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W. J. HOLLAND, *Editor*

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## ERRATA ET CORRIGENDA.

Page 89, line 32, for "CLADINOTINÆ" read "CLADONOTINÆ."

Page 109, line 30, for "**Metradora**" read "**Metrodora**."

Page 269, line 19, *et seq.*, for "lama" read "llama."

Page 435, line 20, for "above" read "subjoined."







# ANNALS

OF THE

# CARNEGIE MUSEUM

VOLUME VII. NO. I.

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## EDITORIAL NOTES.

THE Director of the Museum, according to an understanding with the authorities of the Imperial Academy of Sciences in St. Petersburg, left Pittsburgh on the 4th of June and arrived in St. Petersburg on the 14th of the same month. The work of installing the replica of the skeleton of *Diplodocus carnegiei* in the great Lecture Hall of the Imperial Academy of Sciences was immediately taken in hand and was finally brought to completion about the middle of July. During his stay in St. Petersburg the Director of the Museum received many evidences of the kind regard of the different members of the Imperial Academy of Sciences and the promise that all the publications of the Academy should be sent as soon as possible to the library of the Carnegie Museum. Special hospitality and courtesy were shown by His Imperial Highness the Grand Duke Constantine, by M. Iswolky, the Minister of Foreign Affairs, M. Oldenburg, the Secretary of the Academy, M. Th. Tschernyschew, the Director of the Geological Survey of the empire, M. Mogilansky, the Director of the Great Ethnological Museum bearing the name of Alexander III, and by many others among the leading scientific men of the Russian capital. The Director made it a point to acquaint himself thoroughly with the work which is being done not only in the museums of St. Petersburg, but in Moscow. In the latter city, under the guidance of M. Krishkoff he visited all the museums and was able to obtain thorough knowledge of what is being accomplished for the advancement of science in Moscow, a city the wealthy and intelligent citizens of which are displaying in recent years a

spirit of civic pride and a desire to promote science and art to a degree not surpassed by the citizens of any of the larger municipalities of the world.

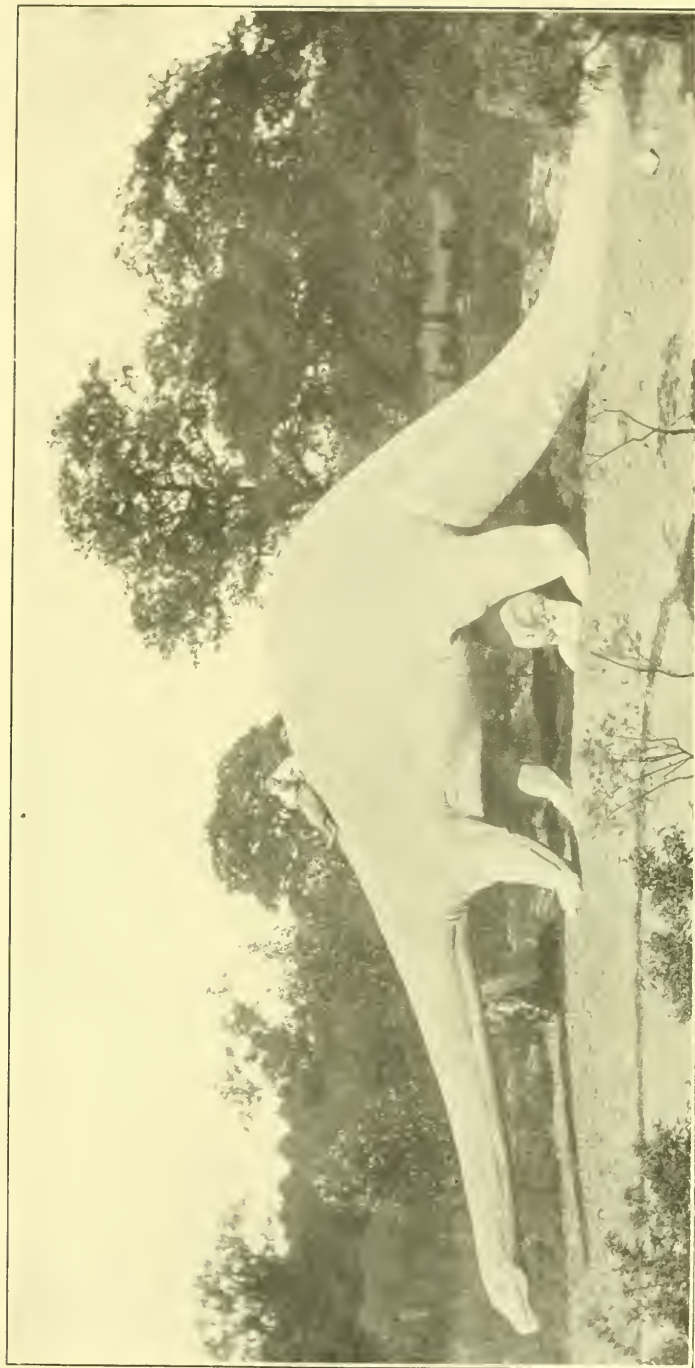
From Russia the Director of the Museum repaired to Stockholm, where he spent a few days visiting the principal public institutions and making arrangements for an exchange of the publications of the Carnegie Museum for those of the Royal Academy of Sciences and other Swedish institutions. He recalls with pleasure the delightful hours passed in the society of Professor Aurivillius, Dr. Sjöstedt, and Mr. C. V. Hartman. An excursion was made to Upsala, where the grave of Linnæus was visited, and the authorities of the University with the most amiable kindness caused the collections of Linnæus, which had been sealed up and retired for the summer, to be opened for the inspection of the Director, who was able to examine many of the types of the insects named and described by the father of natural history.

