresponding difference throughout the entire successions, but in the initial stages of the successions there is practically no humus in the habitat, and the exposure is in both cases so severe that the corresponding formations are practically identical. In the final stages, on the other hand, the humus has accumulated in both habitats to such an extent as to bring about very similar edaphic conditions, thus permitting the occupancy of the two habitats by the same formations. It is only in the intermediate stages of the successions, where the conditions of exposure and the content of the humus differ considerably, that differences of corresponding stages in the formations may occur.

The Lower Beach. — The *Chlamydomonas* Formation.

The Lower Beach of this succession although consisting mainly of finer sand differs in no respect as to vegetation from the lower beach of the more westerly succession. A few sporadic patches of *Chlamydomonas* were observed.

The Drift-beach. — The *Cakile-Xanthium* Formation.

The Drift-beach and its formation correspond here very closely to the homologous structures occurring to the west of the Fog Whistle, but the effect of the prevailing currents in times of the heaviest surf in carrying the disseminules of various plants to the east and southeast and also, perhaps, the less direct exposure to the prevailing cold westerly winds, is to be seen in the greater abundance of plant-life towards the southeast. The same species constitute the formation in both successions, but they are all, especially *Strophostyles helvola*, much more abundant towards the southeastern extremity of the beach.

The accumulation of drift is considerably greater in this habitat than it is to the northwestward, and, although by far the greater portion of this organic material probably undergoes eremacausis, some humification may occur and may have some part in bringing about a greater abundance of plant-life in this locality. A more important factor is probably the protection afforded many of the seedlings by the driftwood.

The Sand-plain. — The *Panicum-Artemisia* Formation.

In the Sand-plain southeast of the Fog Whistle the habitat differs again very little from its homolog to the east, except in the presence of more driftwood and a finer soil texture. There is thus more soil moisture, and, because of the presence of the driftwood and the proximity of forest to the south and southwest, there is somewhat more protection from the cold winds than is the case in the more eastern sand-plain.

Listing the consocies of the *Panicum-Artemisia* formation in this habitat there are the following:

(*a*) *Panicum-Artemisia* Consocies,
(*b*) *Andropogon furcatus* Consocies,
(*c*) *Stenophyllus capillaris* Consocies,

Vernal aspect of the *Panicum-Artemisia* formation as characterized by the *Arabis lyrata* society. Young *Myrica* thicket in the immediate background. Photographed May 10, 1907.

(*d*) *Sorghastrum nutans* Consocies,
(*e*) *Cladonia* Consocies,
(*f*) *Polytrichum* Consocies.

Most of the above consocies may appear pure, and over considerable areas may consist of the facies alone, but usually several of the facies are promiscuously scattered about, forming a mixed open structure. The *Panicum-Artemisia* consocies occupies more generally the open, more exposed positions nearer the lake, while in the most exposed of the more inland parts of the habitat occurs the *Cladonia* consocies. Areas apparently lowered nearer to the water-table by the drifting away of the sand ("fossil beaches," or "blow-outs") are usually occupied by either the *Stenophyllus capillaris* consocies, the *Sorghastrum nutans* consocies, or by the *Polytrichum* consocies, the different consocies being commingled or occurring alone. *Polytrichum* sometimes forms a pure carpet, and, where occurring with *Stenophyllus*, often crowds out that species altogether, bringing on the final appearance of a heath. The formation of humus with either *Stenophyllus* or *Polytrichum* is quite rapid, the organic matter and indrifting sand being bound firmly together by the roots and rhizoids. Inland, towards Long Ridge, the *Andropogon furcatus* consocies becomes more and more abundant, usually replacing the *Panicum-Artemisia* consocies altogether as the forest is approached.

Principal Species of the Panicum-Artemisia Formation. —

Lathyrus maritimus,	*Aster ericoides*,
Solidago nemoralis,	*Arabis lyrata*.

In the smaller areas of the sand-plain between the lagoons and marshes near the southern end of the extension of Long Ridge and northwest of Horse-Shoe Pond the force of the winds is much broken by the quite abundant thickets and cottonwood trees, and in these sheltered positions occurs the *Arabis lyrata* society, which determines thus a vernal aspect, being usually in full bloom on May 15 (see Plate XXXIV). Associated with *Arabis* as secondary species are *Moehringia lateriflora* and *Arenaria serpyllifolia*. During the period of bloom of *Arabis* the society is quite conspicuous, appearing during that aspect as a prominent part of the formation.

The *Lathyrus maritimus* society occurs mainly in the new soil a short distance back from the drift-beach and usually more or less in the shelter of driftwood. The society becomes quite conspicuous during the time of blooming of the *Lathyrus*, when the ends of the branches assume a more or less upright position. The plant blooms continuously from early June to late August or September.

The *Solidago nemoralis* society, together with the *Aster ericoides* society, characterize the autumnal aspect in the lakeward half of the habitat of the formation. These societies are usually associated with the *Panicum-Artemisia* consocies. There is often a distinct zonation in the distribution of the *Solidago nemoralis*, it forming a rather broad band just outside of the zone of cottonwoods, the latter forming the outer boundary of the lagoon vegetation. The only plausible explanation suggesting itself is that there may be more suitable conditions of moisture at these places, although the surface of the sand-plain is usually at the same elevation as farther back in the *Panicum-Artemisia* habitat.

Secondary Species of the Panicum-Artemisia Formation. —

Euphorbia polygonifolia,
Gnaphalium polycephalum,
Cenchrus carolinianus,
Cyperus Schweinitzii,
Cyperus filiculmis,
Arenaria serpyllifolia,
Asclepias Syriaca,
Salix syrticola,
Prunus pumila,
Geaster hygrometricus,
Onagra biennis,
Onagra Oakesiana,
Lupinus perennis,
Polygala verticillata,
Moehringia lateriflora,
Panicum Scribnerianum,
Lithospermum Gmelini,
Fragaria virginiana,
Psilocybe ammophilus,
Marasmius sp.

The distribution of the secondary species among the different consocies is mainly as follows, most of the species exhibiting a preference for some one particular consocies:

In the *Panicum-Artemisia* consocies —

Euphorbia polygonifolia,
Onagra biennis,
Onagra Oakesiana,
Polygala verticillata,
Arenaria serpyllifolia,
Gnaphalium polycephalum,
Cenchrus carolinianus,
Cyperus Schweinitzii,
Moehringia lateriflora,
Salix syrticola,
Prunus pumila.

A community of *Lithospermum Gmelini* in the *Andropogon furcatus* consocies of the *Panicum-Artemisia* formation. The dark-colored objects in the foreground are cushions of a moss, *Ceratodon purpureus*. Photographed June 10, 1906.

In the *Andropogon furcatus* consocies — (see Plate XXXV)

Lupinus perennis, *Panicum Scribnerianum*,
Asclepias syriaca, *Lithospermum Gmelini*,
Geaster hygrometricus.

In the *Stenophyllus capillaris* consocies —

Cyperus filiculmis, *Marasmius* sp.

In the *Sorghastrum nutans* consocies —

Fragaria virginiana.

The *Myrica* Thicket Formation.

Next following the *Panicum-Artemisia* formation comes the thicket-formation, composed of small trees and shrubs, which is in its turn to be finally replaced by a forest-formation. The thicket in this succession is the homologue of the heath in the succession previously described. It begins at about the same distance from the lake, in soil of about the same age, and is, similarly, to be finally replaced by a forest. This formation at Presque Isle may be called the *Myrica*-thicket-formation, its facies being the wax myrtle, *Myrica carolinensis.*

Myrica carolinensis apparently cannot at once accomplish ecesis in the upper layers of dry, loose sand, such as are occupied by the *Panicum-Artemisia*, the *Andropogon furcatus*, or the *Cladonia* consocies, but in the other consocies of the formation, especially in the finer, moister soil occupied by the *Stenophyllus capillaris* or the *Sorghastrum nutans* consocies, the waxy *Myrica* drupes can successfully sprout and give rise to healthy plants. From these plants as centers the *Myrica* may by vegetational reproduction and dissemination invade the dryer soils of the first mentioned consocies. Young shoots of the *Myrica* arise in a radial zone all about the parent plant, having their origin both in lower limbs, which may have become buried in the sand, and also from subterranean branches.

In this manner the *Myrica carolinensis* consocies may in the course of a few years successfully occupy quite extensive areas, displacing not only the *Stenophyllus* and *Sorghastrum*, but also the consocies of more xerophytic habit.

Principal Species of the Myrica Thicket-formation. —

Prunus serotina, *Rubus allegheniensis*,
Prunus pennsylvanica, *Fragaria virginiana*,
Prunus virginiana, *Celastrus scandens*,
Solidago canadensis.

Secondary Species. —

Rhus typhina,	*Rubus occidentalis*,
Alnus incana,	*Juniperus virginiana*,
Vitis vulpina,	*Andropogon furcatus*,
Poa compressa.	

Quite conspicuous in the *Myrica* thicket-formation in autumn is the *Solidago canadensis* society, an autumnal aspect thus being characterized. At this time the tall golden-rods considerably overtop the shrubby *Myrica*, and being quite abundant, the effect is often to almost hide the shrubs from view. The difference in the choice of habitats of *Solidago nemoralis* and *S. canadensis* is indeed very striking. Neither species is found to occur in the habitat of the other, although there is often but a very few years intervening between the disappearance of the former and the occupation of the same spot by the latter species. The effect of the thicket-formation upon its habitat is rapid, as is evidenced by the quick change in the species of *Solidago*. The bushy, compact clumps of *Myrica* catch and securely retain vegetable litter, leaves, etc., blown about by the wind, and in a short time a considerable layer of humus is formed. In this manner the ecological conditions soon become favorable to species other than those of the *Myrica* thicket-formation, and in the course of but a few years the thicket will be displaced by a forest-formation.

Ganong notes[65] that on sheltered slopes of the low dune-beaches on the sand-plain of the island of Miscou, in situations similar to those occupied by the low shrubby mats of *Juniperus nana* and *Hudsonia tomentosa*, are patches of "A bright green, leathery-leaved, tufted shrub, the wax-berry, *Myrica carolinensis*, which comes to form discoid (sometimes almost fairy-ring-like) masses on the crests and inner slopes," and he further remarks that the shelter of the shrubby mats formed by this species "Affords in reality the principal starting point for the development of other plants, which lead gradually to the development of the forest."

Kearney, in his description of the "Myrica association" of the "Middle (Open) Dunes" near the Dismal Swamp, says:[66] "In sheltered flat places *Ammophila* sometimes makes a comparatively dense, almost meadow-like growth, often associated with scattered

[65] Ganong, W. F. *l. c.*, pp. 92–93.

[66] Kearney, T. H. "Report on Dismal Swamp." *l. c.*, pp. 370–395.

depauperate shrubs — *Myrica carolinensis, Quercus virginiana maritima, Rhus copallina.* The higher sand-hills are often occupied by dense thickets of *Myrica carolinensis* usually 1½ to 2 meters (5 to 6 feet), but frequently 3 meters (9 feet) high, often unaccompanied by other woody species. This plant, which is more or less at home in the drier portions of the forested plain, is, however, most characteristic as a dune-plant and is noteworthy as the shrub which usually occurs nearest the beach."

At Presque Isle *Myrica* never assumes the rôle of a dune-plant. It rarely seems able to extend itself, even by vegetative dissemination, up to the tops of the ridges and neither do the drupes seem to be capable of successful growth in the drier portions of the sand-plain. Although structurally a xerophyte,[67] and usually occupying quite xerophytic habitats along the Atlantic sea-board, it must be regarded at Presque Isle as being much less xerophytic in habit.

In the advanced stages of the *Myrica* thicket-formation other plants than *Myrica* become more and more prominent, until finally a transitional stage is attained, representing the advanced guard of the coming forest. At this stage the thicket consists typically of the following species:

Rubus allegheniensis,	*Vitis vulpina,*
Rubus occidentalis,	*Celastrus scandens,*
Prunus serotina,	*Prunus pennsylvanica.*

The *Prunus* Forest-formation.

A forest-formation soon displaces the transitional thicket following the *Myrica* thicket-formation. This forest-formation is at present best seen immediately to the west and south of Long Ridge, where it alternates with a formation derived from the *Rhus-Alnus* thicket, to be described in connection with another succession.

Typically the structure of the *Prunus* forest-formation is as follows:

Facies. —

Prunus serotina,	*Prunus pennsylvanica.*

Principal Species. —

Rubus allegheniensis,	*Celastrus scandens,*
Rubus occidentalis,	*Vitis vulpina.*

[67] Kearney, T. H. "Plant-Covering of Ocracoke Island." *l. c.*, p. 294.

Secondary Species. —

Prunus virginiana,	*Alnus incana,*
Fragaria virginiana,	*Juniperus virginiana,*
Acer saccharinum,	*Quercus velutina,*
Toxicodendron pubescens,	*Poa compressa,*
Myrica carolinensis,	*Smilax herbacea,*
Psedera quinquefolia,	*Amelanchier oblongifolia.*

The layering in the *Prunus* forest is rather indefinite, but below the facies are the smaller trees and saplings of the two wild cherries (*Prunus serotina* and *P. pennsylvanica*) together with a considerable number of the secondary species, constituting thus altogether a layer of variable importance throughout the formation. Below this secondary layer is a more definite layer of bushes, the tertiary layer, dominated by *Rubus allegheniensis* and *Rubus occidentalis* and occurring throughout the formation, but best developed in the more open spaces, and tending to form a fringing zone about the edges of the forest. Clambering about quite promiscuously is the *Celastrus scandens* and some *Vitis vulpina* and *Smilax herbacea*, which, together with the clumps of dead and dying *Myrica*, often forms a tangle very difficult to push through.

The herbaceous layer is very poorly developed in this formation, the tertiary layer so completely occupying the habitat. However, *Poa compressa* occurs in the few openings among the bushes and is accompanied sometimes by *Fragaria virginiana.*

The successor to the *Prunus* forest-formation is evident from the seedlings of *Quercus velutina*, which appear early in the life of the formation, and which gradually become more important, until finally the wild cherries are relegated to a minor position. Were it not for the difficulty with which *Quercus* is disseminated, as compared with the species of *Prunus*, the *Myrica* thicket-formation would, undoubtedly, be succeeded directly by a *Quercus* forest.

The *Prunus* forest-formation is evidently the homolog of the *Pinus Strobus* forest-formation, in that it immediately precedes the *Quercus velutina* forest, but, although the habitats are closely similar, the two formations have very few species in common in the lower layers, on account of the difference in the amount of light under the forest canopies.

Mixed *Pinus-Prunus* forest formation along Board Walk near the Lighthouse. *Pinus Strobus*, *Prunus serotina*, and *Rubus nigrobaccus* constitute the larger part of the vegetation. Photographed June 10, 1906.

The *Quercus velutina* Forest-formation.

This formation is so closely similar to the forest-formation following the *Pinus Strobus* forest-formation that its separate treatment is not deemed necessary. The only essential difference noted was the presence of occasional large trees of *Prunus* and *Acer*, relicts of the earlier *Prunus* forest-formation.

Mixed Formations.

To the southwest of the Fog Whistle the *Panicum-Artemisia* formation gives way, near Long Ridge, to a mixed formation representing the overlapping of the heath and the *Myrica* thicket-formations (see Plate XXVIII). Here may be seen a struggle between the two formations sometimes resulting in favor of the one, sometimes of the other. *Juniperus* and *Pinus* here find apparently equally congenial habitats in either the heath or the thicket so that often a patch of *Pinus Strobus* forest may be seen originating in a *Myrica* thicket (see Plate XXIV). There is also a mixing of the principal and secondary species of the two formations, so that in total number of species the mixed formation is richer than either of the pure formations.

Following this mixed heath-thicket-formation, as the structure may be called, comes a mixed forest-formation derived from the *Pinus Strobus* and the *Prunus* forest-formations (see Plate XXXVI). This mixed forest occupies much of the area between Long Ridge and the Yellow and Ridge Ponds (see map of Presque Isle). The disposition of the respective facies is, perhaps, not so much a true mixture as it is a case of promiscuous alternation of various sized clumps of the two formations. The principal and secondary species of each clump are usually those peculiar to the formation represented by the facies of the clump, there being no indiscriminate mingling as in the mixed heath-thicket-formation.

Following the mixed *Pinus-Prunus* forest-formation comes finally the same *Quercus velutina* forest which follows in the normal successions. Such a *Quercus velutina* forest following a mixed *Pinus-Prunus* forest is represented in a limited way south of Cranberry Pond.

The Dune-Thicket-Forest Successions.

Undoubtedly, in no phase of ecology has there been more field work carried on than in the study of the vegetation of sand-dunes.

In America such studies have been made in several localities.[68] The dunes of Lake Michigan have been worked out by Cowles,[69] and, in many respects his descriptions are equally applicable to similar but less pronounced structures at Presque Isle.

The dunes at Presque Isle may be classified as follows:

(*a*) *Populus* dunes or ridges,
(*b*) *Ammophila* dunes,
(*c*) *Andropogon* dunes,
(*d*) *Prunus* dunes,
(*e*) Mixed *Prunus-Smilax* dunes.

The *Populus* Dune-formation.

The cottonwood, *Populus deltoides*, occupies by far the most important position among dune-forming plants at Presque Isle, just as Cowles finds it characterizing the shore of Lake Michigan at many places, especially southward.

During exceptionally heavy storms from the north or northeast the surf often piles up the sand of the shore into sand-bars, which upon the subsidence of the waves may remain more or less permanently above ordinary water-levels (see Plate XXVI). Between such a bar and the shore proper is usually a long narrow pond or lagoon, which may be cut off from the lake by the drifting in of dry sand from the beach, or, possibly, by the closing in of the ends by the waves. At Presque Isle the subsequent history of such a lagoon depends largely upon its size, its position with respect to drifting sand, and the rapidity with which the general shore-line is advancing upon the lake, and so leaving the lagoon inland.

If the lagoon be towards the north or northwest portions of the peninsula the greater exposure to strong winds generally results in a rapid filling even of a large lagoon by drifting sand (see Plate XXVII). Farther to the southeast the lagoon, being less exposed to filling by wind-driven sand, may escape filling, until the general shore-line has advanced lakeward to such a distance as to leave the lagoon inland, where the advancing vegetation more and more prevents

[68] Hill, E. J. *l. c.*, pp. 419–436; Kearney, T. H. "The Plant-Covering of Ocracoke Island," *l. c.*, pp. 270–271; "Botanical Survey of Dismal Swamp," *l. c.*, pp. 368–393; *and* Gleason, H. A. *l. c.*, pp. 141–189.

[69] Cowles, H. C. "Sand-Dunes of Lake Michigan," *l. c.* "Physiographic Ecology of Chicago and Vicinity," *l. c.*

such a drifting of the sand. A glance at the map of the peninsula shows very plainly the preponderance of ponds and lagoons towards the southeastern part of the peninsula.

During the fruiting period of the cottonwood and of the sand-bar willow, *Salix syrticola*, the cottony disseminules of both of these species are blown over the sand-plain in great numbers by the westerly winds, which prevail during fair weather, and the disseminules are thus blown into the ponds and lagoons in such abundance as to collect along the shores in little windrows. The right conditions for successful ecesis, however, are to be found only in the young lagoons near the lake-shore, where the shores of the lagoons are composed of loose, rapidly accumulating sand, in which the seeds quickly become buried and as quickly sprout. Along the shores of the older lagoons the disseminules collect as abundantly, but the shores being composed of more firmly packed sand, the seeds do not become buried and so cannot accomplish ecesis. Along the lake-beach ecesis is effectually prevented by the mechanical violence of the waves.

At Presque Isle it was found that the cottonwoods always sprouted in the loose sandy shore of lagoons not more than three or possibly four years after the separation of the lagoon from the lake. It is interesting to note that Whitford found in the Philippine Islands the "mangrove and *Nipa-Acanthus* formations behind sandy beaches" having methods of dissemination and ecesis very similar to those just described for the *Populus-Salix* formation at Presque Isle. In both instances the disseminules first float upon areas of quiet water protected by bars or beaches and both find the dynamic conditions of the strand too strenuous to admit of their obtaining a foothold.[70]

Wherever, as towards the southeastern part of the peninsula, the lagoons are less exposed to drifting sand, the vegetation generally passes through a marsh-succession and no dunes or ridges are formed. Where the sand is drifted in more abundantly, however, it tends to accumulate in the line of *Populus* and *Salix* surrounding the lagoon, thus beginning the formation of the dune. Most of the lagoons being long narrow ponds parallel to the lake-shore, the dunes formed along the line of trees arising on the banks of the lagoon also have a direction parallel to that of the lake-shore.

[70] Whitford, H. N. "The Vegetation of the Lamao Forest Reserve." *Philip. Journ. Science*, 1: 673–674, 1906.

The *Andropogon* Dune-formation.

As the cottonwoods of the *Populus* dune-formation rapidly grow in height, they constantly act as an obstacle to the drifting sand, and the ridge grows higher and higher, soon completely burying any accompanying *Salix*. The upward growth of the ridge continues usually as long as the cottonwood has an abundance of lower bushy limbs which serve to catch and retain the drifting sand. With increasing age, however, the lower limbs of the trees begin to die away and the upper growth of the dune ceases — the top of the ridge may even be blown away. Generally with the dying off of the lower limbs of the trees and the cessation of the upward growth of the dune, there appears another dune-plant, *Andropogon furcatus*, which in a measure takes the place of the lower limbs of the trees in protecting the top of the dune, or ridge, from the action of the wind. Sparingly associated with the *Andropogon* are usually a few species from the *Panicum-Artemisia* formation:

Artemisia canadensis,	*Euphorbia polygonifolia*,
Artemisia caudata,	*Lathyrus maritimus*.

The *Andropogon* dune-formation, as above described, is typically represented on the ridge commencing near the Key Post and running along the lake-shore nearly to the Light House. About a half-mile east of the Light House the lake is cutting into the shore and in places has carried away part of the ridge, thus exposing the lower buried portion of the tree-trunks to view. Where exposed the trees had been buried from nine to fourteen feet in the dune (see Plate XXXVII), and at the base of the exposure, about one and one-half feet above the water of the lake, the trunks were about two inches in diameter, increasing upwards to six to eight inches in diameter at the top of the ridge. The buried portion of the trunks had numerous dead limbs in various stages of decay and scattered among these limbs, extending nearly to the top of the ridge, were many strong roots. As mentioned in the discussion of the historical development and probable age of the peninsula, one of the undermined cottonwoods which had been cut off to free a telephone wire showed twenty-six rings of annual growth. In places this ridge is over twenty feet high and the cottonwoods are still growing vigorously, the top of the ridge being mainly held in place by the *Andropogon*.

Outer *Populus* ridge east of Lighthouse, showing washing away by waves. Note adventitious roots on buried portion of tree trunks. Photographed May 8, 1906.

The *Toxicodendron* Thicket-formation.

The effect of the *Andropogon* formation upon the the habitat is, likely, the addition of considerable humus, not at the surface of the soil, but by the decay of roots and buried limbs, etc., in the lower layers. At the same time the soil is made firmer by the binding action of the roots, and the surface becomes more protected by the growth of the grass.

Under these conditions there soon appears a new set of species constituting the *Toxicodendron* thicket-formation having the following structure :

Facies. —

Toxicodendron pubescens.

Principal Species. —

Celastrus scandens, *Vitis vulpina*,
Prunus serotina, *Rubus allegheniensis*,
Prunus pennsylvanica, *Populus deltoides.*

Secondary Species. —

Rubus occidentalis, *Poa compressa*,
Fragaria virginiana, *Andropogon furcatus*,
Juniperus virginiana.

This formation is typically represented in the southeastern half of Long Ridge. The *Toxicodendron* (poison ivy) occupies almost the entire habitat by a dense thicket composed of stiffly upright, closely growing shrubs, two to five feet high. To the writer the species was quite poisonous, and the thickets impede progress considerably by being bound together by *Rubus* and *Celastrus*. *Populus deltoides* is quite abundant on Long Ridge, but the trees are dying and appear to play a relatively insignificant part in the structure of the formation and they may here be considered relicts of the preceding formation.

The *Arctostaphylos-Juniperus* Heath-formation (on ridges).

Towards the Light House the *Toxicodendron* thicket-formation gives way quite suddenly to heath, apparently exactly the same structure on the ridge as on the former sand-plain adjoining (see Plates XXVIII and XXIX). The only difference apparent is the presence on the ridge of the relict *Populus* and a greater amount of *Celastrus scandens.* There is no such broad mixed zone on Long Ridge between the *Toxico-*

dendron and the heath as there is on the sand-plain between the *Myrica* thicket and the heath. The pure heath-formation extends farther inland along Long Ridge than it does on the sand-plain, showing here its greater adaptability to positions of greater exposure.

The *Pinus Strobus* and *Quercus velutina* Forest-formations (on ridges).

The heath on Long Ridge passes into the *Pinus Strobus* forest and finally into the *Quercus velutina* forest, as does also the heath on the sand-plain. A typical example of the white pine forest occurs on the older arm of Long Ridge extending to the southwest of the Light House. The fine black oak forest at the western end of the ridge near Jetty No. 2 and on the two ridges between ridges No. 2 and No. 3, probably occupies the site (at least partially) of a former white pine forest. As has been seen, the last mentioned ridges are probably between five hundred and six hundred years old, and, from what can be deduced from known facts, it is probable that the portions of these ridges which constituted the habitat of the white pine forest have been largely washed away.

The *Prunus* Forest-formation (on ridges).

The *Toxicodendron* thicket, like the *Myrica* thicket, accumulates vegetable débris quite rapidly and with the consequent increase of humus conditions becomes suitable for other species. The succeeding formation is practically the same as that following the *Myrica* thicket ; the *Prunus* forest-formation. About the only difference noted was the greater abundance of lianes ; *Celastrus*, *Vitis*, *Psedera* (*Parthenocissus*) and *Smilax*, and the absence of *Alnus* and *Acer*. *Prunus virginiana* is more abundant in the early stages of the formation, and there are usually a few old cottonwoods, relicts of the earlier formations.

The *Prunus* forest-formation on ridges is relatively short lived and soon gives way to the *Quercus velutina* forest. Portions of the ridge between the Board Walk and Big and Graveyard Ponds are occupied by the *Prunus* forest, but much of this area, has evidently been burned over, and is now occupied by a secondary burn succession.

The *Quercus velutina* Forest-formation (on ridges).

The *Quercus velutina* forest-formation succeeding the *Prunus* forest is at its best on the ridges between Long and Big Chimney Ponds.

The description of this formation, as given for the forest succeeding the white pine, applies equally well for the formation as it occurs on the ridges, although the ridges attain in places to a height of nearly thirty-five feet.

The *Ammophila* Dune-formation.

For a distance of about half of a mile west of the Key Post, and again for about the same distance west of the Light House Jetty, there is a more or less broken line of *Ammophila*-dunes fringing the beach. West of the Key Post the *Ammophila* now characterizes a weak line of small dunes between the first cottonwood ridge and the beach. *Ammophila arenaria* is a stiff upright grass growing just back of drift-beaches along much of both coasts of the North Atlantic. The grass propagates itself readily in a horizontal direction by vegetative methods and is able to grow vertically for a number of feet, when continuously buried by accumulating sand. In this manner the grass and the drift-sand reciprocally operate to build up dunes, the grass acting as an obstacle around which the drifting sand accumulates. There is a limit, however, to the ability of the *Ammophila* to grow vertically with the increasing height of the dune, and at Presque Isle this limit appears to be reached at about fourteen feet above Lake Erie. The effectiveness of the grass as a dune-former is materially impaired, however, before this limit is reached, and the small dunes west of the Key Post are mainly not more than four or five feet above the surrounding sand-plain. Unlike the cottonwood ridge the *Ammophila* dune always has gentle slopes, because of the radial propagation and the small stature of the *Ammophila*.

The structure of this formation is essentially:

Facies. —

Ammophila arenaria.

Principal Species. —

Psilocybe ammophila.

Secondary Species. —

Cakile edentula,	*Euphorbia polygonifolia,*
Artemisia canadensis,	*Lathyrus maritima,*
Artemisia caudata,	*Andropogon furcatus,*

Panicum virgatum.

During the most vigorous growth of the *Ammophila* dune there are very rarely any plants present, except the facies and the principal species, the latter being found attached to the old dead stems and roots of the grass, and during damp periods often becoming quite abundant. In the early stages of the dune *Cakile* may be present, and in the later stages there is an increasing number of invaders from the sand-plain, especially on the lower slopes of the dune.

At Presque Isle the *Ammophila* dune, when finally surrounded by sand-plain by the general advance of the shore-line, is either quickly blown away, following the death of the grass, or else it passes quickly into an *Andropogon* dune.

As Ganong points out for the Miscou Beach,[71] the *Ammophila* starts in some accumulation of driftwood, which lying at the upper limit of the drift-beach has had time to accumulate more or lesss and. Here the *Ammophila* comes in, and, thriving best when partly covered with freshly blown sand, begins the formation of a dune. In quiet sand the grass dies in a very few years.[72]

To the west of the Light House Jetty the erosion of the beach was stopped by the building of the jetty, and the beach has since been growing lakeward, so that, instead of an abrupt cliff, there is now a gentle slope towards the water. Back of the former sea-cliff and extending up to it is the white pine forest. Outside of the forest and capping the crest of the present slope is a small area of the mixed *Myrica* heath-formation in which are a few *Prunus* and *Andropogon* dunes, and into this the pine forest is now advancing. The upper half or two-thirds of the slope is occupied by the *Ammophila* formation essentially forming a fringing dune, but on account of the proximity of the forest- and shrub-formations sand has continually filled in back of the *Ammophila* dune, as rapidly as the latter has risen above the level of the inclined plane of the slope.

Outside of the true *Ammophila* zone, and extending from there down to the *Cakile-Xanthium* formation of the drift-beach, there is a mixed formation derived from the *Ammophila*-dune and the *Panicum-Artemisia*-formations:

Andropogon furcatus,	*Lathyrus maritimus,*
Artemisia canadensis,	*Ammophila arenaria,*
Artemisia caudata,	*Panicum virgatum,*

Populus deltoides.

[71] Ganong, W. F. *l. c.*, p. 88.

[72] Hitchcock, A. S. "Methods Used for Controlling and Reclaiming Sand-Dunes." U. S. Dept. Agr., Bur. Plant Industry, Bull. 57 : 14, 1904.

Andropogon dune formation near the Key Post. In the immediate foreground note the *Lathyrus maritimus* community.
Photographed September 20, 1906.

There is here the beginning of the *Populus*-ridge, a narrow lagoon having been formed and filled up, but not till after the cottonwoods had become established. The cottonwoods are now only saplings, but, present conditions continuing, there will develop in time a ridge.

The *Ammophila*-zone is now on its decline at this place, and in a few years it will likely be supplanted by the *Panicum-Artemisia*-formation. Such a result will be accelerated by the growth of the cottonwood ridge and the subsequent building up behind it of a more level plain. Associated with the *Ammophila* here are all the species mentioned for the formation in general, excepting *Cakile* and *Euphorbia*. *Andropogon*, *Artemisia* and *Lathyrus* are, perhaps, more abundant than the designation, "secondary species," would indicate.

The *Andropogon* Dune-formation.

In the discussion of the *Populus* dunes or ridges and the formations succeeding the *Populus* on them, the *Andropogon* dune-formation was discussed at some length as a component stage of a succession beginning with the *Populus* ridge or dune, but, as there are conditions under which the *Andropogon* dune-formation has no connection with the former, it has been deemed best to accord the *Andropogon* dune-formation a separate treatment.

The *Andropogon* is not a strong formation, but, aside from the important service it performs in holding together *Ammophila* or *Populus* dunes until other vegetation can obtain a foothold, there is considerable evidence that on Presque Isle *Andropogon* may cause the formation of a dune independently of other dune-forming plants (see Plate XXXVIII).

Andropogon furcatus is a bunch-grass growing in dense rounded clumps, often two feet or more in diameter, and sending up flowering stems to a height of two to three feet. Ordinarily the clumps on the sand-plain are so far apart, that, although each individual clump forms a miniature dune, there is no continuous accumulation of sand due to the joint effect of several neighboring clumps. Occasionally, however, the clumps are so close together as to have such a joint effect and a low dune is formed.

The grass apparently grows more vigorously, if somewhat elevated above the general surface of the sand-plain, and upon the new dune, or upon an old *Ammophila* or *Populus* dune, the grass-clumps are closer together, thus bringing about a greater ability on the part of the grass as a dune-former.

The *Andropogon* dune-formation of independent origin has typically the following structure :

Facies. —

Andropogon furcatus.

Principal Species. —

Artemisia canadensis, *Euphorbia polygonifolia*,
Artemisia caudata, *Lathyrus maritimus.*

Secondary Species. —

Asclepias syriaca, *Panicum virgatum*,
Panicum Scribnerianum.

The general topography of an *Andropogon* dune, either when following *Ammophila* or when originating independently, is that of a low mound or ridge with gentle slopes. Succeeding the *Andropogon* dune formation are practically the same formations as enumerated in the successions starting with the *Populus* dune or ridge, viz., either (*a*) heath, (*b*) white pine, and (*c*) black oak ; or (*a*) *Toxicodendron* thicket, (*b*) wild cherry, and (*c*) black oak.

The *Prunus pumila* Dune-formation.

The sand-cherry, *Prunus pumila*, is a low shrub forming clumps, often several yards in diameter, which are capable of stopping the drifting sand and of building up a considerable dune without the vitality of the plant being impaired. This species is quite common about certain portions of the Great Lakes, but is not common at Presque Isle. There are perhaps eight or nine small clumps of the species on the interior portion of the sand-plain and about as many more on the wind-swept narrow portion of the peninsula between the Chimney Ponds and the Head.

The dune formed by this species is usually small, but quite steep, and is more symmetrical than dunes formed by the other dune-building plants on Presque Isle. The largest *Prunus pumila* dune observed, near the remains of the Pier of 1839, is about four feet in height and eleven feet in diameter (see Plate XXXIX). No other species than the facies occurs on the *Prunus pumila* dunes, and the succession could not be definitely determined. Probably most of the dunes disappear with the death of the *Prunus*, but, possibly *Prunus virginiana* or *Toxicodendron pubescens* may sometimes act as a dune-holder and, together with *Rubus*, etc., finally pass into a thicket-formation.

Prunus pumila dune on exposed sand-plain opposite Lagoon X. Miniature dune to the right formed by *Panicum virgatum*. Photographed June 10, 1906.

The Mixed *Prunus-Smilax* Dune-formation.

Along the lake-shore near Jetty No. 3, where the shore-line is receding and is faced with a sea-cliff, the wind striking the perpendicular face of the cliff is deflected upwards with sufficient force to carry sand over the brow of the cliff. There the sand is deposited in the form of a fringing ridge upon the plants constituting the lower layers of the *Quercus velutina* forest-formation. Most of these plants quickly perish under the changed conditions, but a few species survive, and these, together with certain invaders from other formations, constitute a secondary mixed shrub-formation which may be termed the Mixed *Prunus-Smilax* dune-formation.

The structure of this formation is typically as follows:

Facies. —

Prunus virginiana, *Smilax herbacea.*

Principal Species. —

Vitis vulpina, *Myrica carolinensis*,
Toxicodendron pubescens.

Secondary Species. —

Arctostaphylos Uva-Ursi, *Lonicera glaucescens*,
Solidago canadensis, *Celastrus scandens*,
Rubus allegheniensis, *Rubus occidentalis.*

The thicket produced by this formation is almost impassable, the shrubs being bound together by the luxuriant growth of lianes, particularly the *Smilax.* The oaks here are gradually dying and falling, mostly into the lake, but a few are blown backwards into the thicket and contribute to its impenetrability.

Locally, along the bay-side of the peninsula, are to be seen a few small fringing dune-formations of this character; as about three-fourths of a mile east of Big Bend, at Crystal Point, and near the U. S. L. H. Boat House.

Between the Chimney ponds and the Head there has been within comparatively recent years considerable washing away and reconstruction of the peninsula and the larger part of this area is now a sand-plain in various phases of the *Panicum-Artemisia* formation. During the various changes in the shore-line many *Populus* ridges have likely been formed, or at least begun, and subsequently wholly, or in part, again washed away. There are cottonwoods scattered about rather promiscuously over much of this area, many of them forming dunes which appear to be fragments of former ridges. Behind the remains of the Pier of 1839 are three steep *Populus* dunes which are at least thirty feet high, and which now support the *Andropogon* dune-formation. On one trip *Morchella esculenta* was found to be quite abundant between the clumps of grass on the dunes.

THE LAGOON-MARSH-THICKET-FOREST SUCCESSION.

In the discussion of the conditions under which a *Populus* dune-formation may be instituted, it was stated that in the southeastern portion of the sand-plain, where the lagoons are less exposed to drifting sand, there is likely to be no dune-formation, but that the *Populus-Salix* formation constitutes the initial stage of a marsh-succession.

The *Populus-Salix* Formation.

Perhaps no distinction should be made between the initial stages of the *Populus* dune-succession and the *Populus-Salix* formation of the lagoon-succession. At the very first they appear to be identical, but the environment of the dune changes so rapidly with the growth of the dune, and the *Salix* plays relatively so unimportant a part in the formation, that it has seemed best to here recognize two formations. By so doing confusion of the two habitats is also avoided.

In the lagoon succession there is a remarkable gradual interpolation of successively later formations, each forming at the time of its appearance an inner ring or *zone* around the edges of the lagoon (or pond). Thus, in the structure of the lagoon-formations, *zonation*, and not *alternation*, as in the *Panicum-Artemisia* formation, is the usual method of disposition of the component parts. Some ecological workers will probably take exception to the large number of vegetational structures, which we have here given the rank of formations, but the abrupt dissimilarity in the systematic classification and in the structural adaptations of the plants of adjacent zones combine to make the ecotones very distinct, indeed, and, considering the differences in the ecological conditions of the habitat, there appear to be good reasons for the recognition of a considerable number of zoned formations.

The accumulation of drifting sand about the banks of a lagoon is usually so rapid that in a few years the surface of the soil in the *Populus-Salix* zone has been brought up to the general level of the surrounding sand-plain, but the general advance of the shore-line lakeward leaves the lagoon farther and farther inland, and, at the same time, the vegetation increases immediately around the lagoon, so that decreasing amounts of sand will be drifted into the lagoon and into the innermost zones of vegetation. From this it follows, that, after the *Populus-Salix* formation, each succeeding inner zone will have been built up of less rapidly accumulated sand, and, as farther inland the drifting sand is composed of finer particles, the zoned habitats are thus characterized by successively finer-grained, moie compact soils, and in a general way each has taken a longer time in its building. Furthermore, the accumulation of organic matter, humus, becomes relatively a more important factor in the edaphic conditions of each successive habitat.

Contemporaneous with the initial stages of the *Populus-Salix* formation there is a submerged formation in its initial stages in the waters of the lagoon, and, as the ecological relations of the land and water formations of the lagoons are very intimate, it has seemed best to take up their consideration together. The different stages in the succession will be considered, as they are exemplified in the different lagoons and ponds, in the order of development of the successive formations.

Stage A. — Lagoon Aa (see Map).

(*a*) *Potamogeton* formation,
(*b*) *Populus-Salix* formation.

The *Potamogeton* Formation.

During the first few years of the existence of the lagoon, and contemporaneously with the beginning of the *Populus-Smilax* formation, the lagoon is in many respects merely a portion of the lake, cut off by a sand-bar, and of the same character as the lake itself; but, considered as a habitat, the two are quite distinct. The waters of the lagoon, not being mingled with the uniformly cool currents of the lake, but being comparatively shallow and stationary, are subjected to greater variations in temperature than are the waters of the lake. During the growing season the water of the lagoon presents an excess of heat above the waters of the lake; during hot midsummer days temperatures above 90° Fahrenheit were noted in some of the more open lagoons south of the Fog Whistle, while at the same time the lake along the beach-line had a temperature of about 70° Fahr.

Another difference between the two habitats is to be noted in the constant clearness and transparency of the waters of the lagoons, whereas the lake is often distinctly turbid.

To briefly sum up the differences between the environment afforded by the lagoons and the lake; the former (*a*) is warmer during the growing season, but (*b*) has a greater variation of temperature, (*c*) is free from currents and mechanically violent waves, and (*d*) has a greater amount of insolation below the surface.

The structure of the *Potamogeton* formation is typically:

Facies. —

Potamogeton pectinatus.

Principal Species. —

Potamogeton pusillus, *Vallisneria spiralis.*

Fruiting specimens of *Potamogeton pectinatus* appear very early in the life of the lagoon, and perhaps may represent simply a continuation of a formation of the lake itself. Probably many of the plants of the lagoon are derived directly from the lake by the separation of the lagoon from it. Other plants were likely derived from disseminules which were buried by wave-action in the sand forming the bottom of the lagoon. The facies of the formation appears mainly in the deeper part of the lagoon where the depth is three feet or more. The principal species, however, are quite abundant in the shallower water, even where not over eight or nine inches deep. In Lagoon Aa the plants were spreading rapidly by rhizomes, which were buried about an inch in the sand, and which were sending up rosettes at intervals of a few inches. The rosettes in the shallow water near the shore were probably buried by indrifting sand before they attained maturity.

The *Populus-Salix* Formation.

During periods of wet weather or of high water in the lake the water in the lagoons quite frequently rises sufficiently to inundate the zone of cottonwood and willow seedlings which at this stage constitutes the *Populus-Salix* formation. Around Lagoon Aa the ecesis of these two species was accomplished during the summer following the segregation of the lagoon from the lake. In places on the west side of the lagoon the formation is about thirty feet wide and consists almost entirely of seedlings in their fourth year in 1906 (see Plate XL). The indrifting

Between C and Aa, looking south. Wide Zone of the *Populus Salix* formation, cottonwoods four years old. The *Juncus-Eleocharis* formation is coming in along the water's edge. Photographed May 8, 1906.

of sand was mainly from the westward so that the formation as a whole is considerably narrower on the east side of the lagoon (see Plate XXVI).

The habitat may be said to be dissophytic. During the most xerophytic periods the sand even at its surface is generally distinctly dark-colored on account of the water it contains. The water-table is so near the surface that even in the loose sand capillarity suffices to keep the water-content of even the surface very high. However, with the drifting in of sand the zone is gradually elevated and becomes dryer at the surface, while a zone of wet sand is simultaneously formed inside the first zone, thus providing a habitat for a succeeding formation. During the year 1906 no little seedling cottonwoods or willows could be found in the innermost zone of wet sand around Lagoon Aa, and thus the *Populus Salix* formation has here reached its territorial limits for this lagoon.

In the manner indicated, there is brought about a remarkable regularity in age and size among the plants constituting the *Populus-Salix* zone, so that the formation often appears like a planted hedge surrounding the lagoon. All over the sand-plain there are long regular lines of cottonwoods indicating the shore of a former lagoon, long since filled up with sand. These vegetational structures are to be regarded, not as component parts of the *Panicum-Artemisia* formation, but rather as "relicts" of a *Populus-Salix* formation, although they may figure quite prominently in the general landscape.

The typical structure of the *Populus-Salix* formation is:

Facies. —

Populus deltoides, *Salix syrticola.*

Secondary Species. —

Artemisia caudata, *Artemisia canadensis*,
Onagra biennis, *Aster ericoides*,
Panicum virgatum.

During the first few years of this formation there are practically no species present other than the facies, but, as the surface-level becomes more elevated, approaching more closely the conditions of the sand-plain, there are a few invaders from the latter habitat, ranking, however, merely as secondary species.

Stage B. — Lagoons C and G.

(*a*) The *Potamogeton* formation,
(*b*) The *Juncus-Eleocharis* formation,
(*c*) The *Populus-Salix* formation.

Around Lagoons C and G (see map) the *Potamogeton* and *Populus-Salix* formations are older and somewhat more mature than around Lagoon Aa, although otherwise essentially the same. Inside the *Populus-Salix* zone, however, there is a new zone, which from its facies may be termed the *Juncus-Eleocharis* formation (see Plate XLI). This formation is also to be seen at the extremè northern end of Lagoon Aa, where encroachment of the sand upon the water is proceeding more rapidly.

The *Juncus-Eleocharis* Formation.