A brief visit was paid to Christiania where the museums and art galleries were visited and where in the Librarian of the University was found a friend who was familiar with the work which is being done in Pittsburgh.

Two days were spent in Copenhagen, visiting the museums of the Danish capital and in arranging for the exchange of publications. A brief visit was paid to Hamburg. Dr. Kræppelin and Dr. Reh of the great museum of Hamburg were most courteous and gave the Director every opportunity to look into the work which is being done there to promote popular instruction and to advance scientific research. An exceedingly cordial welcome was received from Mr. Carl Hagenbeck of Stellingen. Several hours were spent with him examining his superb collection of exotic mammals and birds and in viewing the restorations of the extinct animals of the past, which he is installing in one section of the great zoological garden which he has established. The life-size reproduction of the Diplodocus, of Triceratops, and other dinosaurs are certainly very interesting. The former is based upon the reproductions made by Mr. Hatcher and the Director of the Carnegie Museum.

While in Hamburg arrangements were made with a well-known dealer in that city to purchase the skins of a number of species of penguins, it being the plan of the Director to set up in the Museum a large group representing these interesting antarctic birds in their natural environment.

A week was spent in Brussels in attendance upon the first International Entomological Congress. As one of the three Americans present the Director of the Carnegie Museum was honored by being chosen to preside over the sessions of the Section of the Congress given over to the reading



Life-sized restoration in concrete of *Diplodocus carnegiei* erected in the Zoölogical Park at Stellingen near Hamburg by Mr. Carl Hagenbeck. The restoration is based upon the replica in the British Museum, and the various papers published by J. B. Hatcher and W. J. Holland.



of papers upon Museology and Historic Entomology. The Congress was attended by delegates from all parts of the world, and many of the most noted entomologists of Great Britain and the continent were in attendance. The sessions were remarkably successful, and a handsome volume embodying the papers, which were presented, will shortly be published.

Leaving Brussels a few minutes after midnight on the 6th of August, Cherbourg was reached on the afternoon of the same day, and the Director was back at his post in the Museum on August the 15th.

THE Director wishes to acknowledge his profound gratitude for the generosity and public spirit shown by Mr. Childs Frick in presenting to the Museum the magnificent collection of the skins and skeletons of the East African mammals which he took upon the occasion of his hunting excursion to British East Africa during the fall and winter of 1909 and the spring of 1910. The collection is very large, numbering nearly two hundred specimens, which represent in almost every case species not hitherto represented in the collections of the Museum. The work of mounting this superb collection will necessarily consume some time, but the task has been approached with great enthusiasm and energy by the Messrs. Santens and their associates. It is proposed to assemble the collection of the mammalia of East Africa at the eastern end of the great Hall of Mammals, where a space will be definitely set apart for "the Frick Collection." A group of oryx antelopes in lifelike poses is already well under way, and before these lines pass through the press the great bull giraffe will have been mounted in a most lifelike pose. As rapidly as possible various other great mammals will be set up. The example of Mr. Frick is one which may well be emulated by the brotherhood of Nimrods in Pittsburgh, a brotherhood large and enthusiastic, and including many men mighty with the rifle and the camera.

MR. C. R. EASTMAN has spent the summer in studying the fossil fishes of Monte Bolca and Solenhofen acquired by the Carnegie Museum at the time the Bayet Collection was purchased. Mr. Eastman reports that the assemblage of fossil fishes from these formations in the Carnegie Museum is in some respects finer even than similar collections in Europe, and altogether the best in America.

MR. EARL DOUGLASS reports that the work which he had been carrying on at Dinosaur Peak in Utah is progressing as rapidly as could be expected.

Owing to the hardness of the rock and the immense size of the specimens considerable time will yet be required before the skeletons are extracted from the matrix. The work of excavation has proved itself more difficult than it was originally supposed that it would be.

DURING the past twelve months the Carnegie Museum has received from Mr. M. A. Carriker, Jr., large shipments of the birds of Venezuela, representing several hundred species, most of which are new to our collections. The number of our desiderata among South American birds has been materially lessened by shipments received from Mr. José Steinbach, who is working for the Museum in Bolivia. We hope that ultimately our collection of the birds of South America will be as large as our collection of the fishes of that continent.

A NUMBER of interesting Egyptian antiquities have been received through the Egypt Exploration Fund.

DR. C. H. EIGENMANN was present at the International Zoological Congress at Graz, Austria. Prior to appearing at the Congress he visited London, Berlin, Vienna, and other points with a view to studying the collections of South American fishes preserved in those cities. The manuscript of his memoir upon the Fishes of British Guiana is well in hand and will soon be put into press.

I. THE GEOLOGY OF THE COAST OF THE STATE OF  
ALAGÔAS, BRAZIL.

PART I.

BY J. C. BRANNER.

*Introductory.*—The following brief sketch of the geology of the coast of the state of Alagôas, Brazil, is given here, partly in order to make clear the stratigraphic relations of the beds from which the fossil fishes described by Dr. Jordan in the second part of the paper come, and partly because the discovery of the fossiliferous beds in which these fishes were found has thrown much light on the geology of the state of Alagôas and of the eastern coast of Brazil. The fossil fishes were obtained from a



FIG. 1. Looking northward on the sea-coast three kilometers north of Jequiã da Praia, showing the coast sediments forming the bluffs. (Crandall phot.)

series of bituminous shales at the village of Riacho Doce on the coast. These shales form part of the coastal belt of sedimentary rocks exposed along the entire sea-coast of that state. The accompanying map (Plate II) shows the general geology of Alagôas so far as it is now known; the belt referred to is the narrow one lying next to the ocean. From this

map it will be seen that in the interior the rocks exposed at the surface are mostly crystalline, that is, they are granites, gneisses, and crystalline schists. These rocks belong to the old rocks of the continent, and their age or ages are not known. They have a strong resemblance to the Archean and Algonkian rocks of North America, and it is assumed that stratigraphically they belong there or thereabout.

Resting directly on these crystalline rocks is a series of sedimentary beds which are provisionally called Paleozoic. These beds are exposed at many places along and near the Rio S. Francisco from about ten kilometers above Penedo to the mouth of the Rio Traipú. This Paleozoic area extends northward and eastward, and ends somewhere west of the town of Pilar. The details of the distribution of these beds are not known at present. The rocks are mostly shales, quartzites, and conglomerates. No fossils have thus far been found in any of them.

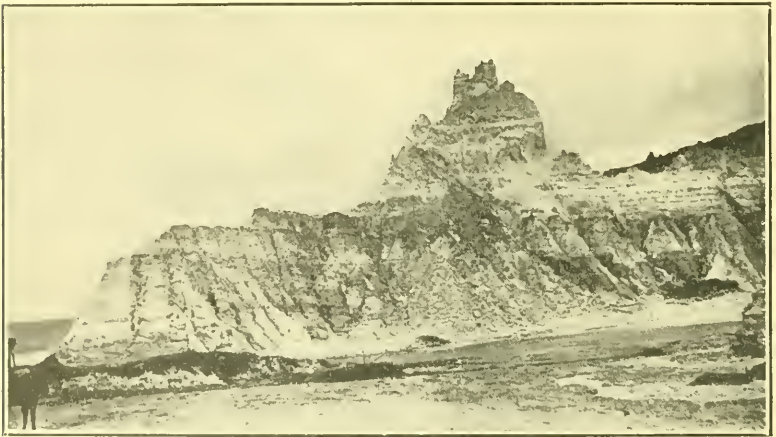


FIG. 2. Denudation of the coast sediments thirteen kilometers north of Jequiá da Praia, Alagôas. (Crandall phot.)

Overlying these Paleozoic beds are the red sandstones on which the city of Penedo is built, and which are identical in color, character, and stratigraphic position with the Estancia beds which are supposed to be of Triassic age. These beds have also failed thus far to yield any fossils, but their stratigraphic position is remarkably constant over wide areas in Alagôas, Sergipe, Bahia, and adjoining states. The area covered by the Estancia beds in Alagôas is shown approximately on the map. It should



be kept in mind, however, that, except in the vicinity of Penedo, the details of the areal distribution of these beds have not been worked out.

*The Coastal Sedimentary Belt.*—Upon and against these older rocks rest the conglomerates, sandstones, and shales which are all grouped together here under the name of coastal sediments. It is not possible to say at present whether these sedimentary beds in Alagôas belong to a single series or to two or more series of rocks. In Pernambuco, the next state on the north, fossils of both Cretaceous and Tertiary ages have been found, though the question still remains unsettled as to whether the formations in which they occur belong to the Cretaceous alone or to both the Cretaceous and the Tertiary.<sup>1</sup>

In Sergipe, the next state to the south, Cretaceous beds are well known, and characteristic fossils are abundant in them;<sup>2</sup> but up to the present time no unquestioned Tertiary beds have been reported in that state, though it is highly probable that Tertiary beds cover a considerable part of the coastal belt. A little further south, in the state of Bahia, both Cretaceous and Tertiary beds are known. The coastal belt of Alagôas, lying as it does between both Cretaceous and Tertiary beds to the north



FIG. 3. Characteristic topography and false bedding of the coast sediments ten kilometers north of Lagoa Jequiá, Alagôas. (Crandall phot.)

<sup>1</sup>Geologia Elementar, por J. C. Branner, p. 272.

<sup>2</sup>Charles A. White, "Contribuições á paleontologia do Brasil," *Archivos do Museo Nacional*, VII, Rio de Janeiro, 1887.

and south, might naturally be expected to contain rocks of both Cretaceous and Tertiary ages. Unfortunately but little geologic work has been done in the state of Alagôas, and this little has not hitherto yielded unquestionable evidence of the age or ages of the sedimentary beds in that particular state, while the somewhat conflicting nature of the evidence which might be adduced from neighboring regions makes it impossible to use that evidence to settle the question. In order to determine the age or ages of the Alagôas coastal sediments we have therefore to depend entirely upon the few fossils that have been found in the state and upon such inferences as may reasonably be drawn from the geology of Sergipe, just across the Rio São Francisco.