The hedge of small cottonwoods and willows constituting the *Populus-Salix* formation serves as a partial protection against the drifting sand and the habitat (*edaphic*) of the inner zone is thus formed of a more compact soil of a finer texture, which is not easily worked over by the little waves of the lagoon, and thus does not afford suitable conditions for the burial and ecesis of *Populus* or *Salix*. However, the zone is soon occupied by a formation of rush-like and sedge-like plants, mostly spreading about in the wet sand by means of rhizomes. The structure of the formation is:

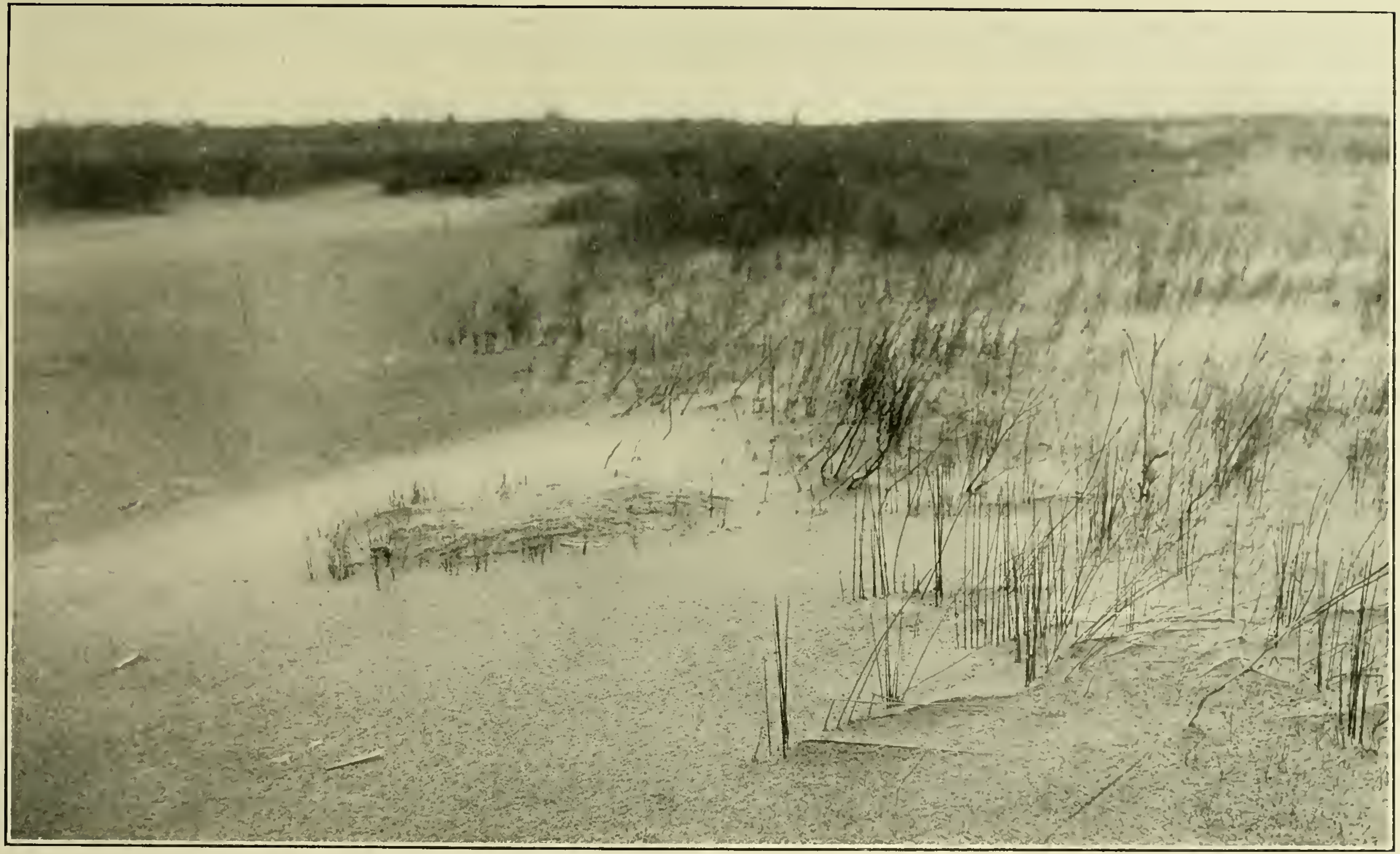
Facies. —
Juncus balticus littoralis, *Eleocharis acuminatus*,
Eleocharis obtusa.

Principal Species. —
Triglochin palustris, *Carex Oederi pumila*.

Secondary Species. —
Cyperus flavescens.

Each of the two species of *Eleocharis*, by aggregation, usually form closed circular mats (families and communities), into which no other species of the local flora appears able to penetrate and which often accumulate the sand quite rapidly, appearing then in miniature dunes two or three inches above the surrounding sand, these patches increasing in area radially by the further growth of the rhizomes of the *Eleocharis* (see Plate XLII).

Southwest shore of Lagoon G near Key Post. *Scirpus* is being buried by accumulating sand, but the *Juncus-Eleocharis* formation is rapidly advancing and building up the shore. Photographed May 8, 1906.



North end of Lagoon C, looking towards Fog Whistle. *Juncus-Eleocharis* formation advancing into moister portion of rapidly accumulating sand. Note mound of *Eleocharis* in center of picture. Photographed May 15, 1905.

Lagoon C, looking south along west bank. Stage D of the Lagoon Succession. *Populus Salix* zone in distance at edge of sand-plain. Next lower is *Myrica-Salix* zone, in *Aster ericoides* aspect; *Sabbatia-Linum* and *Typha-Scirpus* zones. Photographed September 20, 1906.

The *Juncus* spreads rapidly along the wet banks and out under the water by means of its strong slender rhizomes. Sometimes the plant forms practically closed associations, but, usually, the plants are more or less scattered in lines indicating the direction of growth of the rhizome. When the sandy shore is advancing rapidly upon the water of the lagoon the direction of growth of the rhizomes is very strikingly inward, towards the water-line.

Triglochin palustris appears scattered here and there in the *Juncus-Eleocharis* zone, sometimes becoming so prominent as perhaps to merit a higher rank than principal species. It never penetrates the closed *Eleocharis* consocies, but is sometimes mixed with the *Juncus balticus littoralis.*

The formation, as may be seen from the above statements, is composed of alternating consocies which may be termed :

The *Juncus balticus littoralis* consocies,

The *Eleocharis acuminatus* consocies,

The *Eleocharis obtusa* consocies.

In the upper, dryer part of the zone, practically marking the ecotone between the *Populus-Salix* and the *Juncus-Eleocharis* formations, is the *Carex-Oederi pumila* society, which characterizes very distinctly an early summer aspect. The same area is occupied later in the season by the less abundant *Cyperus flavescens.*

Stage C. — Lagoons C, D, and part of G.

(*a*) *Potamogeton* formation,

(*b*) *Typha-Scirpus* formation,

(*c*) *Sabbatia-Linum* formation,

(*d*) *Populus-Salix* formation.

Towards the ends of Lagoon G, which had been quite largely filled with sand during 1905 and 1906, there are patches of two formations not found along the sides of the lagoon, but which can be seen to be replacing the *Juncus-Eleocharis* formation as well as occupying the previously occupied shallower parts of the lagoon. These formations are to be seen farther advanced and more typical in Lagoons C and D (see Plate XLIII).

Taking the formations in regular order from the center of the lagoons outward, the formations of Stage C may be described as follows :

The *Potamogeton* Formation.

This formation has undergone no change from its structure in the earlier stages except that *Potamogeton pectinatus* is more abundant and is more frequently found fruiting than was the case in the earlier stages. No rosettes are to be seen in shallower water, as in Lagoon Aa, as this area has been taken over by the *Typha-Scirpus* formation.

The *Typha-Scirpus* Formation.

The structure of the formation is, typically:

Facies. —
Scirpus Americanus, *Scirpus validus*,
Typha latifolia.

Principal Species. —
Eleocharis olivacea, *Sparganium eurycarpum*.

Secondary Species. —
Juncus balticus littoralis, *Utricularia cornuta*,
Eleocharis obtusa, *Nostoc* sp.

This formation has its outer limit in about one and one-half feet of water and from here it extends back on the bank to a height of about eight inches above the water level. The habitat might thus be said to be amphibious, but to the plants it is uniform in that the top of the stem is in the air and the roots are in a saturated soil. The *Juncus-Eleocharis* formation probably added some humus and thus increased the capillary power of the soil. The soil is here made dark with moisture back to a height of about a foot above the water-level of the lagoon. The lower part of the *Juncus-Eleocharis* formation is supplanted by the *Typha-Scirpus* formation; in places almost the entire habitat has been so occupied.

The *Typha latifolia* consocies appears in the deeper, submerged portion of the habitat, and alternates with the *Scirpus validus* consocies. The *Scirpus americanus* consocies occupies by far the most important place in the formation, but it exhibits more or less zonation with the *Scirpus validus* consocies, which usually occupies the outer, more deeply submerged zone. Excepting *Sparganium*, which occurs in the *Typha latifolia* consocies, the principal and secondary species of the formation occupy the bank in the *Scirpus americanus* consocies. In places the soil around the bases of the stems of the *Scirpus* is almost completely covered with little pellets of a species of *Nostoc*.

The *Sabbatia-Linum* Formation.

Supplanting the upper part of the *Juncus-Eleocharis* formation, and, more especially, the *Carex Oederi pumila* society, is a formation, which, unlike any of the formations before described, consists mainly of rosette-forming biennials and perennials.

The structure of the formation is, typically:

Facies. —

Sabbatia angularis, *Linum medium.*

Principal Species. —

Gerardia paupercula, *Ibidium incurvum*,
Lobelia Kalmii.

Secondary Species. —

Utricularia cornuta, *Juncus tenuis*,
Eleocharis obtusa, *Scleria verticillata*,
Juncus canadensis, *Campanula aparinoides*,
Nostoc sp., *Psilocybe ammophila.*

This formation is practically a closed one, but aside from several quite distinct aspects there is practically no grouping, the species being indiscriminately intermingled within the limits of the habitat. This formation more proportionally than any other formation on the peninsula is marked by the variety and abundance of its floral display, the different species alternating with each other in their periods of bloom to such an extent that flowers are in evidence almost continuously from early summer till late fall.

Some of the more important species characterizing corresponding aspects are:

Sabbatia angularis, *Linum medium*,
Lobelia Kalmii, *Gerardia paupercula*,
Ibidium incurvum *Utricularia cornuta.*

The *Populus-Salix* Formation.

This formation in the stage under discussion usually occupies a habitat now completely on a level with the surrounding sand-plain, and indeed very little different from that habitat in most particulars. Around Lagoon D the cottonwoods have attained to a diameter of three and one-half inches and are beginning to lose some of the lower branches. The willows are beginning to die out also, so that the hedge-like appearance of the formation is disappearing, and the environment is becoming changed, because there is a much greater illumination of the soil about the base of the trees.

Stage D. — Lagoons C, D, and end of G (see Plate XLIV).

(*a*) *Potamogeton* Formation,

(*b*) *Typha-Scirpus* Formation,

(*c*) *Sabbatia-Linum* Formation,

(*d*) *Myrica-Salix* Formation,

(*e*) *Populus-Salix* Formation.

Stage D presents most of the formations in essentially the same condition as they were described for Stage C, but in the more advanced portions of the vegetation of the banks around the lagoons mentioned in the heading there appears a new formation, so that it seems best to indicate a stage of the succession coincident with the entrance of the new formation, which may be called from its facies the *Myrica-Salix* thicket-formation.

The *Myrica-Salix* Thicket-formation.

With the further advance of the sand upon the lagoon and the consequent widening of the bank inside of the *Populus-Salix* zone, there is a forward movement of the *Sabbatia-Linum* formation, at the same time that its outer border is being invaded and taken over by the *Myrica-Salix* formation, the latter thus forming a zone between the *Sabbatia-Linum* formation and the *Populus-Salix* formation.

The *Myrica-Salix* formation is a typical shrub association and is characterized by the wax myrtle, *Myrica carolinensis*, and the two willows, *Salix discolor* and *Salix cordata*. The ecotone between the two willows of this formation and the *Salix syrticola* of the *Populus-Salix* formation is very striking, but when the ecological conditions obtaining in the two habitats at the time of ecesis of the respective formations are considered, the apparent similarity of conditions is not so great. The one willow accomplished ecesis under practically sand-bar conditions, while the other two found suitable conditions in the more compact, damp, humus-containing soil of the rosette zone (*Sabbatia-Linum* formation).

The structure of the *Myrica-Salix* formation is thus :

Facies. —

Myrica carolinensis, *Salix cordata*,

West bank of Lagoon D, looking south. Stage C of Lagoon Succession showing *Myrica-Salix* formation displacing *Scirpus* and *Sabbatia-Linum* formations; between this and the sand-plain is the *Populus-Salix* zone. Photographed May 8, 1906.

Lagoon D, looking east across the depression running towards the Fog Whistle. Shows a mature *Scirpus americanus* consocies of the *Typha-Scirpus* formation. Photographed September 20, 1906.

Lagoon E, looking north. In the foreground is expanse of *Cladium* consocies of the *Cladium-Calamagrostis* formation. Next is *Typha-Scirpus* formation, *Typha* to right. *Nymphæa* in center of Lagoon. Photographed May 8, 1906.

Lagoon Ea, looking north. Stage E of the Lagoon Succession. Beginning in the center are: *Potamogeton*, *Nymphæa*, *Scirpus-Typha*, *Cladium-Calamagrostis* (in middle foreground), *Myrica-Salix* and *Populus-Salix* zoned formations. Photographed May 8, 1906.

Salix discolor.

Principal Species. —

Solidago canadensis, *Aster ericoides.*

Secondary Species. —

Scleria verticillata, *Linum medium*,

Nostoc sp.

The *Solidago canadensis* aspect is very conspicuous in the fall, just as in the *Myrica* thicket-formation on the sand-plain. There is much similarity, in fact, between these two thicket-formations, but in their manner of origin they are quite distinct, and the willows do not enter into the structure of the thicket on the sand-plain.

The beginning of the *Myrica-Salix* thicket-formation is best exemplified in the "swale" which marks the former extent of a lagoon, of which Lagoon D is the remnant (see Plate XLV). This swampy area averages about three rods in width and extends from Lagoon D towards the Fog Whistle for a distance of about one-eighth of a mile. The area is but a little lower than the sand-plain adjacent and the habitat now affords a beautiful example of a mature *Scirpus americanus* consocies of the *Typha-Scirpus* formation. This formation, however, is bordered by a *Sabbatia-Linum* zone, which is being rapidly supplanted by the *Myrica-Salix* zone. The pioneers of the shrub zone are *Myrica*, while the two willows and the *Aster* are just appearing.

Stage E. — Lagoons E, Ea, F, and Fa.

(*a*) *Potamogeton* Formation,

(*b*) *Nymphæa* Formation,

(*c*) *Scirpus-Typha* Formation,

(*d*) *Cladium-Calamagrostis* Formation,

(*e*) *Myrica-Salix* Formation,

(*f*) *Populus-Salix* Formation.

Stage E is exemplified around Lagoons E, F, and Fa, which were apparently segregated from the lake at about the same time, being nearly in line with each other abreast and being very similar in their vegetation (see Plates XLVI and XLVII).

The *Potamogeton* Formation.

The *Potamogeton* formation here is becoming somewhat more restricted but at the same time it is better developed and is more clearly defined from the zones surrounding it. It occupies the deeper water of the lagoons, shallowing out to a depth of about five feet.

The structure of the *Potamogeton* formation in this stage is:

Facies. —

Potamogeton pectinatus.

Principal Species. —

Potamogeton natans, *Naias flexilis*,
Potamogeton lonchitis, *Utricularia vulgaris.*

Secondary Species. —

Vallisneria spiralis, *Philotria canadensis.*

The *Nymphæa* Formation.

The *Nymphæa* formation occupies a zone outside of the *Potamogeton* formation, in water from two to five feet in depth. It is not yet well developed in this stage, but it is invading all three of the lagoons associated with this stage.

The structure of the formation as here developed is:

Facies. —

Nymphæa advena.

Principal Species. —

Pontederia cordata.

The *Scirpus-Typha* Formation.

The *Scirpus-Typha* formation in Stage E extends from a few inches above the water-level on the wet bank to a depth of about fourteen inches below the water-level. Its structure is mainly the same as in Stage D, but the *Sabbatia-Linum* formation surrounding it has been supplanted by a formation, which, when once invasion has begun, rapidly gains entire possession of the habitat, and, being very stable, is able to retain possession for a comparatively long period.

The *Cladium-Calamagrostis* Formation.

The structure of this formation is here as follows:

Facies. —

Cladium mariscoides, *Calamagrostis canadensis.*

Principal Species. —

Aster ericoides.

Secondary Species. —

Asclepias incarnata, *Hypericum boreale*,
Dryopteris thelypteris, *Cyperus flavescens*,
Equisetum hyemale.

This formation consists so largely of the grass-like facies that it conveys at once the impression of a wet meadow. The structure of the formation is simple, but there is a very distinct succession of the two facies. The *Cladium mariscoides* consocies always appears first, and usually it has the *Sabbatia-Linum* formation suppressed before the appearance of *Calamagrostis canadensis*. In older structures the *Cladium* has entirely disappeared, leaving the *Calamagrostis canadensis* consocies in undisputed possession. The later appearance of the *Calamagrostis* depends probably upon the accumulation of certain amounts of humus in the soil.

Usually contemporaneously with the appearance of the *Calamagrostis* there appears in the upper portion of the consocies a zone characterized during the autumn aspect by *Aster ericoides*, thus constituting an *Aster ericoides* society. Often associated with the *Aster* is *Equisetum hyemale*. In places the *Aster ericoides* society becomes very prominent and almost entirely dominates an upper zone of the formation.

Of the other secondary species mentioned in connection with the *Cladium-Calamagrostis* formation the *Cyperus* is more largely associated with the *Cladium mariscoides* consocies, while the *Dryopteris*, *Asclepias*, and *Hypericum* are found with the *Calamagrostis*.

This formation, essentially a wet meadow, which is rarely or never submerged, occupies comparatively large areas around Lagoons E, F, and Fa, and in the older portions of the peninsula is represented by the *Calamagrostis canadensis* consocies, as around Lagoon B, and in the three marshy areas between B and Horse-shoe Pond. Lagoon Y is now essentially such a wet meadow with, however, some *Phragmites* in the moister portion and a border of shrubs on the landward side.

The *Myrica-Salix* Formation.

The *Myrica-Salix* zone of shrubs has at this stage attained its greatest development, and will soon be supplanted by another shrub-formation characterized by taller and more rapidly growing species. This succession is apparently made possible by the accumulation of humus in the soil, and perhaps also by the protection offered the young seedlings by the brushy growth of *Myrica*. The structure of the *Myrica-Salix* formation at its culmination is not essentially different from its structure as described for Stage D, excepting that invasion by the next formation has begun, as is evident from the presence here of *Alnus incana* and *Rhus typhina*.

The *Populus-Salix* Formation.

This formation, at the stage under discussion, shows but little change from its structure in Stage D, other than in the growth of the cottonwood trees. The willow has almost entirely died out and a few of the sand-plain species are beginning to crowd in around the bases of the cottonwoods.

Stage F. — Lagoon Eb.

The middle one of the three marshy areas between Horse-shoe Pond and Lagoon B presents an example of a stage in the succession somewhat further advanced than in Lagoon E, and there are quite a number of changes to be noted in the different formations, as well as the appearance of one new formation.

The structure of the vegetation of this marsh, as far as it is at present represented, is as follows:

(*a*) *Scirpus-Typha* Formation,
(*b*) *Cladium-Calamagrostis* Formation,
(*c*) *Rhus-Alnus* Formation,
(*d*) *Populus-Salix* Formation.

The habitat of this series has been derived from a long narrow lagoon, running parallel to the shore of the northwest end of Horse-shoe Pond, from which this area as well as the two adjacent marshy areas were derived, formerly having been lagoons (see Plate XLVIII). In the middle one of these areas the lagoon has been filled to such an extent that the lowest portion is inundated only at times of heavy rainfall. The vegetational zones have closed in on the lagoon, so that the deeper central portion is now occupied by the *Scirpus-Typha* formation.

The *Scirpus-Typha* Formation.

This formation is here in a rather advanced stage, which is mainly marked by the predominance of the *Typha latifolia* consocies. *Scirpus americana* is present, but is rather scarce and is not in a vigorous condition. Of the three consocies of the formation the *Typha latifolia* consocies is evidently more partial to a humus soil, while *Scirpus americana* and *Scirpus validus* reach their best development in almost pure sand. Drainage conditions perhaps enter into the problem to a certain extent.

Secondary species are here more abundant than in previous stages and are as follows:

North end of Horse Shoe Pond, showing regular lines of willows and cottonwoods formed with the cutting off and filling of narrow lagoons. The depression in the middle of the picture is now occupied by an impure *Sabbatia-Linum* formation. Photographed May 8, 1906.

Hypericum boreale, *Hypericum canadense*,
Scirpus cyperinus, *Juncus canadensis*,
Eleocharis quadrangulata, *Pontederia cordata*,
Nostoc sp.

Muskrats have formed many mounds and run-ways in this area, and in so doing have exposed to view the sand, upon which there has been a return of *Eleocharis acicularis* and a new invader from the shrub-zone, *Salix lucida*.

The *Cladium-Calamagrostis* Formation.

This formation is being here invaded very rapidly by the shrub-zone around most of the marsh, the pioneer *Myrica* clumps (families and communities in many cases) being scattered about here and there in advance of the main shrub-zone. *Salix cordata* here advances by even longer leaps than does the *Myrica*, but it does not form such compact clumps.

The structure of the formation at this stage is as follows:

Facies. —

Calamagrostis canadensis (predominant),
Cladium mariscoides (inconspicuous).

Principal Species. —

Dryopteris thelypteris, *Triadenum virginicum*,
Aster ericoides.

Secondary Species. —

Onoclea sensibilis.

Where the *Cladium-Calamagrostis* zone is wider, or where for some reason the shrub-zone advances more slowly, the meadow-formation develops a structure consisting of what may be called the *Fragaria virginiana* society, which is followed later in the season by the *Aster ericoides* society, as described under Stage E. The structure of the *Fragaria virginiana* society is as follows:

Principal Species. —

Fragaria virginiana.

Secondary Species. —

Dasystoma virginica, *Lactuca canadensis*,
Solidago nemoralis, *Solidago canadensis*,
Aster ericoides, *Eupatorium perfoliatum*,
Sorghastrum nutans, *Panicum virgatum*,
Cladonia sp.

This society consists in part of species, which are representative of the sand-plain, and this fact in connection with the sandy condition of the soil, which is in places comparatively free from humus, indicates a close similarity between this habitat and portions of the sand-plain. However there are invading groups of *Myrica* and scattering individuals of *Salix cordata*, so that a final occupation of the habitat by the shrub-formation is indicated.

The *Compositæ*, mentioned above as secondary species in the *Fragaria virginiana* society, reach their most conspicuous development only in the autumnal aspect, when that society is overshadowed by the *Aster ericoides* society.

The *Rhus-Alnus* Formation.

The *Myrica-Salix* thicket, as is evident at this stage, and still more evident in the next stage of the formation, is supplanted eventually by a shrub-formation, which is in reality rather intermediate between thicket and forest. The formation is mainly composed of shrubs and small trees and its vegetational structure is as follows :

Facies. —

Alnus incana,	*Rhus typhina.*

Principal Species. —

Vitis vulpina,	*Cornus stolonifera,*
Solidago canadensis,	*Cornus amomum.*

Secondary Species. —

Salix cordata,	*Salix discolor,*
Salix nigra,	*Fragaria virginiana,*
Rubus allegheniensis,	*Acer saccharinum,*
Dryopteris thelypteris,	*Toxicodendron pubescens.*

During the earlier stages of this formation, and before the taller growing species have become large enough to shut out the light, the principal and secondary species flourish, but with the maturity of the facies and the consequent development of a more or less dense but low "forest cover,"[73] there is a corresponding disappearance or rearrangement of these smaller species. When typically well developed the formation consists of a dense growth of either the *Alnus incana* consocies or the *Rhus typhina* consocies, or a consocies composed of a mixture of the two facies, the whole forming a zone just inside of the zone of cottonwoods.

[73] Pinchot, Gifford. "A Primer of Forestry." Part I.—The Forest. U. S. Dept. Agriculture, Div. Forestry, Bull. 24 : 11. 1900.

Wet meadow between Horse-Shoe Pond and B. Stage G of the Lagoon Succession. *Calamagrostis canadensis* consocies with a clump of relict *Typha* in distance. *Rhus-Alnus* zone encroaching. The larger trees are cottonwoods of the old *Populus-Salix* formation. Rising fog obscures on right. Photographed September 20, 1906.

Wet meadow between Horse-Shoe Pond and B. Stage G of the Lagoon Succession. The *Rhus-Alnus* shrub formation rapidly occupying the *Calamagrostis* meadow. Foremost invaders are *Alnus* at the left and *Myrica* at the right. *Solidago* and *Eupatorium* in middle distance. Photographed September 20, 1906.

Besides this alternation of consocies the formation also exhibits layering and zonation within itself.

On the outside of the mature *Rhus-Alnus* zone, and often leading out into the *Populus* zone, there is usually a low shrub zone characterized by *Myrica carolinensis*, *Rubus allegheniensis*, and *Solidago canadensis*, the whole often being overgrown with *Vitis vulpina*. On the inside of the tall *Rhus-Alnus* zone there is again a secondary zone, which is often rather complex in structure. Principal among its species, besides young plants of the facies, are *Myrica*, *Solidago canadensis*, *Cornus stolonifera*, *Cornus amomum*, *Salix discolor*, and *Salix nigra*.

Where the facies forms a closed structure, the forest-cover is so complete, that none of the plants the disseminules of which reach this location, aside from certain fleshy fungi, *Russula emetica*, *Lactarius piperatus*, *Boletus* sp., etc., which form a transitory ground layer, are able to accomplish ecesis, and the dark pper soil is in places entirely devoid of vegetation. With the death of some of the facies, or where the forest-cover is not so complete, there is a rather weak secondary layer consisting usually of the species which constitute the inner secondary zone.

Stage G. — Lagoon B, Eb, and Marsh 3.[74]

In Marsh 3 (see Plates XLIX and L) the central portion of the lagoon is now entirely filled up and has progressed to the *Calamagrostis canadensis* consocies of the *Cladium-Calamagrostis* formation. There is much *Dryopteris thelypteris* and some *Scirpus cyperinus*, and in a depression at one end there is a small clump of *Typha latifolia*, a relict of a former consocies. Several of the Compositæ of the *Cladium-Calamagrostis* formation are also present. The shrub-zone is encroaching on the meadow very rapidly, and at one end of the meadow there is now only a narrow lane between the shrub-borders, so nearly have they approached each other. Some of the last meadow species to disappear among the advancing plants of the shrub-formation are *Eupatorium perfoliatum* and *Scirpus cyperinus*. *Solidago canadensis* increases in abundance among the smaller shrubs, especially the *Myrica* of the inner secondary zone of the *Rhus-Alnus* formation.

Lagoon Eb, a small oblong pool near Long Ridge, now about thirty feet long, presents the following rather fragmentary structure:

[74] The three small marshes immediately north of Horse-shoe Pond are spoken of, consecutively from north to south, as Numbers 1, 2, and 3.

(*a*) *Nymphæa* formation, which here consists mainly of *Nymphæa advena* with some *Alisma Plantago* and *Pontederia cordata*, together with remnants of the *Potamogeton* formation — *Potamogeton pectinatus*, *Naias flexilis*, and some *Myriophyllum spicatum*.

(*b*) The *Scirpus-Typha* formation, which is here represented by *Typha latifolia* with some *Scirpus americanus* and *Dulichium arundinaceum*, and around the outer border a few plants of *Carex gynandra*.

(*c*) The *Calamagrosis canadensis* consocies of the *Cladium-Calamagrostis* formation with a few relict plants of *Cladium*.

(*d*) The *Rhus-Alnus* formation, in which *Alnus* has become mature and dominant, having associated with it some *Cornus amomum*, *Salix discolor*, and around the outside a secondary zone of *Myrica*.

Another little pool near the south end of Long Ridge has about the same vegetation, except that the *Potamogeton* formation is still intact in a small patch. The structure is essentially thus:

(*a*) *Potamogeton* formation,

(*b*) *Nymphæa* formation,

(*c*) *Typha-Scirpus* formation, represented only by the *Typha latifolia* consocies, and having around its outer border a distinct zone of *Carex gynandra*.

(*d*) The *Rhus-Alnus* formation, which has completely conquered the *Cladium-Calamagrostis* formation, and consists here mainly of *Alnus incana* and *Cornus stolonifera*.

(*e*) There is the beginning in the older part of the shrub-zone of a forest-formation, as is evidenced by the appearance of *Acer saccharinum* and *Prunus serotina*.

At Lagoon B the following structure is evident:

(*a*) *Potamogeton* Formation,

(*b*) *Nymphæa* Formation,

(*c*) *Scirpus-Typha* Formation,

(*d*) *Cladium-Calamagrostis* Formation,

(*e*) *Fragaria-Polytrichum* Formation,

(*f*) *Rhus-Alnus* Formation,

(*g*) *Prunus-Acer* Formation.

The above structure of vegetation is not exemplified in totality in any one portion of the area characterized as Lagoon B. This is a semi-marshy lagoon, U-shaped, with several small ponds scattered here and there, and probably mainly inundated in very wet periods. One of the small ponds has an area of *Nymphæa* with a few *Potamogetons* still remaining; outside of this being a zone consisting of the *Typha latifolia* consocies of the *Typha-Scirpus* formation.

Surrounding the zone of *Typha* is the *Cladium-Calamagrostis* formation, which in several places is a number of rods wide, and in fact occupies a large part of the lagoon. There is a very marked segregation of this formation into zones; an inner one consisting of the *Cladium mariscoides* consocies, and an outer one consisting of the *Calamagrostis canadensis* consocies. The latter presents a very beautiful *Aster ericoides* aspect during late September.

The *Fragaria-Polytrichum* Formation.

At the outer border of the *Cladium-Calamagrostis* meadow appears a rather broken zone, characterized by *Polytrichum* and *Fragaria*. This formation appears to be a sort of "filler" between the meadow and the succeeding shrub-zone. The old shore of the lagoon is here rather wide and has almost no slope, and the *Fragaria-Polytrichum* formation appears only where there seems to be a space, which cannot be occupied by the shrub-zone by the time that the conditions have become more or less unsuitable for the *Calamagrostis canadensis* consocies.

The typical composition of the formation is:

Facies. —

Fragaria virginiana, *Polytrichum* sp.

Secondary Species. —

Sphagnum sp., *Aster ericoides*,
Rhus typhina, *Alnus incana*,
Salix cordata.

This formation is probably a further development, in conditions of a soil with more humus, of what was termed in the *Cladium-Calamagrostis* formation of Stage F, the *Fragaria* society. A further development of probably the same structure is the *Aronia-Polytrichum* formation skirting the *Sphagnum-Oxycoccus* formation of Cranberry Pond and of which more will be said later. It appears probable that the *Fragaria-Polytrichum* formation is not necessarily a member of the lagoon-marsh-thicket-forest succession, but that it represents, either in whole or in part, a formation belonging essentially to some other succession, having found between the meadow and the shrub-zones certain conditions suitable for its successful intercalation. More will be said along this line in the discussion of the phyto-geographical relations of the flora of Presque Isle.

Outside of the *Fragaria-Polytrichum* formation, and advancing gradually into that zone, is the *Rhus-Alnus* formation, which is quite well developed, and around the outer border is even passing into a forest-formation, as indicated by the invading *Prunus serotina* and *Acer saccharinum*.

Stage H. — Cranberry Pond.

In the various lagoons or ponds to the south and west of Long Ridge there can be more or less clearly traced a gradual development into ecological conditions and vegetational formations quite dissimilar to those described for the lagoons to the north and west of the ridge.

The habitat most typical of what perhaps can be most definitely designated as the next clearly distinct stage after Stage G, is Cranberry Pond, a long narrow lagoon closely similar to Ridge Pond and comparatively but little older. The lagoon has practically the same water-level as Lake Erie, there being, however, no drainage outlet excepting through seepage, a character common to most of the lagoons of the peninsula. Currents are thus reduced to a minimum, there being no drainage currents, and the action of the wind upon the surface of the lagoon is also very small, owing to the narrowness of the basin and the protection afforded by the tall forest closely surrounding it.

The vegetational formations, proceeding from the middle of the pond to the shore, are as follows:

(*a*) *Potamogeton* Formation,
(*b*) *Castalia-Nymphæa* Formation,
(*c*) *Cephalanthus-Cornus* Formation,
(*d*) *Sphagnum-Oxycoccus* Formation,
(*e*) *Aronia-Polytrichum* Formation,
(*f*) *Rhus-Alnus* Formation,
(*g*) *Prunus-Acer* Formation.

The *Potamogeton* Formation.

With the limited means at hand the writer was unable to make more than a very superficial survey of the deeper waters of the pond, but enough was learned to make it certain that there is more or less *Chara* and *Naias* in the central portion of the pond, and it is quite likely that a more complete examination would reveal the presence of a *Chara* formation in the deepest water and more or less mixed with the *Potamogetons*.

In Lake St. Clair Pieters[75] found that wherever the bottom was of clay or of alluvial origin, the "*Characetum*" covered the bottom from the line of the zone of rushes (*Scirpus*) to a depth of two to seven meters. Where the bottom was sandy the *Charas* were scarce or entirely absent. Although there is every reason to believe that the bottom of Cranberry Pond is sandy, it is probably covered with a considerable deposit of humus, and it is certain that at least some *Chara* grows there; where hunters had poled a small boat back and forth from the shore a number of good sized fragments of *Chara* were obtained.

The *Castalia-Nymphæa* Formation.

This formation in places has become a closely packed zone of *Nymphæa advena*, often twenty-five to thirty feet wide, but more often it consists of a rather weak zone of rather scattering individuals, containing also a few species from the *Potamogeton* formation, *Myriophyllum spicatum*, *Potamogeton natans*, and *Potamogeton pectinatus*. In the deeper parts of the zone are a few plants of *Castalia tuberosa*.

The *Cephalanthus-Cornus* Formation.

One of the most striking features of distinction between the vegetation of Cranberry Pond and the lagoons to the north and east of Long Ridge is the complete supplanting of the *Scirpus-Typha* formation by a zone composed almost entirely of shrubs. The structure of this zone is essentially as follows:

Facies. —

Cephalanthus occidentalis, *Cornus stolonifera*,
Rosa carolina.

Principal Species. —

Salix cordata, *Salix lucida*,
Bidens cernua, *Triadenum virginicum*,
Persicaria laurina, *Persicaria incarnata*,
Dryopteris thelypteris.

Secondary Species. —

Salix nigra, *Salix discolor*,
Nymphæa advena, *Dulichium arundinaceum*,

[75] Pieters, A. J. "The Plants of Lake St. Clair." Michigan Fish Commission, Bull. 2: 6, 9, 1894.

Eleocharis quadrangulata,	*Eleocharis obtusa,*
Proserpinaca palustris,	*Calamagrostis canadensis,*
Naumbergia thyrsiflora,	*Asclepias incarnata.*

The formation as a whole presents very little zonation or alternation within itself. *Cephalanthus* is the only one of the facies that can ever be said to constitute a distinct consocies, it usually being indiscriminately mixed with the other facies. *Rosa carolina* seems sometimes to prefer the outer border of the formation, thus indicating a *Rosa carolina* consocies, but in the present stage such association is not prominent.

The formation constitutes a zone of varying width, in a few places even being absent altogether, but towards the west end of the pond it sometimes reaches a width of about forty feet. The soil is always a saturated muck several inches deep, the pondward side of the zone being usually three to four inches under water and the landward side just above its surface.

The ecological conditions of this habitat are approximately those of the "undrained swamp" as described by Cowles and others.[76] *Cephalanthus* is almost invariably one of the most characteristic facies in the shrub-zone around undrained swamps and ponds, where there has been an accumulation of vegetable matter resulting finally in a saturated muck-soil. Towards the southern part of the glaciated area of the northern states the shrub-formation of the morainal ponds and open swamps consists almost always, in large part, of *Cephalanthus.*[77] Northwards this species gives way to other plants, such as *Cassandra,* willows, etc.

At the west end of Cranberry Pond there is an area of about an acre which is now above water most of the year and which might best be described as a mud-flat. The soil is a black muck and it is now sparsely occupied by young *Cephalanthus* bushes, the open spaces between being partially taken up by *Nymphæa advena,* small and unhealthy, *Hypericum canadense, Dulichium arundinaceum,* and *Eleocharis quadrangulata.* This area appears to have only comparatively recently been filled to such an extent that the *Nymphæa* has had to succumb and

[76] Cowles, H. C. "Physiographic Ecology of Chicago and Vicinity," *l. c.,* pp. 147–155, *and* Coulter, S. M. "An Ecological Comparison of Some Typical Swamp Areas." Ann. Rept. Mo. Bot. Gard., 15: 56, March, 1904.

[77] Schaffner, J. H., Jennings, O. E., and Tyler, F. J. "An Ecological Study o Brush Lake." *Proceed. Ohio Acad. Science,* 4: 159–160, 1904.

give place to the *Cephalanthus*. In a few years this area will probably support one of the best examples of the *Cephalanthus-Cornus* formation to be found anywhere on the peninsula.

Ridge Pond, as might be expected, being somewhat younger than Cranberry Pond, has the *Cephalanthus-Cornus* formation less well developed than the latter. In fact most of the vegetation in Ridge Pond corresponding to this formation has a transitional appearance. On the south side of the pond *Scirpus* and *Typha* still remain in considerable quantities, but *Cephalanthus*, *Iris*, *Rosa carolina*, *Proserpinaca*, etc., are invading the habitat quite abundantly. The *Rosa carolina* clings quite closely to the border of the shrub-zone surrounding this habitat, characterized by *Alnus incana* and *Cornus amomum*. The corresponding zone on the north side of the pond is fairly typical of the *Scirpus-Typha* formation, *Cephalanthus* and *Rosa* having merely just begun to invade the habitat.

The *Sphagnum-Oxycoccus* Formation.

The successor to the *Cladium-Calamagrostis* formation under certain conditions is a cranberry bog (*Sphagnum-Oxycoccus* formation). Just what the conditions are, which determine whether the wet meadow shall pass into a cranberry bog, or into a *Rhus-Alnus* thicket, are not known to the writer. Where the shores are wide and low, the accumulation of humus in the saturated, undrained *Calamagrostis* marsh or wet meadow, may finally bring about edaphic conditions too cold and too acid for the ready ecesis of the shrubs, thus permitting the entrance of the *Sphagnum-Oxycoccus* formation. Whether this may be the true explanation or not, the formation appears not to be a regular stage of the succession, but is rather to be regarded as a formation belonging to a more northern succession, and, like the *Fragaria-Polytrichum* formation, to which it may be a succeeding stage, it is to be here regarded as an intercalation.

The structure of this formation, as exemplified at the eastern end of Cranberry Pond, is as follows:

Facies. —

Oxycoccus macrocarpus, *Sphagnum* sp.

Secondary Species. —

Iris versicolor, *Pinus strobus*,
Acer rubrum, *Acer saccharinum*
Alnus incana, *Spiræa latifolia*,

Aronia melanocarpa, *Rubus hispidus*,
Eriophorum gracile.

From certain historical data it appears that half a century ago cranberries were abundant on Presque Isle. For the particular benefit of the people of Erie, laws were passed by the State in 1841, imposing a fine of $10 to $25 for picking cranberries before October 1, "Cranberry Day." Probably the *Sphagnum-Oxycoccus* formation of Cranberry Pond was formerly quite extensive. Around most of the pond the shores have a gentle slope, and each formation is thus given the opportunity to occupy a wide zone of fairly uniform ecological conditions. At the present time the total area of the *Sphagnum-Oxycoccus* formation on Presque Isle probably does not exceed one-half acre. Big Chimney Pond formerly contained considerable *Oxycoccus*, but with the laying of the intake pipe for the Erie waterworks this pond was dredged and later largely filled in with sand, so that very little of the formation is left.

The fate of the *Sphagnum-Oxycoccus* formation around Cranberry Pond is easily to be recognized. There are many seedlings of *Pinus strobus*, *Acer rubrum*, *Acer saccharinum*, together with *Spiræa* and *Aronia*, so that eventually the zone will be supplanted by a forest.

The *Aronia-Polytrichum* Formation.

Skirting the outer and higher side of the *Sphagnum-Oxycoccus* formation around Cranberry Pond there is a zone consisting almost exclusively of two species, the structure of the formation being as follows:

Facies. —
Polytrichum sp., *Aronia nigra*.
Secondary Species. —
Vaccinium corymbosum, *Populus tremuloides*,
Rubus hispidus, *Prunus serotina*,
Prunus virginiana.

There is but a limited area of this zone, about one hundred feet long by fifteen to eighteen feet wide, but the structure of the formation is very distinct and the plants occupy the habitat very completely. The *Aronia* occurs in dense clumps (families and communities) between which the *Polytrichum* forms a matted heath. Of the secondary species there are a very few individuals present, these being mostly seedlings and confined to the borders of the formation.

The *Rhus-Alnus* Formation.

The *Rhus-Alnus* formation is not prominent about Cranberry Pond although around Ridge Pond it is still a strong zone. Around Cranberry Pond the formation consists almost entirely of the *Alnus incana* consocies, but where the *Aronia-Polytrichum* zone is present, the former is absent altogether. In fact, the two formations are apparently coördinate, the *Aronia-Polytrichum* formation occupying the wider zone of a gently sloping shore, while the *Alnus incana* consocies occupies the narrower zone of the steeper shores towards the middle and west end of the pond, where the water comes closer to the forest and the zone is more deeply shaded.

Where the *Alnus incana* consocies is present, there is no undergrowth, except that seedlings and young trees of *Acer saccharinum* are more or less numerous.

The *Prunus-Acer* Formation.

Back of the *Rhus-Alnus* formation and extending to the top of the bank in the habitat of the former *Populus-Salix* formation, following closely behind the *Alnus* thicket, is a narrow zone with the following structure:

Facies. —

Acer saccharinum, *Prunus serotina*.

Secondary Species. —

Quercus velutina, *Quercus palustris*,
Quercus borealis, *Acer rubrum*,
Smilax herbacea, *Aralia racemosa*,
Phryma leptostachya, *Galium aparine*,
Galium circæzans, *Osmorhiza claytoni*,
Dryopteris spinulosa.

This formation derives many of its species from the adjoining *Quercus velutina* forest of the Beach-Sand-Plain-Heath-Forest succession but, as the encircling zones advance with the filling up of the lagoon, the habitat comes more and more to occupy a habitat with a black, undrained, more or less acid soil, and such species as are peculiar to this environment more and more predominate in this formation. With the advent of more shady conditions the *Prunus* disappears, leaving the zone more typically an *Acer saccharinum* consocies, but nowhere on the peninsula does this consocies assume any considerable importance. It is usually crowded out by the *Quercus velutina* formation from above and the hydrophytic forest, which later develops on the muck-soil below. In the pure tamarack forest at the "first Sister Lake," in the Huron River Valley of Michigan, Weld finds coming in a formation composed of almost exactly the same species here included in the *Prunus-Acer* formation.

Stage I. — Ponds R, S, U, V, north end of P.

The climax formations of the Lagoon-Marsh-Thicket-Forest Succession, for Presque Isle at least, are to be seen in the Chimney Ponds (R, S, U, and V). The arrangement of the formations at this stage being typically as follows:

(*a*) *Potamogeton* Formation,
(*b*) *Castalia-Nymphæa* Formation,
(*c*) *Decodon-Persicaria* Formation,
(*d*) *Cephalanthus-Cornus* Formation,
(*e*) *Rhus-Alnus* Formation,
(*f*) *Quercus-Acer* Formation.

The ecological conditions obtaining in the Chimney Ponds are evidently very closely similar to those obtaining in undisturbed glacial ponds in the northern states. The Chimney Ponds are quite old and are considerably protected from the winds of the lake by the surrounding forest. The accumulation of vegetable matter has been sufficient to cause the basins to be fringed and lined with a layer of humus, which by humification has been reduced mainly to the form of a black, semi-liquid muck. The drainage is merely that due to seepage through the porous sand of the peninsula, ordinarily very little water passing either into or out of the ponds, excepting such as is necessary to maintain the water-level against fluctuations due to precipitation, evaporation, or fluctuations in the level of the lake. Even then the seepage is not rapid, and the ponds have on the whole a very uniform water-level. Such exchanges of water must to some extent at least prevent the accumulation of acids in the pond water, and thus at the same time permit the conversion by humification of the vegetable débris into black muck.

Within recent years several ecological studies have been made of glacial ponds and small lakes throughout the region bordering the Great Lakes. In undisturbed conditions throughout this region the ponds and lakes have practically the same formations, arranged in essentially the same order as has been described for the Chimney

Ponds. The species are not always the same in the corresponding formations, but they are usually closely similar in ecological structure, and are quite often nearly related systematically.

The *Chara* Formation.

In basins with a clay or alluvial bottom, the deeper portions are generally occupied in the Great Lakes region by a *Chara* formation, which with certain of the Cyanophyceæ may eventually result in the deposition of more or less marl.[78] As was stated in the discussion of the *Potamogeton* formation of Cranberry Pond, *Chara* has been found to prefer clayey or alluvial pond-bottoms to sandy ones, but, as the plant was collected in Pond U together with *Myriophyllum* and *Naias*, it can be assumed to be present in the other Chimney Ponds also.

The *Potamogeton* Formation.

The *Potamogeton* formation is well developed in all of the Chimney Ponds and, as represented there, the vegetational structure is typically as follows:

Facies. —

Potamogeton pectinatus, *Potamogeton lonchitis*,
Potamogeton heterophyllus.

Secondary Species. —

Potamogeton lucens, *Potamogeton natans*,
Vallisneria spiralis, *Philotria canadensis*,
Naias flexilis, *Myriophyllum spicatum*,
Lemna minor.

This formation, as listed, may be taken as representative of the mature *Potamogeton* zone whether at Presque Isle; Brush Lake, Ohio, where *Potamogeton zosteræfolius*, *Potamogeton lucens*, *Ceratophyllum demersum*, *Myriophyllum*, and *Chara*, are listed as typical species;[79] or in the Three Sister Lakes, Michigan (near Ann Arbor), where *Potamogeton lucens* and *Potamogeton zosteræfolius* are facies.[80]

[78] Davis, C. A. "Contribution to the Natural History of Marl." *Journ. Geology*, 8: 485, 1900, and "A Second Contribution to the Natural History of Marl." *Journ. Geology*, 9: 491, 1901.

[79] Schaffner, J. H., Jennings, O. E., and Tyler, F. J. *l. c.*, pp. 153–154.

[80] Weld, L. H. "Botanical Survey of the Huron River Valley, II. A Peat Bog and Morainal Lake." *Bot. Gaz.*, 37: 39–40. January, 1904.

Reed, H. S. "Botanical Survey of the Huron River Valley, I. The Ecology of a Glacial Lake." *Bot. Gaz.*, 34: 129. 1902.

The *Castalia-Nymphæa* Formation.

The water lily zone (*Castalia-Nymphæa* formation) is almost as regularly present in the small ponds and lakes of the glaciated region of the northern states as is the *Potamogeton* formation. It occupies water, usually between the depths of one and one-half and six feet, where the bottom is covered to a depth of often several inches with a black mud composed very largely of humus. In the Chimney Ponds the formation consists of the following species:

Facies. —

Castalia tuberosa, *Nymphæa advena.*

Principal Species. —

Pontederia cordata.

Secondary Species. —

Sagittaria latifolia, *Potamogeton natans*,
Naias flexilis, *Myriophyllum spicatum*,
Lemna minor, *Utricularia vulgaris*,
Philotria canadensis.

There is a strong tendency towards zonation in this structure. Wherever *Castalia* appears it prefers the deeper part of the habitat, thus forming the *Castalia* consocies, with which are usually associated some of the *Potamogetons* — notably *P. natans*, and often *Naias* and *Myriophyllum.*

The outer (shoreward) part of the formation is characterized by *Nymphæa advena*, forming thus the *Nymphæa advena* consocies, with which is associated *Pontederia cordata*, which during early and middle summer becomes prominent in beautiful clumps (families and communities), characterizing thus the *Pontederia cordata* aspect. Other species in this consocies are *Sagittaria latifolia*, *Lemna minor*, *Utricularia vulgaris*, and scattering individuals of the other secondary species of the consocies.

The *Castalia-Nymphæa* formation probably builds up the soil more rapidly than does any other formation in the pond. The rhizomes of the characteristic plants are for the most part quite large, and both when alive and when decayed contribute quite considerably to the increase of the soil substratum. Furthermore the tangle of fine-leaved submerged vegetation together with the long petioles and broad leaves of the water-lilies brings about a freedom from water-currents, and makes more certain the deposition within the limits of the zone of its abundant annual accumulation of vegetable débris.

Eventually with the continued addition of humus to the soil of this zone, there will be built up a belt of deep, semi-liquid muck just inside of the *Cephalanthus-Cornus* shrub-zone, and, when this has come to within a few inches of the surface of the water, the *Castalia-Nymphæa* formation will find the conditions unsuitable to such an extent that it will be supplanted by an association of plants constituting a new formation.

The *Decodon-Persicaria* Formation.

The *Decodon-Persicaria* formation occupies a very distinct zone in some of the Chimney Ponds, in water of a depth from four to twelve inches, but with the older clumps forming mounds above the surface of the water. The soil is always made up of a semi-liquid muck of considerable depth, and represents the abandoned habitat of the *Castalia-Nymphæa* formation. Pond U has much of this formation, constituting a distinct zone, while Pond V is now almost filled with *Decodon* families and communities, the middle of the pond being in the last stages of the *Castalia-Nymphæa* formation. The new formation is present sparingly in Ponds T, S, and R, conspicuously so in Z, and forms several strong communities in the west end of Long Pond.

The typical structure of the formation is as follows:

Facies.—

Decodon verticillatus, *Persicaria fluitans.*

Principal Species. —

Solanum dulcamara.

Secondary Species. —

Naumbergia thyrsiflora,	*Cephalanthus occidentalis*,
Bidens cernua,	*Scutellaria lateriflora*,
Cicuta bulbifera,	*Scirpus cyperinus*,
Alisma plantago-aquatica,	*Sagittaria latifolia.*

There is a tendency in this formation towards the segregation ot two consocies: the *Decodon verticillatus* consocies in the shallower water, and the *Persicaria* consocies in the deeper water. Of the two, however, the former is here much more vigorous, and, where it is best developed, occupies the whole habitat to the exclusion of the latter consocies.

In other localities these consocies have been regarded as different formations but at Presque Isle their relation is best described as zonation within the same formation.

Around R, before the vegetation was destroyed by the laying of the waterworks intake-pipe, there appeared some intensely interesting examples of alternation between different formations. There may have been disturbances within recent years due to the washing in of water from the bay or the lake, either of which is but a few feet distant from the pond. At any rate there are three formations represented in the zone between the *Castalia-Nymphæa* formation and the *Cephalanthus-Cornus* formation: viz., the *Decodon-Persicaria* formation, the *Sphagnum-Oxycoccus* formation, and the *Scirpus-Typha* formation. The relative positions of the *Sphagnum-Oxycoccus* and *Cephalanthus-Cornus* formations are here just the reverse of what they are around Cranberry Pond, although they must be regarded as occupying more typical positions around Cranberry Pond. Of the three alternating formations mentioned above the *Decodon-Persicaria* formation must be regarded as the normal formation. The *Sphagnum-Oxycoccus* formation is an intercalated formation, representing normally a stage in another succession, while the *Scirpus-Typha* formation normally represents an early stage in the succession under consideration, its presence here being probably due to the inwashing of fresh sand.

The *Cephalanthus-Cornus* Formation.

The perennial tangle of vegetation in the *Decodon-Persicaria* zone is well adapted to catch and hold any vegetable débris blowing in from the surrounding forest or floating on the surface of the pond. This, together with the accumulation of vegetable matter derived directly from the plants of the formation itself, gradually builds up the soil to such a level that conditions become suitable for the ecesis of the shrubs of the *Cephalanthus-Cornus* formation.

The structure of the formation here is essentially the same as that described for the formation under Stage H, excepting that the *Cephalanthus-occidentalis* consocies is more prominent, and the number of secondary species is reduced by the disappearance of some of the more hydrophytic species — as *Proserpinaca palustris* and *Nymphæa advena*.

The *Rosa carolina* consocies is also more clearly defined and can be seen to show a decided preference for the shoreward zone of the habitat. A little pond at the west end of Long Pond has been entirely filled in, and the only trace of the *Cephalanthus-Cornus* formation to be seen is a *Rosa carolina* consocies, which is being killed out by the shade of the encroaching trees.

The *Rhus-Alnus* Formation.

Outside of the *Cephalanthus-Cornus* formation there is present in most of the Chimney Ponds more or less of a zone of the *Rhus-Alnus* formation. Most of the ponds are surrounded by forest-trees and, in the more or less shaded conditions, the *Rhus* has given place to the pure *Alnus incana* consocies. In the more open places, however, certain other species become more or less prominent and the formation there exhibits the following structure:

Facies. —

Rhus typhina, *Alnus incana.*

Principal Species. —

Sambucus canadensis.

Secondary Species. —

Acer rubrum, *Acer saccharinum*,
Sassafras sassafras, *Salix nigra*,
Cornus stolonifera, *Cornus amomum*,
Cephalanthus occidentalis, *Vaccinium corymbosum*,
Dryopteris thelypteris.

The *Ulmus-Acer* Formation.

With the advance of the shrub-formations towards the center of the pond, there appears at the rear of the *Rhus-Alnus* formation, or, more generally the *Alnus incana* consocies, a semi-hydrophytic forest-formation which includes also most of the area occupied in the earlier stage by the *Acer saccharinum* consocies of the *Prunus-Acer* formation. The habitat of this formation consists, of course, of a black muck soil, but little above water-level and imperfectly drained. There is protection from strong air-currents by the surrounding forest and, below the forest-cover afforded by the *Alnus*, there is deep shade, with freedom from abrupt extremes of heat and cold.

The ecological conditions are apparently those required by a semi-hydrophytic forest, and, as thus far developed on Presque Isle, the structure of the formation is typically as follows:

Facies. —

Acer rubrum, *Ulmus americana.*

Secondary Species. —

Fraxinus americana, *Liriodendron tulipifera*,
Fraxinus nigra, *Nyssa sylvatica*,

Quercus palustris, *Quercus rubra,*
Acer saccharinum, *Salix nigra,*
Toxicodendron pubescens, *Viburnum opulus,*
Psedera quinquefolia, *Galium circæzans,*
Galium triflorum, *Unifolium canadense,*
Phryma leptostachya, *Impatiens biflora,*
Ilex verticillata, *Bœhmeria cylindrica,*
Smilax herbacea, *Salomonia biflora,*
Onoclea sensibilis, *Osmunda claytoniana,*
Osmunda spectabilis, *Osmorhiza claytoni,*
Trillium erectum.

Vegetation other than trees is not a prominent feature of this forest. Many of the herbaceous and shrubby species enumerated above occur only sparingly and are really constituents of another formation.

The total area covered by the formation is not large. In the vicinity of the Chimney Ponds it is confined to irregular zones around the borders of the basins. There is, however, marking the position of extinct ponds, a circular area of this formation about 30 rods in diameter south of the west end of Long Pond and another smaller one to the northeast of Big Chimney Pond, R, near the bay.

The ecological conditions obtaining in the habitat of the *Ulmus-Acer* formation at Presque Isle are closely similar in most respects to those obtaining about numerous filled-in basins throughout the southern part of the glaciated area of the northern states. There is always the black muck-soil, imperfectly drained, more or less acid, and with a high water content, the position being more or less sheltered by neighboring banks. At a higher elevation, or farther north, the normal formation in such a habitat is the Tamarack forest, or, later, the Arbor Vitæ forest.[81] It is not probable that the *Ulmus-Acer* formation represents the climax forest for these pond basins, but that, with the annual accumulation of considerable quantities of forest litter, much of which at Presque Isle blows into it during the fall and winter from the more open and exposed *Quercus velutina* formation, the soil will finally become higher and more xerophytic to such an extent that the *Quercus velutina* formation will be able to invade and eventually occupy the habitat. Even under present conditions there

[81] Whitford, H. N. "The Genetic Development of the Forests of Northern Michigan." *Bot. Gaz.*, 31 : 312–316, May, 1901.

Outlet of pond at Head, looking across towards the mainland escarpment. Beginning in the immediate foreground the following zoned formations are shown: *Alnus-Salix*, *Carex-Phragmites*, *Typha-Scirpus*, then shrubs at the base of escarpment: Photographed June 10, 1906.

is an occasional black oak in the habitat and, although they are as yet merely saplings, they appear healthy and vigorous.

At the "Head" there is a pond Z (see Plate LI) which constitutes an ecological habitat considerably different from the ponds and lagoons described above. This pond is fed by springs issuing from the lake bluff and it also receives a considerable run-off from the land above — a couple of small streams debouching at this point. As a consequence, there is a considerable outward current flowing through the outlet into Presque Isle Bay, and the water in the pond was found on several visits to be several degrees colder than in the ponds out on the peninsula.

The banks and bottom of this pond are not entirely composed of the clean white sand, which constitutes the basins of the ponds and lagoons on the peninsula, but have a considerable mixture, especially on the landward side, of fluvial material ; around most of the basin there is enough silt and clay mixed with the sand to form a quite compact and firm soil. Formerly, the stream now emptying into the lake west of the head of the peninsula, emptied into the bay just inside of the neck of the peninsula, and doubtless much of the soil now composing the more landward parts of the head was deposited as a sort of alluvial fan inside of the peninsula.

The vegetation of the basin of the pond is in many respects quite dissimilar to the vegetation of the ponds and lagoons of the peninsula proper. The sequence of formations on the lakeward side of this pond is as follows:

(*a*) *Chara* Formation,
(*b*) *Potamogeton* Formation,
(*c*) *Castalia-Nymphæa* Formation,
(*d*) *Decodon-Persicaria* Formation,
(*e*) *Typha-Scirpus* Formation,
(*f*) *Carex-Phragmites* Formation,
(*g*) *Alnus-Salix* Formation.

The *Chara* Formation.

As may be seen from the Waldameer Park bridge, which crosses the pond at about its middle, the *Chara* formation occupies a considerable portion of the deeper part of the pond. The growth is quite dense and quite completely covers the bottom of the pond.

The *Potamogeton* Formation.

The *Potamogeton* formation has here almost precisely the same structure as described for the climax stages in the ponds of the peninsula proper, for instance in the Chimney Ponds.

The *Castalia-Nymphæa* Formation.

This formation is comparatively a strong one in the pond. Its structure is typically as follows:

Facies. —

Nymphæa advena, *Castalia tuberosa.*

Principal Species. —

Pontederia cordata.

Secondary Species. —

Brasenia schreberi, *Potamogeton natans*,
Naias flexilis, *Myriophyllum spicatum*,
Utricularia vulgaris, *Philotria canadensis*,
Vallisneria spiralis.

There is a tendency here as elsewhere to the segregation by zonation of an inner *Castalia* consocies, including some of the *Potamogetons*, and an outer *Nymphæa* consocies, including the *Pontederia cordata* society.

The *Decodon-Persicaria* Formation.

The *Decodon-Persicaria* formation is very closely similar in ecological structure to the corresponding formation in Stage I described above, excepting that the *Decodon-verticillatus* consocies is but weakly developed. In Stage I the formation contains a number of secondary species, which probably more properly belong to the *Scirpus-Typha* formation, but which have been crowded forward by the shrub-zones. On the lakeward side of the pond there has been no crowding forward in this manner, and there is a clearly defined zone similar to the *Typha-Scirpus* formation of the earlier stages of the succession, although somewhat more complex in composition.

The *Typha-Scirpus* Formation.

The structure of this formation around Pond Z is typically as follows:

Facies.—

Scirpus americanus, *Scirpus validus*,

Typha latifolia.

Principal Species.—

Bidens cernua.

Secondary Species.—

Cicuta bulbifera, *Iris versicolor*,

Sagittaria latifolia, *Sparganium eurycarpum*,

Rumex altissimus, *Lemna minor*,

Nostoc sp.

The *Bidens cernua* society determines during late summer the only conspicuous aspect of the formation. *Cicuta bulbifera* in places attains to considerable importance, but is never very conspicuous. In the *Typha latifolia* consocies the *Sparganium* shows a strong tendency towards the segregation of a secondary zone on the shoreward side of the formation in water even shallower than that occupied by the *Typha*.

The *Carex-Phragmites* Formation.

The outer bank of the pond Z has just outside of the *Typha-Scirpus* formation a zone occupied by grasses and sedges and extending from the wet bank of humus just above the water's edge into the pond to a depth of three to four inches. There is, however, considerable fluctuation in the water-level of the pond, and during periods of heavy rainfall the whole habitat is often inundated.

The structure of the formation is as follows:

Facies.—

Carex stricta angustata, *Phragmites phragmites*.

Principal Species.—

Aster novæ-angliæ, *Zizania aquatica*.

Secondary Species.—

Scirpus americanus, *Scirpus fluviatilis*,

Dryopteris thelypteris, *Calamagrostis canadensis*,

Panicularia nervata, *Dulichium arundinaceum*,

Carex hystricina, *Carex lanuginosa*,

Carex aquatilis, *Carex prasina*,

Carex muhlenbergii, *Naumbergia thyrsiflora*,

Galium aparine, *Scutellaria lateriflora*,

Scutellaria galericulata.

This formation is somewhat intermediate in structure between the corresponding formations of the ponds and lagoons of the peninsula proper and the open marshes along the bay-side of the peninsula. The pond originally must have been part of the bay, which with the formation of a bar across the narrow channel was cut off from the main body of the bay, and was then filled in to a considerable extent by vegetable remains and alluvial material from the mainland.

Before the segregation of the pond from the bay it probably supported a littoral marsh, such as is now to be found along the shore to the east, and the *Carex-Phragmites* formation is in part derived from this former structure.

The *Salix-Alnus* Formation.

The *Carex-Phragmites* formation is closely followed by a shrub-formation, characterized by *Salix* and *Alnus*, as follows:

Facies. —

Salix nigra,	*Alnus incana.*

Secondary Species. —

Equisetum hyemale,	*Cardamine pennsylvanica,*
Mentha canadensis,	*Panicularia nervata,*
Galium aparine,	*Impatiens biflora,*
Cornus stolonifera,	*Lycopus americanus,*
Sambucus canadensis,	*Lobelia syphilitica.*

This formation is but sparingly developed along the lakeward bank of the pond, but it forms a considerable thicket at the lower end of the pond around the outlet. The soil here is a black muck containing more or less sand, the edaphic conditions of the habitat being quite similar to those found along the average alluvial flood-plain in the northern states.

THE BAY-MARSH-THICKET-FOREST SUCCESSION.

Along the bay shores of the peninsula there is a rather complex series of formations, constituting what may be termed the Bay-Marsh-Thicket-Forest Succession. The irregular contour of the peninsula on the bay-side results in quite widely differing conditions at different points due to the action of the surf and water-currents and the accumulation of drift. The different environments thus brought about are each characterized by correspondingly different vegetational structures, which may be roughly classified as follows, upon the basis of habitat :

A. — *The Marsh.* — This habitat comprises those shores exposed to the waves, but having usually shallow water and a gently sloping sandy or gravelly bottom.

B. — *The Cove.* — The cove habitat comprises the indentations of the shore line — coves, bays, etc. — which are generally well protected from wave action and have deeper water than the marsh.

C. — *The Driftwood Habitat.* — This habitat comprises those shores, which are so situated with respect to wind and current as to be subjected to the accumulation of driftwood.

The Marsh Habitat.

This habitat is represented along a large part of the shore of the bay. The vegetational structures along the narrow neck of the peninsula near the Head, enumerated from the water to the shore, are as follows:

(*a*) *Scirpus* Formation,
(*b*) *Salix discolor-lucida* Formation,
(*c*) *Solidago-Meibomia* Formation.

The *Scirpus* Formation.

The *Scirpus* formation consists of the two facies, *Scirpus validus* and *Scirpus americanus.* The former species constitutes the advance guard and frequently occurs far out in the bay, where the water is six feet or more in depth. The *Scirpus americanus* consocies, however, occurs nearer the shore, and, as in the recently formed lagoons at the eastern end of the peninsula, it may occur even on the beach several inches above the ordinary water-line.

This formation is evidently of considerable importance in determining what the contour of the shore shall be, both from the protection it affords the shore, and from the part it plays in the actual outbuilding of the shore. The plants have strong rapidly-growing rootstocks, and, once having accomplished ecesis, families and communities are soon formed. The slender wiry stems and leaves bend with the wind and wave and are rarely broken, even in the most severe storms. With the formation of ecological families and communities the rushes, growing thickly together, act as an impediment to drifting sand and the bottom is thus sometimes built up quite rapidly where otherwise the sand would not have come to a permanent rest. The bottom is thus built up not only in the area actually occupied by the plants themselves but also in the area intervening between them and the shore.

The *Salix discolor-lucida* Formation.

Facies. —

Salix discolor, *Salix lucida.*

Secondary Species. —

Salix sericea, *Salix nigra*,
Salix cordata, *Melilotus officinalis*,
Persicaria laurina, *Cardamine pennsylvanica*,
Bidens connata, *Argentina anserina*,
Sambucus canadensis, *Hibiscus moscheutos.*

With the development of the outlying *Scirpus* formation there is usually an accumulation of débris on the low beach. This débris consists mainly of dead *Scirpus* leaves and stems, washed up during the winter and spring. It becomes matted together and packed down with sand, so that the shore usually grows outward in little ridges of a foot or fifteen inches in width and three or four inches high. Behind these little ridges miniature lagoons are sometimes formed. In this habitat the *Salix discolor-lucida* formation is at its best, reaching on the outside to the water's edge and meeting there the *Scirpus* formation. Occasionally there is a weak intervening development of the *Cakile-Xanthium* formation, but, as far as found, this formation was here represented only by the *Xanthium commune* consocies.

The *Salix discolor-lucida* formation is particularly well developed along the narrow neck of the peninsula east of the Head. There are also several smaller stations east of the region of the Chimney Ponds. Where by alternation *Salix discolor* and *Salix lucida* are absent, the secondary species occupy the habitat. The *Salix lucida* consocies is comparatively much less important in this habitat, but in the Driftwood Habitat it is more important than is the *Salix discolor* consocies.

The *Solidago-Meibomia* Formation.

Between the *Salix cordata* thicket and the xerophytic sand-plain to the rear there is usually a zone characterized by various Leguminosæ and Compositæ. The usual path of hunters is just back of the fringing zone of willows and the sand there has been enriched by the vegetable débris trodden into it, so that in places there has been formed a rather firm, compact, dark-colored soil, comparatively rich in humus and constituting altogether a very favorable habitat for certain weeds.

The structure of this formation is typically as follows :

Facies. —

Solidago canadensis, *Meibomia canadensis*.

Principal Species. —

Anemone canadensis.

Secondary Species.

Lactuca canadensis,	*Melilotus officinalis*,
Strophostyles helvola,	*Trifolium pratense*,
Trifolium repens,	*Ranunculus abortivus*,
Poa compressa,	*Vitis vulpina*,
Plantago lanceolatus,	*Mentha piperita*,
Mentha cardiaca,	*Carduus arvensis*,
Erechtites hieracifolia,	*Xanthium commune*,

Barbarea barbarea.

In certain respects the formation resembles a roadside formation. In a few spots a thin sod has formed, composed of *Poa compressa*. During early summer, June, there is an aspect characterized by the *Anemone canadensis* society, but the main mass of vegetation develops later in the season, the facies becoming most conspicuous in late summer and early fall.

In X and Y (see map) and along the bay-shore to the Chimney Ponds including T also, the vegetation is in a much more highly developed stage, owing doubtless to the longer period in which it has been allowed to develop undisturbed. The occasional incursions of the lake through the narrow neck of the peninsula to the west since 1861 must have considerably disturbed, if not totally destroyed, the vegetation of the marsh along that shore, and as a consequence the vegetation there represents a younger stage than does the vegetation farther to the west, where the development has been continuous and undisturbed.

The structure of the vegetation in the more highly developed marsh is typically as follows :

(*a*) *Scirpus* Formation,
(*b*) *Phragmites-Typha* Formation,
(*c*) *Cladium-Calamagrostis* Formation,
(*d*) *Rhus-Alnus* Formation,
(*e*) *Ulmus-Acer* Formation.

The *Scirpus* Formation.

The *Scirpus* formation is here much more extensive than in the habitat just referred to. It has a maximum width of perhaps one-third of a mile, and in places forms a quite dense growth, which quite effectually calms the waves of ordinary storms. Zonation within the formation is clearly evident in the deeper zone (consocies), characterized by *Scirpus validus*, and in the shallower zone characterized by *Scirpus americanus*. There are a very few isolated families of *Pontederia cordata* and *Sagittaria rigida* mainly in the *Scirpus validus* consocies.

The *Phragmites-Typha* Marsh Formation.

The shallower part of the habitat, occupied in the earlier stage by *Scirpus americanus*, has now been taken over by a well marked formation with the following structure:

Facies. —

Phragmites phragmites, *Typha latifolia.*

Principal Species. —

Zizania aquatica.

Secondary Species. —

Sagittaria latifolia, *Sparganium eurycarpum*,
Persicaria laurina, *Juncus canadensis.*

This formation, as compared with the *Scirpus-Typha* formation of the ponds and lagoons at the northern end of the peninsula, presents some interesting differences. In the lagoons *Scirpus validus*, although occupying the deeper part of the habitat, never occurs in so deep water as it occupies in the bay, and it usually alternates in the ponds with *Typha latifolia.* With the *Typha*, however, the case is different. It occupies about the same depth of water as in the ponds and lagoons, rarely more than fifteen to eighteen inches deep. This may be due, perhaps, to the inability of the *Typha* to cope with the surf in the bay.

The formation exhibits one marked aspect characterized by *Zizania aquatica*, this society filling in the areas not occupied by the *Phragmites* and *Typha* consocies, and, during the latter half of the season, largely obscuring the associated secondary species.

The *Phragmites-Typha* formation is characterized, in a general way, by the possession of large rootstocks and the production of a rather large amount of aerial and submerged vegetation, which each season adds materially to the humic content of the soil, thus producing in a comparatively short time a deposit of muck-soil. The protection afforded by the outlying *Scirpus* formation is usually so efficient, that almost no sand is carried into the habitat even in the most violent storm, and as a consequence the upper six or eight inches of the soil, when finally built up to the water level, is usually found to be a pure black or dark brown humus.

The *Cladium-Calamagrostis* Formation.

With the formation of a humic soil, the surface of which is ordinarily during the summer above water-level, there is created a habitat in which the *Phragmites-Typha* formation is forced to give way to the *Cladium-Calamagrostis* formation, thus constituting a wet meadow:

Facies.—

Cladium mariscoides, *Calamagrostis canadensis.*

Principal Species.—

Aster ericoides, *Parnassia caroliniana*,
Gentiana andrewsii.

Secondary Species.—

Fragaria americana, *Rubus hispidus*,
Linum medium, *Solidago canadensis*,
Leptorchis loeselii, *Blephariglottis peramœna*,
Dryopteris thelypteris *Argentina anserina*,
Polytrichum sp.

One of the finest examples of the wet-meadow formation is to be seen at Y. Here the meadow occupies a depression about one-fourth of a mile in length and about twenty rods wide. It is bordered on nearly all sides by shrubs, but at the eastern end has an opening into the bay which is now occupied by the *Phragmites-Typha* formation, while farther out is the *Scirpus* formation.

There is here practically no difference between the *Cladium-Calamagrostis* formation and the same formation around the ponds and lagoons, excépting that the *Cladium mariscoides* consocies plays here a much less important part in the succession, the *Calamagrostis canadensis* consocies almost immediately succeeding the *Phragmites-Typha* formation. This is probably due to the somewhat different edaphic conditions obtaining in the two habitats. The soil around the newly formed ponds and lagoons, when first occupied by the *Cladium*, is largely sand with more or less humus, the *Calamagrostis* coming in with the accumulation of humus. In Y, however, the soil, as accumulated by the *Phragmites-Typha* formation, is almost exclusively humus, and the *Cladium*, although usually in evidence in the earlier part of the formation, is relatively unimportant in it. Along the eastern border of Y there is now some *Cladium* and in the central portion and towards the outlet in the more moist spots there still remain some *Phragmites* and *Typha*.

There is in this formation an early autumn aspect determined by the *Aster ericoides* society, but occupying rather restricted areas. During late summer a quite conspicuous aspect is determined along the northern side of the meadow by the *Parnassia-Gentiana* society, this being the only station for this society on the peninsula.

The *Rhus-Alnus* Formation.

The wet meadow, *Cladium-Calamagrostis* formation, is being everywhere invaded by a shrub-formation similar to that around the ponds and lagoons described as the *Rhus-Alnus* formation, but differing somewhat in composition, owing probably to differences in the environment. The structure of the formation here is typically as follows :

Facies. —

Rhus typhina,	*Alnus incana.*

Principal Species. —

Solidago canadensis	*Cornus amomum.*

Secondary Species. —

Fragaria virginiana,	*Myrica caroliniana*,
Argentina anserina,	*Vitis vulpina*,
Salix discolor,	*Salix cordata*,
Toxicodendron pubescens,	*Rubus* sp.,
Meibomia dillenii.	

There is here again the larger percentage of humus in the soil, which may be more or less directly the reason for the difference in the composition of the formation. *Rhus typhina* although present is not abundant, and the thicket is chiefly composed of the *Alnus incana* consocies.

The formation presents some alternation. The wet meadow is invaded by *Myrica* and *Cornus amomum*, these species, together with some young *Alnus*, forming an advance zone containing most of the secondary species. This zone is gradually subjugated by the *Alnus* consocies.

There are two conspicuous aspects in the formation ; one determined in mid-summer by the *Cornus amomum*, and the other in early autumn by the *Solidago canadensis* society.

The *Ulmus-Acer* Formation.

The *Alnus incana* thickets are being invaded by the *Ulmus-Acer* formation, which is here essentially as described for the preceding succession, so that no further discussion of this formation need be here given.

The four ponds — Niagara Pond, Yellow Bass Pond, Grave-Yard Pond, and Big Pond — each have large areas of the various stages of the succession now under consideration, especially the rush vegetation — *Scirpus* formation ; and the reed and cat-tail marsh — *Phragmites-Typha* formation. The area dominated later in the season by the wild rice, *Zizania aquatica* society, is especially large in these ponds, excepting Big Pond, where somewhat more of the total area is taken up by other formations. The shores of these ponds present various phases of the two shrub-formations, but have mainly the *Rhus-Alnus* formation. The shores towards the north and east sides of Yellow Pond and Niagara Pond are more sandy and the formations are there practically identical with those around the ponds and lagoons to the north and east.

The Cove Habitat.

The Cove Habitat comprises sheltered portions of the bay with little or no current. The vegetation near the shore is that of the Marsh Habitat, but in deeper water, one and one-half to two feet, the *Scirpus* formation is absent, its place being mainly taken by pond formations. The structure of the vegetation is usually more or less of a mixture of pond and marsh associations, the quieter water being occupied by the pond-plants. The typical cove vegetation at Presque Isle is essentially as follows :

(*a*) *Chara* formation,
(*b*) *Potamogeton* formation,
(*c*) *Castalia-Nymphæa* formation,
(*d*) *Phragmites-Typha* formation,
(*e*) *Rhus-Alnus* formation,
(*f*) *Ulmus-Acer* formation.

Owing to the lack of proper facilities for the work no extended study was made of the formations occupying the deeper waters of the coves, but from a couple of tours in a rowboat and from such studies as could be made from shore it was seen that the *Chara* formation is present in the deeper waters, extending beyond the *Potamogeton* formation, and that the *Potamogeton* formation is by far the most important one in the cove. Its structure is typically as follows:

Facies. —

Potamogeton natans, *Potamogeton heterophyllus.*

Principal Species. —

Utricularia vulgaris.

Secondary Species. —

Naias flexilis,	*Philotria canadensis*,
Vallisneria spiralis,	*Potamogeton foliosus*,
Potamogeton lonchites,	*Potamogeton foliosus niagarensis*,
Potamogeton zizii,	*Potamogeton lucens*,
Potamogeton pectinatus,	*Bidens beckii*,
Myriophyllum spicatum,	*Utricularia intermedia.*

The genus *Potamogeton* comprises the main bulk of the vegetation visible at the surface of the water, although *Naias* and *Philotria* are quite abundant below the surface. In the quieter and more sheltered coves the *Utricularia vulgaris* aspect is quite pronounced during July and August, the society disappearing largely by the time the *Potamogetons* have attained their best development. The exact status of the various species of *Potamogeton* in the structure of the formation proved to be an extremely difficult problem, but it is believed that the above classification is as exact as can be made, without establishing quadrats and laboriously determining the structure plant by plant — a very difficult thing to accomplish in such a habitat.

The *Castalia-Nymphæa* Formation.

The *Castalia-Nymphæa* formation is not so well developed in the coves as one would be led to suspect from the general characters of the habitat — in fact the suspicion at once arises that abnormal conditions may have been brought about by the continual search for flowers on the part of the people of Erie, just across the bay. In the more inaccessible ponds of the peninsula the formation appears to be more nearly normal. The formation, as it appears where best developed in a cove to the southwest of the Chimney Ponds, presents the following structure:

Facies. —

Castalia tuberosa, *Nymphæa advena*.

Secondary Species. —

Pontederia cordata, *Potamogeton natans*,
Potamogeton lonchites, *Potamogeton heterophyllus*,
Myriophyllum spicatum, *Utricularia intermedia*,
Utricularia vulgaris, *Sagittaria latifolia*,
Naias flexilis, *Philotria canadensis*.

Wherever the *Phragmites-Typha* formation, or in some cases even the *Scirpus* formation, has been disturbed, as in making an opening through the vegetation for a passage to a boat-landing, the *Castalia-Nymphæa* formation, at least the secondary species, will soon come in. The formation in this case is of course to be regarded as a secondary formation, and, if left undisturbed, would soon give place again to the normal formation. Cove formations very similar to those at Presque Isle are to be seen highly developed along the Sandusky Bay side of Cedar Point, Ohio, but there the *Castalia-Nymphæa* is more important as a constituent of the vegetation, ranking relatively as high as does the *Phragmites-Typha* formation.[82]

The *Phragmites-Typha* Formation.

This formation in a sheltered cove is usually either dominated or entirely replaced by the *Typha latifolia* consocies, the latter forming a very dense vegetation, giving but scant opportunity for the development of secondary species. This formation builds up a humus-soil which is finally invaded by the following shrub-formation.

The *Rhus-Alnus* Formation.

On account of the rapid accumulation of humus by the *Typha* zone that zone has a distinct slope from the outer to the inner edge, and is comparatively narrow, being followed closely by the *Rhus-Alnus* formation without the occurrence of an intervening *Cladium-Calamagrostis* zone. The *Rhus-Alnus* zone is much the same as in the marsh habitat, the *Alnus incana* consocies predominating. Among the secondary species are here to be included *Hibiscus moscheutos* and *Sambucus canadensis*. This formation is ultimately followed by the *Ulmus-Acer* formation, as described for the marsh habitat.

[82] Jennings, O. E. "An Ecological Classification of the Vegetation of Cedar Point." *l. c.*, pp. 334–338.

The Driftwood Habitat.

The region included in this habitat is the eastern shore of Misery Bay, extending from the U. S. North Pier to the mouth of Niagara Pond. The shore is here fronted by an old line of wooden piers which serve to some extent to protect the shore from the force of the waves. The sandy bottom slopes gradually from the shore, at least inside the line of piers, and the westerly winds have piled here much driftwood and floating rubbish of all sorts.

The sand-plain extends almost to the water's edge along the southern two-thirds of this shore, but along the northern third the *Prunus* forest formation has occupied the corresponding area. With the decay of the driftwood much organic matter is mixed with the sand, which is continually being blown over from the sand-plain, and the result is a dark-colored sandy loam with a very high humic content. The structure of the vegetation along this shore is essentially as follows:

(*a*) *Potamogeton* Formation.

(*b*) *Typha-Scirpus* Formation.

(*c*) *Sagittaria-Alisma* Formation,

(*d*) *Salix-discolor-lucida* Formation (or the *Cladium-Calamagrostis* Formation).

There is comparatively little of the *Potamogeton* formation inside of the old piles along shore, the water being for the most part quite shallow, and the *Scirpus-Typha* formation taking up most of the area. There is some indication of a change towards the *Phragmites-Typha* formation as the entrance to Niagara Pond is approached—some *Zizania* making its appearance, but most of the zone is clearly to be referred to the same formation which is to be seen in the nearby ponds and lagoons, there being, however, more *Typha*. The habitat of this formation is probably very little affected by the accumulation of humus from the decay of the driftwood, and the protection afforded from the active surf by the line of old piles makes the habitat very similar to that of the recently formed ponds and lagoons along the northeastern extremity of the peninsula.

The *Sagittaria-Alisma* Formation.

The character of this formation is chiefly determined by the accumulation of humus derived from the driftwood. The plants composing this formation consist of species usually associated with rich alluvial deposits of mud, the composition of the formation being essentially as follows:

Facies. —

Sagittaria latifolia, *Alisma plantago-aquatica.*

Secondary Species. —

Cardamine pennsylvanica, *Radicula palustris hispida*,
Salix sp. (seedlings), *Naumbergia thyrsiflora*,
Isnarda palustris, *Stachys palustris*,
Dulichium arundinaceum, *Cicuta bulbifera*,
Carex comosa, *Persicaria laurina*,
Persicaria incarnata, *Rumex altissimus.*

This formation extends from slightly above water on the shore to a depth of five or six inches, it being on rare occasions entirely out of the water, due to a falling of the water-level in the bay, and often being inundated in times of higher water.

The *Salix discolor-lucida* Formation.

The *Salix discolor-lucida* formation is at its best at about the middle of the driftwood habitat opposite the widest part of Horse-shoe Pond. In places the shore becomes more xerophytic and the drift-beach, thickly strewn with débris, supports *Xanthium* and *Argentina*, but no *Cakile.* Towards the entrance to Niagara Pond there is a narrow zone of the *Cladium-Calamagrostis* formation backed by an *Alnus* thicket with *Cornus stolonifera* and *Cornus amomum* at its outer edge, but this thicket is being killed out by the shading effects of the *Prunus-Acer* formation just behind it.

The typical *Salix discolor-lucida* formation as exhibited along the driftwood habitat of Presque Isle is as follows:

Facies. —

Salix discolor, *Salix lucida.*

Secondary Species. —

Salix cordata, *Radicula palustris hispida*,
Persicaria laurina, *Cardamine pennsylvanica*,
Argentina anserina, *Carex comosa*,
Xanthium commune, *Erigeron ramosus.*

This formation differs here but little from its corresponding station near the Head, excepting in the greater prominence of *Salix lucida.* The latter species is here more prominent than is *Salix cordata* and is extending itself out into the *Sagittaria-Alisma* formation in little islands and peninsulas, where the driftwood and sand have risen above the water. Several of the secondary species are often able to successfully complete their growth upon decaying driftwood floating upon the water near the shore. Among these species may be mentioned *Radicula palustris hispida*, *Cardamine pennsylvanica*, and *Erigeron ramosus*.

It is very likely that this formation will eventually fill up the space out to the old piles and will be followed by an *Alnus* thicket. That the formation has not made more progress in the past has doubtless been due to the proximity of the lake to the east and the consequent drifting of sand, but with the recent closing in of the Horse-shoe Pond on the east, and the further advance of the shore-line beyond, the driftwood habitat will be farther and farther removed from these xerophytic influences, and will approach more and more the conditions of a hydrophytic muck-swamp, passing eventually into the *Ulmus-Acer* stage.

SECONDARY SUCCESSIONS.

Presque Isle presents but two secondary successions — the Burn Succession and the Cultural or Pasture Succession.

The Burn Succession.

Examples of this succession are to be seen in small areas immediately to the south of the east end of Long Ridge and along the ridge to the south of Ridge Pond. The first mentioned area evidently supported in part a mixed formation derived from the *Rhus-Alnus* thicket and the *Prunus-Acer* forest formations, and in part supported a patch of the *Sorghastrum nutans* consocies. During the year following the denudation of the habitat many shoots arose from the uninjured roots of the *Rhus typhina* and a few shoots of *Myrica caroliniana* appeared. The habitat will likely soon support a well-developed *Rhus typhina* thicket.

Where the habitat of the *Sorghastrum nutans* consocies had been burned over, apparently but little damage had been done. The clumps had not been burned so low as to kill the roots entirely and the grass, although thinned out considerably, appeared again the following season in sufficient abundance to completely dominate the area. Most of the normal secondary species were also present in reduced numbers.

To the south of Ridge Pond it appears that certain portions of the sandy ridge had been cleared and burned in connection with the building of the board-walk running over to the lighthouse. The vegetation of this area now consists of a secondary formation which may be termed the

Populus-Rhus Secondary Formation.

This formation is considerably mixed with various adjacent formations, but its general structure is as follows:

Facies. —

Populus tremuloides,	*Rhus typhina.*

Secondary Species. —

Andropogon furcatus,	*Panicum scribnerianum,*
Danthonia spicata,	*Agrostis hyemalis,*
Poa triflora,	*Poa compressa,*
Rubus alleghenicnsis,	*Rubus villosus,*
Prunus virginiana,	*Prunus serotina,*
Celastrus scandens,	*Acer saccharinum,*
Koellia verticillata,	*Gnaphalium polycephalum,*
Gnaphalium uliginosum,	*Pinus strobus,*
Myrica carolinensis,	*Quercus borealis,*
Quercus velutina,	*Sassafras sassafras,*
Meibomia dillenii,	*Prunus pennsylvanica,*
Prunus pumila,	*Tilia americana,*
Leptilon canadense,	*Artemisia canadensis,*
Erechtites hieracifolia.	

No species among the long list of secondary species could with propriety be designated as "principal species." The larger part of the vegetation is comprised in the *Populus tremuloides* consocies, this being of much larger extent than is the *Rhus typhina* consocies. The two facies are rarely found closely associated, but are in separate clumps, or in the absence of *Rhus*, the *Populus* occurs singly, scattered about among the secondary species.

After the normal vegetation was destroyed, there was evidently considerable shifting of the sand by the wind, and some dune building, this latter process leading to the invasion of the area by certain dune-plants, some of which (*Prunus pumila, Andropogon furcatus*) still persist among the so-called secondary species.

As the matter now stands with reference to the secondary species the *Populus-Rhus* formation is being invaded by various formations of both the sand-plain, the ridge, and the dune successions. There are, however, a considerable number of *Quercus velutina* trees now in evidence, mostly small as yet, so that the habitat will in the not distant future pass into the *Quercus velutina* forest formation, and thus be restored to its proper position with respect to the adjacent normal successions.

The Pasture Succession.

The pasture succession (cultural succession) is due, indirectly, to human agency by the pasturing of cattle near the U. S. Life Saving Station (see map). The continual trampling of the normal vegetation into the sand has resulted in the addition of humus to the soil, thus enriching it, and at the same time has made the soil more compact, with a greater and more uniform water-holding power, furnishing thus suitable edaphic conditions for the invasion of certain ruderal plants, common to such situations, as well as for certain mesophytic grasses, which under constant grazing have formed in places a compact and vigorous turf.

The structure of this formation as here presented is as follows:

Facies. —

Poa pratensis.

Secondary Species. —

Poa triflora,	*Poa compressa,*
Salix nigra,	*Trifolium repens,*
Trifolium pratense,	*Ranunculus abortivus,*
Plantago major,	*Plantago lanceolatus,*
Cyperus rivularis,	*Cerastium vulgatum,*
Moehringia lateriflora,	*Medicago lupulina,*
Onagra biennis,	*Taraxacum taraxacum,*
Erigeron philadelphicus,	*Carduus arvensis,*

Achillea millefolium.

The total area occupied by this formation is small, and at one-fourth of a mile from the Life Saving Station it has disappeared entirely. None of the species could be regarded as important enough to merit the rank of principal species, being much scattered and very few in number of individuals.

PHYTOGEOGRAPHIC RELATIONSHIPS OF THE FLORA OF PRESQUE ISLE.

The phytogeographic relationships of the flora of Presque Isle are comparatively rather complex. The vegetation of the mainland about

Erie, classified according to Merriam's system of life-zones,[83] belongs typically to the Alleghanian area of the transition zone; the northern or southern elements dominating in limited areas, the ecological conditions of which approach more nearly to the boreal or austral zones respectively. The escarpment at the head of Presque Isle is more than eighty feet in height, and, although almost perpendicular, it is quite heavily wooded. Its forest is typically a hemlock-birch formation with secondary species of *Ostrya*, red maple, beech, and *Tilia*. The shrubs are *Sambucus racemosa*, *Rubus odoratus*, and *Hamamelis*, while the herbaceous layer consists mainly of various mosses, *Adiantum pedatum*, and *Dryopteris spinulosa*. The distinct tendency of the cliff vegetation here is Canadian as to the trees, but Alleghanian as to the under vegetation.

As to the mainland back of the escarpment the forest is about equally composed of hemlock, black and red oak, and chestnut, with considerable *Magnolia acuminata*, *Liriodendron*, and *Prunus serotina*, and lesser numbers of white ash and *Betula lutea*. This forest, as to the trees, is thus composed about equally of northern and southern (boreal and austral) species, and may thus be regarded as typical Alleghanian (eastern transition). The undergrowth here is typically composed of Alleghanian species, but there are a few species, the ranges of which extend far to the south, reaching the gulf coast or even the tropical region.