FIG. 4. Characteristic view looking southward along the coast, nineteen kilometers north of Jequiá da Praia. (Crandall phot.)

In the state of Alagôas the coastal sedimentary belt varies in width from about ten kilometers in the north to sixty kilometers in the vicinity of Penedo on the south. These sediments formerly extended further inland and also further toward the east, but they have been removed by denudation on the north and west, and have been encroached upon by the ocean on the east until only this narrow belt now remains. The encroachment of the sea has left a great deal of the coast in the form of bare and abrupt escarpments some fifty to ninety meters high. The illustrations incorporated in the text (Figs. 1-6) are made from photographs taken in

the vicinity of Lagoa Jequiá and give a good idea of the appearance of these sediments in characteristic exposures at and near the coast.

The rocks are mostly soft sandstones varying greatly in color—red, pink, purple, yellow, orange, and gray predominating. In many places



FIG. 5. A headland on the coast, three kilometers northeast of Jequiá da Praia. (Crandall phot.)

the beds are mottled; often they are false-bedded, and the true beds are sometimes more or less lenticular. The bedding is approximately horizontal with such local exceptions as might be looked for in the deposition of sediments of the kind. None of the beds are hard, but they all break

down under weathering influences into incoherent sandy clays on steep slopes, or form a hard packed water-shedding layer over horizontal surfaces. The upper beds, so far as they have been examined, are the soft variously colored sandstones, while near the base of the series there are



FIG. 6. Characteristic topography and false bedding in the coast series nine kilometers north of Lagoa da Jequiá. (Crandall phot.)

black bituminous laminated shales varying in thickness from three to twenty meters. These shales contain lenses and thin interbedded layers of fine sand. Below the shales are sandstones at some places, and below the sandstones are usually conglomerates made up of water-worn boulders

derived directly from the basal granites. In the section exposed along the railway running north from Maceio the rocks seen are mostly the colored sandstones, but about a kilometer northeast of the station of Utinga (Kil. 26.6) some horizontal gray shales are exposed by the side of the railway. Unfortunately this exposure could not be examined for fossils at the time of my visit. Further northeast along the line of the railway (about Kil. 29) the railway cuts into the base of the Serra de Ouro, and for two or three kilometers exposes heavy beds of decomposed granite boulders. Similar conglomerates are exposed less than a kilometer south of the station of Cachoeira. At this last named station the granites are exposed in places and continue across the entire northern part of the state, so that Cachoeira marks the northwestern margin of the sedimentary belt where it is crossed by the railway.

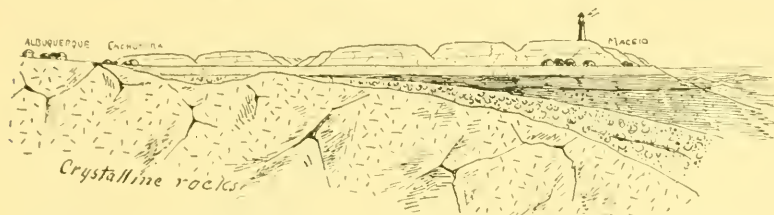


FIG. 7. Ideal section from Maceio to Albuquerque, 35 kilometers, along the Alagôas Railway, showing the coast sediments resting on the crystalline rocks.

The branch of the railway running from Albuquerque to Assembleia passes all the way over granites and other old crystalline rocks, except for a short distance between Bittencourt and Ataláia where a deep cut exposes a beautiful unconformity between the underlying granites and the inland margin of the abutting sediments.

*Beds Dipping Landward.*—There are certain noteworthy exceptions to the horizontality of the coast sediments. At many places on the coast the lowest sedimentary beds exposed are mostly shales, and these are often found dipping decidedly toward the land. Good examples of the landward dip of these beds are exposed on the beach at the following localities beginning in the northern part of the state and following down the coast. The compass bearings given are the magnetic readings.

At the mouth of Rio Maragóy  $9^{\circ} 3' s.$  latitude, the shales are somewhat wrinkled where exposed in a wave-cut bench. The dips observed in the shales are  $10^{\circ} s. 71^{\circ} w.$  and  $6^{\circ} s. 31^{\circ} w.$  These shales dip landward beneath the red and mottled sandstones exposed in the hills near the coast. Just

south of the *renda*, known as Camáxo, black bituminous shales are exposed at low water. The following dips were recorded at that place  $9^{\circ}$  s.  $60^{\circ}$  w.;  $4^{\circ}$  s.  $80^{\circ}$  w.;  $4^{\circ}$  s.  $33^{\circ}$  w.;  $10^{\circ}$  s.  $50^{\circ}$  w. In every instance the dip is toward the hills of the coast. Just south of the stream entering the sea near the village of Japaratóba conglomerates, sandstones, and dark shales are exposed at low tide. They dip s.  $80^{\circ}$  w., that is, landward. In latitude  $9^{\circ} 7'$  s. in front of the town of Pitinguí shales are exposed at low tide with a dip of  $9^{\circ}$  n.  $70^{\circ}$  w. and  $7^{\circ}$  due west.