The flora of Presque Isle comprises at least 430 ferns and seed-plants, and, grouping these in a general manner according to Merriam's life-zones, there are to be distinguished three main groups as follows:

A. Species the range of which is northern, Canadian, or Alleghanian, or extending over more or less of both areas. Total, 115 species.

Typical representatives of this group are:

Viola rotundifolia,	*Viola rafinesquii*,
Lepargyræa canadensis,	*Arctostaphylos uva-ursi*,
Oxycoccus macrocarpus,	*Trientalis americanus*,
Menyanthes trifoliata,	*Gerardia paupercula*,
Viburnum acerifolium,	*Viburnum dentatum*,

[83] Merriam, C. H. "A Provisional List of Canadian Plants — The Vertebrates of the Adirondack Mountain Region." *Trans. Linnæan Soc. N. Y.*, I: 26, Dec., 1882: and "Life Zones and Crop Zones of the United States." Div. Biol. Survey, U. S. Dept. of Agriculture, Bull. 10: 1–79, 1898.

Lobelia kalmii, *Hieracium canadense*,
Aster polyphyllus, *Gnaphalium decurrens*,
Artemisia canadensis, *Argentina anserina*,
Prunus pumila, *Prunus pennsylvanica*,
Pinus strobus.

B. Species the range of which is southern — Carolinian, or extending also over other areas of the austral (austroriparian or gulf strip). Total 42 species.

Typical representatives of this group are:

Lycopodium alopecuroides, *Hemicarpha micrantha*,
Magnolia acuminata, *Liriodendron tulipifera*,
Blephariglottis peramœna, *Ptelea trifoliata*,
Hypericum drummondii, *Sabbatia angularis*,
Asclepias tuberosa, *Lithospermum gmelini*,
Lycopus rubellus, *Galium pilosum*,
Gnaphalium purpureum, *Sassafras sassafras*,
Nyssa sylvatica.

C. Species the range of which with respect to the position of Presque Isle is neither definitely northern nor southern. Species generally ranging over both Carolinian and Alleghanian areas. Total, 283 species.

From the above grouping it appears that, taken as a whole, the flora of Presque Isle is more distinctly northern than southern, and in a general way may be termed Alleghanian, although the greater majority of the species are not closely restricted to either class. It is of interest to note in this connection that Todd, in his studies on the Birds of Erie and Presque Isle,[84] says: "The region under consideration [Presque Isle] may safely be considered as included within the Alleghanian Fauna, although with a slight admixture of the Carolinian element."

Transeau has pointed out that in eastern North America there may be distinguished four great forest centers, each center having peculiar to it a forest the species of which attain there their best development, thinning out from the region in all directions.[85] These centers are: "(1) the Northeastern Conifer Forest, centering in the St. Lawrence Basin, (2) the Deciduous Forest, centering in the lower Ohio basin and Piedmont

[84] Todd, W. E. Clyde. "The Birds of Erie and Presque Isle, Erie County, Pennsylvania." ANNALS CARNEGIE MUSEUM, II: 497, 1904.

[85] Transeau, E. N. "Forest Centers of Eastern America." *Am. Nat.*, 39: 875–889, 1905.

Plateau, (3) the Southeastern Conifer Forest, centering in the south Atlantic and Gulf coastal plain, and (4) the Insular Tropical Forest of the southern part of the Florida peninsula, centering in the West Indies.'' As far as Presque Isle is concerned the first two centers alone need to be considered.

The Northeastern Conifer Forest center, at least as far as the woody species are concerned, practically includes the eastern part of Merriam's Canadian Area together with the northern part of his Alleghanian Area, and in a general way this forest center may be regarded as the center for our first group of Presque Isle species (A), including altogether one hundred and fifteen species.

Our second group (B) of forty-two Presque Isle species is very closely co-extensive with Transeau's Deciduous Forest center, including thus the Carolinian Area and the southern extension of Merriam's Alleghanian Area, thinning out in all directions from this region.

It is thus to be seen that the region in which Presque Isle is located is more or less intermediate in geographical position between these two centers, but the true relations of the different elements as entering into the vegetation of Presque Isle are most evident when the formations and successions are individually considered. The intermediate position of Presque Isle is such that variations in the local ecological conditions of the soil, wind-exposure, etc., may swing the habitat into either the one or the other forest center (climatic or geographic) while in the more permanently intermediate habitats there may be a vegetation composed in part of derivatives from both centers; or, from historical causes the one or the other forest center may even there predominate.

In general it may be stated that on Presque Isle, proceeding from the physiographically youngest habitat to the oldest, the relationship of the corresponding vegetation swings gradually from the Northeastern Conifer Forest to the Deciduous Forest center, and on the northern side of the peninsula, with greater exposure and coarser soil particles, the northern element persists longer than on the southern side, where these conditions are less pronounced.

Transeau [86] has shown that the great forest centers are correlated very closely with certain ''rainfall-evaporation ratios,'' the ratio of total rainfall being largely dependent upon the same conditions of temperature, wind velocity, relative humidity, etc., which most largely in-

[86] Transeau, E. N. *l. c.*, 883–886.

fluence transpiration. Transeau found that in a general way, "The southeastern area where the rainfall is from 100–110 per cent. of the evaporation, corresponds to the region of the Deciduous Forest center," and that in the Southern Appalachians at least, the region with the ratio above 110 per cent. coincides with the southern extension of the Northeastern Conifer Forest, while the forest center in the St. Lawrence basin is marked by ratios above 100 per cent.

The ratio for the city of Erie is not less than 110 per cent., but the instruments of the U. S. Weather Bureau Station there are about 180 feet above Lake Erie and it is probable that the ratio for Presque Isle, but a few feet above the lake and within reach of its more immediate effects upon humidity, temperature, etc., would be found to be considerably higher. However the ratio would vary greatly between the various habitats on the peninsula itself; as, for instance, between the interior of the sand-plain, with its loose sand fully exposed to wind and insolation, and the interior of the black oak forest, with its shaded, humus-covered soil, the temperature of which never presents the rapid and extreme variations of the surface of the sand-plain. The rainfall-evaporation ratio would probably be below 100 for the sand-plain and perhaps a careful instrumental determination of the factors would show that there is a constantly increasing ratio from the sand-plain to the black oak forest, which could be correlated with the shifting of the relationship of the respective formations from the northeastern conifer forest to the deciduous forest.

The lower and drift beaches of Presque Isle are under the equalizing influences of the water to such an extent that they are inhabited by a formation found in similar habitats almost throughout North Temperate America, but removed from the more immediately modifying influences of the water, the sand-plain, with its sterile, porous, wind-exposed soil, supports a formation including several distinctly northern species: *Artemisia canadensis*, *Lathyrus maritimus*, or, around the lagoons and ponds in the sand-plain, *Triglochin palustris*, *Carex aquatilis*, *C. gronovii*, *C. œderi pumila* and *C. canescens*, *Juncus balticus*, *J. articulatus*, *Salix syrticola*, *Hypericum boreale*, etc., or, on the dunes in the sand-plain, *Prunus pumila*.

With the advent of considerable numbers of woody species upon the sand-plain its southern portion is occupied by the *Myrica* thicket, which must be regarded as having southern affinities, while the northern portion of the sand-plain is occupied by the *Arctostaphylos-Juni-*

perus heath, a distinctly northern formation. The *Myrica* thicket is soon superseded by the *Prunus serotina* forest, which in its turn gives way to the *Quercus velutina* forest, both formations being distinctly southern and related to the deciduous forest. The heath stage is succeeded by the *Pinus strobus* forest, distinctly northern, but this is eventually displaced by the black oak forest, distinctly southern.

In the Dune-Thicket-Forest Succession the initial stage may be distinctly northern, as in the *Ammophila* and *Prunus pumila* dunes, or more southern, as in the *Populus* and *Andropogon* dunes. In either case these dunes may towards the southern side of the peninsula pass into the *Toxicodendron* thicket and the *Prunus serotina* forest, both related to the deciduous forest center, or towards the northern side of the peninsula they may pass into the *Arctostaphylos-Juniperus* heath and then into the *Pinus strobus* forest, both with northern affinities. The climax forest for the succession is, however, the *Quercus velutina* forest, this being distinctly related to the deciduous forest center.

In the Lagoon-Marsh-Thicket-Forest Succession the more hydrophilous formations on Presque Isle consist of species of wide distribution, but in the zoned formations on the banks of the lagoon or pond there may be seen tendencies towards either the one or the other forest center. Thus, in the first three stages of the succession a considerable number of the species are northern — *Triglochin palustris*, *Carex œderi pumila*, *Juncus balticus*, *J. articulatus*, *J. alpinus insignis*, *J. nodosus*, etc.

With the growth of the outer *Populus-Salix* zone and the advent of an inner shrub-zone around the lagoons, together with the leaving of the lagoons farther inland with the onward growth of the peninsula, the direct exposure to high winds becomes less and less at the same time that species with southern relationships become more prominent. However, the wet meadow formation, *Cladium-Calamagrostis* formation, and its outer shrub-zones, the *Myrica-Salix* and *Rhus-Alnus* formations, are quite distinctly northern, and the wet meadow may be invaded and occupied by other typically northern formations, as the *Fragaria-Polytrichum* and the *Sphagnum-Oxycoccus* formations. The climax stages of the succession, however, are more southern than northern, the final *Ulmus-Acer* forest belonging clearly to the deciduous forest center.

The burn succession also apparently begins with formations belonging to the northeastern conifer forest and ends in the black oak forest with more southern relationships. Fire by removing the organic matter brings the habitat on Presque Isle back to practically sand-plain conditions, and so invites invasion by species from the northeastern conifer forest, but with the accumulation of humus in the soil and the occupation of the habitat by sheltering vegetation more uniform conditions of moisture and temperature obtain, and there is a gradual reversion on the part of the vegetation to the deciduous forest species.

In considering the invasion of species or associations of species from the one or the other forest center it must be remembered that in the initial stages of the successions on Presque Isle the vegetation is more or less "open," there being considerable unoccupied territory between the individual plants of the formation, competition being therefore reduced to the minimum. The beach-sand plain successions and the dune successions do not really approach "closed" conditions until the advent of the *Prunus serotina* or the *Pinus strobus* forests, while the lagoon succession remains more or less open until about "Stage E."

The comparative rapidity with which the land form of Presque Isle has been extended to the north and east makes necessary upon the part of the plants a corresponding ability to migrate. The disseminules of the plants must in some manner be distributed to a considerable distance from the parent plant, especially in the case of trees, where a number of years must elapse before the attainment of a seed-bearing age.

Of the numerous agents of dissemination three are prominent among the species of the initial stages of the successions occupying the newly-formed land towards the northeastern extremity of the peninsula: (*a*) water, (*b*) wind, and (*c*) animals, mainly birds. Of these agents the first, of course, prevails in the beach formations and in the fringing *Ammophila* dune, although indirectly wind has an important part in this also.

In the sand-plain and in the earlier stages of the lagoon succession wind is evidently the most important agent of dissemination, although for the initial invasion of a species around a lagoon birds are probably the all-important factor. The disseminules of *Juncus*, *Eleocharis*, *Cyperus*, etc., are known to be carried considerable distances adhering to the plumage or sticking in the mud on the feet of water-birds of various kinds, especially during the migrating season.[87] When once invasion has been accomplished, the formation of zones will rapidly proceed, mainly through the agency of wind.[88] The submerged formations and the formations at the edge of the water will depend to a large extent upon water as an agent of distribution, and in most of these formations vegetative dissemination by means of rootstocks and off-shoots of various kinds is also prominent.

Many of the plants of the sand-plain and its included habitats have disseminules with special adaptations to dispersal by wind: *Populus*, *Salix*, *Solidago*, *Aster*, etc. In other species the small seeds are probably drifted about with the dry sand, or more or less of the whole plant may be undermined and uprooted and drift about, scattering seeds along its path. It is also highly probable that disseminules of several of the sand-plain species and species of the adjoining thickets are blown over the level expanses of crusted snow during winter: *Alnus*, *Rhus*, *Myrica*, *Pinus strobus*, etc. In most of these species the disseminules are more or less persistent until long into the winter.

Deglutition by birds is an important means of distribution of the forest and thicket species, but these species do not thus reach the sand-plain to any considerable extent until the vegetation offers perching facilities. A large number of the species of the forest and thicket formations have fruits eaten by birds, many of the fruits being persistent during the winter months. Among such species may be mentioned *Juniperus*, *Toxicodendron*, *Arctostaphylos*, *Rhus*, *Celastrus*, *Smilax*, *Vitis*, and *Myrica*, while of the less persistent fruits eaten and distributed by birds are such species as *Fragaria*, *Rubus*, *Prunus*, *Unifolium*, *Vagnera*, *Vaccinium*, etc. *Juniperus virginiana* almost invariably first appears on the sand-plain a few feet to the leeward of a cottonwood, where the drupe was deposited by a bird whose perching position was probably determined by the strong wind.

As to the dissemination of the oaks invasion must be due to animal agencies, as no other explanation seems sufficient to explain the appearance of seedlings at considerable distances from trees old enough

[87] Kerner, A. von Marilaun. Trans. by Oliver, F. W. "The Natural History of Plants." Vol. 2: 867–868.

[88] As an instance of probable invasion by means of bird migration may be cited *Hypericum drummondii* which has a distribution from "Va. to Ga., Ill., Iowa, Kansas, and Tex." (Britton, N. L., "Manual," *l. c.*, p. 628), but now occurs in Ashtabula County, Ohio, and at Presque Isle. The minute seeds of this plant might easily be transported long distances in mud adhering to the feet of migrating birds.

to bear fruit. Usually the seedlings are in such a position as would indicate that the acorn had been secreted by bird or animal, as for instance, in the *Arctostaphylos* mat of the heath, where young black oaks are quite numerous at a distance of at least 40 rods from trees old enough to bear acorns. It is well known that the blue jay and the crow subsist largely upon wild fruits and mast during the winter months and probably secrete quantities of larger nuts, acorns, etc., as stores to resort to in cases of scarcity of food.[89] The former bird is an abundant permanent resident of Presque Isle, while the latter is abundant during late fall and early spring, or even remaining on the peninsula in limited numbers during the winter.[90] From this the dissemination of the oaks may be ascribed to these agents, in at least a large measure.

Vegetative dissemination by means of branching rhizomes, offshoots, etc., is very prevalent in the earlier stages of the successions, especially where the soil is loose and the formation is open. Among the more conspicuous examples of this method of dissemination on Presque Isle are: *Panicum*, *Andropogon*, *Ammophila*, *Myrica*, *Linum*, *Aster*, *Solidago*, *Arctostaphylos*, *Juncus*, *Eleocharis*, *Typha*, *Scirpus*, *Vagnera*, *Unifolium*, etc. In the more hydrophytic formations, as mentioned for the inner zones around the lagoon, and also as represented by *Cephalanthus*, *Decodon*, *Castalia*, *Sphagnum*, etc., this method is a very prominent one.

This brief sketch of the methods of dissemination on Presque Isle shows that here, as elsewhere,[91] *water* is the most important agent of dissemination with beach plants; *wind* with xerophytic (dry sand-plain plants), or poöphytic plants (grasses of the sand plain and wet meadow, as *Andropogon* and *Calamagrostis*); and *animals* with hylophytes (forest plants).

A fact to be noted, in connection with the prevailing methods of migration of plants to the new habitats on Presque Isle, is that the species with northern relationships, such, for instance as *Populus*, *Salix*, *Pinus*, *Arctostaphylos*, *Triglochin palustris*, *Carex œderi pumila*, *Juncus balticus*, etc., have, as a rule, a much greater ability to

[89] Barrows, W. B., and Schwartz, E. A. "The Common Crow of the United States." Div. Ornithology and Mammalogy, U. S. Dept. Agr. Bull. 6: 79–87, 1895; and Beal, F. E. L. "Some Common Birds in Their Relation to Agriculture." U. S. Dept. Agr., Farmers' Bulletin No. 54: 14–17, 1898.

[90] Todd, W. E. C. *l. c.*, pp. 565–566.

[91] Clements, F. S. *l. c.*, p. 218.

migrate, both as to distance covered and as to numbers of migrating disseminules, than do species with more southern relationships, as, for instance, *Quercus velutina*, *Ulmus americana*, *Acer saccharinum*, etc., so that for historical reasons, as well as for reasons of adaptation to a more northern environment, the earlier stages in most of the successions are more largely related to the northeastern conifer forest center, or at least are more northern in their relationship.

A SYSTEMATIC CATALOGUE OF THE FERNS AND FLOWERING PLANTS OF PRESQUE ISLE, ERIE COUNTY, PENNSYLVANIA.

OPHIOGLOSSACEÆ.

Ophioglossum vulgatum Linnæus.
Botrychium obliquum Muhlenberg.
Botrychium virginianum (Linnæus) Swartz.

OSMUNDACEÆ.

Osmunda claytoniana Linnæus.
Osmunda spectabilis Willdenow.

POLYPODIACEÆ.

Onoclea sensibilis Linnæus.
Woodsia obtusa (Sprengel) Torrey.
Dryopteris boottii (Tuckerman) Underwood.
Dryopteris spinulosa (Retzius) Kuntze.
Dryopteris spinulosa dilatata (Hoffmansegg) Underwood.
Dryopteris spinulosa intermedia (Willdenow) Underwood.
Dryopteris thelypteris (Linnæus) A. Gray.
Polystichum acrostichoides (Michaux) Schott.

EQUISETACEÆ.

Equisetum arvense Linnæus.
Equisetum hyemale Linnæus.
Equisetum sylvaticum variegatum Schleicher.
"Erie, Presque Isle, Garber."[92]

LYCOPODIACEÆ.

Lycopodium alopecuroides Linnæus.
Gustave Guttenberg, 1879. Specimens in Carnegie Museum Herbarium.

[92] Porter, T. C. "Catalogue of the Bryophyta and Pteridophyta found in Pennsylvania." Boston, 1904.

Lycopodium clavatum Linnæus.

Lycopodium complanatum Linnæus.

Lycopodium lucidulum Michaux.

Lycopodium obscurum Linnæus.

ISOETACEÆ.

Isoetes echinospora braunii (Durieu) Engelmann.

A. P. Garber, July 28, 1868. Specimens in Carnegie Museum Herbarium.

PINACEÆ.

Pinus strobus Linnæus.

Pinus virginiana Miller.

Near the Head and evidently planted by U. S. Government.

Tsuga canadensis (Linnæus) Carriere.

Juniperus virginiana Linnæus.

TYPHACEÆ.

Typha latifolia Linnæus.

SPARGANIACEÆ.

Sparganium eurycarpum Engelmann.

Sparganium simplex angustifolium (Michaux) Engelmann.

Gustave Guttenberg, July 9, 1879. Specimens in Carnegie Museum Herbarium.

Sparganium minimum Fries.

Gustave Guttenberg, Aug. 1, 1880. Specimens in Carnegie Museum Herbarium.

NAIADACEÆ.

Potamogeton natans Linnæus.

Potamogeton lonchites Tuckermann.

Potamogeton heterophyllus Schreber.

Potamogeton heterophyllus graminifolius (Fries) Morong.

"Erie, Presque Isle."[93]

Potamogeton zizii Roth.

Potamogeton lucens Linnæus.

Gustave Guttenberg, July 9, 1879. Carnegie Museum Herbarium.

Potamogeton perfoliatus richardsonii A. Bennett.

Gustave Guttenberg, Aug. 10, 1880. Carnegie Museum Herbarium.

[93] Porter, T. C. "Flora of Pennsylvania." Boston, 1903.

Potamogeton foliosus Rafinesque.
Potamogeton foliosus niagarensis (Tuckermann) Morong.
Potamogeton pectinatus Linnæus.
Naias flexilis (Willdenow) Roemer & Schultes.

SCHEUCHZERIACEÆ.

Triglochin palustris Linnæus.

ALISMACEÆ.

Alisma plantago-aquatica Linnæus.
Sagittaria latifolia Willdenow.
Sagittaria rigida Pursh.
Sagittaria graminea Michaux.
Gustave Guttenberg, July 9, 1879. Carnegie Museum Herbarium.

HYDROCHARITACEÆ.

Philotria canadensis (Michaux) Britton.
Vallisneria spiralis Linnæus.

GRAMINEÆ.

Andropogon furcatus Muhlenberg.
Sorghastrum nutans (Linnæus) Nash.
Panicum virgatum Linnæus.
Panicum scribnerianum Nash.
Cenchrus carolinianus Walter.
Zizania aquatica Linnæus.
Oryzopsis asperifolia Michaux.
Gustave Guttenberg, "Big Bend," May 8, 1880. Carnegie Museum Herbarium.
Muhlenbergia mexicana (Linnæus) Trinius.
Sporobolus cryptandrus (Torrey) A. Gray.
Gustave Guttenberg, "Misery Bay," Sept. 26, 1879. Carnegie Museum Herbarium.
Agrostis hyemalis (Walter) Britton, Sterns & Poggenberg.
Calamagrostis canadensis (Michaux) Beauvois.
Ammophila arenaria (Linnæus) Link.
Avena sativa Linnæus.
Fugitive along shore of Presque Isle Bay.
Danthonia spicata (Linnæus) Beauvois.
Gustave Guttenberg, July 10, 1879. Carnegie Museum Herbarium.

Phragmites phragmites (Linnæus) Karsten.
Triplasis purpurea (Walter) Chapman.
Eragrostis purshii Schrader.
Poa triflora Gilibert.
Poa pratensis Linnæus.
Poa compressa Linnæus.
Panicularia nervata (Willdenow) Kuntze.
Gustave Guttenberg, "Lower Lighthouse," June 12, 1879. Carnegie Museum Herbarium.
Festuca octoflora Walter.
Elymus canadensis Linnæus.

CYPERACEÆ.

Hemicarpha micrantha (Vahl) Britton.
Dulichium arundinaceum (Linnæus) Britton.
Cyperus rivularis Kunth.
Cyperus schweinitzii Torrey.
Cyperus engelmanni Steudel.
Gustave Guttenberg, Aug. 12, 1879. Carnegie Museum Herbarium.
Cyperus strigosus Linnæus.
Cyperus filiculmis Vahl.
Cyperus houghtonii Torrey.
Eriophorum gracile Roth.
Scirpus pauciflorus Lightfoot.
Scirpus subterminalis Torrey.
Gustave Guttenberg, 1879. Carnegie Museum Herbarium.
Scirpus smithii A. Gray.
Gustave Guttenberg, Aug. 12, 1879. Carnegie Museum Herbarium.
Scirpus americanus Persoon.
Scirpus torreyi Olney.
Scirpus validus Vahl.
Scirpus fluviatilis (Torrey) A Gray.
Scirpus atrovirens Muhlenberg.
Scirpus cyperinus (Linnæus) Karsten.
Eleocharis quadrangulata (Michaux) Roemer & Schultes.
Eleocharis olivacea Torrey.
Eleocharis obtusa Schultes.
J. A. Shafer, Sept. 9–11, 1900. Carnegie Museum Herbarium.
Eleocharis palustris (Linnæus) Roemer & Schultes.

Eleocharis palustris glaucescens (Willdenow) A. Gray.
Eleocharis acicularis (Linnæus) Roemer & Schultes.
Eleocharis acuminata (Muhlenberg) Nees.
Eleocharis ovata (Roth) Roemer & Schultes.
Fimbristylis autumnalis (Linnæus) Roemer & Schultes.
Stenophyllus capillaris (Linnæus) Britton.
Cladium mariscoides (Muhlenberg) Torrey.
Scleria verticillata Muhlenberg.
Carex lupulina Muhlenberg.
Carex schweinitzii Dewey.
Gustave Guttenberg, "Crystal Point," June 9, 1880. Carnegie Museum Herbarium.
Carex hystricina Muhlenberg.
Carex pseudo-cyperus Linnæus.
Carex comosa Boott.
Carex scabrata Schweinitz.
Carex lanuginosa Michaux.
Carex filiformis Linnæus.
Carex stricta Lamarck.
Gustave Guttenberg, May 30, 1879. Carnegie Museum Herbarium.
Carex stricta angustata (Boott) Bailey.
Carex aquatilis Wahlenberg.
Carex goodenovii J. Gay.
Gustave Guttenberg, July 9, 1879. Carnegie Museum Herbarium.
Carex prasina Wahlenberg.
Carex virescens Muhlenberg.
Carex arctata Boott.
Carex œderi pumila (Cosson & Germain) Fernald.
Carex laxiflora varians Bailey.
Carex digitalis Willdenow.
Carex aurea Nuttall.
"Erie, Presque Isle."[94]
Carex varia Muhlenberg.
Carex communis Bailey.
Carex umbellata Schkuhr.
Carex sartwellii Dewey.
"Erie, Presque Isle."[94]
Carex muhlenbergii Schkuhr.

[94] Porter, T. C. *l. c.*, p. 67.

Carex canescens Linnæus.
Carex scoparia Schkuhr.

LEMNACEÆ.

Lemna minor Linnæus.

PONTEDERIACEÆ.

Heteranthera dubia (Jacquin) MacMillan.
Pontederia cordata Linnæus.

JUNCACEÆ.

Juncus balticus littoralis Engelmann.
Juncus tenuis Willdenow.
Juncus dudleyi Wiegand.
Juncus articulatus Linnæus.
Juncus alpinus insignis Fries.
Juncus nodosus Linnæus.
Juncus torreyi Coville.
Juncus scirpoides Lamarck.
Juncus brachycephalus (Engelmann) Buchenau.
Juncus canadensis J. Gay.

CONVALLARIACEÆ.

Vagnera racemosa (Linnæus) Morong.
Vagnera stellata (Linnæus) Morong.
Unifolium canadense (Desfontaine) Greene.
Uvularia perfoliata Linnæus.
Salomonia biflora (Walter) Farwell.
Salomonia commutata (Roemer & Schultes) Farwell.

TRILLIACEÆ.

Trillium erectum Linnæus.

SMILACEÆ.

Smilax herbacea Linnæus.

IRIDACEÆ.

Iris versicolor Linnæus.

ORCHIDACEÆ.

Cypripedium acaule Aiton.
Perularia flava (Linnæus) Farwell.
Lysias orbiculata (Pursh) Rydberg.

Lysias hookeriana (A. Gray) Rydberg.
Blephariglottis peramœna (A. Gray) Rydberg.
Ibidium incurvum Jennings.[95]
Ibidium strictum (Rydberg) House.
Epipactis pubescens (Willdenow) A. A. Eaton.
Leptorchis lœselii (Linnæus) MacMillan.
Leptorchis liliifolia (Linnæus) Kuntze.
Corallorhiza maculata Rafinesque.
Gustave Guttenberg, July 9, 1879. Carnegie Museum Herbarium.

SALICACEÆ.

Populus alba Linnæus.
Populus tremuloides Michaux.
Populus deltoides Marshall.
Salix nigra Marshall.
Salix lucida Muhlenberg.
Salix fragilis Linnæus.
Salix fragilis × *alba*.
Salix alba Linnæus.
Salix cordata Muhlenberg.
Salix syrticola Fernald.
Salix discolor Muhlenberg.
Salix eriocephala Michaux.
Gustave Guttenberg, June 26, 1879, "Big Bend." Carnegie Museum Herbarium.
Salix sericea Marshall.

MYRICACEÆ.

Myrica carolinensis Miller.

JUGLANDACEÆ.

Juglans cinerea Linnæus.

BETULACEÆ.

Ostrya virginiana (Miller) K. Koch.
Betula lutea F. A. Michaux.
Alnus incana (Linnæus) Moench.

[95] Jennings, O. E. "A New Species of *Ibidium* (*Gyrostachys*)." ANN. CARNEGIE MUSEUM, 3: 483–486. 1906. The *Ibidium cernuum* reported previously for Presque Isle is evidently *I. incurvum*.

FAGACEÆ.

Quercus rubra Linnæus.
Quercus palustris DuRoi.
Quercus borealis F. A. Michaux. (*Q. ambigua* F. A. Michaux.)
Quercus velutina Lamarck.

(Perhaps some of the specimens referred to the three first named species are here to be regarded as extreme variations of *Q. velutina.*)

ULMACEÆ.

Ulmus americana Linnæus.

URTICACEÆ.

Bœhmeria cylindrica (Linnæus) Swartz.

POLYGONACEÆ.

Rumex acetosella Linnæus.
Rumex verticillatus Linnæus.
Rumex altissimus Wood.
Persicaria fluitans (Eaton) Greene.
Persicaria incarnata (Elliott) Small. (*Polygonum incarnatum* Elliott.)
Persicaria hydropiperoides (Michaux) Small. (*Polygonum hydropiperoides* Michaux.)
Persicaria laurina Greene.[96]
Persicaria punctata (Elliott) Small. (*Polygonum punctatum* Elliott.)
Tracaulon sagittatum (Linnæus) Small. (*Polygonum sagittatum* Linnæus.)
Bilderdykia scandens (Linnæus) Greene. (*Polygonum scandens* Linnæus.)

PHYTOLACCACEÆ.

Phytolacca decandra Linnæus.

CARYOPHYLLACEÆ.

Lychnis alba Miller.
Silene antirrhina Linnæus.
Cerastium vulgatum Linnæus.
Arenaria serpyllifolia Linnæus.
Mœhringia lateriflora (Linnæus) Fenzl.

[96] Greene, E. L. "Certain Polygonaceous Genera." Leaflets, 1: 17–50. Jan. 5, 1904.

NYMPHÆACEÆ.

Brasenia schreberi Gmelin.
Nymphæa advena Solander.
Castalia tuberosa (Paine) Greene.

MAGNOLIACEÆ.

Magnolia acuminata Linnæus.
Liriodendron tulipifera Linnæus.

RANUNCULACEÆ.

Actæa alba (Linnæus) Miller.
Anemone cylindrica A. Gray.[97]
Anemone canadensis Linnæus.
Clematis virginiana Linnæus.
Batrachium circinatum (Sibthorp) new combination.
Ranunculus abortivus Linnæus.
Ranunculus pennsylvanicus Linnæus, filius.

LAURACEÆ.

Sassafras sassafras (Linnæus) Karsten.

CRUCIFERÆ.

Radicula palustris hispida (Desvaux) Robinson.
Barbarea barbarea (Linnæus) MacMillan.
Brassica arvensis (Linnæus) Britton, Sterns & Poggenberg.
Brassica campestris Linnæus.
Cakila edentula (Bigelow) Hooker.
Cardamine pennsylvanica Muhlenberg.
Arabis lyrata Linnæus.
Arabia lævigata (Muhlenberg) Poiret.

DROSERACEÆ.

Drosera rotundifolia Linnæus.

PARNASSIACEÆ.

Parnassia caroliniana Michaux.

HAMAMELIDACEÆ.

Hamamelis virginiana Linnæus.

[97] Porter, T. C. *l. c.*, p. 138.

GROSSULARIACEÆ.

Ribes cynosbati Linnæus.
Ribes floridum L'Heritier.

ROSACEÆ.

Spiræa latifolia Borkhausen.
Rubus odoratus Linnæus.
Rubus idæus aculeatissimus C. A. Meyer, Regel & Tiling.
Rubus occidentalis Linnæus.
Rubus allegheniensis Porter.
Rubus davisianus Blanchard.
Rubus procumbens Muhlenberg.
Rubus hispidus Linnæus.
Fragaria americana (Porter) Britton.
Fragaria virginiana Duchesne.
Argentina anserina (Linnæus) Rydberg.
Potentilla monspeliensis Linnæus.
Potentilla paradoxa Nuttall. (Porter's "Flora," p. 170.)
Agrimonia gryposepala Wallroth.
Rosa carolina Linnæus.
Rosa humilis Marshall.

POMACEÆ.

Malus malus (Linnæus) Britton.
Aronia melanocarpa (Michaux) new combination.
Amelanchier canadensis (Linnæus) Medicus.
Amelanchier oblongifolia (Torrey & Gray) Rœmer.

DRUPACEÆ.

Prunus americana Marshall.
Prunus pumila Linnæus.
Prunus pennsylvanica Linnæus, filius.
Prunus virginiana Linnæus.
Prunus serotina Ehrhart.

PAPILIONACEÆ.

Lupinus perennis Linnæus.
Medicago lupulina Linnæus.
Melilotus officinalis (Linnæus) Lamarck.
Trifolium pratense Linnæus.
Trifolium hybridum Linnæus.

Trifolium repens Linnæus.
Robinia pseudacacia Linnæus.
Astragalus canadensis Linnæus.
Meibomia dillenii (Darlington) Kuntze.
Meibomia canadensis (Linnæus) Kuntze.
Lespedeza capitata Michaux.
Apios apios (Linnæus) MacMillan.
Phaseolus polystachyus (Linnæus) Britton, Sterns & Poggenburg. (Porter's "Flora," p. 190.)
Strophostyles helvola (Linnæus) Britton.
Lathyrus maritimus Linnæus.
Lathyrus palustris Linnæus.

LINACEÆ.

Linum medium (Planchon) Britton.

RUTACEÆ.

Ptelea trifoliata Linnæus.

POLYGALACEÆ.

Polygala verticillata Linnæus.

EUPHORBIACEÆ.

Euphorbia polygonifolia Linnæus.
Euphorbia helioscopia Linnæus.

ANACARDIACEÆ.

Rhus typhina Linnæus.
Rhus aromatica Aiton.
Toxicodendron pubescens Miller. (*Rhus toxicodendron* Linnæus.)[98]

ILICACEÆ.

Ilex verticillata (Linnæus) A. Gray.
Ilex verticillata cyclophylla Robinson.
Ilex verticillata tenuifolia (Torrey) Watson.

CELASTRACEÆ.

Celastrus scandens Linnæus.

ACERACEÆ.

Acer rubrum Linnæus.
Acer saccharinum Linnæus.

[98] See Greene, E. L. "Segregates of *Rhus*." Leaflets, 1: 114–144. Nov. 24 and Nov. 29, 1905.

BALSAMINACEÆ.

Impatiens biflora Walter.

VITACEÆ.

Vitis æstivalis Michaux.
Vitis bicolor LeConte.
Vitis vulpina Linnæus.
Psedera quinquefolia (Linnæus) Greene.

TILIACEÆ.

Tilia americana Linnæus.

MALVACEÆ.

Hibiscus moscheutos Linnæus.

HYPERICACEÆ.

Hypericum perforatum Linnæus.
Hypericum punctatum Lamarck.
Hypericum boreale (Britton) Bicknell.
Hypericum majus (A. Gray) Britton.
Hypericum canadense Linnæus.
Hypericum drummondii (Greville & Hooker) Torrey & Gray.
Triadenum virginicum (Linnæus) Rafinesque.

CISTACEÆ.

Helianthemum canadense (Linnæus) Michaux.
Lechea villosa Elliott.

VIOLACEÆ.

Viola affinis LeConte.
Viola papilionacea Pursh.
Viola rotundifolia Michaux.
Viola blanda Willdenow.
Viola rafinesquii Greene.

ELÆAGNACEÆ.

Lepargyrea canadensis (Linnæus) Greene.

LYTHRACEÆ.

Decodon verticillatus (Linnæus) Elliott.

ONAGRACEÆ.

Isnarda palustris Linnæus.
Epilobium densum Rafinesque.

Gustave Guttenberg, Aug. 10, 1880. Carnegie Museum Herbarium.

Epilobium coloratum Muhlenberg.
Epilobium adenocaulon Haussknecht.
Onagra biennis (Linnæus) Scopoli.
Onagra oakesiana (A. Gray) Britton.
Kneiffia linearis (Michaux) Spach.

HALORAGIDACEÆ.

Proserpinaca palustris Linnæus.
Myriophyllum spicatum Linnæus.

ARALIACEÆ.

Aralia nudicaulis Linnæus.

UMBELLIFERÆ.

Osmorhiza claytoni (Michaux) Clarke.
Cicuta bulbifera Linnæus.
Daucus carota Linnæus.

CORNACEÆ.

Cornus amomum Miller.
Cornus obliqua Rafinesque.[99]
Cornus baileyi Coulter & Evans.
Cornus stolonifera Michaux.
Cornus paniculata L'Heritier.
Nyssa sylvatica Marshall.

PYROLACEÆ.

Pyrola americana Sweet.
Pyrola elliptica Nuttall.
Pyrola secunda Linnæus.
Chimaphila maculata (Linnæus) Pursh.
Chimaphila umbellata (Linnæus) Nuttall.

MONOTROPACEÆ.

Monotropa uniflora Linnæus.

ERICACEÆ.

Arctostaphylos uva-ursi (Linnæus) Sprengel.

[99] Specimens show all gradations between *C. amomum* and *C. obliqua.*

VACCINIACEÆ.

Vaccinium corymbosum Linnæus.
Vaccinium canadense Richards.
Gustave Guttenberg, 1879. Carnegie Museum Herbarium.
Oxycoccus macrocarpus (Aiton) Persoon.

PRIMULACEÆ.

Lysimachia terrestris (Linnæus) Britton, Sterns & Poggenburg.
Naumbergia thyrsiflora (Linnæus) Duby.
Trientalis americana (Persoon) Pursh.

OLEACEÆ.

Fraxinus americana Linnæus.
Fraxinus nigra Marshall.

GENTIANACEÆ.

Sabbatia angularis (Linnæus) Pursh.
Gentiana andrewsii Grisebach.

MENYANTHACEÆ.

Menyanthes trifoliata Linnæus.

ASCLEPIADACEÆ.

Asclepias syriaca Linnæus.
Asclepias tuberosa Linnæus.

CONVOLVULACEÆ.

Convolvulus sepium Linnæus.

CUSCUTACEÆ.

Cuscuta gronovii Willdenow.

BORAGINACEÆ.

Myosotis laxa Lehmann.
Myosotis arvensis (Linnæus) Lamarck.
Lithospermum gmelini (Michaux) Hitchcock.

LABIATÆ.

Teucrium canadense Linnæus.
Scutellaria lateriflora Linnæus.
Scutellaria galericulata Linnæus.
Physostegia virginiana (Linnæus) Bentham.
Stachys palustris Linnæus.
Hedeoma pulegioides (Linnæus) Persoon.

Kœllia verticillata (Michaux) Kuntze.
Kœllia mutica (Michaux) Britton.
Lycopus uniflorus Michaux.
Lycopus americanus Muhlenberg.
Lycopus rubellus Moench.
Mentha spicata Linnæus.
Mentha piperita Linnæus.
Mentha cardiaca Gerarde.
Mentha canadensis Linnæus.

SOLANACEÆ.

Solanum dulcamara Linnæus.

SCROPHULARIACEÆ.

Mimulus ringens Linnæus.
Mimulus alatus Solander.
Dasystoma virginica (Linnæus) Britton.
Gerardia paupercula (A. Gray) Britton.
Castilleja coccinea (Linnæus) Sprengel.
Gustave Guttenberg, May 30, 1879. Carnegie Museum Herbarium.
Melampyrum lineare Lamarck.

LENTIBULARIACEÆ.

Utricularia cornuta Michaux.
Utricularia resupinata B. D. Greene.
Gustave Guttenberg, July and Aug., 1879. Carnegie Museum Herbarium.
Utricularia vulgaris Linnæus.
Utricularia clandestina Nuttall.[100]
Utricularia intermedia Hayne.
Utricularia minor Linnæus.
Gustave Guttenberg, Aug. 10, 1880. Carnegie Museum Herbarium.
Utricularia gibba Linnæus.

PHRYMACEÆ.

Phyrma leptostachya Linnæus.

PLANTAGINACEÆ.

Plantago major Linnæus.
Plantago lanceolata Linnæus.

[100] Porter, T. C. "Flora of Pennsylvania," p. 286.

RUBIACEÆ.

Cephalanthus occidentalis Linnæus.
Mitchella repens Linnæus.
Galium aparine Linnæus.
Galium pilosum Aiton.
Galium circæzans Michaux.
Galium triflorum Michaux.
Galium trifidum Linnæus.

CAPRIFOLIACEÆ.

Sambucus canadensis Linnæus.
Sambucus racemosa Linnæus.
Viburnum acerifolium Linnæus.
Viburnum dentatum Linnæus.
Viburnum lentago Linnæus.
Lonicera glaucescens Rydberg.
(Forms with purple flowers occur here.)
Diervilla diervilla (Linnæus) MacMillan.

CAMPANULACEÆ.

Campanula aparinoides Pursh.
Lobelia syphilitica Linnæus.
Lobelia kalmii Linnæus.

CICHORIACEÆ.

Taraxacam taraxacum (Linnæus) Karsten.
Lactuca canadensis Linnæus.
Hieracium canadense Michaux.
Hieracium paniculatum Linnæus.
Hieracium scabrum Michaux.
Hieracium gronovii Linnæus.
Nabalus albus (Linnæus) Hooker.

AMBROSIACEÆ.

Xanthium commune Britton.
Xanthium macounii Britton.

(The burs of these plants answer to the description of this species very nicely, but the leaves are apparently larger and more deeply lobed.)

COMPOSITÆ.

Eupatorium perfoliatum Linnæus.
Solidago cæsia Linnæus.

Solidago flexicaulis Linnæus.
Solidago serotina Aiton.
Solidago canadensis Linnæus.
Solidago nemoralis Aiton.
Euthamia graminifolia (Linnæus) Nuttall.
Aster novæ-angliæ Linnæus.
Aster ericoides Linnæus.
Aster polyphyllus Willdenow. (*Aster faxoni* Porter.)[101]
Erigeron philadelphicus Linnæus.
Erigeron ramosus (Walter) Britton, Sterns & Poggenburg.
Leptilon canadense (Linnæus) Britton.
Antennaria plantaginifolia (Linnæus) Richards.
Anaphalis margaritacea (Linnæus) Bentham & Hooker.
Gustave Guttenberg, Aug. 27, 1879. Carnegie Museum Herbarium
Gnaphalium polycephalum Michaux.
Gnaphalium decurrens Ives.
Gnaphalium uliginosum Linnæus.
Gnaphalium purpureum Linnæus.
Helianthus petiolaris Nuttall.[102]
Helianthus tracheliifolius Miller.
Helianthus strumosus Linnæus.
Bidens cernua Linnæus.
Bidens connata Muhlenberg.
Bidens beckii Torrey.
Achillea millefolium Linnæus.
Artemisia caudata Michaux.
Artemisia canadensis Michaux.
Artemisia biennis Willdenow.[103]
Tussilago farfara Linnæus.
J. A. Shafer, Sept. 9–11, 1900. Carnegie Museum Herbarium.
Erechtites hieracifolia (Linnæus) Rafinesque.
Senecio aureus Linnæus.
Carduus arvensis (Linnæus) Robson.

Total. — 420 species, 18 varieties, and 1 hybrid.

[101] Porter, T. C. "Flora of Pennsylvania," p. 325.
[102] Porter, T. C. "Flora of Pennsylvania," p. 332.
[103] Porter, T. C. *Ibid.*, p. 337.

X. CATALOG OF RELICS AND OBJECTS, MANY OF THEM PERTAINING TO THE EARLY HISTORY OF PITTSBURGH, EXHIBITED AT THE CARNEGIE MUSEUM UPON THE OCCASION OF THE SESQUI-CENTENNIAL CELEBRATION OF THE FOUNDING OF PITTSBURGH, SEPTEMBER 27–NOVEMBER 25, 1908.

By Douglas Stewart.

At the time when plans were being formulated for the celebration of the Sesqui-Centennial of the founding of the city of Pittsburgh, a committee was appointed to arrange for an appropriate exhibition at the Carnegie Institute and Library. It seemed proper that the exhibit should consist of an historical collection especially relating to the early history of the city. Many objects of great historical interest were in possession of the Carnegie Museum, having been received as gifts from time to time, and these served as a nucleus for the collection. Letters were sent to the members of the local "Chapter of the Daughters of the American Revolution" and to other persons known to have objects of interest, requesting them to permit their collections to be placed upon exhibition. The response to these requests was not as great as it undoubtedly would have been at a more propitious season. Many families were out of town and their houses closed for the summer, thus it was impossible to obtain many things, which would have added materially to the exhibition. In spite of this fact a great number of people kindly consented to loan their collections, and the addition of the objects kindly brought from abroad by Miss Pitt-Taylor and Mr. Arthur Forbes enabled the museum to make an exhibition which seemed to be greatly appreciated by the public.

I. Colonial and Revolutionary Period.

Silver Plate, China, Articles of Personal and Household Use, etc.

1. Set of Sheffield Plate, formerly the property of William Pitt, Earl of Chatham, consisting of four covered vegetable dishes, two platters, a soup tureen, a pair of candlesticks, a mustard pot with spoon, and a coffee pot.

Set of Sheffield Plate which belonged to William Pitt, Earl of Chatham.

Seal and Fob and Cameo Scarf-ring which belonged to William Pitt. (Upper figures). Leather Wallet carried by General John Forbes on his march to Pittsburgh, 1758. (Lower figure).

One china plate with the Pitt coat of arms, formerly the property of William Pitt, Earl of Chatham, gold and carnelian seal and fob, and cameo scarf ring, formerly the property of William Pitt, Earl of Chatham. (See Plates LII and LIII.)

Loaned by Miss Pitt-Taylor, London, England.

William Pitt was born at Westminster on November 15, 1708. He was educated at Eton and Oxford, but never took a degree, as he was afflicted with gout, and upon medical advice gave up his studies and traveled for a while. In the year 1731 he became a cornet in the army, and in 1735 entered Parliament as the representative of Old Sarum. Soon after entering Parliament he was dismissed from the army because of the support he gave to Frederick, Prince of Wales, in his course of opposition to George II. He was also very obnoxious to Walpole on account of his satirical speeches. Almost from his first appearance in Parliament his great oratorical abilities made him a power, and he contributed much to the downfall of Walpole in 1742. In the year 1756 the King, notwithstanding his personal dislike for Pitt, had to call upon him to carry on the government. His popularity with the people demanded this course. A new cabinet was formed, of which the Duke of Devonshire was nominal Prime Minister, but Pitt was the real power. At once Pitt began to vigorously carry on the war, but the feeble support he received from the King forced him to resign in 1757. But again the popular approval forced the King to immediately recall Pitt and give him full control of foreign and military affairs. His war policy was vigorous and full of sagacity. The French armies were defeated everywhere, and Pitt became practically absolute ruler of England and the populace bestowed upon him the title of "the Great Commoner."

With the accession of George III in 1760 Pitt was forced to take Lord Bute into his cabinet and finally was obliged to resign in 1761. As a small recompense for his great services to the government he was granted, a pension of £3,000 a year, and his wife was given the title of Baroness Chatham.

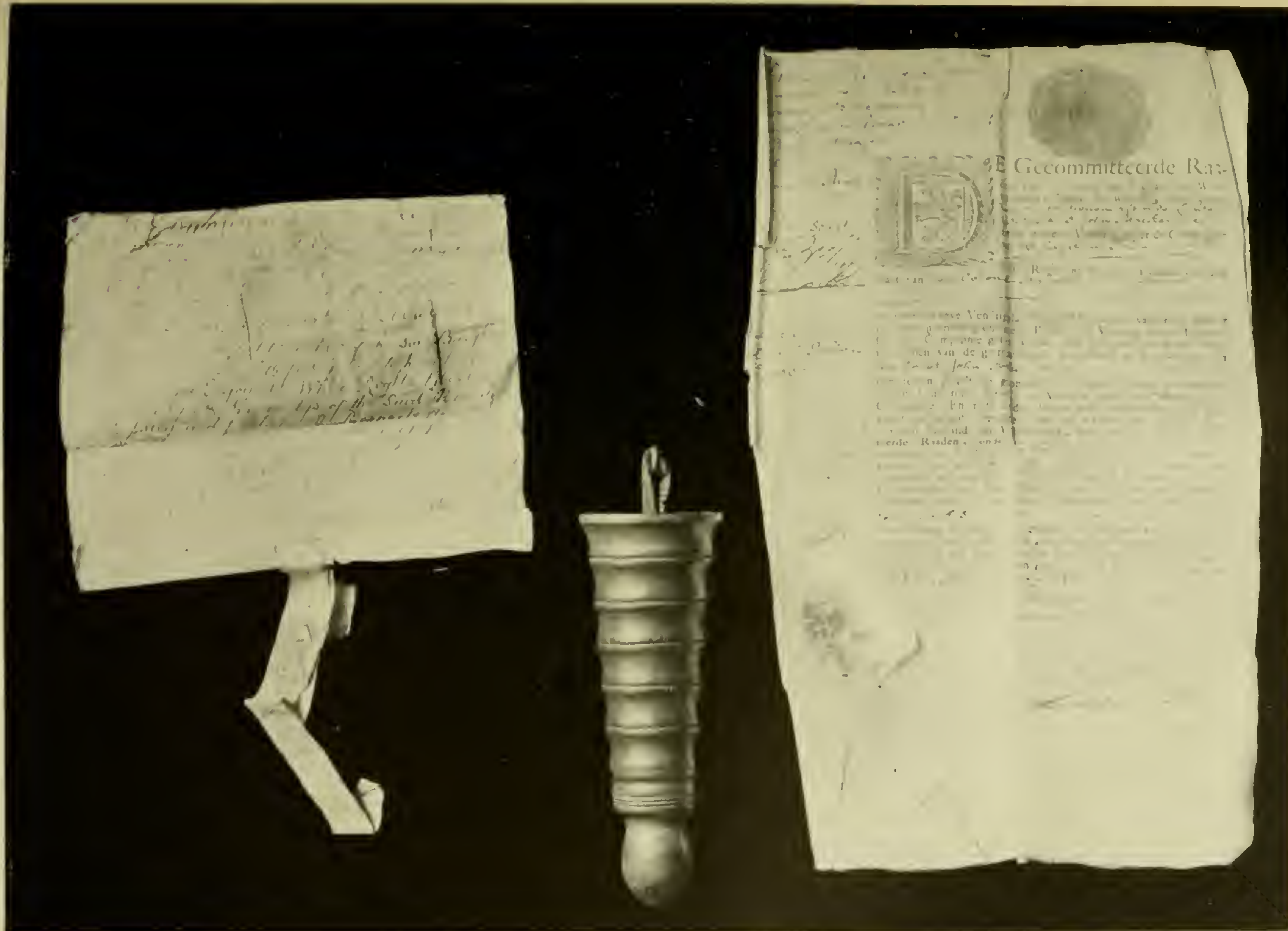
Pitt remained out of office until 1776, but still used his eloquence to defeat what he considered the unjust measures of the government, and opposed with vehemence the various acts to tax the American Colonies. In July, 1776, Pitt formed a new ministry, but, as his health was broken, he took for himself the office of Privy Seal and was created Viscount Pitt and Earl of Chatham. His acceptance of a peerage was very unpopular and lessened his influence with the government as well as with the people. His eloquence could not have the same effect upon the small numbers, who were accustomed to attend the House of Lords, as it had had upon the House of Commons. In the year 1768 he resigned, never to hold office again. In spite of his ill health he continued his interest in public affairs, and opposed with great ardor the taxation of the American colonists. All means in his power were used by him to bring about an amicable settlement of the differences between England and the American Colonies. When America entered into an alliance with France and it was proposed to remove the ministry and make peace at any price, Pitt, though in a dying state, appeared in the House of Lords and made a powerful address against the disruption of the British Empire. It was his last effort, and a few days later, May 11, 1778, he died.

2. Leather Wallet carried by General John Forbes on his march from Philadelphia to Fort Duquesne. Wooden tobacco mull with dog whistle attached, formerly the property of General John Forbes. Commission of John Forbes in Colonel Stewart's Regiment, given by the Dutch Government. Certificate bestowing upon John Forbes the freedom of the town of Dunfermline. (See Plates LIII and LIV.)

Loaned by Mr. Arthur Forbes, Edinburgh, Scotland.

General John Forbes, who commanded the expedition against Fort Duquesne in 1758, was a Scotch soldier, born at Dunfermline, Scotland. He was sent to America in 1757 and at that time had the rank of Adjutant-general, but in the latter part of the same year was appointed Brigadier-general. Preparations to retrieve the results of the disastrous defeat of Braddock in 1755 were soon begun. Forbes reached Philadelphia in April, 1758, but sufficient troops and supplies were not in readiness, so it became necessary for him to wait until the latter part of June before setting out on his slow and perilous march to Fort Duquesne. At first it was his intention to follow Braddock's route, but he later decided to open a new road from Bedford, over the mountains. This decision met with great opposition from the Virginians headed by Colonel George Washington, but Forbes persisted, and the march was made over this route.

At this time General Forbes was stricken with disease, and had to be carried on a litter the entire way; nevertheless he directed in person the entire plan of the campaign. Upon reaching Loyalhanna he decided that he would go into winter quarters. The roads were



Certificate of Freedom of Dumfermline, Tobacco Mull, and Commission in Colonel Stewart's Regiment which belonged to General John Forbes.

almost impassable owing to the heavy rains, supplies were hard to obtain, and both men and horses were worn out with the long march. Upon learning that the French were almost without defense, being cut off from their base of supplies by the surrender of Fort Frontenac, and also that through the efforts of Frederick Post their Indian allies had deserted them, Forbes in spite of all difficulties determined to push on, and upon his arrival found that the French, not awaiting his attack, had blown up Fort Duquesne and fled. He immediately took possession of the place, built a rough stockade, left a portion of his troops, and then, carried on his litter, returned to Philadelphia, where he died on the tenth of March, 1759.

In a letter to William Pitt, written on November 27, 1758 — two days after his arrival at Fort Duquesne — he writes: "I have used the freedom of giving your name to Fort Duquesne, as I hope it was in some measure the being actuated by your spirits that now makes us master of the place."

3. Colonial decorated stoneware teapot.

4. Colonial glass vase, date 1776.

5. Glass bottle, decorated in colors, said to be two hundred years old, brought to Pittsburgh in the year 1800.

Loaned by Mrs. David Aiken, 710 Amberson Ave., Pittsburgh.

6. Glass bottle found eighteen feet under ground while excavating around the Block House in the year 1904.

Loaned by the Pittsburgh Chapter of the Daughters of the American Revolution.

7. Copper warming-pan, used in Colonial times for warming the bed. The pan was filled with hot coals and rubbed between the sheets.

Loaned by Mrs. Nellie L. Fairley, Midway, Pennsylvania.

8. Colonial candle-snuffers and tray.

Loaned by Mrs. Addison Courtney, Braddock Ave., Pittsburgh, Pa.

9. Colonial tablecloth, with hand-woven border. Three plates, sugar bowl of blue and white china, lustre-ware cream-pitcher, colonial red and white bed-spread. Lance used by physician in Colonial times for "bleeding," iron whale-oil lamp.

Loaned by Miss Jeannette Deemar, Kittanning, Pa.

10. Sampler over one hundred years old.

Loaned by Miss Jeannette Deemar, Kittanning, Pa.

11. Brass candlestick used by Colonel Robert Dunning in 1747, two pewter plates brought from England by Colonel Robert Dunning of the Revolutionary Army.

Loaned by Miss Matilda Horner, 1319 Center Ave., Wilkinsburg, Pa.

12. Silver buttons from a coat which formerly belonged to James Horner.

13. Gold and topaz fob-seal formerly property of James Horner and worn by him in the year 1790. Horner was a soldier both in the Indian and Revolutionary Wars.

Loaned by Mrs. Franklin M. Gordon, 1319 Center Ave., Wilkinsburg, Pa.

14. Hat formerly owned by Rev. David Philips, who organized the Peter's Creek Baptist Church at Library, Pa. He was a personal friend of General Washington, and served as a Captain in the Revolutionary War.

Loaned by Miss L. D. Everhart, 6640 Dalzell Place, Pittsburgh.

15. Shell comb with gold ornamentation, Colonial Period.

16. Silver tankard brought to Pittsburgh from Scotland by Peter Shiras, great-grandfather of George Shiras, Justice of the Supreme Court of the United States.

17. Two silver spoons and silver calendar pencil, formerly the property of Peter Shiras.

Loaned by Mrs. James Morris, 6009 Stanton Ave., Pittsburgh.

18. Blue and white china tea-pot (Colonial Period).

19. Silver tea service, consisting of tea-pot, sugar bowl, cream-pitcher, and slop-bowl, made in the year 1799.

20. Two Sheffield Plate candlesticks, 1799. These were formerly the property of a Saxon squire, who joined the American army in 1775.

21. Silver sugar-tongs, tea-spoons, and salt-spoon of the Revolutionary Period.

22. Silver punch ladle, date 1799.

23. Two Colonial cut-glass tumblers and one Colonial cut-glass wine glass.

Loaned by Mrs. H. C. Shaw, Glenshaw, Pa.

24. A set of Colonial pewter household utensils consisting of thir-

teen plates, four cups, two salt-shakers, six spoons, three lamps, and a mustard pot.

Loaned by W. J. Sanborn, 1947 Perrysville Ave., North Side, Pittsburgh.

25. Blue and white china sugar-bowl, formerly the property of Captain Joseph Brady, a Revolutionary officer.

26. Pewter cream-pitcher, formerly the property of Lieutenant LeFevre, a Revolutionary officer.

27. Silver tea-spoon made by Joseph Post, a silver-smith and also a Revolutionary soldier. This tea-spoon was made from the knee buckles of Colonel Thomas Smith of the Revolutionary army.

28. Silver spoon made prior to the year 1774.

29. Decorated china tea-pot, one of a dozen given by Lieutenant George LeFevre to his daughter, Elizabeth, upon the occasion of her marriage to Peter Tritt, a Revolutionary soldier.

Loaned by Mrs. C. A. W. Lindsay, 137 Millvale Ave., Pittsburgh.

30. Foot-warmer made of wood and tin, used by the early settlers when traveling in cold weather. The inner pan was filled with ignited charcoal, and retained the heat for a considerable time.

Property of the Carnegie Museum. Purchased, Acc. No. 1506.

31. Collection of lanterns consisting of five perforated tin lanterns and eight glass lanterns, in which the light was supplied by a candle.

32. Two iron lamps used for burning whale-oil.

33. Glass lamp used for burning whale-oil.

34. Tin candle moulds.

Property of the Carnegie Museum. Purchased, Acc. No. 1506.

35. Collection of five spinning-wheels and two reels. The largest wheel was used for spinning wool and the others for flax.

Loaned by Mr. E. C. Eisengart, 235 Charles St., Pittsburgh.

36. A Colonial "quill" wheel.

Loaned by Mr. W. J. Sanborn, 1947 Perrysville Ave., North Side, Pittsburgh.

37. Three spinning-wheels.

Property of the Carnegie Museum. Donated by Mr. C. A. Gorby, Acc. No. 2598.

38. A silk kerchief, formerly the property of Rachel Lawrence, the wife of Colonel Harry Gordon of the English Army. Colonel Gordon was Chief of Engineers with General Braddock's Army and had charge of the construction of Braddock's Road.

39. An inlaid tortoise-shell reticule, formerly the property of Anne Gordon, the daughter of Colonel Harry Gordon.

40. A brooch surrounded by pearls, said to contain a lock of the hair of Prince Charlie of Scotland, formerly the property of Anne Gordon.

41. A miniature on ivory of Anne Edgar, daughter of Anne Gordon.

Loaned by Mrs. Elisa Gibson, 1509 Shady Ave., Pittsburgh.

42. Lace collar made by the wife of General Philip Benner of the Revolutionary army.

43. Lace baby-cap and embroidered baby-cap made by the wife of General Benner.

Loaned by Mrs. Thomas S. Anderson, Denniston and Irwin Aves., Pittsburgh.

44. Yard-stick made by Lieutenant Adam Keller of the Revolutionary army.

45. Clasp-knife found at Valley Forge.

46. Wooden butter-bowl made by Lieutenant Adam Keller while stationed at Valley Forge during the Revolutionary War.

47. Piece of brown silk from the lining of General Lafayette's coat.

48. Mother-of-pearl "butter-taster" used by the women of Colonial times to test the quality of butter when marketing.

49. Handkerchief with lace border made by Eliza Meredith (Revolutionary Period).

50. China cup and saucer (Colonial Period).

51. Blue and white china pitcher formerly the property of the wife of Lieutenant Adam Keller.

52. Pewter candle-snuffers.

53. Blue and white "willow pattern" plate, used in the family of General Thomas Bull during the time of the Revolutionary War.

54. Two silver salt spoons (Revolutionary Period).

Loaned by Mrs. Sidney O. Hartje, Dunmoyle St., Pittsburgh.

55. General Braddock's shoe buckles. These buckles were obtained in 1840 by the late W. S. Haven of Pittsburgh from an old resident of

Braddock's Field, whose account of the manner in which he obtained them seems plausible.

General Edward Braddock was mortally wounded in the sanguinary battle of July 9, 1755. He was shot through the arm, the ball passing into his lungs. He was carried back on the retreat as far as "Great Meadows," where he died July 13, 1755, and was buried the following day. Young George Washington officiated at the funeral. For years the place of Braddock's burial was unknown, but in 1823 laborers, engaged in the construction of the National Road, exposed the remains, which were recognized by their military trappings. The grave was despoiled and even the bones distributed by the vandals. Hon. Andrew Stewart of Uniontown, Pennsylvania, collected most of the bones and sent them to Peale's Museum in Philadelphia, Pa.

These corroded buckles were among the relics obtained at this time and retained in western Pennsylvania, and finally came after the death of Mr. W. S. Haven into the possession of Col. T. P. Roberts.

Loaned by Col. T. P. Roberts, No. 519 Aiken Ave., Pittsburgh.

56. Silver snuff-box, one hundred and fifty years old, formerly the property of Mr. Alexander Semple of Pittsburgh.

Property of Carnegie Museum, Acc. No. 3630. Donated by Miss Mary Pattison Semple, 5554 Avondale Place, Pittsburgh.

57. Colonial cut tin lantern.

58. Facsimile of silver cream spoon used by Martha Washington.

59. Facsimile of enameled sleeve-buttons used by General George Washington.

Loaned by Mr. Vincent Imbrie, 6409 Fifth Ave., Pittsburgh.

60. Brass carpenter's square, said to have been used by workmen during the construction of Fort Pitt.

Loaned by Rev. A. A. Lambing, 711 Rebecca St., Wilkinsburg, Pa.

61. Spindle of distaff used by Mrs. John Dickerson, an aunt of General William Henry Harrison, to spin flax in the year 1794.

Loaned by Mrs. James R. Robinson, Mt. Lebanon, Pa.

62. Lace cap worn by Mrs. John Dickerson.

63. Spectacles worn by Mrs. John Dickerson.

Loaned by Miss Priscilla Trunick, Mt. Lebanon, Pa.

64. Embroidered pocket, made and worn by Mrs. John Dickerson, and in which she carried her valuables to Fort Pitt during an uprising of the Indians.

Loaned by Mrs. L. R. Mayer, Mt. Lebanon, Pa.

65. Woven red and white curtain, one of a set sent from Philadelphia to Fort Pitt on the occasion of the birth of Eliza McCully, daughter of Major George McCully, the Commandant. Eliza McCully was born in the year 1787.

Loaned by Mrs. Richard Hays, 717 Ridge Ave., Northside, Pittsburgh.

66. Bust of General George Washington made from the sawdust of a cherry tree which grew on the site of Fort Necessity. Made by James Hadden.

Property of Carnegie Museum, Acc. 3402. Donated of Mr. James Hadden, 85 Morgantown St., Uniontown, Pa.

67. Sampler made by Rachel Castleman in the year 1780.

Loaned by Miss Rachel Castleman Aiken, 710 Amberson Ave., Pittsburgh.

68. Stone sun-dial found under the foundation of a house which stood next to the Block House, Pittsburgh, and was torn down in April, 1894.

Loaned by the Pittsburgh Chapter of the Daughters of the American Revolution.

69. Chestnut pin taken from old and decaying timbers of Fort Pitt on June 10, 1854, when excavations were being made at "The Point."

Property of Carnegie Museum, Acc. No. 1778. Donated by Mr. Joseph Banks, through Mr. A. Watson Black.

II. ARMS, AMMUNITION, AND MILITARY ACCOUTREMENTS.

69. Drum used during the Revolutionary War and carried at the battle of Monmouth by a soldier named Ream. During the action the top was carried away by a ball and consequently the shell of the drum was shortened to its present size. The heads are of later date. This drum was for many years in the possession of the Ream family who were relatives of General St. Clair.

Loaned by Mr. D. St. Clair Wineland, 3441 Ligonier St., Pittsburgh.

70. Wooden canteen purchased at the government sale held at Fort Pitt.

71. Copper hoop with two marks of the "King's Arrow" found at Fort Ligonier, Pennsylvania. The "King's Arrow" was the mark of the property of the British government and is similar to the "U. S. A." used on American army equipment.

72. Bayonet excavated on Fort St., Pittsburgh.

Loaned by the Pittsburgh Chapter of the Daughters of the American Revolution.

73. Section of iron wagon tire used in the pioneer days of Western Pennsylvania. These tires were in sections and were put on with spikes. This section was ploughed up near "Forbes Road," Jenner Township, Allegheny County, Pa.

Property of Carnegie Museum, Acc. No. 7. Donated by Mr. J. G. Beam.

74. Horse-shoe found buried many feet underground on "Forbes Road." Marks show it to be of the date of Forbes' Expedition.

Loaned by the Pittsburgh Chapter of the Daughters of the American Revolution.

75. Wooden canteen used in the Revolutionary War.

Loaned by Mr. Calvin L. May, 807 Franklin St., Wilkinsburg, Pa.

76. Collection of one hundred and twenty-three pistols, showing the evolution from the flint-look through the percussion cap, to the modern revolver.

Loaned by Mr. Otto J. Bierly, 6710 Frankstown Ave., Pittsburgh.

77. Flint-lock "Horse Pistol."

Loaned by Mr. S. H. Jackson, Wilkinsburg, Pa.

78. Short-sword carried at the Battle of Bunker Hill by Captain Silas Heminway of Massachusetts.

79. Sabre carried by a British officer at the Battle of New Orleans, in the Mexican War by a United States officer, and in the Civil War by a Confederate officer.

80. United States Government Springfield Pistol, altered from flint-lock to percussion at the time of the Civil War.

Loaned by Mr. W. J. Sanborn, 1947 Perrysville Ave., Northside, Pittsburgh.

81. Knapsack carried by Robert Ross of the 2nd Ohio Regiment in the War of 1812.

Loaned by Mr. A. Marshall Ross, Confluence, Somerset County, Pa.

82. Wooden canteen used in the War of 1812.

Loaned by Mrs. H. C. Shaw, Glenshaw, Pa.

83. Leather ammunition pouch carried by Rev. David Philips in the Revolutionary War.

Loaned by Mrs. T. R. McLain, 522 South Lang Ave., Pittsburgh.

84. Sword carried by Captain Irwin, a Pennsylvania Volunteer in the War of 1812.

Loaned by Dr. Hiram DuPuy, 339 Fifth Ave., Pittsburgh.

85. Two swords carried in the War of 1812.

Property of the Carnegie Museum. Donated by Mr. J. R. Whitfield.

86. Sword and scabbard found at the "Point" near the old Block House.

Loaned by Dr. Adolph Koenig, 200 Ninth St., Pittsburgh.

87. Flint-lock musket, formerly the property of William Giffen who took part in the Whiskey Rebellion.

Loaned by Mr. W. H. Green, Boyce Station, Pa.

88. Cannon-ball found on Cecil Alley, Pittsburgh, thirteen feet below the surface.

89. Three cannon-balls found while excavating near the site of Fort Pitt.

90. Cannon-ball found while excavating in Exchange Alley — the Magazine of Fort Pitt.

91. Cannon-ball found while excavating at the corner of Penn Ave. and Garrison Alley, Pittsburgh.

92. Cannon-ball found while excavating on Redoubt Alley, Pittsburgh.

93. Three small cannon-balls found while excavating on Fort Street, Pittsburgh.

Property of Carnegie Museum, Acc. 51. Donated by Mr. Samuel T. Paisley.

94. Cannon-ball found at Braddock's Field.

Property of Carnegie Museum, Acc. No. 186. Donated by Mr. Frank Gerstner.

95. Cannon-ball found on George Sibert's farm near the mouth of Turtle Creek, Braddock, Pa.

Property of Carnegie Museum, Acc. 3311. Donated by Mr. J. O. Frost.

96. Portion of a cannon-ball found near the site of the Block House, Pittsburgh.

Loaned by Dr. Adolph Koenig, 200 Ninth St., Pittsburgh.

97. Shell found while excavating at the corner of Penn Avenue and Second Street, Pittsburgh.

Property of Carnegie Museum, Acc. 681. Donated by Mr. George M. Kinzer.

98. Cannon ball from the battlefield of Princeton (January 3, 1777).

Loaned by Mr. Joseph Speer, Fifth Ave., Pittsburgh.

99. Piece of bronze found on the Whittaker farm, opposite Braddock, in the year 1840. This, with two tomahawks and a large number of arrow-heads, had evidently been cachéd by the Indians.

Property of Carnegie Museum, Acc. No. 901. Donated by Mr. W. C. Gearing.

100. Iron camp kettle used by General Washington's army at Valley Forge.

Property of Carnegie Museum, Acc. No. 1306. Donated by Mr. William Wilson.

101. Eight brass cannon which were loaned to the Carnegie Museum by the United States Government. Of these cannon five are known to have been surrendered by General Burgoyne at the Battle of Sarotaga, October, 1777. The large one was captured from the French by the British and surrendered by the British to the American Army in the War of 1812. The two smaller guns are also British and were captured in the Revolutionary War, the date unknown. All of these cannon were formerly deposited in the Allegheny Arsenal.

Loaned by the United States Government.

102. Cannon found while excavating at the corner of Second Avenue and Try Street, Pittsburgh.

Property of Carnegie Museum, Acc. 119. Donated by Rea & Company.

103. Arrow-heads, bullets, clasp-knives, and an ax-head found on

the farm of Mr. Jacob Raymalay, at Newlinsburg, Pennsylvania. These specimens are undoubtedly relics of the Forbes Expedition.

Loaned by Mr. Jacob Raymalay, Newlinsburg, Pa.

FIG. 1. Powder horn carved by William Mackenzie, while in the garrison of Fort Pitt, 1783.

104. Powder horn used by an American soldier, William Mackenzie, while in the garrison at Fort Pitt, in the year 1783. This powder-horn has carved upon it a plan of Fort Pitt, the name of William Mackenzie, his age and the date. (See Plate LV.)

Property of the Carnegie Museum, Acc. No. 1873. Donated by Mr. Daniel Arnheim.

105. Powder horn carried by Captain William Irwin in the French and Indian War. He has carved upon it the route of General Braddock's march from Philadelphia to Braddock's Field and later the route from Saratoga to Philadelphia.

Loaned by Mrs. Thomas S. Anderson, Denniston and Irwin Aves., Pittsburgh.

106. Small powder horn used in priming a flint-lock musket.

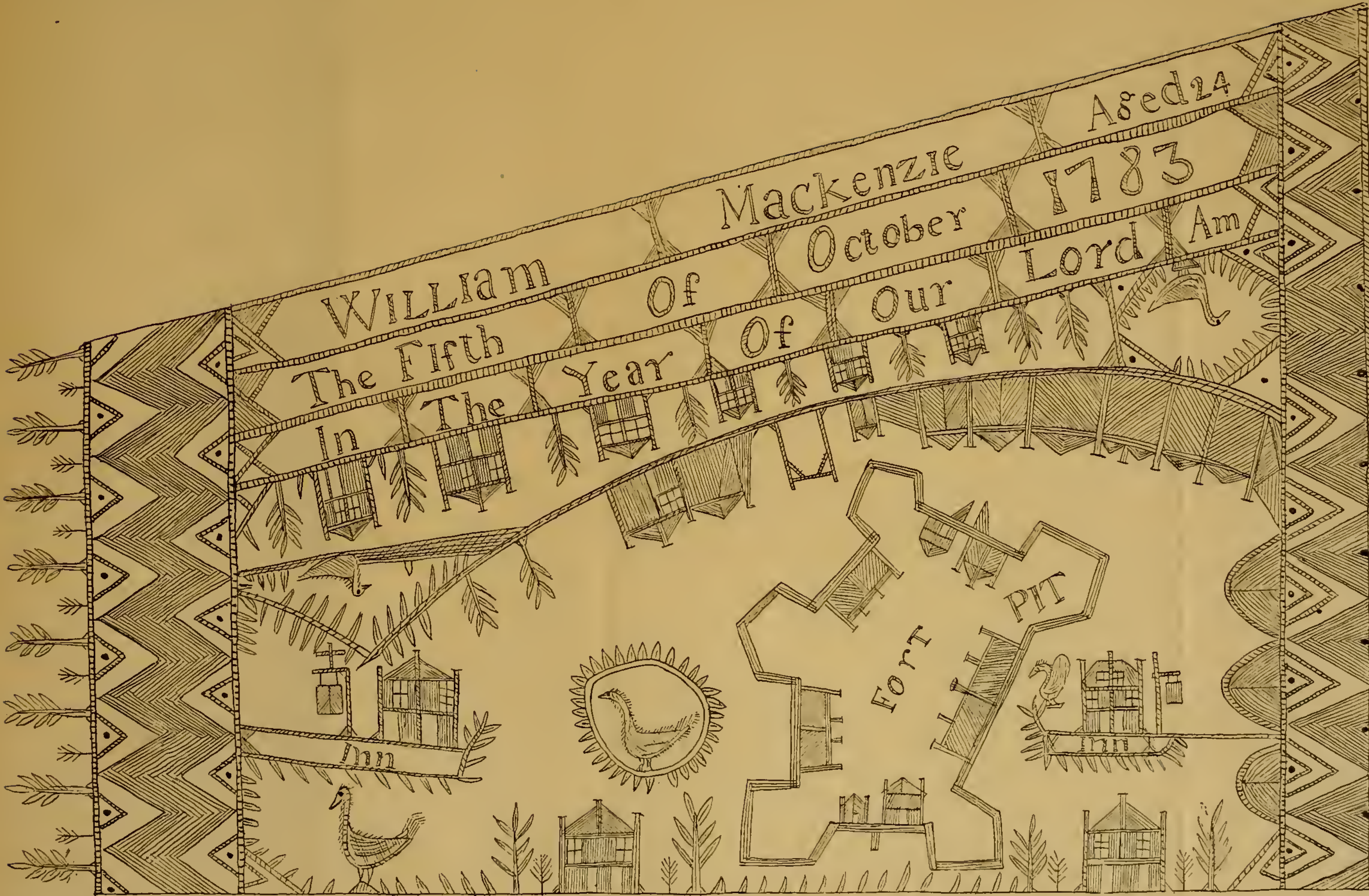
Loaned by Mr. W. J. Sanborn, 1947 Perrysville Ave., Northside, Pittsburgh.

OBJECTS PARTICULARLY ASSOCIATED WITH THE HISTORY OF PITTSBURGH AND VICINITY.

107. Blue and white china soup-tureen, used at a dinner given to General Lafayette upon the occasion of his visit to Pittsburgh in the year 1825.

Loaned by Mrs. H. C. McEldowney, Northumberland and Wightman Sts., Pittsburgh.

108. Counterpane which was loaned by Mrs. Katherine Jones to the Entertainment Committee at the time of General Lafayette's visit to Pittsburgh. This counterpane was used on Lafayette's bed.



Inscription on Sides of Powder-horn carved by William Mackenzie, 1783. (Acc. No. 1873.)

Old Fire Engine Built by Members of the Harmony Society, Economy, Beaver County, Pa., 1826.

109. Sash and tortoise-shell comb worn by Miss Mary Means at the ball given in Pittsburgh in honor of General Lafayette's visit.

110. Hair trunk brought from Ireland by George W. McGunnegle, who located in Pittsburgh in the year 1776. Mr. McGunnegle was one of the first vestrymen of Trinity Church.

Loaned by Miss Matilda Horner, 1419 Center Avenue, Wilkinsburg, Pa.

111. Surveyor's transit made by J. Reed in Washington, Pennsylvania, in the early part of the last century.

Loaned by Mr. S. H. Jackson, 800 Wood St., Wilkinsburg, Pa.

112. Fire engine worked by hand. Built by members of the Harmony Society, at Economy, Beaver County, Pa., in the year 1826. This engine was used by the society until the year 1887. (See Plate LVI.)

Loaned by Mr. John S. Duss, through Pittsburgh Fire Department.

113. Platter, made in the year 1828, decorated with a picture of the Western Penitentiary building, which stood in West Park, Allegheny.

Property of Carnegie Museum. Purchased. Acc. No. 2361.

114. Official seal of the City of Pittsburgh, abolished by the "Ripper Bill" in the year 1901.

Property of the Carnegie Museum, Acc. 1843. Donated by the City of Pittsburgh.

115. Shawl formerly worn by General William Robinson, who was the first white child born in Allegheny City. General Robinson was born in 1785, became first President of the Ohio and Pittsburgh Railroad, first President of the Exchange Bank of Pittsburgh, and Mayor of Allegheny in the year 1840.

Loaned by Mrs. Wilhelm Scholle, 2841 Center Avenue, Pittsburgh.

116. Pair of embroidered gloves said to have been made by the Indian wife of Addison Mowry and brought by him as a gift to Elizabeth Ogden, of Pittsburgh, in 1849.

117. Chinese colored glass vase given to George Ogden of Pittsburgh by Commodore Perry.

118. White tea-pot and cream-jug, ornamented with figures in high relief, formerly property of Elizabeth Ogden.

119. Card case of carved ivory and one of bone ornamented with cut steel, formerly property of Elizabeth Moor, a daughter of Hon. John M. Moor, the first President Judge of Westmoreland County, Pennsylvania.

120. Plated coffee-urn formerly owned by Hon. John M. Snowden, the third Mayor of the City of Pittsburgh. This urn was used at the time General Lafayette was entertained by the City.

Loaned by Miss Caroline O'F. Russell, 704 Clyde St., Pittsburgh.

121. Pottery mug made in Pittsburgh prior to the year 1850.

Property of Carnegie Museum. Purchased. Acc. No. 3468.

122. China plate blackened by the Pittsburgh fire in the year 1845.

Loaned by Mr. S. H. Jackson, 800 Wood St., Wilkinsburg, Pa.

123. China cups and saucers blackened by the Pittsburgh fire of 1845.

Donated by Miss Virginia Hays, Acc. No. 2506.

124. China cup blackened by the Pittsburgh fire of 1845.

Loaned by Mrs. David Aiken, 710 Amberson Ave., Pittsburgh.

The great fire of 1845 started about noon on the 10th of April. It was caused by a fire which a woman had kindled to heat water in a yard back of some frame dwellings at the corner of Second and Ferry streets. An intensely high wind springing up scattered the embers, and in an incredibly short time all the buildings in the block were in a blaze. In spite of the efforts of the fire companies and citizens, the fire rapidly gained headway and before it was overcome had destroyed fifty acres of property and caused a loss (according to a contemporary account) of fifteen millions of dollars.

125. Piece of glass fused by the fire of 1845. This was found in the vault under the glass factory of Bakewell, Pears, & Co., the first glass manufacturers west of the Alleghany Mountains.

Loaned by O. O. Page, 223 Fourth Ave., Pittsburgh.

126. Two tumblers, sugar-bowl and salt-cellar made of glass by Bakewell, Pears, & Co., of Pittsburgh.

Loaned by Miss Mary S. Wright, 125 Linden St., Edgewood, Pa.

127. Small glass bottle, one of the first made in Pittsburgh.

Loaned by Mrs. T. R. McLain, 522 South Lang Ave., Pittsburgh.

128. Cane made of wood taken from Fort Pitt.

Loaned by Mrs. Martha R. Batchelor, 227 Elm St., Edgewood, Pa.

129. Copper coal-scuttle, made by Benjamin Lutton of the first copper rolled in Pittsburgh. The ore was brought from the Michigan Mines.

Loaned by Mrs. Lillie Lutton, Bellevue, Pa.

130. Silver fire trumpet, formerly used by the Vigilant Steam Fire Engine and Hose Company of Pittsburgh.

Property of Carnegie Museum, Acc. No. 1876. Donated by Mr. W. J. Carson.

131. Two canal-boat lanterns used by Captain Bush of the canal-boat "El Dorado" in the year 1845.

Property of Carnegie Museum. Purchased. Acc. No. 1506.

132. Rail and stones, upon which it was mounted, from the old Portage Road.

Property of Carnegie Museum, Acc. No. 6. Donated by Mr. G. M. Beach.

133. Lantern carried by Andrew Carnegie while Second Assistant Superintendent of the Pennsylvania Railroad. When Mr. Carnegie left the employ of the railroad he presented this lantern to Mr. Ambrose Ward of Pittsburgh, whence it came into the possession of Mr. Ward's daughter.

Loaned by Mrs. H. W. Few, 353 Frankstown Ave., Pittsburgh.

134. Flag made by the young ladies of Pittsburgh and used at the Sanitary Fair held in old City Hall in the year 1864.

Loaned by Miss Caroline O'F. Russell, 704 Clyde St., Pittsburgh.

135. Set of drawing instruments used by Robert Donaldson, who surveyed and drew the plan of the City of Pittsburgh from Boyd's Hill to the Point.

Loaned by Andrew H. Donaldson, Pittsburgh.

136. Desk formerly the property of Miss Mary Croghan (Mrs. Schenley) and given by her to her room-mate, Elizabeth Ogden, at the time of her elopement with Captain Schenley.

137. Piece of needle-work left unfinished at the time of the breaking up of Miss McLeod's School at Staten Island. The notoriety of Mrs. Schenley's elopement caused the parents of the young ladies in attendance to withdraw them from the school.

Loaned by Miss Caroline O'F. Russell, 704 Clyde St., Pittsburgh.

138. Silver pitcher "Presented to Livingston, Roggen & Co. as a testimony of esteem for their sterling worth and integrity as employers by their workmen on June 1, 1848," upon the occasion of the first banquet given by a firm to its employees in Pittsburgh.

Loaned by Mr. L. O. Livingston, 819 Heberton Ave., Pittsburgh.

139. Piano formerly owned by Stephen C. Foster, who was a native of Pittsburgh and a famous composer of ballads. He not only composed the music but also wrote the words. His songs "Old Folks at Home," and "Massa's in the Cold, Cold Ground" are among the most popular and are known wherever the English language is spoken. Foster was born in the year 1826 and died in 1864.

Donated by Mr. Henry Butterfield, 433 Liberty St., Pittsburgh.

140. Piano which, although made in New York, has been in Pittsburgh for seventy-five years. It is similar in type to the one in the old Schenley homestead.

Loaned by Miss W. F. Whitmarsh, 116 East Chestnut St., Columbus, Ohio.

141. Tall clock made by Jourdian in Hamburg, Germany, between the years 1640 and 1690. Purchased in Hamburg in the year 1785 by Otto Muller, brought to Baltimore, Maryland, in the year 1808, from thence to Zelienople, Pennsylvania, in 1814, and then to Sewickley, Pennsylvania, in the early '70s.

Loaned by Mr. Joseph G. Taylor, Edgeworth, Pennsylvania.

142. Tall clock formerly the property of Colonel Ephraim Blaine, father of James G. Blaine.

Loaned by Mr. P. B. Malone, 1 Chess St., Mt. Washington, Pittsburgh.

143. Tall clock made in Pittsburgh by J. Thomson over one hundred years ago.

Loaned by Mrs. G. M. Lehman, 4523 Center Ave., Pittsburgh.

144. Old-fashioned three-pronged wooden pitchfork from a farm near Jenner's Cross Roads, Somerset County, Pennsylvania.

Loaned by Mr. Curtis D. Williams, 664 Maryland Ave., Pittsburgh.

145. Old-fashioned inkwell.

Loaned by Mr. S. H. Jackson, 800 Wood St., Wilkinsburg, Pa.

146. Bullet cut from the thigh of an Alabamian at the battle of Drainsville, during the Civil War, by Dr. James King of Pittsburgh.

Loaned by Mrs. William Scott, Bidwell St., Pittsburgh.

147. Official badges of the Pittsburgh Sesqui-Centennial. One of silver for the guests of the City and one of white metal for the General Committee.

Property of the Carnegie Museum, Acc. 3638. Donated by Pittsburgh Sesqui-Centennial Committee.

COLLECTION OF MODELS SHOWING EARLY METHODS OF TRANSPORTATION.

148. Stage-coach as used for passenger traffic between Pittsburgh and Philadelphia. These coaches had a regular schedule, the charges were twenty dollars per passenger and the incidental charges of the journey amounted to seven dollars. The time consumed was six days.

Property of the Carnegie Museum, Acc. No. 1280.

150. One-Horse Shay. — The earliest type of the buggy — name derived from a fancied singular of the French chaise.

Property of Carnegie Museum, Acc. No. 1363.

151. Dray with skid attached. These drays were common along the wharves of Pittsburgh until recent years. Now they have completely disappeared.

Property of Carnegie Museum, Acc. No. 1363.

152. John Bull Engine and Car. — The John Bull Engine, built by Stephenson in England was imported into this country and was one of the earliest locomotives used. It made its first trip on November 12, 1831, in New Jersey and hauled two passenger cars. The original engine is now in the possession of the United States National Museum, Washington, and is the oldest complete locomotive existing in America.

Property of Carnegie Museum, Acc. No. 1374.

153. Sectional Canal-boat. As used on the old Portage Railroad. These boats built in sections which bolted together, were used be-

tween Philadelphia and Pittsburgh. The eastern canal route ended at Hollidaysburg, here the sections were uncoupled and each section put on a car by running the cars into the water underneath the section. The sections were then taken over the mountains by rail and inclined plane and placed in the western canal, at which point the sections were coupled together again and continued their journey to Pittsburgh.

154. Canal lock, worked by hand; used on the Erie Canal and the Old Portage Canal.

Loaned by Mr. D. Rhine, 4403 Davison St., Pittsburgh.

155. Passenger Car, used on the Pennsylvania Railroad, the first type used.

156. Two passenger cars used on the Pennsylvania Railroad about the year 1857.

Property of Carnegie Museum, Acc. No. 2003.

157. Ohio River Flat-boat used about the year 1800.

158. Ohio River Keel Boat, used in the early 19th Century.

159. Steamboat "New Orleans," the first boat on a western river propelled by steam. Built by Fulton and Livingston at Pittsburgh, making its first trip from Pittsburgh to New Orleans in the winter of 1812. The time consumed upon this passage was fourteen days.

160. Ohio River steamboat in use about the year 1814.

Property of Carnegie Museum, Acc. No. 1237.

PICTURES, MAPS, MANUSCRIPTS, NOTES, COINS, ETC.

161. Relief map of Fort Duquesne, modeled by Dr. W. J. Holland and Mr. T. A. Mills, from the original plan preserved in the King's Library, British Museum, London, England.

162. Relief map of Fort Pitt, modeled by Dr. W. J. Holland and Mr. T. A. Mills, from the original plan preserved in the King's Library, British Museum, London, England.

Property of Carnegie Museum, Acc. No. 2001.

163. Colored print showing the plan of Fort Pitt in the year 1795.

Loaned by Miss Jennie Loomis, 905 College Ave., Pittsburgh.

164. Oil painting by J. D. Tucker of the Original Courthouse and market in Pittsburgh. Erected in 1794 and torn down in 1862. This building occupied the site upon which "Old City Hall" now stands. (See Plate LVII.)

First Court-house in the Diamond Market Place, Pittsburgh, Pa. Built 1794, torn down 1862. Site of "Old City Hall," 1908.

Property of Carnegie Museum, Acc. No. 2449. Donated by Commissioners of Allegheny County.

165. Colored print of Boston Harbor in the year 1768, from the original engraving made by Paul Revere.

166. Print: Portrait of Paul Revere, from a painting made by a French officer in the year 1801.

Loaned by Mr. Vincent Imbrie, 6409 Fifth Ave., Pittsburgh.

167. Reprint: Plan of the City of Allegheny in 1795.

Property of Carnegie Museum, Acc. No. 970. Donated by J. E. Schwartz, Pittsburgh.

168. Print of the City of Pittsburgh.

Loaned by Mrs. George Hardy, 211 Noble Ave., Crafton, Pa.

169. Oil portrait of Samuel Lyon. Colonel Lyon was an officer in the Revolutionary War; and the son-in-law of Colonel Ephraim Blaine.

170. Print: Portrait of Eleanor Blaine, a sister of Colonel Ephraim Blaine.

Loaned by Miss Caroline O'F. Russell, 704 Clyde St., Pittsburgh.

171. Portrait of Peter Shiras, great-grandfather of Hon. George Shiras, Justice of the United States Supreme Court.

Loaned by Mrs. James Morris, 6009 Stanton Ave., Pittsburgh.

172. Plan of General Forbes' route on the march against Fort Duquesne 1758. Copy of the original map in "General Forbes Marching Journal to the Ohio" by J. Potts (in possession of the Pennsylvania Historical Society).

173. Rough draught of the Youghiogheny River taken by J. Shippen, Jr., in 1759. (Tracing of original in possession of the Pennsylvania Historical Society.)

174. A draught of the Monongahela and Youghiogheny rivers, November, 1759, by J. Shippen, Jr. (Tracing of the original in possession of the Pennsylvania Historical Society.)

175. Draught of the situation of Fort Burd, on the Monongahela River, laid out by J. Shippen, Jr., and built by a detachment of Pennsylvanians under command of Colonel James Burd in October, 1759. (The original in possession of the Pennsylvania Historical Society.)