FIG. 8. The exposure on the beach at Barreira do Boqueirão. The shaded bed is the fossiliferous shale.

A bluff further south known as the Barreira do Boqueirão is estimated to be between sixty and seventy meters high. The upper part of this bluff is of red, brown, purple, yellow, and mottled sands and clays. At the base is a bed of black bituminous shales some two or three meters thick, which contains fossil fishes like those found at Riacho Doce. This shale dips n.  $40^{\circ}$  w. at an angle varying from  $10^{\circ}$  to  $15^{\circ}$ . The direction of the dip also varies more or less, but it is always landward, in the direction of the red coast hills. Beneath the shale and conformable with it is a strongly bedded conglomerate and sandstone.

In the edge of the village of Porto das Pedras in south latitude  $9^{\circ} 10'$  sandstones with interbedded shales are exposed at the mouth of the Rio Manguaba. These rocks dip toward the southwest at a low angle, perhaps three or four degrees.

South of Marcenerio is an embayment in which the dark shales are exposed at low water and partly covered by a coral-reef. The following dips were observed here:  $10^{\circ}$  n.  $39^{\circ}$  w.;  $13^{\circ}$  n.  $57^{\circ}$  w.;  $12^{\circ}$  n.  $25^{\circ}$  w., always landward and toward the hills which follow the coast.

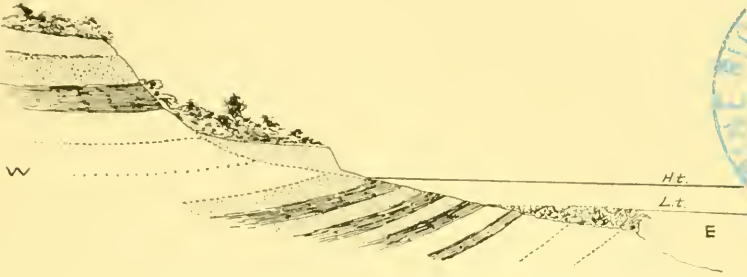


FIG. 9. Geological section south of the Marcenerio embayment showing the bituminous shales dipping landward and overgrown with a coral reef.

At the Barra do Passo, known also as the Barro do Camaragibe, there are some good exposures of dark bituminous shales interbedded with sandstones on the sea-shore near the town. The dips are likewise toward the hills that lie to the landward of the town.

Just south of the Camaragibe at a bluff, known as the Morro de Camaragibe, are some of the most interesting exposures to be seen on the coast of

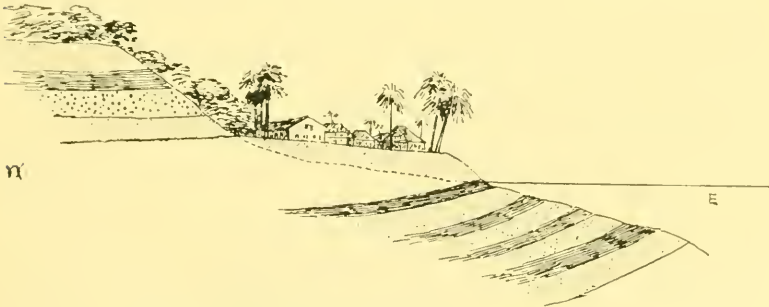


FIG. 10. Section showing the landward dip of the shales at Camaragibe.

Alagôas. The bluffs are from 75 to 90 meters high, and the upper layers are the highly colored and mottled beds so characteristic of this part of the Brazilian coast. At the base of the bluff, however, there are exposed, especially at low tide, a series of alternating sandstones and shales of a dull gray color. The lowest exposed beds of the series are cut off by the

waves, forming a horizontal terrace, which is uncovered at low tide. These lower beds all dip landward beneath the bluff at an angle of from five to ten degrees.

At many places in the beds of shale fragments of plants may be distinguished, but they are so badly ground up that those found are not recognizable.

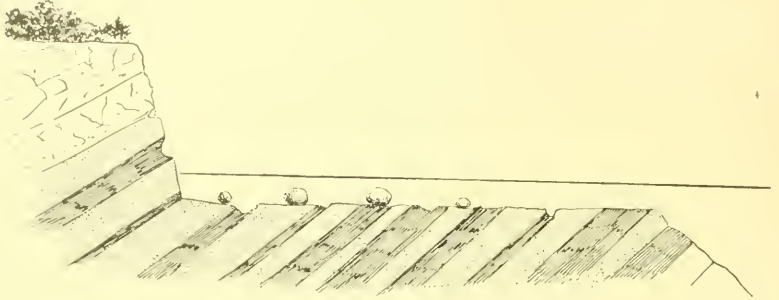


FIG. 11. Sections showing the structure, the wave-cut terrace, and the granite boulders at Morro de Camaragibe. The dip is somewhat exaggerated.

At Riacho Doce the village stands upon a narrow terrace between the sea and the sandstone bluffs which are about 80 meters high at this place. The lowest beds which are visible are heavy conglomerates containing large granite blocks; these are followed downward by sandstones, and these in turn by bituminous shales. The beds exposed on the beach are

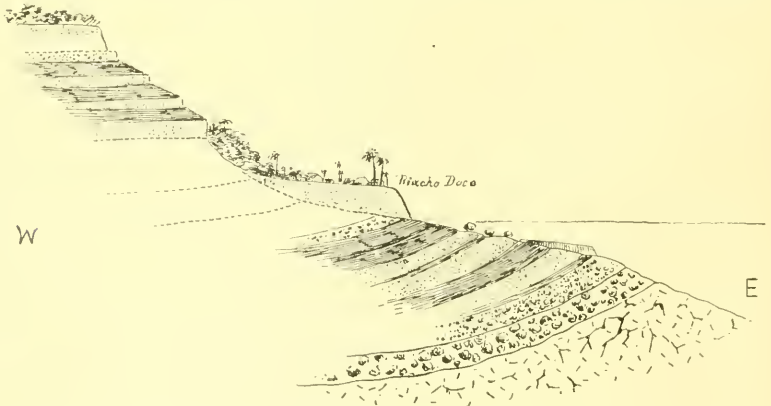


FIG. 12. Ideal section at Riacho Doce showing the relation of the shales and conglomerates to the bluffs west of the town.



considerably wrinkled and somewhat faulted, but the general structure shows that they dip westward beneath the bluffs. The shales exposed on the beach and in pits in the palm groves near by are black, foliated, and thin-bedded, and contain a good many remains of fishes, diatoms, ostracods, and foraminifera. The cases cited above show that the sediments along the Alagôas coast north of Maceio have a general and decided dip toward the land.

*Why the Coast Sediments Dip Landward.*—Two explanations suggest themselves for this apparently universal landward dip of these beds. The first one is that the beds were laid down in a basin parallel with the coast, and somewhat similar to that found at and north of the city of Bahia, and that the ocean has now cut away the entire seaward edge of that basin leaving the westward dipping beds exposed. There is nothing impossible or even improbable in this theory. When the sea shall have encroached upon the coast at and north of Bahia a few kilometers further, it will have cut away a narrow belt of crystalline rocks and will expose the landward-dipping shales of the Bahia basin.

The fact that the granites are exposed at many places along the coast of Alagôas beneath the shales, and the fact that the granite bottom of the basin does not appear in the section made across this sedimentary belt by the railway running from Maceio to Albuquerque lends support to this theory.

The other suggested explanation of the landward dip of the sediments on the coast is that the removal of the 50 to 90 meters of sediments along the coast has permitted the upbending of the rocks relieved of pressure on the shore just as we have the upthrust of the floors of tunnels in deep mines and similar phenomena along the bottoms of deep canyons cut through thick sediments. In either case it seems that the sediments are somewhat thinner on the immediate coast than they are a few kilometers inland.

*Color of the Coastal Sediments.*—It has already been stated that the coastal sediments are highly colored. The most pronounced colors are yellow, red, and orange; but almost all the colors of the rainbow may be seen in the large exposures. Sometimes the colors are more or less banded and one is led to infer that this banding follows certain horizontal beds. Sometimes the beds are mottled rather than banded, and sometimes it even happens that there is a vertical gray, whitish, or leaden-colored band that cuts square across the usual horizontal beds.

It was formerly supposed that these high colors had some stratigraphic

value, and that they were characteristic of the Tertiary beds along the Brazilian coast. It is true that there are good reasons for considering many of the colored beds of this coast as Tertiary, but it is my opinion that the colors are accidental, and that they also extend into the Cretaceous beds, and occasionally into even older beds as well. At a great many exposures examined along this coast the evidence all points to the fact that the beds, which have long lain beyond the reach of weathering, retain their dull gray and drab colors, while those which have been acted upon by surface-waters and oxidizing agencies have usually been profoundly affected. These points are fairly well brought out by the exposure at the cliffs south of the Rio Camaragibe. There the rocks at the base of the bluff are well exposed and show clearly the stratification and the landward dip of the beds. These lower beds range in color from drab through dark brown to almost black, but about three or four meters above the level of high tide the bedding planes fade out, and the drab colors give place to the yellow, red, and mottled colors which continue to the top of the bluffs. Especially striking is the fact that these upper colored beds have the general appearance of being horizontally stratified, although the stratification planes are more or less obscure and uncertain, while the lower beds are well defined and have marked dips. Believers in the theory of the Tertiary age of the colored beds might urge that these facts point to an unconformity between the strata at the bottom and the top. However, a close inspection made with this point in mind not only failed to disclose an unconformity, but showed that the stratification of the lower beds merges very gradually into those which are highly colored, and finally disappears altogether. In other words the weathering process has not only altered the color of these sediments; but it has obscured the stratification, so that the original bedding, in some instances at least, cannot be made out.

*Fossils from the Alagôas Sediments.*—Fossil plants have been seen in the dark bituminous shales which commonly underlie the highly colored sandstones and clays forming the bluffs along nearly the entire coast of Alagôas. At every place where these plant remains have been seen the plants appear to have decayed and then to have been washed back and forth until they were ground into unrecognizable fragments. At all events a diligent search for recognizable remains of plants has thus far failed to discover any.