Loaned by the Pittsburgh Chapter of the Daughters of the American Revolution.

Oil paintings by Russell Smith:

176. An old log house at the foot of Coal Hill opposite Market Street as it appeared in the year 1832; said, at that time, to be the oldest house standing in Pittsburgh.

177. Old tree on Ormsby's farm opposite Bakewell's glass works in the year 1834.

178. Building of the Western University of Pennsylvania in the year 1833. (See Plate LVIII.)

179. View looking up the river from Coal Hill over Ormsby's farm to Birmingham.

180. Nelson's Island from the foot of Hand Street in the year 1840.

Loaned by Mr. James Getty, in care of G. G. O'Brien, 1002 Fifth Ave., Pittsburgh.

181. Lithograph of the Pittsburgh Novelty Works on the corner of Grant and Front Streets, as it appeared before the fire of 1845. These works were owned by Livingston, Roggen & Co.

Loaned by Mr. L. O. Livingston, 819 Heberton Ave., Pittsburgh.

182. Picture of an Indian scout and trapper, formerly the property of Peter Shiras.

Loaned by Mrs. James Morris, 6009 Stanton Ave., Pittsburgh.

183. Silhouette of John Kennedy McGunnegle taken in 1769.

184. Silhouette of George W. McGunnegle and his wife Margaret Kennedy, who came to Pittsburgh from Ireland in the year 1766.

Loaned by Mrs. Franklin M. Gordon, 1319 Center Ave., Wilkinsburg, Pa.

185. Silhouettes of Colonel Thomas Bull and his brother Lewis Bull, soldiers in the Revolutionary War.

Loaned by Mrs. Sidney O. Hartje, Dunmoyle St., Pittsburgh.

186. Three photographs of the ruins of the Allegheny County Courthouse, which was erected in the year 1836 and destroyed by fire May 7, 1882.

Property of Carnegie Museum, Acc. No. 1083. Donated by Mr. E. S. Morrow.

187. Oil painting of the ruins of the Allegheny County Courthouse made in 1882 by Miss Agnes Way.

The Western University of Pennsylvania, from oil painting by Russell Smith, 1833. (Fourth Avenue and Cherry Alley.)

188. Old print depicting the ruins of Pittsburgh after the fire of 1845.

Loaned by Miss Agnes Way, Edgeworth, Pa.

189. Portrait of Stephen C. Foster, the Pittsburgh composer.

Loaned by Department of Fine Arts, Carnegie Institute.

190. Autograph of George Washington.

Property of the Carnegie Museum. Purchased. Acc. No. 1904.

191. Grant of land to Alexander McKee, being the property now known as McKee's Rocks. This property was given to McKee for an annual rental of five shillings. This paper was signed by Colonel Bouquet at Fort Pitt on the 25th of November, 1764.

192. Letter signed by Colonel Bouquet, written from Fort Louden, December 16, 1764.

Loaned by Miss Guthrie, 739 Ridge Ave., North Side, Pittsburgh.

193. Autograph letter from Col. Ephraim Blaine to General William Jack, dated Pittsburgh, November 20, 1794.

194. Autograph letter from Major Isaac Craig to General William Jack, dated Pittsburgh, May 11, 1795.

195. Autograph letter from William Pitt to Deputy Governor of Pennsylvania.

Property of Carnegie Museum, Acc. No. 1777. Donated by Hon. W. J. Diehl.

Aug. 23 1760

Dep. Gov.
of
Pennsylvania.

WHITEHALL 23 August 1760

Sir,

The Commanders of His Majesty's Forces and Fleets, in North America, and the West Indies, having transmitted repeated and certain Intelligence of an Illegal and most pernicious Trade, carried on by the King's Subjects in North America, and the West Indies, as well to the French Islands, as to the French Settlements on the Continent of America, and particularly to the Rivers Mobile; and Mississippi, by which the Enemy is, to the greater Reproach and Detriment of Government, supplied with Provisions, and other Necessaries, whereby they are principally if not alone enabled to sustain and protract this long and expensive War, and It further appearing that large sums in Bullion are also sent, by the King's Subjects, to the above Places, in return whereof, Commodities are taken, which interfere with the Produce of the British Colonies themselves, in open contempt of the Authority of the Mother Country, as well as to the most manifest Prejudice, of the manufacturers, and Trade of Great Britain; In order therefore to put the most speedy and effectual Stop to such flagitious Practices, so utterly subversive of all Law, and so highly repugnant to the Honour and Wellbeing of this Kingdom. It is His Majesty's express Will and Pleasure, that you do forthwith make the strictest, and most diligent Enquiry into the State of this dangerous and ignominious Trade, and that you do use every means in your Power, to detect and discover Persons concerned, either as Principals, or Accessories, therein, and that you do take every Step, authorized by Law, to bring all such heinous Offenders to the most exemplary and condign Punishment, and you will, as soon as may be, and from Time to Time, transmit to me, for the King's Information, full and particular Accounts of the Progress you shall have made in the Execution of these His Majesty's Commands, to which the King expects that you do pay the most exact Obedience; And you are farther to use your utmost Endeavors to trace out and investigate the various Artifices and Evasions, by which the Dealers in the iniquitous Intercourse find means to cover their criminal Proceedings and to elude the Law, in order that from such Lights, due and timely Consideration may be had, what farther Provisions shall be necessary to restrain an Evil of such Extensive and pernicious Consequences.

I am
Sir
your most obedient
humble Servant
W. PITT.

196. Autograph Letter from Gen. Anthony Wayne to Major George McCully, commanding Pennsylvania State Troops.

Loaned by Mrs. Richard Hays, 717 Ridge Ave., North Side, Pittsburgh.

HEAD QUARTERS
PITTSBURGH — June 25th 1792

Sir:

You will herewith receive a copy of a circular letter to all the County Lieutenants, bordering upon the Ohio, in the States of Pennsylvania, Virginia and Kentucky: You will conduct yourself agreeably to the spirit and intention thereof.

But as it is an object of the first consequence to afford effectual protection to the frontier inhabitants, especially during the period of Harvest — You will please advance as many of your command, as can with propriety be spared from your present post to such position, or positions as will, in your opinion, be the most proper and eligible for the aforesaid purpose; and if you should discover any party, or parties, of hostile Indians, hovering upon the borders of the frontiers, you will strike them with effect — provided, you can do it, without risking too much, but you will, both, on your march, and in encamping, take every precaution, lest you should experience a surprise.

You'l please to keep me constantly informed of any material discovery or event. Lieut!. Jeffry's with his rangers will be on the frontiers — it may be well to have an interview with him, in order to form a plan of eventual co-operation.

Knowing your military abilities and confiding in your prudence, I have only to wish you success and happiness! and am Sir,

Your most obt.
Hum Servant
Ant..y Wayne

Major George McCully
Commanding the State Troops.

197. The Pittsburgh Gazette, April 12, 1794.

Containing President George Washington's Proclamation on the "Whiskey Rebellion."

By the President of the United States
A Proclamation

Whereas by information given on oath, it appears that in the night time of the twenty second day Of November a number of armed men having their faces blackened and being otherwise disguised, violently broke open and entered the dwelling house of Benjamin Wells collector of the revenue arising from spirits distilled within the United States, in and for the counties of Westmoreland and Fayette in the district of Pennsylvania, & by assaulting the said collector and putting him in fear and danger of his life, in his dwelling house aforesaid, in the said county of Fayette did compel him to deliver up to them his commission for collecting the said revenue, together with the books kept by him in the execution of his said duty, and did threaten to do further violence to the said collector, if he did not shortly thereafter publicly renounce the further execution of his said office :

And whereas several of the perpetrators of the said offence are still unknown, and the safety and good order of society require that such daring offenders should be discovered and brought to justice so that infractions of the law may be prevented, obedience to them secured, and officers protected in the due execution of trusts reposed in them, therefore I have thought proper to offer a reward of Two Hundred Dollars for each of the said offenders that shall be discovered and brought to justice for the said offence, to be paid to the person or persons who shall first discover and give information of the said offenders to any judge, justice of the peace, or other magistrate.

And I do hereby strictly charge and enjoin all officers and ministers of justice according as their respective duties may require, to use their best endeavors to cause the offenders to be discovered apprehended and secured, so that they may be speedily brought to trial for the offence aforesaid.

In testimony whereof I
(L.S) have caused the seal of
the U. States of America to be affixed to
these presents, and
signed the same with
my hand. Done at
the city of Philadelphia
the 24th day of February one thousand
seven hundred & ninety four, and of the Independence of the United States of America, the eighteenth

GO. WASHINGTON

By the President —

Edm. Randolph

Loaned by Miss S. H. Killikelly, Times Building, Pittsburgh.

198. The Pennsylvania Gazette, October 31, 1765.

199. The Pennsylvania Gazette, October 14, 1768.

Loaned by Mr. J. F. Young, 114 Graham St, Pittsburgh.

200. The Pittsburgh Gazette, March 22, 1788.

Loaned by W. W. Fulton, Carnegie Library, Pittsburgh.

201. Tax List of Robinson Township, Allegheny County, Pennsylvania, for the year 1814.

Property of Carnegie Museum, Acc. No. 2853. Donated by Wm. T. Lindsay.

202. Pittsburgh Directory for the year 1837.

Loaned by Dr. J. G. Connell, in care of Miss Russell, 704 Clyde St., Pittsburgh.

203. First death warrant issued in Allegheny County, being an order for the execution of John Tiernan to Lazarus Stewart, Sheriff of Allegheny County, signed by William Findlay, Govenor of Pennsylvania, February 5, 1818.

Property of Carnegie Museum, Acc. No. 3442. Donated by Robert B. Lea.

204. The Trenton "Mercury," issue of Tuesday, July 17, 1787, containing news of the exchange of Indian and white prisioners at points near Pittsburgh.

Property of Carnegie Museum, Acc. No. 3620. Donated by Mrs. George Hardy.

205. The Pittsburgh "Mercury" of Wednesday August 21, 1821. Contains list of real estate for sale by the executors of the will of James O'Hara. The executors were James Ross, Harmar Denny, Dennis S. Scully, and James R. Butler.

Property of Carnegie Museum, Acc. No. 3649. Donated by Mr. E. S. Morrow.

206. Docket of Squire Gazzam of Pittsburgh for the years 1803 and 1804.

Loaned by Mr. Charles H. Weber, 4001 Butler St., Pittsburgh.

207. Autograph letter from President Andrew Jackson to Mayor J. M. Davis, of Pittsburgh, dated December 2, 1833.

Loaned by Mrs. William Morris, 6009 Stanton Ave., Pittsburgh.

208. Catalogue of an Auction Sale of Relics held at the Sanitary Fair in Pittsburgh, June 24, 1864.

Property of Carnegie Museum, Acc. No. 3022. Donated by Mr. Wm. Hamilton, N. S., Pittsburgh.

209. Diploma issued to George H. Evans by the Pittsburgh High School in the year 1867 and also Commission as Second Lieutenant in the United States Army signed by President U. S. Grant. Evans was the first native of Pittsburgh to pass a competitive examination for West Point and was appointed by General James K. Moorhead, at that time Congressman from the Pittsburgh District.

Loaned by Mr. R. L. Evans, Carnegie Library, Pittsburgh.

210. Schedule of the Garfield funeral train from Pittsburgh to Cleveland, September 24, 1881.

Donated by Mr. C. R. Cunningham, Carnegie Library, Pittsburgh.

211. Cancelled Bonds and Notes issued by the City of Pittsburgh and neighboring townships:

City of Pittsburgh $500, November 1832, interest 5 per cent., due 1860, total issue $12,000. This bond (No. 12) was one of the first bonds issued by the city and was to obtain money for the construction of the first water works. The pumping station was located on the Allegheny River at the foot of Fifth Street and the reservoir was on or near the present site of the Frick Building on Grant Street.

Property of Carnegie Museum, Acc. No. 684. Donated by Mr. E. S. Morrow.

212. $10, 1839 signed by Wm. R. Holmes, Assistant Treasurer.
213. $1.00, 1846 signed by L. R. Johnston, Treasurer.
214. $2.00, 1846 " " " " " "
215. $3.00, 1837 " " William Pentland, "

Donated by Mr. E. S. Morrow.

216. City of Pittsburgh — Pittsburgh & Connellsville Railroad Bond $1000.00, 6 per cent., 30 years, 1853.

Signed
Robert M. Riddle, Mayor.
Andrew McMaster, Treasurer.

217. City of Pittsburgh Compromise Bond, Allegheny Valley Railroad Company (subscription to stock) $1000, 4 per cent., 50 years, 1862.

Signed
B. C. Sawyer Jr., Mayor.
John McCargo, Controller.

218. City of Pittsburgh, Compromise Bond, $100, 5 per cent., 50 years, 1863.

Signed
William McCallin, Mayor.
E. S. Morrow, Controller.

219. City of Pittsburgh — Water Extension Loan, $500, 7 per cent., 25 years, 1868.

Signed
James Blackmore, Mayor.
Thomas Steel, Controller.

220. Borough of East Birmingham — $500, 7 per cent., 18 years, 1870.

Signed
C. J. Schultz, Burgess.
Alex. P. McKee, Clerk.

221. Birmingham Market Bond, $1000, 8 per cent., 15 years, 1871.

Signed
James Salisbury, Burgess.
H. P. Ramsay, Clerk.

222. Borough of Ormsby, $1000, 7 per cent., 10 years, 1871.

Signed
James S. Atkinson, Burgess.
J. W. Patterson, Jr., Clerk.

223. City of Pittsburgh, Main Street Bond, $1000, 7 per cent., 12 years, 1871.

Signed
James M. Brush, Mayor.
E. J. McGowan, Controller.

224. City of Pittsburgh, Forbes Street Bond, $600, 7 per cent., 12 years, 1872.

Signed
James Blackmore, Mayor.
R. M. Snodgrass, Controller.

225. City of Pittsburgh, Butler Street Bond, $2500, 7 per cent., 12 years 1873.

Signed
James Blackmore.
R. J. McGowan, Controller.

226. City of Pittsburgh, Bedford Avenue Bond, $1000, 7 per cent., 12 years, 1873.

Signed
James Blackmore, Mayor.
R. M. Snodgrass, Controller.

227. City of Pittsburgh, Improvement Bond, $1000, 4 per cent., 30 years, 1885.

Signed
B. McKenna, Mayor.
H. I. Gourley, Controller.
Property of Carnegie Museum, Acc. No. 1887. Donated by City of Pittsburgh.

228. Colonial Coins and State Notes.

Loaned by Mr. J. J. Kane, 1619 Locust St., Pittsburgh.

229. Colonial State Notes.

Loaned by Mr. S. H. Jackson, 800 Wood St., Wilkinsburg, Pa.

230. Two copper pennies excavated near the site of Fort Pitt.

Loaned by the Pittsburgh Chapter of the Daughters of the American Revolution.

Miscellaneous Specimens.

231. Cannon-ball from the battle-field of Princeton January 3, 1777.

Loaned by Mr. Joseph F. Speer, Fifth Ave., Pittsburgh.

232. Photographs of Gyanwahia (The Cornplanter) who was the Chief of the Cornplanter Indians; died 1836 at the age of one hundred years.

233. Photograph of Chief Cornplanter's son.

234. Photograph of Monument erected to Cornplanter.

Property of Carnegie Museum, Acc. No. 364. Donated by Chief Jacobs of the Cornplanter Indians.

235. Piece of wood from the cabin in which Chief Cornplanter lived.

Property of Carnegie Museum, Acc. No. 3641. Donated by Mr. G. M. Lehman.

236. Beaded cap made by the Cornplanter Indians.

237. Silver buckle and copper spoon, engraved upon which is a totem, found in an Indian grave near Kittanning, Pa.

Loaned by Miss Jeannette Deemar, Kittanning, Pa.

238. Pine cones from General Braddock's grave.

Loaned by Col. Thomas P. Roberts, 519 Aiken Ave., Pittsburgh.

239. Gavel made from the wood of the mulberry tree to which John Harris was bound and was about to be burned by the Indians, when liberated by his negro slave Hercules. Harris was the founder of Harrisburg, Pennsylvania.

Loaned by the Pittsburgh Chapter of the Daughters of the American Revolution.

240. Piece of the elm tree under which William Penn signed his treaty with the Indians.

Loaned by the Pittsburgh Chapter of the Daughters of the American Revolution.

241. Cup and saucer saved from the sacking of the Petit Trianon, given by Jerome Bonaparte to his American wife Elizabeth Patterson of Baltimore, owned since the year 1850 by Elizabeth Ogden.

242. Medals, formerly the property of George Ogden, Esq.

243. Early American bible.

Loaned by Miss Caroline O'F. Russell, 704 Clyde St., Pittsburgh.

244. Ten pound note issued by the State of Massachusetts Bay in the year 1782.

Loaned by Mr. W. J. Sanborn, 1947 Perrysville Ave., North Side, Pittsburgh.

245. Snuff box with picture of reception given in honor of General Lafayette in New York City, August 16, 1825.

Loaned by Miss Jeannette Deemar, Kittanning, Pa.

246. Section of rail made at Mount Savage, Maryland. This was the first rail mill in the United States.

Loaned by Mr. Curtis Williams, 664 Maryland Ave., Pittsburgh.

ANNALS

OF THE

CARNEGIE MUSEUM

VOLUME V. NO. 4.

Editorial Notes.

The annual celebration of Founder's Day took place on April the 29th. The distinguished guests of the occasion were Count Johann Heinrich von Bernstorff, who gave a most scholarly address upon "The Constitution of the German Empire"; Sir Caspar Purdon Clarke, Director of the Metropolitan Museum of Art, New York City, and Mr. Alfred East, President of the Royal Society of British Artists. The hall was filled with a large audience. Unfortunately the pleasures of the occasion were somewhat marred at their close by a most furious storm of wind and rain, which swept over the city and which compelled the presence until a late evening hour of many of the audience who had forgotten to bring with them umbrellas and raincoats. However, the rare feast which was provided for them in the Art Galleries and in the Museum served to make their involuntary detention more pleasurable than it would otherwise have been.

Although from time to time during the twelve months preceding Founder's Day most interesting exhibits were placed upon exhibition in the Museum, a special effort was made on that occasion to put on view some of our accumulated treasures. The Gallery of Reptiles, although only scantily furnished, was for the first time thrown open to the public. In the Gallery of Vertebrate Zoölogy a magnificent specimen of *Portheus molossus*, believed to be the finest in existence in any museum in the world, was put upon display. Two skeletons of *Stenomylus tyleri* Loomis, one of them almost complete in every part, both prepared as slab mounts, were put on view. The material in the possession of the Carnegie Museum representing the ancestry of the camel is very extensive and perfect. A number of changes were made in the Gallery of Vertebrate Paleontology and a large amount of material, most of it collected by the members of the paleontological staff, and some of it obtained in exchange, was put on exhibition. The collection of Hawaiian fishes, which has been materially added to, is calculated to attract attention. The ivories loaned by Mr. H. J. Heinz, the collection of Japanese weapons loaned by Mr. Irwin Laughlin, the beautiful collection of watches, which has been materially increased by Mr. H. J. Heinz during the past six months, awakened unusual interest. All of the collections in the various sections received more or less interesting and important accessions, and the general impression created by the collections of the Museum as a whole is believed to have been greatly heightened by the efforts which have been bestowed upon these things during the past few months.

DR. VICTOR STERKI of New Philadelphia, Ohio, has been appointed as an assistant to Dr. A. E. Ortmann in the Section of Recent Invertebrates of the Carnegie Museum, and will give a certain proportion of his time to the arrangement of his great collection, which has become the property of the Carnegie Museum, with a special view to a monographic revision of some of the groups therein represented of which he has made a special study and in which his collection is probably richer than any other in existence. As a student of the minuter mollusca Dr. Sterki has earned for himself a distinguished reputation.

DR. CARL H. EIGENMANN, Dean of the Postgraduate School of the Indiana State University, and Professor of Zoölogy in that institution, has been appointed by the Director Curator of Ichthyology in the Carnegie Museum. The arrangement is made with the understanding that this appointment will in no wise interfere with the discharge of his duties in the important positions which he holds in the faculty of the Indiana State University, but that he will give so much of his time as he is able to spare to the oversight of the ichthyological collections of the Carnegie Museum and to the study of the collections which are contained in the Museum. In the next number of the Annals there will appear the first of a series of reports by Dr. Eigenmann upon the fishes collected by him in British Guiana. He was remarkably successful, and the forthcoming papers will contain descriptions of a large number of species new to science.

On May 2d, while walking along the north bank of the Allegheny River, below the dam which has been built by the United States Government, Mr. John Clouse found lying upon the shore a huge tusk, which has since been secured for the Carnegie Museum. When first found by Mr. Clouse the tusk measured nine feet four inches in length along its outer curve. Unfortunately while exposed to view in a saloon where it was first exhibited some bits of the base of the tusk were broken off by the fingers of the curious, thus slightly reducing its length. Otherwise it preserves in outline all its characteristic features. A superficial study of the tusk inclines the Director of the Museum to believe that it is the left tusk of *Elephas colombi* Falconer. The peculiar curvature of the tusk is such as to suggest this specific determination. There has not been time as yet to study the specimen with minute care. It is, however, in a very good state of preservation, and will not require from present appearances to be greatly reinforced, although it has become necessary to treat it externally with a coating of shellac.

Ever since the new building was occupied our entomological collections, which are vast, have been more or less inaccessible for purposes of study, owing to the fact that no provision had been made for cases in which to systematically arrange and display them. The problem of designing a system of cases, which would meet the requirements, has for a long time engaged the careful attention of the Director of the Museum, and early in the winter he began the drawing of plans for a gallery and a series of cases rising from the floor to the ceiling of the entomological laboratory. The gallery is a light structure of steel, so built as to admit of the placing of the cabinets underneath and above. The work of the construction of the steel part of the gallery was awarded to the Chester B. Albree Manufacturing Company; the building of the cabinets is being carried on in the shops of the Museum under the supervision of Mr. Banks, the foreman. When completed our collections will be properly housed and arranged. A similar gallery with cabinets is proposed for the laboratory of Invertebrate Zoölogy, under the care of Dr. Ortmann, who at present is laboring under many disadvantages owing to the fact that the furniture of his laboratory is not modern, and most of his collections are practically in storage, where they are wholly inaccessible.

THE Editor has received from Dr. D. Starr Jordan the manuscript of a paper upon the Fishes of Formosa, which will shortly appear as the Fourth Part of Volume IV of the "Memoirs" of the Museum. From Professor P. P. Calvert of the University of Pennsylvania he has received the manuscript of a monographic revision of the Odonata of the South American continent, based upon the collections belonging to the Carnegie Museum. This paper represents in part the results of the labors of Professor Calvert upon the Odonata of South America, which have extended over many years. The authorities of the United States National Museum, the Museum of Comparative Zoölogy at Cambridge, the Academy of Natural Sciences in Philadelphia, and many others have kindly placed their collections at the disposal of Professor Calvert, and he has thus had before him in the preparation of this monograph all the available material existing in American collections, and his report will undoubtedly become a classic work of reference.

XI. DROMOMERYX, A NEW GENUS OF AMERICAN RUMINANTS.

By Earl Douglass.

In 1878 Professor E. D. Cope described, under the name *Blastomeryx borealis*,[1] the larger portions of two skulls of a ruminant from the Ticholeptus (Deep River) beds of Smith River valley in Montana. Later he published a figure of the skull,[2] which is evidently in part a restoration from the two skulls (Amer. Mus. Nat. Hist., No. 8132 and No. 8133).

The name *Blastomeryx*[3] had been proposed by Cope in 1877 for a posterior lower tooth of a small ruminant, in case the specimen should be found to represent a new genus. The tooth was obtained from the upper Miocene ("Loup Fork") deposits of northwestern Colorado.

In 1879 Dr. J. L. Wortman found in the Mascall (Cottonwood Creek) beds of Oregon some incomplete upper jaws, teeth, and bones of limbs and feet, which Cope referred to *Blastomeryx borealis*.[4]

The Princeton Scientific Expedition of 1891 discovered a smaller, but closely related, species in the same locality and horizon from which Cope's type of *Blastomeryx borealis* had been obtained. To this species Scott gave the name *Blastomeryx antilopinus*.[5] The posterior portion of a skull, a radius, part of an ulna, a nearly complete tarsus, and anterior and posterior canon-bones were figured and described.

Concerning the generic reference of this genus Scott said ("Mam. of Deep River Beds," p. 167): "This Deep River species [*Blastomeryx borealis*] is in many ways similar to the larger species of *Palæomeryx* from the Upper Miocene of Europe, and perhaps should be referred to that genus, though in the present state of knowledge it would be

[1] "Description of New Vertebrata from the Upper Tertiary Formations of the West," *Proc. Amer. Philos. Soc.*, 1878, p. 222.

[2] "The Artiodactyla," *American Naturalist*, Vol. XXII, 1889, p. 129, fig. 19.

[3] Geographical Survey West of the 100th Meridian, Vol. IV, Part II, p. 350.

[4] *Proc. Amer. Phil. Soc.*, 1886, p. 359.

[5] "Mammalia of the Deep River Beds," pp. 168–178.

premature to do so. This doubt is justified by the fact that the mandibular dentition of *B. borealis* is still unknown, and we cannot therefore determine whether the lower molars possessed the very characteristic *Palæomeryx* fold, and it is uncertain whether the type of the European species had developed horns.'' [5]

While collecting vertebrate fossils from the Upper Miocene deposits in the Lower Madison Valley in Montana (1894–1896) Earl Douglass found portions of lower jaws and teeth of *Blastomeryx*, the last lower molars being nearly like the type of the genus. In the same beds two portions of lower jaws were obtained, which were much larger than those of *Blastomeryx*, and the lower molars possessed the so-called ''*Palæomeryx* fold'' which was then supposed by him to be characteristic of *Palæomeryx*. These specimens were therefore described under the generic name *Palæomeryx*. The most nearly complete mandibular ramus (Pl. LXII, Figs. 1 and 2) was named *Palæomeryx americanus*.[6] Two upper premolars and the greater portions of the three upper molars of one individual (Pl. LXIII, Fig. 2) were in the original description provisionally referred to this species.[7] In the same deposits, a portion of a brain-case (Figs. 2 and 3) as large as that of *Blastomeryx borealis* Cope, was found, but not described.

Since that time the American Museum of Natural History has recovered sufficient material for the restoration of *Blastomeryx*. This has been described by Matthew in a recent paper entitled ''The Osteology of Blastomeryx and Phylogeny of the American Cervidæ.''[8] This paper settles doubts, if any existed, with regard to the generic identity of the true *Blastomeryx* and the larger species described in the present paper.

In the spring of 1899, Mr. Earl Douglass found, in the Flint Creek beds (Upper Miocene) near New Chicago in Montana, a skull, the corresponding parts of which do not differ in any important particular, so far as the present writer is able to discern, from the portion ot a skull which is the type of *Blastomeyrx borealis* Cope, or from the more complete skull which was found in the same deposits. With the skull from the Flint Creek deposits, were associated the left horizontal ramus of the mandible, and good parts of the skeleton.

[6] ''The Miocene Lake-beds of Western Montana,'' University of Montana, 1899, p. 21.

[7] *l. c.*, p. 22.

[8] *Bull. Amer. Mus. Nat. Hist.*, Vol. XXIV, 1908, pp. 535–562.

These discoveries showed conclusively that the larger species described as *Blastomeryx borealis* Cope and *B. antilopinus* Scott were very different from the true *Blastomeryx*. I had not access to the European specimens which had been described as *Palæomeryx*, or to the literature describing them, but I judged from the writings of others that the larger American species were *Palæomeryx*.

The above mentioned skeletal remains show by far the greater number of the osteological characters of *Blastomeryx borealis* Cope. A restoration of the skeleton was made by Mr. Sydney Prentice under my direction and a paper was read before the American Society of Vertebrate Paleontologists, on "The Restoration of *Palæomeryx borealis*" in 1906; but on account of the doubt concerning the relation of this animal to the type of *Palæomeryx* and to other European *Palæomerycinæ*, the paper was not published. The author wished, on the one hand to avoid further perpetuating the use of a name that would be misleading, and on the other hand to refrain from creating a synonym.

The generic name *Palæomeryx* was given by Hermann von Meyer in 1834 to various fragments of jaws and teeth found at Georgensmund in southeastern Bavaria. In the paper,[9] which contains the original description, several teeth and portions of the mandible were described. Evidently the specimens do not all belong to the same species and perhaps not to the same genus. Apparently the portion of a mandible with teeth, illustrated on Plate X, Fig. 77, should be taken as the type, as it is the first used in establishing the characters of the genus. Other specimens, in part at least from supposedly different Miocene horizons, have since been variously referred by European authors to *Palæomeryx*, *Dicrocerus*, *Cervus*, *Dromotherium*, *Propalæomeryx*, etc.

The types of *Palæomeryx* are not accessible, and I do not know whether they still exist; but I judged from von Meyer's figures and descriptions that *Palæomeryx* was different from anything that had been found in America; and in fact I was for some time satisfied in my own mind that the fossil remains which were referred to *Blastomeryx* by Cope and to *Palæomeryx* by myself, had been erroneously referred to these genera. Dr. Matthew has entirely removed doubt

[9] *Die Fossilen Zähne und Knochen und Ihre Ablagerung in der Gegend von Georgensmund in Bayern.* Abhandlungen der Senck. Nat. Ges., Supplement zu Band I, 1834, pp. 93–98.

in regard to the former genus, but it has not been so easy, on account of the lack of proper material for comparison, to remove all doubt in regard to *Palæomeryx*.

Some specimens recently received by the Carnegie Museum from Europe, though not belonging to the type itself, and not from the same locality as the type of *Palæomeryx*, enable me, without great danger of serious error, to point out differences which exist between *Palæomeryx* and the American species, which have been referred to that genus. It seems indeed that there is really no very intimate relationship between the American and European forms, and it would be an error to employ them for a close correlation of horizons. This is only another example of the general rule that there are very few mammalian genera common to the Eastern and Western Continents; and as more complete material accumulates and is more carefully studied, the apparent number grows less. I therefore venture, in order to prevent error and misconception, to suggest for the American forms a new generic name. The possession of very complete material permits a very satisfactory definition of the osteological characters of the new genus. Some of the distinguishing features which separate it from the European species, which have been referred to *Palæomeryx*, can be pointed out, and the differences which separate it from the type of *Palæomeryx* can be stated with a large measure of certainty.

The following are the characters which Cope gave for *Blastomeryx borealis*: "The superior dental formula is I.0; C.0; Pm.3; M.3. The molars all have two pairs of crescents excepting the last premolar where the posterior pair are rudimental. The external face of the anterior crescent in all the molars presents a groove, which is bounded posteriorly by a vertical ridge. The posterior crescent is directed a little inward posteriorly on the true molars. The palate is much contracted in front of the first molars. The horns stand above the posterior parts of the orbits; their section is triangular, the posterior angle being rounded, and the external produced and acute, bounding the orbits outwards and backwards. There is no trace of a burr. The temporal fossæ approach so as to be represented only by a rather wide and low occipital crest. . . . This species was as large as the black-tailed deer, *Cariacus macrotis*." [10]

In Volume XVIII of the *American Naturalist* Cope observes that

[10] "Description of New Vertebræ from the Upper Tertiary of the West," *Proc. Amer. Philos. Soc.*, 1878, p. 223.

the molars of *Blastomeryx borealis* differ from *Cosoryx* [*Merycodus*] as much as those of the deer differ from those of the antelope; those of "*Blastomeryx*" and the deer being brachyodont, while those of *Cosoryx*, and the "antelope" (*Antilocapra*) are hypsodont.

In his "Mammalia of the Deep River Beds" Scott gave some characters of *Blastomeryx borealis* Cope. He says "The skull is remarkable for the high and narrow occiput the upper portion of which is drawn out into a long backwardly projecting process composed of the parietals and supraoccipitals, which is very similar to the corresponding part of the occiput of the Oreodontidæ. The horns are trihedral at the base gradually becoming rounded distally and are of remarkable length; they are perfectly simple and unbranched, and in no specimen which I have seen is there any trace of a burr. The surface of the horns is faintly marked by vascular impressions, but is on the whole remarkably smooth, much more so than in the antlers of the deer, and, as Cope has suggested, they were doubtless covered with skin during the lifetime of the animal. . . . The upper premolars, three in number, have the internal crescent, deuterocone, complete; $P^{\underline{2}}$ and $P^{\underline{3}}$ are massive and oval in section, while $P^{\underline{4}}$ is more extended transversely. The molars are very brachyodont and are covered with very rugose and strongly wrinkled enamel; the internal crescents are complicated by accessory spurs which invade the valleys. The internal pillar or style is very variable, being sometimes quite large, while in many specimens it is absent from one or the other of the molars."

DROMOMERYX gen. nov.

I propose the name *Dromomeryx* (running ruminant) for this genus of American fossil mammals including *Blastomeryx borealis* Cope, *B. antilopinus* Scott, and perhaps *Palæomeryx americanus* Douglass, and *P. madisonius* Douglass. *Blastomeryx borealis* Cope was the first to be described, so this would become the type-species of the genus. In the collections of the American Museum of Natural History the less complete skull (Fig. 1) but the one which possesses the greater portion of a horn (No. 8132) is marked on the label as the "type" and the more nearly complete skull (No. 8133) is indicated as the "co-type." Cope's original labels do not accompany the specimens, so I do not know whether or not Cope selected one specimen as the type, but he apparently used both skulls in his original diagnosis of the genus and species. There appear to be no important differences between the two skulls, and they supplement each other very well.

Below is given a summary of the distinguishing characters of *Dromomeryx* as they now appear :

The size was greater than that of an ordinary specimen of *Odocoileus americana* or *Antilocapra americana*, at least the bones are heavier. The skull is long and the crest of the occiput is produced backward. The face is quite long, the orbit is large, and the malar below the orbit projects outwardly. The horn-cores are large and simple, and they expand outward below into heavy lateral wings behind the upper

FIG. 1. *Dromomeryx borealis* (Cope). No. 8132, American Museum of Natural History. The specimen marked "Type." One fourth natural size.

portions of the orbits. They stood nearly perpendicular to the upper plane of the skull. There are no lachrymal pits. There is a slit or oblong vacuity in the upper portion of the face anterior to the orbit. The parieto-temporal suture is below the middle of the brain-case. The basi-cranial axis forms a considerable angle with the basi-facial axis. The palate is quite broad between the cheek teeth, but is narrow anterior to them. The mandible is long and not deep and it curves downward beneath the molars and premolars. The teeth are brachyodont with a tendency to become hypsodont. There are quite prominent pillars on the anterior outer portions of all the outer crescents of the upper cheek teeth. The lower molars have median outer pillars on the teeth and "*Palæomeryx*-folds" on the anterior outer crescents. The neck and limbs are long, but heavier than those of *Odocoileus* and *Antilocapra*. There were at least vestiges of the lower portions of the lateral metapodials. The humerus is proportionally larger than in *Antilocapra*. The radius and ulna were separate; but the trapezoid and magnum, the navicular and cuboid were united. The distal heels of the metapodials are high, the ungual phalanges high and narrow.

Comparison of Dromomeryx with Palæomeryx. — As previously stated, it is difficult to make reliable comparison with the type of *Palæomeryx*. From von Meyer's figures I inferred that the teeth of the European genus were lower in proportion to the length and width, the valleys between the crescents shallower, and the outer walls of the teeth more convex vertically. The mandible in von Meyer's figure is deeper posteriorly and narrows more rapidly anteriorly.

There are now in the Carnegie Museum, several specimens from Sansan, France, and Steinheim, Germany, which have been referred to the genus *Palæomeryx* by European paleontologists. Three specimens referred to *Palæomeryx bojani*, the type species, have recently been acquired by the Museum. Whether these specimens are referable to the species *P. bojani*, or not, I see no reason to doubt that they belong to the genus *Palæomeryx*.

No. 2263A (Carn. Mus. Cat. Vert. Foss.) is a portion of a mandible with the last molar tooth complete (Plate LXII, Figs. 7 and 8). This tooth, like all the teeth of *Palæomeryx* which I have seen from Europe, strikes one at once as belonging to a quite different animal from those of which remains have been found in America. The tooth is low, heavy, and broad, the outer and inner crescents are thick transversely, the outer and inner surfaces of the tooth are convex, the valleys between the crescents are shallow, the heel is sub-conical in form, and its outer element is represented by a small, short, antero-posterior ridge resembling a cingulum. There is a quite large internal median conule and the enamel of the tooth is coarsely wrinkled. The last lower molar of *Dromomeryx borealis* is much higher and narrower in proportion to the length, the outer and inner walls are less convex — more nearly perpendicular, the valleys are deeper, the heel proportionally longer and composed of an outer and an inner crescent.

The enamel is more nearly smooth, but is finely wrinkled, and the outer median conule is smaller. The tooth of *Palæomeryx* has the appearance of belonging to a larger, heavier animal with more primitive teeth.

No. 2263 (Carn. Mus. Cat. Vert. Foss.) is part of a maxillary with the last premolar and the three molars complete (Plate LXIII, Figs. 4 and 5). This is also labelled "*Palæomeryx bojani.*" This, like the lower tooth just described, represents an animal approaching in size that of *Cervus canadensis.* To describe their most striking characteristics would be to repeat what has been said concerning those of the lower molars. The teeth are broad, heavy, and low, and the valleys are shallow. Among the other characters of this specimen are the following: All of the teeth which have been preserved have heavy inner cingula. The inner crescent of P^{4} has the appearance of having been formed from two cusps or crescents uniting near the transverse median line. The posterior portion of the crescent sends outward two long horns, instead of one, to near the outer crescent. The posterior portions of the anterior inner crescents of the molars end abruptly in a rounded border anterior to the middle of the anterior portions of the postero-inner crescents — that is, the antero-inner crescents do not send long horns outward to near the inner wall of the antero-external crescent parallel with the anterior horns of the postero-inner crescents. The smaller specimen described as *Palæomeryx americanus* (No. 755, Carn. Mus. Cat. Vert. Foss.), which is figured in this paper, has this peculiarity also. On M^{2} of *Palæomeryx* the anterior horn of the postero-inner crescent has an accessory spur, and in M^{3} there is a small tubercle in the median valley, between the anterior and posterior inner crescents. The outer faces of the postero-external crescents are concave and have only the faintest trace of a median ridge.

Nearly all of the above characters distinguish the available specimens of *Palæomeryx* from those of *Dromomeryx.*

An astralagus (No. 2263B, Carn. Mus. Cat. Vert. Foss.) from Sansan, indicates a much larger animal than *Dromomeryx* and there are some differences in form. The specimens of teeth in the Carnegie Museum from Steinheim confirm the characters exhibited by the specimens from Sansan.

To sum up, then: As near as I am able to judge *Dromomeryx* differs from *Palæomeryx* (1) in having higher, narrower, more modernized teeth, the molars have a more decided tendency to become hypsodont, (2) the upper molars are not provided with heavy cingula, (3) the upper molars and last premolars are set more obliquely in the jaw, (4) the postero-internal crescents have slender horns reaching nearly to the outer crescent, and (5) there are median ribs on the outer surfaces of the postero-external crescents. There are numerous other small differences, but we have not sufficient material of *Palæomeryx* for extended comparisons, and so cannot properly estimate the taxonomic value of many of the characters.

It should be stated here that one specimen No. 706 (Carn. Mus. Cat. Vert. Foss.) which was described under the name *Palæomeryx americanus*, though smaller than the known specimens of *Palæomeryx*, is more nearly like that genus in having shorter horns on the posterior portions of the antero-internal crescents, in having the outer faces of the postero-external crescents concave, and in having more coarsely wrinkled enamel. This specimen will be figured and referred to later in this paper.

There are other probable differences between *Dromomeryx* and *Palæomeryx* as for example the supposed absence of horns or antlers in the latter and the presence of large, very unique and characteristic horns in the former. Indeed it appears now that the two genera are not closely related, and had it not been for the differences in the horns it would perhaps be more difficult to separate the American genus *Dromomeryx* from *Dicrocerus*.

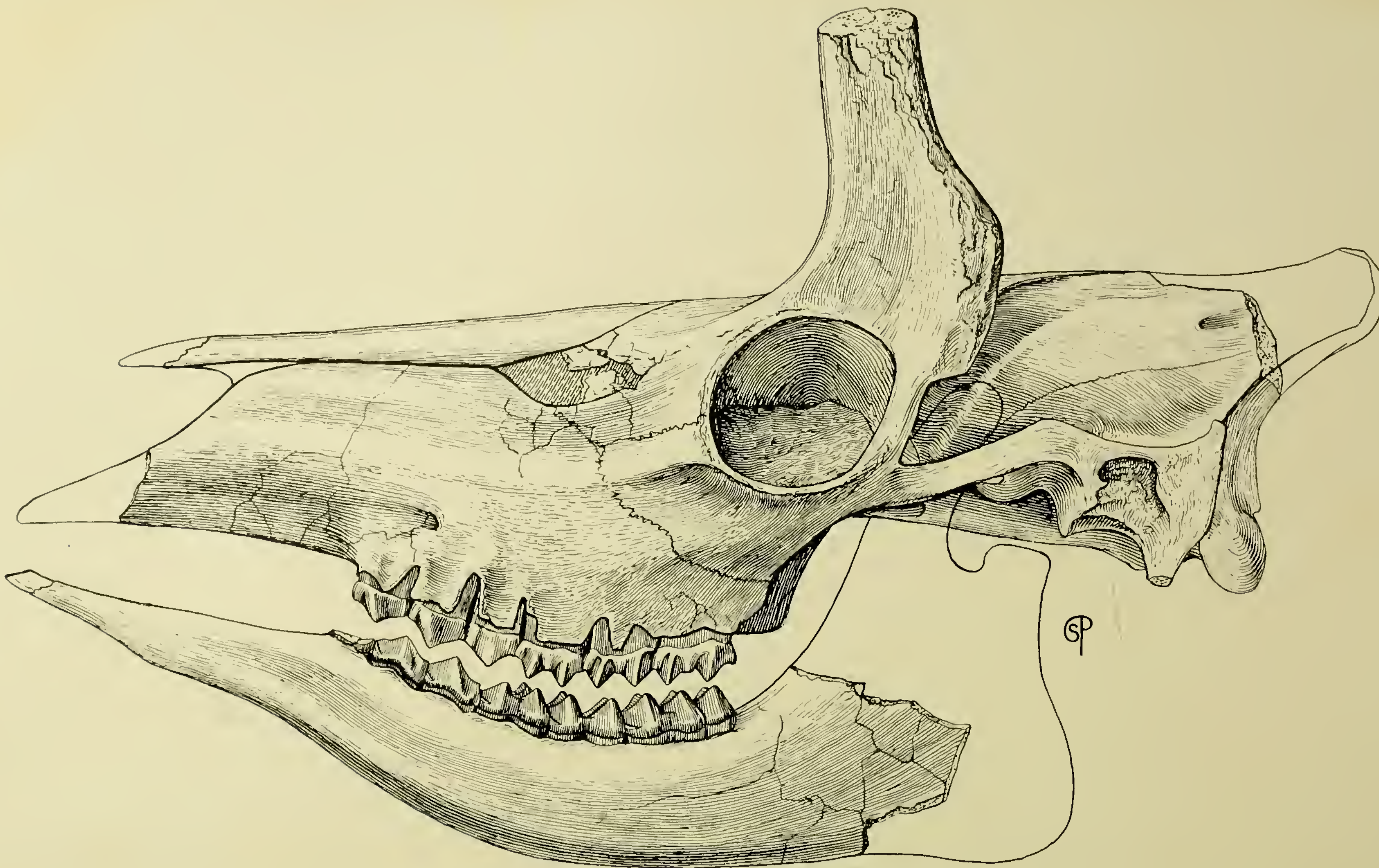
Osteology of Dromomeryx.

The following descriptions are taken principally from No. 827, Carn. Mus. Cat. Vert. Foss. They are supplemented by descriptions of parts of No. 1542 (Carn. Mus. Cat. Vert. Foss.), which is usually referred to by number when mentioned.

Of No. 827, we have the skull, the left ramus of the mandible, the bones of the neck with the exception of the last two cervicals, five lumbar vertebræ, the sacrum, a large portion of the pelvis, a humerus, a radius, and one anterior canon-bone. Other portions of skulls and skeletons were found in the same deposits. Among these there is a specimen (No. 1542) which consists of large portions of a skull including a complete molar-premolar series, the bones of the neck with the exception of a part of the atlas, the first four dorsal vertebræ, a nearly complete fore limb exclusive of the scapula and a large portion of the hind limb including part of the hind foot.