*Diatoms.*—Specimens of the bituminous shales collected at Riacho Doce were submitted to Mr. Wm. A. Terry, of Bristol, Conn., who kindly

examined them for diatoms. Mr. Terry writes me in regard to one specimen sent him that it contains a small amount of quartz sand, and a little muscovite, but no diatoms. Another lot of this same shale was sent Mr. Terry later and he says of it: "None of these shales contain any diatoms. They differ somewhat from the specimens I examined in 1908 from the same locality, but they are substantially the same. They contain a large amount of iron oxide and of bituminous matter, but the bulk of the rock is a hydrocarbon. . . . It is probably formed from algæ."

*Ostracods.*—The bituminous shales, and some of the sandy layers accompanying them, contain many impressions of ostracods. Some of these have been submitted to Dr. E. O. Ulrich and he writes as follows in regard to them:

"The specimens are of one or two species of *Estheria*, but their preservation is so poor that I cannot classify them more exactly. They might be of any age from late Triassic to Pleistocene, but it is my belief that they will finally turn out to be early Cretaceous. Do not rely on this opinion unless it is in accord with other evidence."

*Fishes.*—The fossil fishes described in the accompanying paper by Dr. Jordan were first collected by me at Riacho Doce and Barreiro do Boqueirão in 1899. Later I sent my assistant, Mr. Roderic Crandall, to make a fuller collection, and he brought away several boxes of these bituminous shales from Riacho Doce. Those thinly laminated shales were carefully split up after they reached this country, and all the specimens figured and described in Dr. Jordan's paper are from this material.

The collection made in 1899 contained the remains of a single species which was identified by Professor F. A. Lucas, of the U. S. National Museum, as *Diplomystus*. This genus had already been described by Cope from similar shales at Itacarânia, Plataforma, and Agua Comprida, near the city of Bahia.<sup>3</sup>

In addition to the clupeoid fishes from Riacho Doce described by Dr. Jordan, mention should be made of some fossil fishes now in the collections of the Instituto Archeologico e Geographico Alagoano at Maceio. These fossils were seen and examined by me in 1899. They are said to have been found at or near the town of Fernão Velho which stands at the north end of Lagoa de Norte, fourteen kilometers north of the city of Maceio. These fishes are in concretions of hard cream-colored lime rock that bears a striking resemblance to the limestone nodules in which fossil fishes are

<sup>3</sup>E. D. Cope, "A contribution to the vertebrate paleontology of Brazil," *Proc. Amer. Phil. Soc.*, XXIII, 3-4, Jan., 1886.

found in the interior of Ceara. One of these fishes was identified as *Rhacolepis buccalis* Agassiz; the other was not identified.

The lack of specific information regarding the origin of these fossil fishes, the character of the matrix, and the species identified all lead one to doubt whether they really come from Fernão Velho. At Fernão Velho (Kil. 14) there are some good exposures of soft, partly-colored sandstones close to the railway station, and for half a kilometer along the line toward the north. The beds are all more or less oxidized as far down as they are exposed in the railway cuts, and in none of them were fossils of any kind seen. South of Fernão Velho the oxidized sedimentary beds are exposed at a number of places on and close to the railway, but everywhere they are yellow, red, purple, mottled gray, and white. Nowhere were calcareous concretions found like those containing the fossil fishes.

The facts thus far gathered fail to support the theory that the *Rhacolepis* and the other fossil fish in the collection at Maceio come from Fernão Velho. It is hoped, however, that local geologists will keep up the search for evidence in the field, for though the theory of their origin lacks support at present, it is not at all improbable that they are really from Fernão Velho or somewhere thereabout. The verification of the occurrence of these fossil fishes in Alagôas would be a very interesting and valuable contribution to our knowledge of the geology of that state.

*Conclusions from the Fossil Fishes.*—Leaving aside the *Rhacolepis* about which there is some question, the fossil fishes thus far found in the state of Alagôas come from the laminated dark gray bituminous shales exposed at Riacho Doce, Garça Torta, Morro do Camaragibe, Porto das Pedras, Barreira do Boqueirão, Pitinguí, Japaratúba, and the mouth of the Rio Maragogy, and from various other places on the immediate coast, where they are exposed near the base of the sedimentary series. These fishes represent four genera, *Diplomystus*, *Dastilbe*, *Halecopsis*, and *Arius?*, there being six determinable species, four of *Diplomystus*, one of *Dastilbe*, one of *Halecopsis*, and one of *Arius?* The forms are such as are to be expected in an estuary.

Dr. Jordan feels some doubt in regard to the exact age of the beds, and he ventures only to say that "the shales of Riacho Doce were deposited in an estuary and that their age is Cretaceous or Lower Eocene, possibly Upper Cretaceous."

These fishes form the most important collection of fossils thus far made in the state of Alagôas, and they also make an interesting and valuable contribution to our knowledge of the coast sediments of eastern Brazil.

*Other Fossils from Alagôas.*—The occurrence of Cretaceous fossils at Villa Navo in the state of Sergipe on the Rio S. Francisco below Penedo leads to the inference that Cretaceous fossils should be expected on the Alagôas side of the river. No systematic search has been made for fossils in the southern part of Alagôas, so that it cannot be stated positively whether the beds known at and about Maroim and Larangeiras in Sergipe do, or do not, extend into Alagôas.