The Skull. Lateral Aspect. — The skull (Plate LIX) (Carn. Mus. Cat. Vert. Foss. No. 827) is long, yet the face is quite deep anterior to the orbits. The facial portion is rather long, the anterior margin of the orbit being about midway between the extreme anterior and posterior portions of the skull. The muzzle is comparatively slender as seen from above, but has on its sides broad longitudinal convexities. The general upper contour of the cranium is nearly straight, though the forehead is somewhat concave between the orbits, and back of this the top of the brain-case is somewhat convex. The anterior portion of the skull very much resembles that of *Antilocapra*, but the shape and contour of the brain-case are very different. In *Dromomeryx* it is larger and the upper surface does not descend backward as in *Antilocapra.* In the former the low supra-temporal ridges begin at the postero-internal angles of the bases of the horns and converge backward forming a low, broad, sagittal crest about six and one half centimeters in length. The orbits are large and the jugal beneath is produced outward into a shelf which is not so wide nor flat as in *Antilocapra.* The outer border of the jugal is thickened and it is concave transversely beneath. The horns are nearly circular in section above, but are triangular just above the basal wing-like processes. The latter are directed postero-externally. The antero-external faces are concave and the outer borders thickened. The skull is slightly injured in this region, so it is uncertain whether the lachrymal bone reached to the nasal or whether it was separated by the vacuity which lies beneath a part of the posterior portion of the nasals; but apparently the lachrymal was excluded from articulation with the nasals by the antorbital vacuity, as in the *Cervidæ.* The parieto-temporal suture is below the middle of the brain-case which is, according to Brooke,[11] a bovine feature. The temporal ridges are quite heavy and are a little nearer the parieto-temporal suture than they are to the supra-temporal ridges, and they are nearly parallel with both. The zygomatic portion of the squamosal is heavy. The excavation in the squamous portion of the temporal for the external portion of the auditory apparatus (ectotympanic) is large and nearly semicircular in form as seen from the side. The mastoid portion of the temporal is heavy, thickened, and rugose. The infraorbital foramen opens above the anterior portion of $P^{\underline{3}}$.

[11] "On the Classification of the Cervidæ, etc.," *Proc. Zoöl. Soc. Lond.*, 1878, p. 885.



Skull of *Dromomeryx borealis* (Cope). (One half natural size.)
(Car. Mus. Cat. Vert. Foss. No. 827.)

In skull No. 1542 the summit of the occiput is produced about 4 cm. posterior to the occipital condyles.

Palate View. — The palate (No. 827, Carn. Mus. Cat. Vert. Foss.) is quite broad between the cheek teeth, but narrows rapidly anterior to them. The anterior portion of the palatal notch is between the last molars. The posterior narial opening is deep vertically on account of the elevation of basi-cranial elements of the posterior portion of the skull — the upward trend forward of the basi-cranial axis. The optic foramen, the sphenoidal fissure, the foramen ovale, the anterior lacerated foramen, the anterior portion of the tympanic bullæ, and the posterior lacerated foramen are in nearly straight lines converging forward and bordering the basi-occipital and the convex portions of the basi-sphenoid and presphenoid. There is a short process on the sphenoid just antero-external to the large sphenoidal fissure.

The glenoid articular surface is convex antero-externally. Between this and the post-glenoid process the surface is concave antero-posteriorly, but a broad antero-posterior convex ridge divides it into two depressions. The post-glenoid process is rather small and low. The tympanic bulla is small, but the anterior portion of the tympanic was large. What I suppose to be the pit for the tympano-hyal is large. The paroccipital process is low and flattened. It is directed antero-internally and postero-externally. The antero-external face is concave while the postero-internal one is convex.

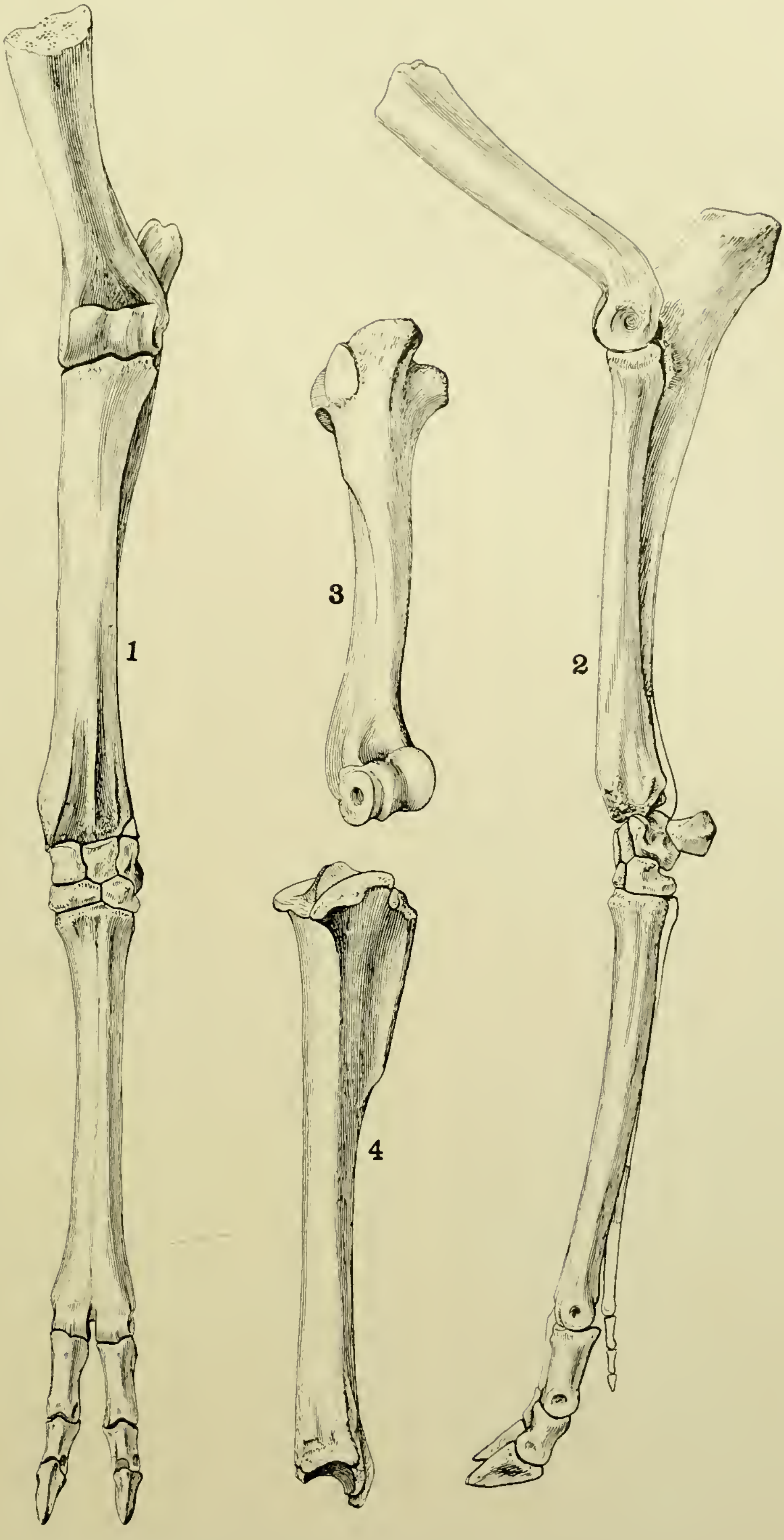
Dentition. — In specimen No. 827 (Carn. Mus. Cat. Vert. Foss.) the most of the cheek teeth are in a good state of preservation (Plate LXIII, Fig. 6). They are not greatly worn. They are not high-crowned and the valleys between the internal and external crescents are not deep. The inner crescents of the upper premolars are comparatively simple. The internal cusps are quite heavy. The anterior outer pillar of $P^{\underline{4}}$ is well developed. On the outer faces of the molars there are prominent anterior and median outer styles and they project outward. The outer faces of the external crescents are very convex. There are cingula on the anterior faces of the antero-inner cusps and small accessory cusps or pillars on the antero-inner faces of the postero-inner crescents. The teeth are not as large as those of Carnegie Museum specimen No. 1542 (Plate LXIII, Figs. 1 and 3) or the types of the genus (Nos. 8132 and 8133 of the Amer. Mus. Nat. Hist.). The teeth of No. 1542 (Carn. Mus.) are somewhat complicated by spurs extending into the median valleys from the inner crescents as is the case in the types.

Lower Teeth (Plate LXII, Figs. 2 and 3).—$P_{\overline{3}}$ is rather long antero-posteriorly and is not broad. It has five loops or lobes on the inner side. The last two enclose a small lake. In $P_{\overline{4}}$ the folds are larger except the first and the last three enclose two lakes. The median inner fold has developed into a large antero-posterior cusp, the anterior portion of which is larger than the posterior portion. The lower molars increase in length from the first to the last. All have small, low, basal cusps between the two external crescents. These are oval in horizontal section. All the molars have the "*Palæomeryx*-fold" on the posterior faces of the anterior outer crescents.

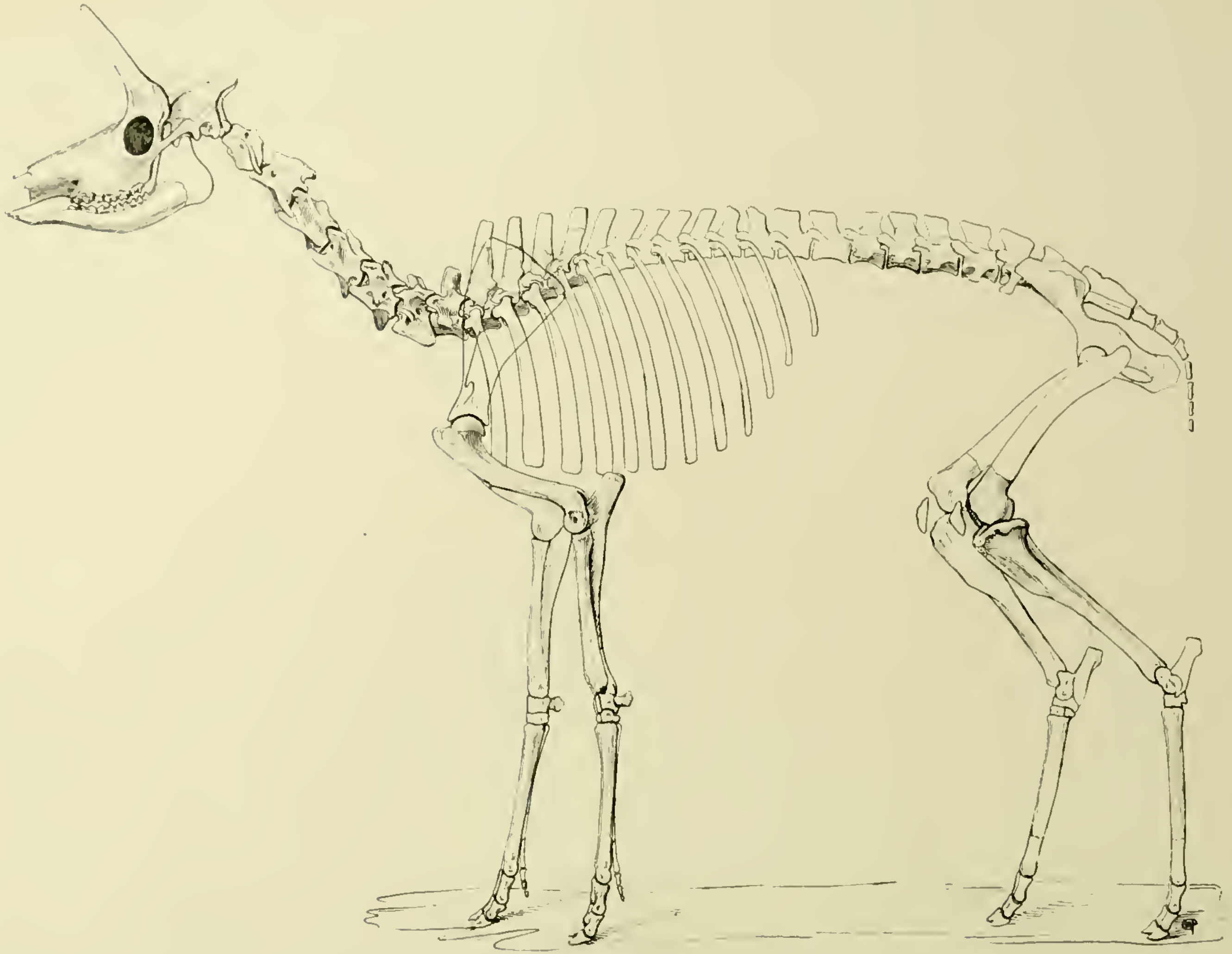
The Spinal Column (Plate LXI).—The neck is long—a little longer than the head. The individual vertebræ are heavy and none of the transverse processes are long. This gives to the cervicals posterior to the axis a square or block-like appearance, much as the cervicals of *Antilocapra* would appear were the transverse processes shorter. The spine of the axis is only moderately high. It is low in front, curved upward antero-posteriorly on the upper margin, and is higher behind; the upper posterior portion is overhanging. The inferior median keel on the posterior portion of the centrum and the descending borders of the transverse processes do not form such deep concavities as they do in the axis of *Antilocapra.* The neural spine in No. 827 is represented by low tubercles while on No. 1542 there are two separate spines, low and unequal in size, situated on either side of the median line of the vertebra. In this vertebra the element which forms the prominent upper branch of the transverse process in the succeeding cervicals is a long ridge, anterior to the middle of the centrum. The base of the spine of C4 is fairly large, but its full height is not shown in any of the specimens. The lower branches of the transverse processes are not very high.

The Limbs (Plate LX).—The humerus and the radius are nearly equal in length. The radius is slightly sigmoid as seen from the front. It is broad transversely and flattened antero-posteriorly. The radius and ulna were separate. The latter was broad antero-posteriorly above, and it narrows rapidly downward. It is thin transversely behind the radius.

The lower portion of the ulna is not preserved in any of the material that has been worked out, but, judging by the contiguous bones, it was quite large. The canon-bone of the fore foot is shorter than the radius in No. 1542. In this specimen part of the distal portion of



Limbs of *Dromomeryx borealis* (Cope). (One fourth natural size.)
Figs. 1–2. Left fore-limb (No. 1542, Car. Mus. Cat. Vert. Foss.).
Fig. 3. Humerus (No. 827, Car. Mus. Cat. Vert. Foss.).
Fig. 4. Tibia (No. 1542, Car. Mus. Cat. Vert. Foss.).



Restoration of *Dromomeryx borealis* (Cope). (One twelfth natural size.)

one of the metapodials is preserved. It lies in the matrix just posterior to the metacarpal. It is flat, and 8 cm. above the distal end of the metacarpal it is 6 mm. in width. The trochlear keels of the metapodials are high and narrow on the palmar side, and they extend as far upward on the dorsal side as do the distal articular surfaces. The

MEASUREMENTS.

	Dromomeryx borealis. No. 827. mm.	No. 1542. mm.
Length of portion of skull preserved	307	
Total length of skull, partly estimated	375	
Width of skull including wings of horns	190	
Height of skull anterior to orbit	100	
Vertical diameter of orbit, about	45	
Height of occiput, about	83	92
Depth of mandible under $P_{\overline{2}}$	29	
Depth of mandible under $M_{\overline{1}}$	30	
Depth of mandible under heel of $M_{\overline{3}}$	32	
Length of upper molar-premolar series	99	109
Length of upper premolar series	45	46
Length of upper molar series	59	63
Length of lower molar-premolar series	110	
Length of lower premolar series	43	
Length of lower molar series	67	
Length of neck articulated		390
Length of atlas	77	77
Length of axis including odontoid process	91	87
Length of third cervical including processes	74	74
Length of cervical 4	80	80
Length of cervical 5	80	80
Length of cervical 6		80
Length of cervical 7		67
Length of humerus	237	
Greatest diameter of head of humerus	63	
Transverse diameter of distal end of humerus	46	51
Length of radius	237	246
Antero-posterior diameter of olecranon of ulna	46	
Length of metacarpal		215
Length of proximal phalanx		47
Length of medial phalanx		28
Length of ungual phalanx		40
Height of ungual phalanx		21
Length of tibia		305
Length of astragalus		47
Width of astragalus		31

ungual phalanges are high and narrow. The tibia is long and is slender below.

Throughout the skeleton there is a general resemblance to that of *Antilocapra*, though the bones are all heavier. There are, of course, many differences in detail. The most striking differences are in the teeth and the posterior portion of the skull.

Restoration and Habitat.

The restoration of *Dromomeryx* here given (Plate LXI) was made from two portions of skulls and skeletons, numbers 827 and 1542 of the Carnegie Museum Catalogue of Vertebrate Fossils. The scapulæ, most of the dorsal vertebræ, the caudal vertebræ and the length of the femur and the size and proportions of the lateral metapodials are conjectural. The bones of the skeleton are individually heavier than those of *Antilocapra* and the Virginian deer, but the skeleton is gracefully proportioned. Evidently *Dromomeryx borealis* was about 5 feet (1.5 meters) long, over 3 feet (97 cm.) high at the shoulder. The head, neck, and limbs are long, but not extremely so in proportion to the size of the body. The only features which are very striking are the long heavy horns with thin, peculiar wing-like processes behind the orbits. These must have given to the animal a very peculiar appearance, especially when viewed from in front. The eyes were evidently large.

Dromomeryx was well adapted to life in the open country. It could undoubtedly run swiftly, quickly detect the approach of danger, and, with its powerful horns, defend itself against its carnivorous adversaries. It had not, like *Pronomotherium* of the same beds, strongly hypsodont molars, and, like nearly all of the *Merycoidodonts* (Oreodonts) a deep mandible for the attachment of heavy muscles which were used in the mastication of coarse vegetable food. It probably occupied, in part, the same habitat as the camels (*Procamelus*, etc.) and the horses (*Merychippus ?*), etc., which were found in the same beds.

Dromomeryx from the Lower Madison Valley in Montana.

In the collection from the Lower Madison Valley in Montana, a portion of a skull (Figs. 2 and 3), which was found in a bed of pure stream-sand may belong to the species *Dromomeryx borealis*. The size is nearly the same as that of the type, and of the various specimens from Montana which have been referred to this species, as the fragment shows no characters which would distinguish it from the type-species, though it can only be referred provisionally to *Dromomeryx borealis*. It is much larger than any of the other specimens from the deposits in the Lower Madison Valley.

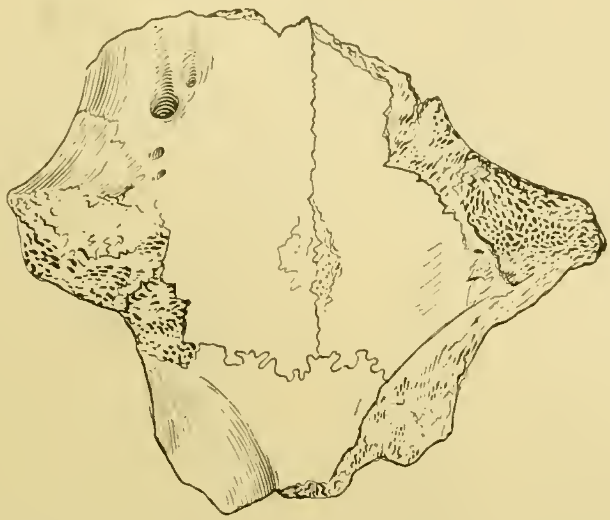


FIG. 2. *Dromomeryx borealis* (?). Portion of brain-case. Carnegie Museum Catalogue of Vertebrate Fossils No. 806. From Miocene deposits, Lower Madison Valley, Montana. One fourth natural size.

FIG. 3. *Drymomeryx borealis* (?). Portion of brain-case. Carnegie Museum Catalogue of Vertebrate Fossils No. 806. From Miocene deposits, Lower Madison Valley, Montana. One fourth natural size.

Four other specimens from the Lower Madison Valley are referred provisionally to *Dromomeryx*. They are in the collections in the Carnegie Museum and have the following numbers:

No. 705. Ramus of mandible with molar and premolar teeth. Type of *Palæomeryx americanus* Douglass.

No. 706. Last two upper premolars and greater portions of molars. Provisionally referred in the original description to *Palæomeryx americanus* Douglass. The reference of this to *Dromomeryx* is more doubtful than that of the other specimens.

No. 755. The greater portions of the lower molars in fragment of mandible. Type of *Palæomeryx madisonius.*

No. 2146. A third upper premolar. Referred in the original description to *Palæomeryx americanus* Douglass.

These specimens indicate animals very much smaller than *Dromomeryx borealis.*

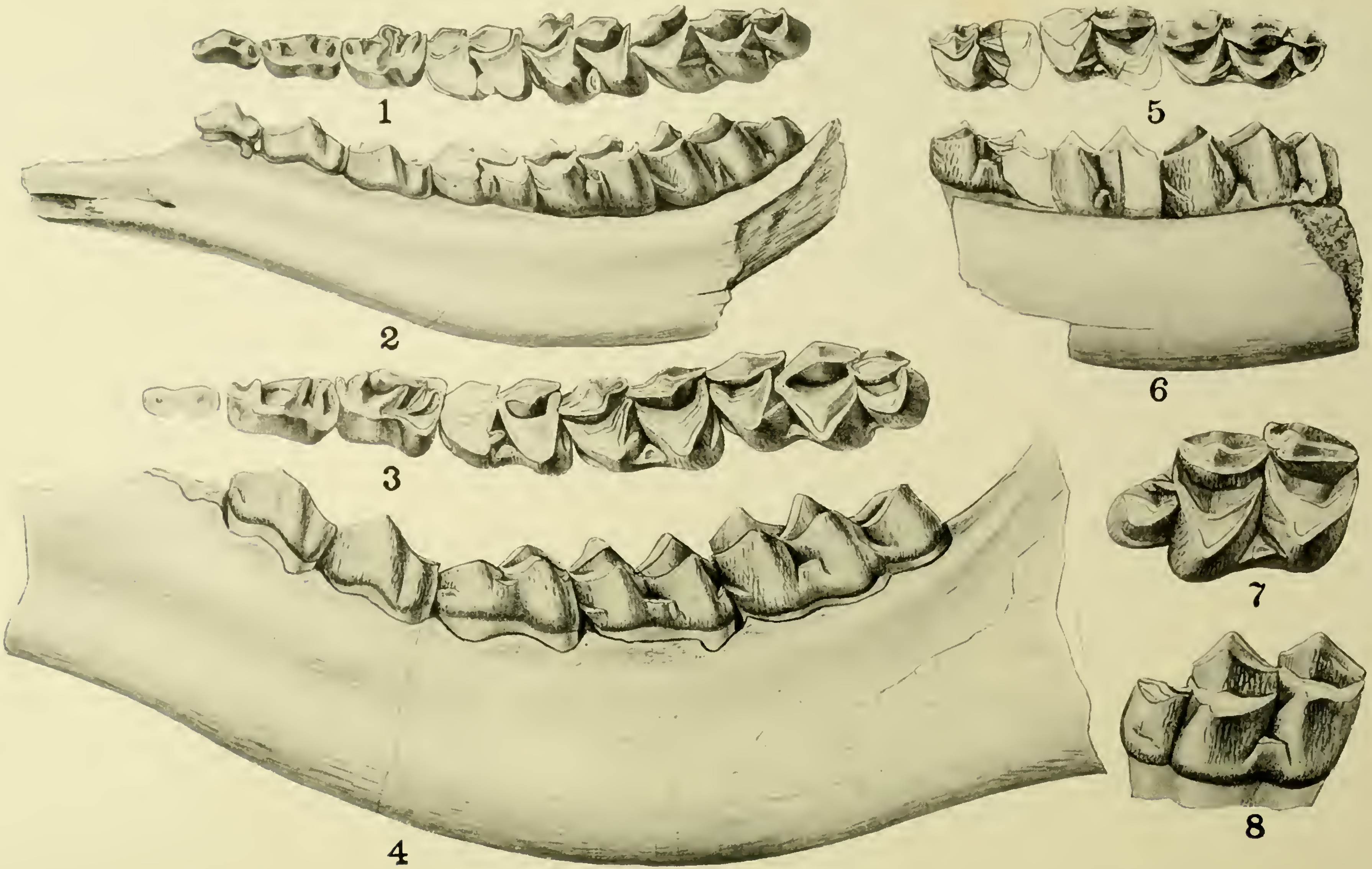
Dromomeryx ? americanus (Douglass).

(PLATE LXII, FIGURES 1 AND 2; PLATE LXIII, FIGURE 2.)

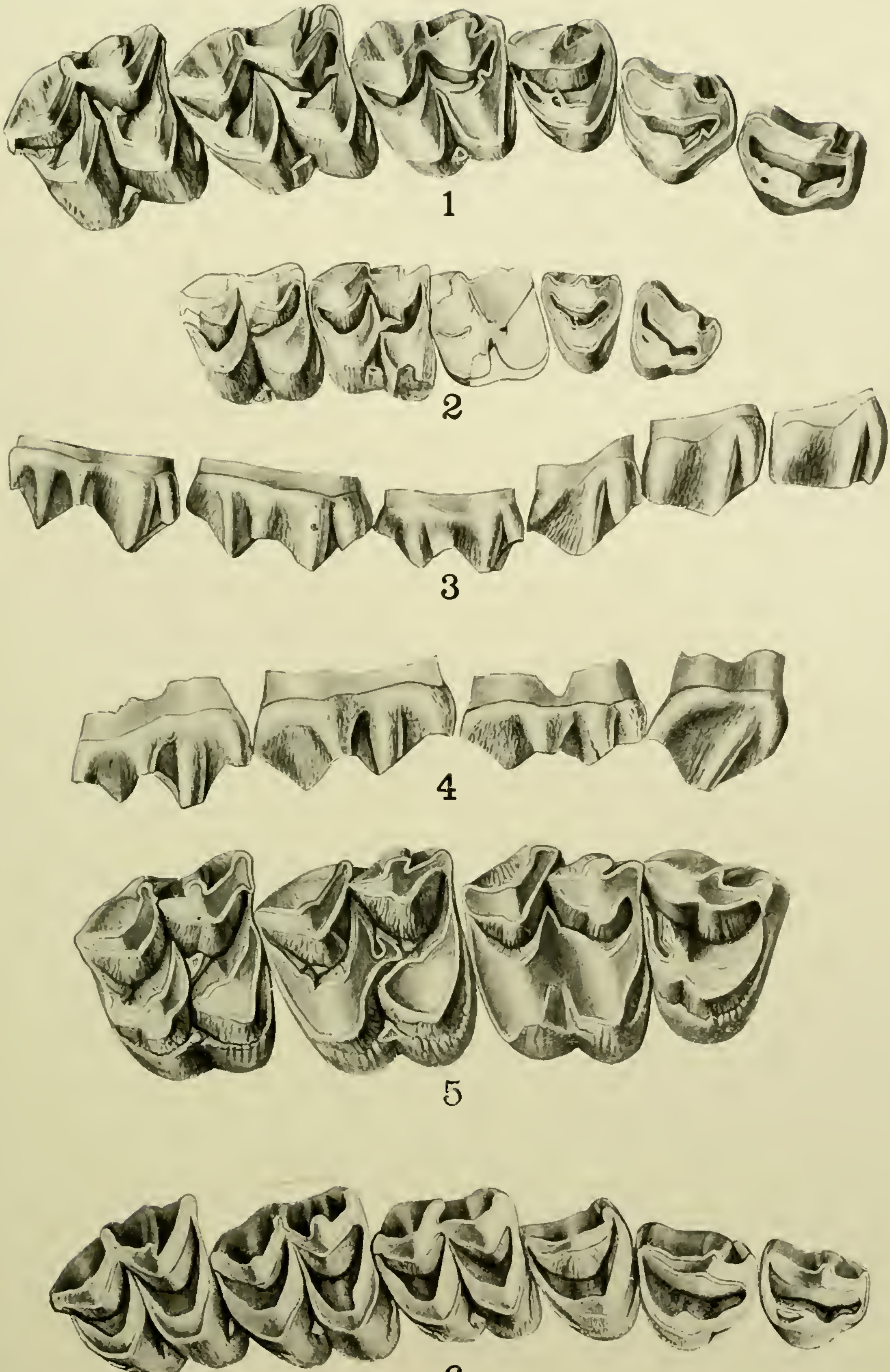
Palæomeryx americanus Douglass. "The Miocene Lake Beds of Western Montana," etc., University of Montana, 1899, Pages 20–23. Plate IV, Fig. 3.

The type of this species is the left ramus of a mandible (No. 705, Carn. Mus. Cat. Vert. Foss.) with the molars and premolars complete. The associated specimen consists of the last two premolars and the greater portions of the molars of the upper jaw (No. 706, Carn. Mus. Cat. Vert. Foss.). This specimen was associated with the type on account of its close similarity in size. The measurements of the teeth approximate those of *Dromomeryx antilopinus* Scott.

The ramus of the mandible is slender, nearly uniform in depth under the molar-premolar series, and curved downward as in *Dromomeryx borealis.* $P_{\overline{2}}$ is low and not large. From its principal cusp a sharp ridge extends downward and forward to the anterior portion of the tooth, where it curves inward. A similar but much longer and heavier ridge extends downward and backward from the principal cusp, sending a lobe inward about half way between the cusp and the posterior border of the tooth. $P_{\overline{3}}$ is much higher, longer, and broader, and there are two inwardly directed lobes before and two behind the principal cusp. The lobe which projects inward from the protoconid is directed backward. On $P_{\overline{4}}$ this element is much larger and forms a subcylindrical cusp opposite the protoconid. $M_{\overline{1}}$ and $M_{\overline{2}}$ have large median outer pillars attached to the anterior outer walls of the pos-



Figs. 1–2. Lower dentition of *Dromomeryx americanus* (Douglass).
Figs. 3–4. Lower dentition of *Dromomeryx borealis* (Cope).
Figs. 5–6. Lower dentition of *Dromomeryx madisonius* (Douglass).
Figs. 7–8. Lower dentition of *Palæomeryx bojani* H. von Meyer.
(All figures natural size.)



Figs. 1, 3, 6. Upper dentition of *Dromomeryx borealis* (Cope).
Fig. 2. Upper dentition of *Dromomeryx americanus?* (Douglass).
Figs. 4, 5. Upper dentition of *Palæomeryx bojani* H. von Meyer.
(All figures natural size.)

terior outer crescents. On $M_{\overline{3}}$ the pillars between the outer crescents are small. In all the molars the antero-external crescents are connected with the postero-internal crescents on the triturating surfaces of the teeth. The first molar is much worn and the last molar slightly abraded.

The associated teeth (No. 706, Carn. Mus. Cat. Vert. Foss.) are very well shown in the figure. All of the teeth show a good deal of wear. The median inner pillars are fairly large. The enamel is more coarsely wrinkled than in the other specimens in the Carnegie Museum. The external surfaces of the postero-external crescent of $M^{\underline{2}}$ is concave (not much ribbed) and the antero-internal crescent has not a long posterior horn. It is doubtful whether this is a species of *Dromomeryx*.

DROMOMERYX MADISONIUS Douglass.

(PLATE LXII, FIGURES 5 AND 6.)

Palæomeryx madisonius Douglass. "The Miocene Lake Beds of Western Montana," University of Montana, 1899, p. 23.

The type of this species is a portion of a mandible with the three molars incomplete (No. 755, Carn. Mus. Cat. Vert. Foss.). Though this specimen undoubtedly represents a species distinct from *Dromomeryx americanus*, yet it is perhaps unfortunate that so small a fragment should be made the type of a species. The teeth in this species are proportionately higher than those of the other species from Montana, in fact there is a pronounced tendency in the teeth to become hypsodont, and the "*Palæomeryx*-fold" is unusually high and sharp. The median outer pillars are not large. The last tooth is worn nearly as much as in *Dromomeryx americanus*, but in all the molars the inner crescents are unconnected by wear with the outer crescents, except in the anterior portion of $M_{\overline{1}}$. The enamel on the outer surfaces of the teeth is very much wrinkled, being completely covered with narrow ridges and valleys of about the same diameter.

A third upper premolar (No. 2146, Carn. Mus. Cat. Vert. Foss.) is provisionally referred to this species on account of its size.

AFFINITIES OF DROMOMERYX.

In his original description of "*Blastomeryx borealis*" Cope said: "While *Dicrocerus* [*Merycodus*] was probably the ancestor of *Antilo-*

capra, *Blastomeryx* was the ancestor of *Cervus* or *Cariacus*."[12] In Volume XX of the *American Naturalist* (1886, p. 369) he calls "*Blastomeryx*" one of the deer-antelopes with persistent horns and deer-like dentition. Scott in his "Mammalia of the Deep River Beds" (page 167) says that the Deep River species "is in many ways similar to the larger species of *Palæomeryx* from the Upper Miocene of Europe, and perhaps should be referred to that genus, though in the present state of knowledge it would be premature to do so. This doubt is justified by the fact that the mandibular dentition of *B. borealis* is still unknown, and we cannot therefore determine whether the lower molars possessed the very characteristic '*Palæomeryx*-fold,' and it is uncertain whether the type of the European species had developed horns." In 1899 Earl Douglass[13] expressed the opinion that the so-called *Blastomeryx borealis*, *B. antilopinus*, and the species which he described were really *Palæomeryx*.

In his paper, "A Complete Skeleton of *Merycodus*," Matthew says: "Two groups of the higher ruminants (*Pecora*) are found in the American Miocene, each combining characters now peculiar to distinct families. The first includes small hypsodont species related to the antelopes, but with branching, deciduous antlers like those of the deer. The second includes brachydont species, mostly of large size, related to the deer, but with horn-cores or antlers unbranched, probably non-deciduous. The hypsodont group includes *Merycodus* (= *Cosoryx*) and the true *Blastomeryx*; the brachydont includes a number of species which have been variously referred to *Dicrocerus*, *Blastomeryx*, and *Palæomeryx*, and which I leave provisionally under the last-named genus."[14] On page 127 of the same paper Matthew says: "Douglass has recently described under this genus two large American species, closely allied to the large brachydont forms referred to *Blastomeryx* by Cope and Scott. Professor Scott had stated in regard to the latter that they would probably have to be removed to *Palæomeryx* if the lower jaw were known to possess the characteristic fold of the anterior crescent of the molars, and this is the chief reason given by Mr. Douglass for referring his species to the European genus. As indicated above, this character is common to many or all

[12] "Descriptions of New Vertebrates from the Upper Tertiary of the West," *Proc Amer. Philos. Soc.*, Vol. XVII, 1877, p. 223.

[13] "The Miocene Lake Beds of Western Montana," 1899, p. 20.

[14] *Bull. Amer. Nat. Hist.*, Vol. XX, Art. VII, March, 1904, p. 101.

of the Miocene deer with very brachydont molars; it occurs in *Dicrocerus*, *Dremotherium*, and *Amphitragulus*, as well as in *Palæomeryx*. All the American species that I have seen differ considerably in their dentition from any of the European genera, and appear to possess a different type of antler from any, perhaps a more primitive one. Unfortunately all the known specimens are more or less damaged in this part; all appear to be in velvet, unbranched, and without burr, but whether this was a permanent condition it would be unsafe to say. The specimens in this museum, though numerous, are mostly fragmentary, and the correlation of parts more or less uncertain. For the present, therefore, it is better to leave this group of brachydont American species under *Palæomeryx*."

In the paper[15] from which I have just quoted, Matthew proposed *Merycodontidæ* as the name of a family equal in rank with the *Bovidæ*, *Antilocapridæ*, and *Giraffidæ* in the *Bovidæ typica*. In this new family he put the two extinct American genera *Merycodus* and *Blastomeryx* — not including the species which are described in the present paper as *Dromomeryx*. These he put in the family *Cervidæ*.

In a more recent paper by Matthew is the following: "*Blastomeryx antilopinus* Scott, 1894, and *B. borealis* Cope, 1878, with *Palæomeryx americanus* and *madisonius* Douglass, 1900, belong to a larger, more brachydont phylum of *Cervidæ*, with supraorbital horns (or antlers) of peculiar type. They are distinct from *Blastomeryx*, probably also from the true *Palæomeryx*, but at present are of uncertain relationship."[16]

Without a long and painstaking study of the Ruminantia I would not wish to give an opinion as to the relationship of *Dromomeryx*. I may say, however, that I agree with Dr. Matthew in his last statement, quoted above. *Dromomeryx* at present undoubtedly stands, like *Antilocapra*, by itself, and it may well be that the ancestors of the latter were no very distant relatives of the former, but the proof is wanting. As before implied the general skeletal structure of the two is very similar, the most striking differences being in the teeth, the brain-case, and the proportions of the bones. For comparison with *Palæomeryx* a re-study of the European in connection with the American forms is needed. The ruminants however illustrate very well the

[15] *Ibid.*, pp. 103–104.

[16] "Osteology of *Blastomeryx* and Phylogeny of the American Cervidæ," *Bull. Amer. Mus. Nat. Hist.*, Vol. XXIV, June, 1908, p. 546.

fact that the very wealth of individuals and species brings one into confusion when forming phylogenetic trees. When there were fewer known, this seemed a comparatively easy matter, but the discovery of more complete material and of hitherto unknown forms nearly always destroys hypothetical genealogies and shows that they are only approximations to the truth.

If we class *Dromomeryx* with the existing *Cervidæ* it agrees with the Telemetacarpalia in possessing the distal ends of the lateral metacarpals. This group, according to Matthew, includes all of the *Cervidæ* of the new world. If Matthew's contention [17] be true, that *Leptomeryx*, *Blastomeryx*, *Mazama*, *Odocoileus*, and the large Nearctic Cervidæ are structurally and genetically connected, and were separated from the Cervidæ of the Old World; then there is no reason to believe that *Dromomeryx*, the affinities of which are doubtful, has any very intimate connection with European forms. It seems to the writer more probable, then, that instead of *Dromomeryx* furnishing any evidence of Miocene migration from Europe to America, it was derived from some unknown forms either from America, or from some other region outside of Europe; though, of course, the fossils that have been recovered from the most favored regions represent only a fraction of the many forms that lived in these regions, so that we cannot depend too much upon negative evidence.

Geological Relations of Dromomeryx.

In Volume XX of the *American Naturalist* (1886, pp. 368 and 369) Cope gives lists of the faunæ of the Deep River beds of Montana and of the Cottonwood Creek (Mascall) beds of the Miocene of Oregon, both of which he includes in his Ticholeptus beds. *Blastomeryx borealis* is the only name common to these two lists. Professor W. B. Scott, however, doubts the specific identity of the specimens from the two localities. He says: "The presence of *Blastomeryx* would of itself be insufficient for the correlation of the two localities, but the identification of the species is not at all certain. Besides certain minor differences in the teeth, the limb bones from the Oregon beds indicate the existence there of two species, both of which are heavier than the Montana forms and more like others from the Loup Fork of Kansas." [18]

[17] *Ibid.*, pp. 546, 556, etc.

[18] "The Mammalia of the Deep River Beds," *Trans. Amer. Philos. Soc.*, Vol. XVII, 1893, p. 60.

In a recent letter to me Dr. W. D. Matthew writes: "The referred material from Oregon (Mascall) consists of upper jaws more or less incomplete, teeth, and limb and foot bones. It is very close to *B. borealis* although not identical specifically in my judgment."

Professor Scott found *Dromomeryx borealis* and *D. antilopinus* in the Deep River beds of Montana. Mr. Douglass found part of a skull not distinguishable from *Dromomeryx borealis* and two or three other species, referred to *Palæomeryx americanus* and *Palæomeryx madisonius* in the Miocene deposits of the Lower Madison Valley in Montana. He also found part of a skeleton of *Dromomeryx antilopinus* in the typical locality of the Deep River beds. In 1899 he found large portions of skeletons in the Flint Creek beds in Montana. Dr. Matthew has listed "*Palæomeryx*" in the Pawnee Creek beds of Colorado and the Santa Fe beds of New Mexico.

I give below a table showing the deposits in which the species, referred in this paper to *Dromomeryx*, have been found with some of the associated fossils which appear to be most characteristic. I think there is little doubt that these beds are, comparatively speaking, nearly related in time, though no two of the faunas may be exactly contemporaneous.

	Deep River, Montana.	Flint Creek, Montana.	Madison Valley, Montana.	Pawnee Creek, Colorado.	Mascall, Oregon.	Sante Fe, New Mexico.
Mylagaulus	×	×	×?	×		
Trilophodon	×?		×	×		×
Aphelops		×	×	×	×	×
Merychippus		×	×	×	×	×
Hypohippus	×	×?	×?	×		
Protohippus	×	×	×		×	
Pronomotherium		×	×			
Protolabis			×	×		
Procamelus		×	×	×		×
Blastomeryx		×	×	×		
Merycodus		×	×	×	×	×
Dromomeryx	×	×	×	×	×	×
Dromomeryx borealis	×	×	×			

I would for the present place these various deposits in the Upper Miocene, though some may be found to belong to the uppermost portion of the Middle Miocene of America. On account of the differences existing in the faunas of the Miocene of Europe and America it may lead to confusion and misunderstanding to attempt to correlate the minor divisions of the American strata with those of Europe. The most of the fossils which are used in correlation appear, on closer study, to have been wrongly identified.

EXPLANATION OF PLATES.

PLATE LIX.

Dromomeryx borealis (Cope). One half natural size. (No. 827, Carn. Mus. Cat. Vert. Foss.)

PLATE LX.

Dromomeryx borealis (Cope).

Fig. 1. Left fore limb, front view. (No. 1542, Carn. Mus. Cat. Vert. Foss.)
Fig. 2. Left fore limb, external view. (No. 1542, Carn. Mus. Cat. Vert. Foss.)
Fig. 3. Humerus. (No. 827, Carn. Mus. Cat. Vert. Foss.)
Fig. 4. Tibia. (No. 1542, Carn. Mus. Cat. Vert. Foss.)

(*All figures one fourth natural size.*)

PLATE LXI.

Restoration of *Dromomeryx borealis* (Cope). One twelfth natural size. (Restored from specimens Nos. 827 and 1542, Carn. Mus. Cat. Vert. Foss.)

PLATE LXII.

Dromomeryx americanus (Douglass). Type of the species, from the Lower Madison Valley, Montana. (Carn. Mus. Cat. Vert. Foss. No. 705).

Fig. 1. Top view of teeth.
Fig. 2. Outer view of mandible.

Dromomeryx borealis (Cope). (No. 827, Carn. Mus. Cat. Vert. Foss.) This mandible was associated with the skull which is figured on Plate LIX.

Fig. 3. Top view of teeth.
Fig. 4. Outer view of mandible.

Dromomeryx madisonius (Douglass). Type of the species, from the Lower Madison Valley, Montana. (No. 755, Carn. Mus. Cat. Vert. Foss.)

Fig. 5. Top view of molars.
Fig. 6. Outer view of portion of mandible.

Palæomeryx bojana H. von Meyer. Sansan, France. (No. 2263A, Carn. Mus. Cat. Vert. Foss.)

Fig. 7. Top view of last molar.
Fig. 8. Outer view of same.

(*All figures natural size.*)

PLATE LXIII.

Dromomeryx borealis (Cope). From Madison Valley, Montana. (No. 1542, Carn. Mus. Cat. Vert. Foss.)

Fig. 1. Top view of molars and premolars.
Fig. 3. Outer view of the same.

Dromomeryx americanus ? (Douglass).

Fig. 2. Top view of molars and last two premolars. (No. 706, Carn. Mus. Cat. Vert. Foss.)

Palæomeryx bojani H. von Meyer. From Sansan, France. (No. 2263, Carn. Mus. Cat. Vert. Foss.)

Fig. 4. Outer view of molars and last premolar.

Fig. 5. Top view of the same.

Dromomeryx borealis (Cope). Teeth of nearly complete skull. Lower Madison Valley, Montana. (No. 827, Carn. Mus. Cat. Vert. Foss.)

Fig. 6. Top view.

(*All figures natural size.*)

XII. FOSSILS FROM THE GLACIAL DRIFT AND FROM THE DEVONIAN AND MISSISSIPPIAN NEAR MEADVILLE, PENNSYLVANIA.[1]

By William Millward.

This paper falls naturally into two parts, namely, the fossils of the glacial drift, and the fossils found in the bedrock. In dealing with the former phase of the subject the writer has felt free to cover a considerable extent of territory, because of the wide extent of the glacial deposits. Specimens have been collected at Conneaut Lake, Harmonsburg, Meadville, Kerrtown, Saegertown, South Oil City, Reno, Utica, Sugar Creek, Carlton, and from the river gravels at Cheswick. Nearly all of the glacial drift of this section of northwestern Pennsylvania is late Wisconsin. There is, however, on the hills on the east bank of French Creek between Utica and Sugar Creek, an extensive deposit of earlier drift, presumably Kansan or Pre-Kansan. In dealing with the fossils of the bedrock only the immediate region of Meadville has received attention.

The writer takes this occasion to acknowledge his indebtedness to Dr. Percy E. Raymond of the Carnegie Museum, Pittsburgh, for his kindness in checking and correcting the identification of the corals and other fossils from the glacial drift, and of most of the fossils from the bedrock; and for his aid and direction in the preparation of this paper. He is also indebted to Prof. Robert S. Breed, Allegheny College, Meadville, for his direction and oversight in the preparation of the original paper of which this is a revision. Thanks are also due Messrs. W. L. Mould, W. R. Main, Abram Wilkinson, L. W. Sherwin, McNair, Taylor, and First, for specimens contributed or loaned.

The Fossils of the Glacial Drift.

The drift is made up of subangular stones mingled with gravel, clay, and sand. In some places the materials of the drift have been waterworked and are stratified, while in other deposits no stratification

[1] This paper is a revised abstract of a thesis which won the second Heckel prize at Allegheny College, June, 1908. A suite of the fossils on which the paper is based has been deposited in the Carnegie Museum.

is visible. Probably less than one per cent. of the pebbles of the drift in this region were derived from Archæan rocks, and the remaining débris consists of fragments of sandstone, chert, and limestone. Pieces of shale and sandstone bearing Chemung fossils are most abundant. These pebbles contain such characteristic species as *Spirifer disjunctus*, *Reticularia præmatura*, *Camarotœchia contracta*, *Productella lacrymosa*, *Athyris angelica* and *Leiorhynchus mesacostale*. No attempt was made to make a complete collection from this class of pebbles. Less abundant than these sandy pebbles, but still quite common, are fragments of fossiliferous chert, while the pebbles of limestone make up an insignificant portion of the drift. Practically all the fossils in the cherts are silicified, and while many of them are considerably water-worn and rounded, many fine specimens may be obtained. With but few exceptions the cherts have been much weathered since transportation to this region. The flint has decomposed to a white chalky material, and occasionally a delicate coral is found entirely freed from the matrix, a condition in which it could not possibly have withstood the rough usage of ice transportation.

LIST OF FOSSILS FOUND IN THE LIMESTONE AND CHERT PEBBLES OF THE WISCONSIN DRIFT.

Stromatoporella granulata,
S. tuberculata,
Stromatoporella sp.,
Favosites hemisphericus,
F. canadensis,
F. clausus,
F. emmonsi,
F. epidermatus,
F. limitaris,
F. nitellus,
F. placentus,
F. tuberosus,
F. turbinatus,
Favosites 2 sps.,
Aulopora cornuta,
A. serpens,
Romingera umbelifera,
Syringopora hisingeri,
Cystiphyllum sulcatum,
C. varians,
Eridophyllum verneuilanum,
Synaptophyllum simcœnse,
Streptelasma 3 sps.,
Heliophyllum corniculum,
H. halli,
Zaphrentis convoluta,
Z. elegans,
Z. gigantea,
Z. prolifica,
Z. simplex,
Z. spissa,
Stropheodonta perplana,
S. hemispherica,
S. inæquistriata,
Leptæna rhomboidalis,
Schuchertella chemungensis,

S. maclurei,
S. perelegans,
S. tabulata,
Syringopora sp.,
Chonostegites clappi,
C. ordinatus,
Chonostegites 2 sps.,
Michelinia convexa,
Cladopora cryptodens,
C. pulchra,
Striatopora linnæana,
Pleurodictyum styloporum,
Halysites catenulatus,
Acervularia davidsoni,
Philipsastræa verneuili,
Crepidophyllum colligatum,
Acrophyllum oneidaense,
Blothrophyllum decorticatum,
Cyathophyllum conatum,
C. robustum,
Cystiphyllum conifollis,
Chonetes sp.,
Camarotœchia tethys,
Delthyris raricosta,
Spirifer gregarius,
Atrypa reticularis,
Anoplotheca acutiplicata
Dalmanella lenticularis,
D. testudinaria,
Plectambonites sericeus,
Callonema bellulata,
Platystoma lineatum,
Platyceras dumosum,
Tentaculites scalariformis,
Calymmene platys,
Encrinurus sp.,
Acidaspis callicera,
Proëtus sp.,
Phacops cristata,
P. cristata var. *pipa*,
Phacops sp.,
Cornulites sp.

Of these fossils thirty-six species are found in the Onondaga, thirteen in the Hamilton, one in the Niagara, two in the Trenton, nine in both the Onondaga and Hamilton, two in the Onondaga and Chemung, one in the Onondaga, Hamilton, and Chemung, one in the Oriskany, Onondaga, and Hamilton, and two are fossils which range all through the upper part of the Paleozoic.

THE SOURCE OF THE DRIFT.

In the Second Geological Survey of Pennsylvania, 1881, Vol. Q4, p. 31, Dr. I. C. White states that the direction of glacial scratches on thirty or forty hill-tops in Erie and Crawford counties is uniformly about S. 30° E. College Hill, Meadville, is one of these hills. Ice coming in the direction indicated by these scratches, would, in crossing the province of Ontario, pass over strata of Hamilton, Onondaga, Niagara, and Trenton age and this would account for the presence of these fossils in the glacial drift of northwestern Pennsylvania.

Of the corals listed above, ten species are reported from Ontario and not from New York, while but two species are reported from New

York and not from Canada. The other species listed are found in both regions. The evidence of the corals is then in favor of Canada as the source of the drift of this region. The Chemung fossils have no special value in this connection, as they could have been brought from anywhere in the region immediately to the north of Meadville. The presence of granitic pebbles also indicates the Canadian origin of the drift, for Archæan rocks are not found native to New York, save in the northeastern part of the state.

FOSSILS OF THE OLDER DRIFT.

The older drift (Kansan or Pre-Kansan), referred to above was not found to be so fossiliferous as the Wisconsin. The boulders are largely of local origin, many being of Sharon conglomerate. Only one piece of fossiliferous chert was found, and the granitic pebbles were few in number.

THE FOSSILS OF THE BEDROCK.

The formations exposed at Meadville are as follows, in descending order, the section being that given by Dr. I. C. White in the Report on Erie and Crawford counties, cited above:

17.	Sharon conglomerate	45 ft.
16.	Shenango shale	50 ft.
15.	Shenango sandstone	25 ft.
14.	Meadville upper shale	25 ft.
13.	Meadville upper limestone	1 ft.
12.	Meadville lower shale	40 ft.
11.	Sharpsville upper flags. No. 10 is in this formation	50 ft.
10.	Meadville middle limestone	1 ft.
9.	Meadville lower limestone	2 ft.
8.	Sharpsville lower flags	12 ft.
7.	Orangeville shale	75 ft.
6.	Corry sandstone	20 ft.
5.	Cussewago upper shale	5 ft.
4.	Cussewago limestone	2 ft.
3.	Cussewago middle shale	30 ft.
2.	Cussewago sandstone	25 ft.
1.	Riceville shale	80 ft.

Fossils have been found in the Riceville shale, the Orangeville shale, the Sharpsville upper and lower sandstones, the Meadville lower shale, the Meadville middle limestone, the Meadville upper limestone, and the Meadville upper shale.

LIST OF FOSSILS FOUND *in situ*.

1. Riceville shales.

Coral, rr.	*Lyriopecten solox*, r.[2]
Calathospongia sp., r.	*Aviculopecten patulus*, r.
Fenestella sp., r.	*Mytilarca chemungensis*, r.
Lingula sp.	*Leiopteria chemungensis*, r.
Lingulodiscina newberryi, c.	*Leiopteria* sp., r.
Schuchertella chemungensis, r.	*Pararca neglecta*, r.
Chonetes setigerus, c.	*Pararca sao*, c.
Productella hirsuta, c.	*Goniophora chemungensis*, c.
P. boydi, c.	*Paracyclas ignota*, r.
Productella lacrymosa, c.	*Paracyclas rotunda*, c.
Productella sp., r.	*Glossites lingualis*, r.
Spirifer disjunctus, c.	*Euomphalus hecale*, r.
Reticularia prœmatura, c.	*Euomphalus* cf. *laxus*, r.
Cyrtia alta, r.	*Loxonema* sp., rr.
Cryptonella eudora, rr.	*Porcellia* sp., rr.
Leptodesma liopteroide, rr.	*Conularia*, sp., r.
Leptodesma sp., r.	*Orthoceras pertextum*, rr.
Crenipecten glaber, r.	Fish remains, r.
Crenipecten crenulatus, r.	

7. Orangeville shale.

Lingula meeki, c.	*Productella boydi*, r.
Lingulodiscina newberryi, c.	*P. lacrymosa*, r.
Chonetes setigerus, r.	

8. Sharpsville lower sandstone.

Lingula sp., r.

10. Meadville middle limestone.

Crinoids. Species not yet determined.

Lingulodiscina newberryi, c.	*Chonetes setigerus*, r.
Schizophoria tioga, r.	*Schuchertella desiderata*, r.

11. Sharpsville upper sandstone.

Lingula sp., c.	*Syringothyris herricki*, rr.
Glossina waverlyensis, r.	*Cyrtia alta*, rr.
Lingulodiscina newberryi, c.	*Leptodesma potens*, rr.
Schizophoria tioga, a.	*L. mortoni*, rr.
Schuchertella desiderata, c.	*Modiomorpha tioga*, rr.
Chonetes setigerus, c.	*Pholadella newberryi*, rr.

[2] *rr*, signifies very rare; *r*, rare; *c*, common; *a*, abundant.

Productella lacrymosa, r.	*Elymella patula*, r.
P. boydi, c.	*Paleoneilo truncata*, c.
Camarotœchia orbicularis, c.	*Conularia continens*, r.
C. contracta, r.	*Orthoceras* sp., rr.
Spirifer sp., r.	

12. Meadville lower shale.

Orbiculoidea sp., r.	*Glossites depressus*, r.
Schuchertella desiderata, rr.	*Schizodus chemungensis*, rr.
Chonetes setigerus, r.	*Pholadella newberryi*, r.
Athyris angelica, rr.	

13. Meadville upper limestone.

Lingulodiscina newberryi, c.	*Ceratiocaris* sp., rr.
Camarotœchia sp., c.	*Apedodus priscus*, r.
Chonetes setigerus, c.	*Cladodus coniger*, r.
Conularia victa, c.	*Helodus comptus*, r.
Proëtus sp., rr.	*Helodus gibberulus*, c.

14. Meadville upper shale.

Crinoids of species not yet determined.

Lingula sp. r.	*Athyris angelica*, r.
Glossina waverlyensis, r.	*Leda pandoriformis*, r.
Lingulodiscina newberryi, c.	*Paleoneilo sulcatina*, r.
Schizophoria tioga, r.	*Modiomorpha tioga*, r.
Schuchertella crenistriata, rr.	*Bellerophon nactus*, rr.
Chonetes setigerus, c.	*Conularia victa*, r.
Productella boydi, r.	*Orthoceras leander*, r.
Camarotœchia contracta, r.	*Orthoceras* 2 sps.

In addition to the species listed above, three specimens of a new species of *Lepidechinus* have been found near Meadville, but unfortunately not *in situ*. It is not known from what horizon they came, but it seems most probable that they were from the Riceville shale, although the Sharpsville upper sandstone and the Meadville upper shale are considered as possibilities.

CONDITIONS OF DEPOSITION.

A number of facts show that the rock-layers of the region of Meadville are shallow water deposits. (1) First among these facts is the nature of the strata, nearly all the formations being sandstones or shales. The only limestones present are very impure. (2) In the Riceville shale, Cussewago sandstone, and the Sharpsville lower sandstone very pronounced ripple marks are found. These are usually produced on a shallow bottom. (3) The Sharon conglomerate which has at the base a layer ten feet in thickness made up almost entirely of white quartz pebbles shows a near-shore condition. The Meadville upper limestone is a hard layer composed of pebbles of various sizes and kinds, some containing fossils. These pebbles likewise indicate a near-shore condition. (4) The presence of large numbers of fucoidal seaweeds, not only in the Riceville but also in the Meadville shale, is still further evidence of the shallow water conditions. (5) Worm burrows are found in many of the shales. This is especially true of the Riceville shales, and of the shaly layers in the Sharpsville sandstones. (6) The character of the fauna indicates shallow water conditions with a more or less muddy bottom. *Lingulæ* are found rather abundantly in all the fossil-bearing layers except the Meadville lower shale. *Lingulodiscinæ* are found in all the fossil-bearing layers except the Sharpsville lower sandstone. Both of these animals inhabit near-shore muddy and sandy bottoms. The presence of broken up *Lingulodiscinæ* shells and fish remains among the pebbles of the Meadville upper limestone is still further evidence of the near-shore shallow water conditions. The fish remains, which are all dismembered and broken, have been washed in, while the shells of the *Lingulodoscinæ* have been ground up by the action of the water and the pebbles. (7) The absence of a deep-sea fauna indicates a near-shore shallow water condition. It is true that a few *Orthoceratites* have been found, but these were in such a condition as to show that they were broken before being imbedded in the matrix in which they were found. It would seem that the empty shells had floated in from a distance. Only two specimens of coral were found, one in the Riceville shale, and one in the Meadville upper shale. Both of these specimens were poorly preserved. This almost complete absence of the corals would indicate that for the most part the bottom was too muddy for corals to grow. In some of the layers crinoid stems have been found, but in all cases, except occasionally in the Riceville shale, these are but small fragments. (8) Several specimens of *crinoids* have been found in the Meadville middle limestone. This layer is not more than six inches thick, and for the most part is made up of nodules. The presence of so few crinoids and the thinness of the layer in which they are found would indicate a fairly deep-sea condition for a very limited time.

AGE OF THE FORMATIONS.

The Sharon conglomerate belongs to the Pennsylvanian, and has been assigned a place in the upper part of the Pottsville by David White, *Bulletin Geological Society of America*, Vol. XV, 1905. The other formations of this section, excluding the Riceville, were classed by Dr. I. C. White in the report cited above as the sub-conglomerate formations, which he divided into the

Shenango group,
Meadville group, and
Oil Lake group.

The Shenango and Meadville groups are correlated by Dr. White with the Cuyahoga Shales of Ohio, and the Oil Lake group with the Berea Grit of Ohio, both of which belong to the Waverly (Mississippian). The Chemung facies of the fauna of the Riceville shale was recognized by Dr. White, but the position of the formation was not definitely fixed in the report cited.

In the *Bulletin Geological Society of America*, Vol. XIV, page 177, 1903, Professor Williams has correlated the Shenango, Meadville, and Riceville with the Bedford, Berea, and Cuyahoga of Ohio and the strata between the Chemung and Olean of New York. In regard to the fauna, he states, on page 184, that Chemung species are not found above the Riceville shales, the pure Waverly fauna coming in above that formation.

Professor Stevenson, *Bulletin Geological Society of America*, Vol. XIV, page 42, 1903, places the Shenango and upper Meadville in the Mississippian, and correlates them with the Logan and the Waverly shales (Herrick) of Ohio. The Lower Meadville, Sharpsville, Orangeville, and Oil Lake he places in the Devonian, and correlates them with the Cuyahoga and Berea of Ohio. The Riceville and Venango he correlates with the Chemung of New York.

Girty (*Science*, n. s., Vol. XIX, no. 470, Jan. 1, 1904, p. 24) has traced the Berea of Ohio into the Cussewago sandstone of northwestern Pennsylvania.

As may be seen from the above lists of fossils, most of the faunules contain some Chemung species, but those of the strata above the Riceville are closely related to the faunas described from the Waverly of Ohio.

XIII. A NEW SPECIES OF HELODUS.

By Charles R. Eastman.

Helodus comptus, sp. nov.

Description. — Teeth of moderate size, laterally elongated, having the coronal contour gently arched without rising into a distinct prominence, and the general surface wrinkled by a numerous series of fine transverse corrugations which extend over the entire superficies between the long lateral margins without being interrupted by a longitudinal crest. Punctations of the coronal surface confined to and apparently determining the linear arrangement of the transverse rugæ. The root is apparently short, reaching but little below a narrow smooth band at coronal base along the lateral margins, and coarsely crenulated as in some species of *Chomatodus.* Transverse rugæ becoming more or less obliterated in worn specimens, and punctæ appearing as rather conspicuous pores.

The above definition is intended to express the more salient characteristics of a number of detached Cochliodont teeth from the Waverly of northern Pennsylvania, recently submitted to the writer for investigation by Mr. William Millward of Meadville. Although the generic relations of these anterior teeth are necessarily somewhat uncertain, there can be no doubt that they are specifically distinct from all forms of Cochliodont dentition hitherto described, and considerable interest centers, therefore, in their discovery. The majority of dental crowns are well preserved, the roots imperfectly so. They present little individual variation, but show among themselves different effects of wear. The largest specimen in the collection has a total length of slightly less than 2 cm., and breath of 0.7 cm. In smaller specimens the dental crown is proportionally somewhat wider.

Different types of the anterior dentition of Cochliodont sharks are commonly assigned to various genera whose status must be regarded as purely provisional: such, for instance, as *Helodus* (exclusive of *H. simplex*), *Chomatodus*, *Lophodus*, *Venustodus*, in which the lenticular crowns cannot be correlated with the large posterior grinding plates of well recognized forms. It happens, moreover, that the anterior teeth of *Psephodus*, *Cochliodus* and possibly still other forms are generically indistinguishable from those of *Helodus;* and as shown by Dr. Traquair, the teeth described as "*Helodus*" *planus* and "*Lophodus*" *didymus* belong to the mouth of one and the same fish, that to which Agassiz first gave the name of *Cochliodus magnus*, and now known as *Psephodus magnus*.[1] In the same way the present writer has been able to identify the arched series of teeth named *Helodus coxanus* by Newberry as representing in reality the symphysial dentition of *Cochliodus latus* Leidy.[2]

In view of these considerations there are at present no valid means for determining the precise relations of either the teeth which are here regarded as a new species of "*Helodus*," or those which accompany the new form in the same horizon and locality, previously made known by Newberry under the title of *H. gibberulus*. From other provisional species of *Helodus* and *Chomatodus* the form under discussion is distinguished by its transversely wrinkled coronal surface, without either a longitudinal elevation or median prominence. From *Orodus* and its congeners, on the other hand, it differs in that the transverse rugæ are not interrupted by a longitudinal crest or furrow, as well as by the absence of median elevations.

Horizon and Locality. — Meadville upper limestone (base of the Waverly); Cemetery ravine, Meadville, Pennsylvania. Collected by Mr. William Millward, of Peking, China, to whom thanks are due for the privilege of studying the typical material.

[1] *Trans. Geol. Soc. Glasgow* (1884), Vol. VII, p. 396; also *Geol. Mag.* (1885), dec. 3, Vol. II, p. 344.

[2] *Amer. Nat.* (1900), Vol. XXXIV, p. 582, and *Bull. Museum Comp. Zoöl.* (1903), Vol. XXXIX, p. 203.

In Memoriam.

CHARLES CHAUNCEY MELLOR.[1]

The paternal and maternal ancestry of Charles Chauncey Mellor was English. His father, John H. Mellor, was born December 3, 1807, at Heaton-Norris near Stockport, Lancashire, England. The parents of John H. Mellor were James and Hannah Mellor, who emigrated to the United States not long after the birth of their son, and finally made their home in the city of Pittsburgh. The mother of Charles Chauncey Mellor was Julia Ann Hillier, who was born in 1806 at Bath, England, and came with her parents to Philadelphia, where her father engaged in mercantile pursuits, and where he died in the year 1821, leaving a moderate competence to his widow and children. In 1834 Miss Hillier came to Pittsburgh to reside with her eldest brother, Thomas A. Hillier, who several years before had established himself in this city as a merchant, dealing in mirrors and pictures.

Mr. John H. Mellor began his active life in Pittsburgh as a dealer in books, stationery, music, and musical instruments, and because he was a cultivated and skilful musician, was early in the year 1831 chosen as the organist of Trinity Church. Shortly after the arrival of Miss Hillier in Pittsburgh, she became a member of the choir of that church. An acquaintance with Mr. Mellor was inevitable, and this ripened into friendship, and marriage. John H. Mellor and Julia Ann Hillier were united in the bonds of wedlock on January 10, 1836, at the home of Mr. and Mrs. James Mellor, which was at that time located at the corner of Third and Smithfield Streets. The officiating clergyman was the Rev. George Upfold, the Rector of Trinity Church, who subsequently became the Bishop of Indiana.

[1] In preparing this brief biographical sketch the writer has been greatly aided by being permitted to have access to an account of his life prepared by Mr. Mellor for the use of his family, who with the utmost kindness have allowed the writer to have the pleasure of its perusal.

CHARLES CHAUNCEY MELLOR

Born September 26, 1836; Died April 2, 1909.

On September 26, 1836, the home of the young married people was gladdened by the birth of a son, to whom the baptismal name of Charles Chauncey was given, in recognition of the feeling of deep regard which Mrs. Mellor cherished for Mr. Charles Chauncey, who had been her guardian during her minority. Mr. Chauncey was a highly respected member of the legal profession in Philadelphia and a warm friend of the family.

The early life of Mr. Mellor was not unlike that of other healthy American boys. When about six years of age he was sent to the Fourth Ward school, the building of which was located on Ferry Street between Fourth and Liberty. The teacher of this school at that time was a young man named David McCandless, who in later years was a partner of Mr. Andrew Carnegie, and one of the organizers of the Edgar Thompson Steel Company. Brothers and sisters were born, and he learned in the home those lessons of kindness and mutual forbearance which are the result of association in a family where there are a number of children. In the spring of 1843 the family removed from Ferry Street in Pittsburgh, to a new home situated on Sandusky Street, Allegheny, a few doors below Ohio Street, and he was sent to the Fourth Ward school of that city, which was presided over by Mr. Robert Creighton, an Irishman, who plumed himself upon his ability as a penman, and under whose instruction young Mellor soon became proficient in the art of making quill pens and of writing. He began at this time to attend the Sunday school which was maintained in the small Swedenborgian chapel which stood at the foot of Sandusky Street, near the banks of the river. His grandfather was a member of this church, having while still in England identified himself with the followers of Emanuel Swedenborg. He continued for a number of years to attend this Sunday school, and here he became acquainted with a bright, happy-hearted Scotch boy of the neighborhood, who sat beside him in the class. This boy was Andrew Carnegie, of whom the world was destined to hear more in coming years.

The store of Mr. John H. Mellor was located on the east side of Wood Street between Fifth Avenue and Virgin Alley (now Oliver Avenue). To the upper part of this building the family removed in 1844. It was quite customary at this time for merchants to make their homes in the upper stories of the buildings in which they carried on their business. Young Mellor having returned to Pittsburgh was now sent to the Third Ward school, where his skill in penmanship, acquired under Mr. Creighton, served to secure for him some favor from the writing-master of the school, who was also an Irishman, and a rather severe disciplinarian, whose ruler was a terror to his pupils, but from the blows of which young Mellor succeeded in escaping to some extent in recognition of his ability as a penman.

About this time the native instincts of the boy began to assert themselves. He undertook to form a "museum," arranging his collections in shallow pasteboard boxes. Much of his time was spent in the exploration of Grant's Hill, portions of which had been left after streets had been graded through it, all of them contiguous to the Third Ward school. Upon Grant's Hill a skirmish had been fought during the French and Indian War, and prodding over the ground with a sharp piece of iron, young Mellor succeeded in recovering many bullets, a musket, a bayonet, a cartridge-box, and a leather holster in very fair preservation. These things he displayed in his museum, charging the admission price of one cent, the revenue thus received being expended in purchasing additions to the collection.

On the tenth of April, 1845, Pittsburgh was visited by a terrible conflagration, by which about one third of the city as it existed at that time was destroyed, and about two thirds of the property values represented by buildings and their contents consumed. Mr. John H. Mellor and his family made strenuous efforts to remove their belongings from the store and home, but fortunately for them the fire swept by the spot, and though thousands had been financially ruined, this disaster proved in the case of Mr. Mellor a blessing in disguise, for his store was the only one left standing in Pittsburgh at which books, stationary, and similar supplies could be obtained. The result was a great increase in business and the building up of an extensive patronage, which was afterward successfully held because of the uniform affability and courtesy of the owner of the house. The young lad soon made himself helpful in the store. The environment, with a supply of books and musical instruments at hand, was congenial to him. His father and mother were possessed of more than ordinary culture and of great musical taste.

He began to study music, at first apparently with little profit to himself, but afterwards he became more and more interested, and the great talent which he possessed became evident. In 1849, he was sent to Mr. Travelli's Academy in Sewickley. Mr. Travelli, who is still remembered by many of the older men of Pittsburgh, was a singularly successful teacher, and his school enjoyed a well-deserved reputation at that time. He remained here for about two years, and during all of his later life was wont to refer in terms of affection to the faithful care and kindness of the principal of the Sewickley Academy.

In 1852 he began seriously to study the piano under Professor Henry Rohbach, who undoubtedly was the ablest teacher of music then living in Pittsburgh, and in a few years acquired skill in the use of the instrument. He continued to pursue his studies in other branches under different private instrúctors, who at that time maintained schools in Pittsburgh, and also to assist his father in his store, which had come to be the principal dépôt of musical instruments in the city, and in which there continued to be kept a large supply of books and stationery. In the books, to which he thus had access, he found friends, and developed a taste for reading which remained with him through all after life. He occasionally accompanied his father on his visits to Philadelphia, New York, and Boston, and on these occasions was thrown into the company of manufacturers and dealers in musical instruments, and what delighted him most, into the society of distinguished musicians, from association with whom he derived inspiration. His skill as a musical performer became known, and he was occasionally called upon to play in public at concerts.

In 1854 Mr. Jardine came to Pittsburgh in order to erect a new organ in Trinity Church. Young Mellor, though but eighteen years of age, was engaged by Mr. Jardine as one of his assistants to take down the old organ and to erect the new one. His father was especially anxious that he should undertake this work, believing that it would be to his advantage to gain an intimate knowledge of the construction of the instrument. Subsequently this knowledge was turned to useful account, and Mr. Mellor directed the erection of a number of organs in other churches in later years. He came to be recognized as an authority and his advice as to the planning and construction of organs was sought during the latter years of his life, not only by his neighbors, but by contemplating purchasers in distant cities and states.

During the years 1853 and 1854 he studied musical composition under Mr. Gottlieb A. Anthon, from whom he derived a thorough acquaintance with the theory of music, although Mr. Anthon, who was hardly able to speak a word of English, was not peculiarly adapted at the time to be a teacher. The ready ability of his pupil, however, overcame the difficulties of communication which existed between the two. In 1855 he went to Boston, at his father's suggestion, in order to become acquainted with the construction of pianos and reed-organs. He boarded while in Boston with a Mrs. Guild whose kindness he never forgot. Her son subsequently founded the "Boston Commercial Bulletin," and her grandson afterwards became the Governor of Massachusetts. He received much kindness from Mr. Chickering, the head of the great manufacturing firm bearing his name, and from the Messrs. Mason & Hamlin, and enjoyed the opportunity of hearing a number of prominent and skilful musicians whose society was a delight to him.

Returning from Boston he entered at once heartily into the employment provided for him by his father, and in addition to becoming acquainted with all the details of the business, traveled quite extensively through parts of Pennsylvania, Virginia, and Ohio. He still continued his musical studies, making great progress. In April, 1857, Sigismund Thalberg, the most renowned pianist of that day excepting Liszt, came to the United States in order to give concerts in the principal cities. He arrived in Pittsburgh late in April. Young Mellor, who had devoted much time to the study of Thalberg's compositions, was delighted to be placed in charge of the instrument upon which Thalberg performed, and not only became well acquainted with the great master during his stay in Pittsburgh, but accompanied him on his western tour to Wheeling and Zanesville. He derived great inspiration from his brief association with this eminent musician, and on his return nothing would suffice him but to have a grand piano placed in his room on the third floor of the home, where, muffling it with a soft blanket, because his mother's sleeping apartment was below, he played day after day until long after midnight, and also renewed his exercises upon a dumb piano, which he had had made for himself a few years before, constantly exercising one hand upon the instrument, while with the other hand he held a book. The pursuit of music and the delights of literature thus went together.

Already in the summer of 1856 he had become the organist of St. James Episcopal Church located at the corner of Penn and Seventeenth Streets. On the first of January, 1857, he was engaged as the organist of Christ Methodist Episcopal Church located at the corner of Penn and Eighth Streets. About this time he formed the acquaintance of the late Professor Clement Tetedoux, a man of rare accomplishments, who with his cultivated wife came to reside in Pittsburgh, she giving instruction in French, and he in vocal and instrumental music. There was a strong bond of sympathy between young Mellor and the fascinating, but impetuous Frenchman. The reputation of Professor Tetedoux as a teacher rapidly grew, and he never lacked for pupils during all the years that he made his home in Pittsburgh. Constant intercourse with Mr. Tetedoux and daily work at the piano presently created in the young man the belief that his calling in life was to be that of a professional musician. He all but resolved to sunder business relations with his father and to attempt to carve out for himself a career as a public performer. The father, while rejoicing in his son's ability, nevertheless saw matters in a different light, and endeavored to persuade him that while cultivating and using his talents as a musician, it would nevertheless be far more profitable for him to remain where he was and ultimately become his successor in what by this time had come to be a well-established and reasonably profitable enterprise. It was a hard struggle, but finally native prudence and good sense prevailed, and the young man, not without regret, settled down to a career in which music became a secondary interest. It is possible that the musical world lost a great performer, but Pittsburgh gained by this decision an able man of affairs, who because of his musical abilities did perhaps as much as has been done by any one individual to make Pittsburgh the music-loving metropolis of the upper valley of the Ohio.

The business in which he and his father were now engaged prospered, and in June, 1860, as a partial relaxation and for the purpose of widening his knowledge of men and things, young Mellor went abroad in company with his friend Professor Tetedoux, sailing from Boston on June the 13th on the Cunard steamship "Arabia." He visited the cathedral cities of England with a special view to the study of cathedral organs and of English church music. He made the acquaintance of a number of the leading organists and organ builders of London and of other cities. Repairing to France, he devoted himself to a careful study of the manufacture of small instruments, strings, etc., and having been requested by the Chickerings to secure information regarding the manufacture of upright pianos, fortified with a letter of introduction from Mons. Marmontel, the professor of piano at the Conservatory of Music, he visited all the great manufactories of musical instruments, made a collection of all the literature which he could obtain relating to the subject, and a series of notes which he subsequently upon his return submitted to the Chickerings, who not long afterwards engaged in the manufacture of upright pianos. His visit to Paris was full of pleasure and of profit to him and he formed a number of delightful acquaintances among cultivated French people. Returning by way of England he continued his visits to the leading manufacturers and to the cathedral towns, and finally, on October the 8th, embarked for Boston, reaching his home on October the 25th.

Upon his return he found the country and his own city in a ferment. Those were the days which immediately preceded the outbreak of the Civil War. Business was affected most detrimentally, and from that time on until the year 1862 father and son found their ingenuity sorely taxed to meet their obligations and to maintain the well-earned credit of their firm. But in 1862 a remarkable change took place, due to the activities which prevailed, and the enhancement in prices which had taken place. The business became so profitable that all fear passed away. In 1863 Mr. John H. Mellor died, and his son arranged to take over the concern. His training had prepared him for the burdens which he assumed, and from the very outset he was prosperous and succeeded beyond his most sanguine expectations. In this year he was chosen to be the organist of the First Presbyterian Church, which had installed what was at that time the largest organ in Pittsburgh, and here he remained for twenty-one years.

In 1865 Miss Laura Reinhart and her brother, Charles Stanley

Reinhart, became members of the choir of this church, Miss Laura Reinhart being chosen as one of the sopranos, and Mr. Charles Stanley Reinhart assuming the part of one of the bassos. Mr. Charles Stanley Reinhart was destined subsequently to become very eminent, not as a singer, but as an illustrator and painter. Between himself and Mr. Mellor, the young organist, there was soon formed a close friendship, as they were of like ages and tastes, and the acquaintance with the brother led to an acquaintance with the sister, whom he had already known as one of the favorite pupils of Professor Tetedoux, and on the twentieth of June, 1867, they were united in wedlock. They made their home in Allegheny, living first in Cedar Street and in 1873 taking up their residence in Robinson Street where Mr. Mellor built for himself a comfortable house.

Mr. Mellor's interest in the organ, upon which he was rapidly under his own tuition becoming proficient, impelled him in the year 1870 to endeavor so far as possible to improve himself, and he accordingly repaired to Boston, where he made arrangements with Professor Dudley Buck and Mr. John H. Wilcox to give him instruction. He remained there nearly two months studying technique and interpretation under Mr. Buck, and registration under Mr. Wilcox. His visits to Boston were continued from time to time in subsequent years, and he always availed himself of these occasions to study seriously under one or the other of these great masters, who were at that time regarded as the ablest organists in America. In 1873 he erected in his new home an organ blown by a water-motor, the first one set up in Pittsburgh, and here he passed many happy hours, holding the rehearsals of the choir of the First Presbyterian Church under his own roof, and gathering about him many of his cultivated musical friends.

In 1878, on June 13, Mr. Mellor, accompanied by his wife and oldest son, made a tour covering five months in Europe, visiting England, the Netherlands, France, Germany, and Switzerland. In 1881 the family temporarily removed to the old Bakewell Home above what was then known as Superior Station on the Fort Wayne Railroad, where, surrounded by trees and orchards, a couple of years were pleasantly passed.

It was characteristic of Mr. Mellor, while devoting himself with unflagging energy to the cares of his growing business and to his musical work in connection with the services of the First Presbyterian Church, to seek recreation along other lines. While residing in Allegheny he became acquainted with Dr. John Herron, who had erected on the top of his house a small telescope which he invited Mr. Mellor to use. He began the study of astronomy, and purchasing whatever books he could obtain upon the subject, and using the instruments which his learned friend placed at his disposal, he made considerable progress in the knowledge of this science. He presently, however, discovered that in order to go deeply into the mysteries of astronomy it would be necessary for him to have larger facilities, and he discovered that astronomy as a hobby was a pursuit, which in these days of improved telescopy could only be followed by one possessed of larger resources than he at that time felt he could devote to the study. He had become interested in the microscope, and he turned in 1881 from astronomy to the study of the infusoria and of microscopic plants. He soon became very expert in the use of the microscope and began at the same time to form a herbarium of the plants of Pennsylvania. His home life was delightful, and his wife, who possessed great musical culture, found it a pleasure when music palled for the moment, to encourage him in his studies of natural history. He became a member of the American Microscopical Society, and was an attendant upon their meetings and the Treasurer of the Society from 1889 till 1894, when he resigned. He took an active part in organizing the Botanical Society of Western Pennsylvania, and the Iron City Microscopical Society, and was the President of both organizations, and for many years the Treasurer of the former. The local Microscopical Society has passed out of existence, but the Botanical Society still flourishes and is doing commendable work.

In 1884 Mr. Mellor purchased a tract of over seven acres of land in Edgewood on the line of the Pennsylvania Railroad. The tract contained a fine orchard and a bit of the surviving forest lingering in a ravine which was one of its boundaries. His motive in seeking this spot was to find a more healthful home for himself and family, as the hand of death had been laid upon three of his children, and he felt it desirable on this account to escape from the city into the purer air of the country. He resigned his position as organist of the First Presbyterian Church, and devoted himself in all his leisure moments to botanical pursuits. These were for him among the happiest days of his life. His business had prospered; he was able to pursue congenial studies with freedom, his associates being able to carry on affairs in such a way as not to compel him to give unremitting attention to details. Under his guiding hand his place became a garden of beauty. Being a man of public spirit, he entered heartily into the plans of his neighbors, and when the little suburban settlement became a borough he took an active part in affairs, being elected a member of the first borough council, remaining continuously in service from 1890 until 1906, when he resigned. He discharged the duties of the position with unusual fidelity and patience, winning the respect and esteem of his townsmen, among whom he was recognized as a leader in all those things which tend to the advancement of the community. He gave especial attention to the work of laying out, paving, and sewering the streets, securing a municipal supply of light and gas, and more particularly in building up the school-system of the borough. A church having been organized, he and his estimable wife as a labor of love took charge of the musical services, he presiding with his well known skill at the organ, and his wife taking charge of, and singing in the choir. Later he built for himself in an umbrageous spot on Maple Avenue a beautiful home, where he continued to reside until his death.

For some years there had been earnest discussion of the plan for erecting a great library in the city of Pittsburgh to supply the necessary funds for which Mr. Andrew Carnegie had pledged himself. Among other things proposed by Mr. Carnegie was to make provision for the accommodation in the new building of the various scattered scientific societies which had sprung up, among them the Botanical Society and the Microscopical Society. Mr. Carnegie had intimated to the writer of this sketch that it would be practically impossible to treat with a number of societies, and had suggested the organization of a society which should include these various organizations. Representatives of the various societies were accordingly called together for conference and it was resolved to combine them and organize the "Academy of Science and Art of Pittsburgh," of which the various existing organizations should be sections. The plan met with approval. The various societies united their interests, and in 1889 the residence of the late Mr. William Thaw, on Fifth Street in Pittsburgh, was rented as a temporary home for the Academy, the writer becoming the first President, Mr. George H. Clapp the Secretary, and Mr. C. C. Mellor the Treasurer. Mr. Mellor threw himself with his wonted enthusiasm into the work, and when the Carnegie Library of Pittsburgh was dedicated in 1895, he with his associates of the Academy had succeeded in filling the rooms assigned to the museum with a very creditable display of objects representing not only the natural sciences, but also local history.

Upon the dedication of the Library Mr. Carnegie, with that magnificent generosity which has always characterized him, announced his intention of making permanent provision for the support of the Museum and the Department of Fine Arts, which were intended to be housed under the same roof with the Library, and for this purpose stated that he had chosen a certain number of gentlemen, in whose wisdom he had confidence, to administer the affairs of these two departments, for which he gave an endowment amounting to the sum of one million of dollars. This sum has since been greatly increased by Mr. Carnegie. Among the gentlemen selected by Mr. Carnegie as the trustees of this fund was the friend of his boyhood, Mr. Mellor. When the preparation of a constitution and a set of by-laws for the government of the body was proposed, Mr. Mellor became a member of that committee, and the writer, who happened to be the chairman, vividly recalls the interest and enthusiasm with which he embarked upon his duties. The task was most congenial to him. He became the chairman of the committee appointed to administer the affairs of the Museum, and from 1896, until his last illness made it impossible for him to attend the meetings, with unflagging zeal and the keenest enthusiasm followed every step of the development of the Museum and of the Institute of which it is a component part. He often said that he regarded his appointment as one of the trustees of the Carnegie Institute, as "the greatest honor of his life." But the appointment was to him more than an honor. When Mr. Mellor assumed a position it was for service, and there is no department of the varied activities of the Institute, which under the fostering hand of Mr. Carnegie has grown to be one of the foremost establishments of its kind in existence, which did not receive the benefit of his attention and of his wise counsels. His tastes and accomplishments peculiarly fitted him for the work into which he threw himself. The great organ in the main auditorium of the building was erected under his advice and oversight. Every detail of the great and growing work of the Museum received his attention. Mr. Mellor opened the first set of books, began the first Catalog of Accessions, and for the first eighteen months of the existence of the Museum its affairs were almost wholly in his hands, assisted by one or two of his friends, who like himself foresaw the splendid possibilities of this department of activity. Now that the Carnegie Museum has come to be recognized as one of the most important institutions of its kind in America, and its reputation as a center of scientific research and instruction has gone throughout the world, it is due to the memory of Charles Chauncey Mellor to bear testimony to the patient assiduity and the wise foresight with which he kept watch over its affairs in the beginning.

Later when Mr. Carnegie established his foundation intended to recognize heroism in the humbler walks of life and to provide relief for those, who, while doing good, have suffered through no fault of their own, Mr. Carnegie appointed Mr. Mellor one of the trustees of this fund, and to this cause he also brought his wisdom and his experience. He continued to serve as one of the trustees of the Hero Fund Commission, until he felt that with the growing burden of years it was but right for him to resign.

During the last five or six years of Mr. Mellor's life he suffered more or less from an affection of the throat, which led him to seek during the winter months a home in a more equable climate, and he built for himself at Daytona in Florida a pleasant house, in which he passed several winters with pleasure to himself, returning in the springtime apparently greatly benefited by the change. In the early summer of the year 1908 he was seized with an illness necessitating a surgical operation, from which he to some extent rallied. His friends hoped that he might ultimately recover and be spared to those who loved him. But it was ordained otherwise. An acute attack of pneumonia supervened, and in his prostrate condition proved quickly fatal. His long and useful life terminated on April 2, 1909.

It was the privilege of the writer of these lines to be with him frequently during the last months of his illness and shortly before he breathed his last. In this time of his weakness the beauty of his character shone forth resplendently. He did not repine, but calmly and in peace awaited the great change which was impending. The hours were spent in the perusal of books that were dear to him, among them "the Book of books," and in looking retrospectively over the way in which he had come. Speaking of himself he says in the brief autobiography which has been alluded to elsewhere, "My life has been placid and somewhat uneventful, occupied mostly with the cares and work of a congenial and fairly prosperous business, possessing the friendship of many intelligent, cultivated, and respected people, surrounded by a loving wife and affectionate children. While business was in itself interesting to me, yet at times it became somewhat tiresome. To obtain relief it was ever my good fortune at all times to have some hobby which I could ride, obtaining exhiliration and invigoration by such quasi-equestrian exercises. Music has always been a most grateful means of enjoyment, to which has been added according to the interest of the moment the microscope, the camera, and the study of botany. Reading on various lines has always been a most agreeable and never failing source of recreation." . . . "The position given me by Mr. Carnegie on the Board of Trustees of the Carnegie Institute, and by Mr. Frew as the chairman of the committee on the Museum, has been of the greatest interest and pleasure to me, has brought me into contact with many delightful people and enabled me to do something for the instruction and entertainment of the masses of our people."

"While my life has been a quiet and uneventful one, as stated before, it has been a most pleasant one, and had I to live it over again it is hardly likely that it could be passed more agreeably."

Mr. Mellor belonged to a class of American citizens, who are justly the pride of our country, who combine with business instinct and sagacity a love for things which are true and ennobling, and who seek for self-culture and opportunities to serve their fellow men just as diligently as they seek for the rewards of financial enterprise. He was a man of the broadest sympathies, of unbound patience, and kindness of heart. From his very boyhood associated with musicians and musical people, he learned to know their peculiarities, and often said to the writer that musicians were, as Horace has described the poets, "*irascibile genus.*" Like almost all professional men they are more or less subject to that unfortunate mental disease, which is known as "professional jealousy," and are often involved in strife. Mr. Mellor was an unfailing fountain of soothing counsel and helpful advice to all such persons. The unfortunate never appealed to him in vain. He was ready to help both by word and deed. On more than one occasion the writer, when calling upon him in pursuance of his duties, found him in his office closeted with some person in evident distress, and having patiently waited until the first comer was dismissed would be greeted by Mr. Mellor with a smile as rising from his chair, he would exclaim, "Another poor fellow in trouble!" Helpful, kind-hearted, wise, an enthusiastic and loyal friend, who never counted any inconvenience or sacrifice too great, if thereby he could do good, a lover of nature and of his fellow men, Charles Chauncey Mellor has entered into rest, leaving behind him a memory which is fragrant with all the graces of a noble, cultivated, and generous manhood.

W. J. Holland.

INDEX

Publications of the Carnegie Museum Serial No. 53

ANNALS

OF THE

CARNEGIE MUSEUM

Vol. V. No. I.

October, 1908

For sale by Messrs. Wm. Wesley & Sons, 28 Essex St. Strand, London England; Messrs. R. Friedlaender u. Sohn, 11 Carlstrasse, Berlin, N. W. 6., Germany; and at the Carnegie Museum, Schenley Park, Pittsburgh, Pa., U. S. A.

CONTENTS

Publications of the Carnegie Museum Serial No. 54

ANNALS

OF THE

CARNEGIE MUSEUM

Vol. V. Nos. 2 and 3.

May, 1909

For sale by Messrs. Wm. Wesley & Sons, 28 Essex St. Strand, London, England; Messrs. R. Friedlaender u. Sohn, 11 Carlstrasse, Berlin, N. W. 6., Germany; and at the Carnegie Museum, Schenley Park, Pittsburgh, Pa., U. S. A.

CONTENTS

Publications of the Carnegie Museum Serial No. 57

ANNALS

OF THE

CARNEGIE MUSEUM

Vol. V. No. 4.

June, 1909

For sale by Messrs. Wm. Wesley & Sons, 28 Essex St. Strand, London, England; Messrs. R. Friedlaender u. Sohn, 11 Carlstrasse, Berlin, N. W. 6., Germany; and at the Carnegie Museum, Schenley Park, Pittsburgh, Pa., U. S. A.

CONTENTS

B