The red Estancia sandstones on which the city of Penedo stands are older than the Cretaceous, and as pointed out in the introduction to this paper they have thus far failed to yield any recognizable fossils either in Alagôas, Sergipe, or Bahia, where they are well developed.

To the west of Penedo is another and older series of sandstone forming the Serra de Marába, but there again no fossils have yet been found. The Marába beds are older than the Estancia sandstones, and possibly belong to the Carboniferous or to the Carboniferous and Devonian. In the collections of the Instituto Archeologico e Geographico Alagoano in Maceio I saw in 1899 a piece of sandstone labeled "Alagôas" which contained fossil brachiopods that are not newer than the Carboniferous. Unfortunately no information could be had in regard to the origin of this specimen, and I am disposed to think that it is wrongly labeled. It is not at all impossible that there may be Carboniferous sedimentary rocks in the Serra de Marába, but up to the present time they have not been found. I have found at other ports on the coast of Brazil fossiliferous rocks brought from other places and even from foreign countries as ballast in ships. In addition to those mentioned above the only other fossils thus far found in Alagôas have been the remains of large vertebrate animals that have been discovered occasionally in digging pits in low grounds for watering the cattle. Bones, teeth, etc., have occasionally been found at several places in Alagôas and in the adjoining states. The places reported in Alagôas are Meirus, about 15 kilometers northeast of Pão d'Assucar,<sup>4</sup> and near a lake on the west side of the Priáca ridge about eight leagues north-east of Penedo.<sup>5</sup>

Systematic search for the remains of these large extinct mammals in the state of Alagôas would enable geologists to add a valuable chapter to the later geologic history of life on the South American continent.

*Geographic Development.*—Certain topographic features of the coast of

<sup>4</sup>J. C. Branner, "On the occurrence of fossil remains of mammals, etc.," *Amer. Jour. Sci.*, XIII, 136, Feb., 1902.

<sup>5</sup>Maria Graham, "Journal of a voyage to Brazil," London, 1824, 130.



Alagôas throw much light upon the geographic development, not only of this state, but of a large part of northeastern Brazil. Reference is here made to the lakes that are so characteristic of that state.

The accompanying map (Plate II) shows how the lakes of the coast of Alagôas are distributed. It should be noted that the lakes are not parallel with the coast, but that their longer axes are approximately at right angles to the coast. These lakes are all separated from the sea by low flats of loose sand, which are occasionally drawn out into long narrow spits. In all cases the lakes are being gradually filled up by the silts washed into them from the surrounding high grounds.

These geographic features all seem to be satisfactorily explained on the theory that the coast formerly stood considerably higher than it does at present. At the time of this elevation the shore line was somewhat further east, and, owing to the greater height of the land, the rainfall was probably somewhat greater than it is now. At that time the lakes did not exist, but streams flowed across the coastal belt and cut in the soft sediments many deep, steep-sided gorges. A long period of uplift and erosion was followed by a depression which carried the bottoms of the gorges well below the level of the ocean, so that the salt-water backed up in them and made estuaries of them. The shore line was shifted somewhat further inland, and the waves soon cut into the soft materials of the head-lands, threw the shore sediments back into the mouths of the estuaries, and eventually turned them into lakes. The sediments washed into the lakes from the sides and at their upper ends gradually filled them



FIG. 13. The channel of the Rio San Francisco, looking up stream, seen from the Sugar-loaf hill at Pão d'Assucar, state of Alagoas,

up so that some of them have already been turned into marshes, and the same process will, in the course of time, obliterate all of them. Lagoa do Norte may be taken as a type of the larger ones of these lakes. This lake has now silted up to such an extent that it is navigable only for vessels drawing a little more than one meter, and that too along a single channel on the south side of the lake.

At the time when the region stood higher the lower Rio S. Francisco ran through a steep-sided gorge, and the streams entering it from the sides cut their channels down to or nearly to the level of the main stream. When the depression came the lateral streams were flooded and their former channels are now marked by lakes, marshes, or broad flat river-bottoms.

While the coastal lakes have been filling up with silts from inland, those washed from the immediate coast have accumulated locally under the

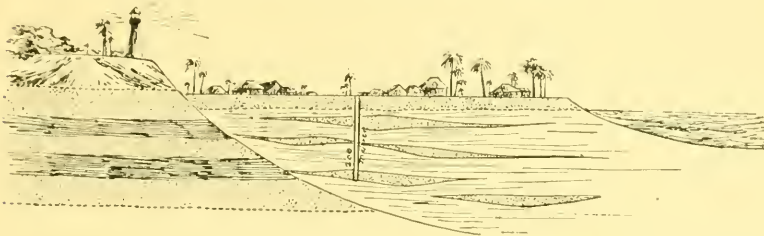


FIG. 14. Section showing the relation of the deep well at Maceio to the rocks of the hills above the city.

protection afforded by the coral reefs which thrive along some parts of the coast of Alagôas. In such places the land has been gaining on the sea. Jaraguá, the southern part of the city of Maceio, for example, is built upon low ground that lies between the city proper and the coral reefs which help to form the harbor of Maceio. A well two hundred meters deep put down several years ago at the railway shops in Maceio is entirely in loose materials. This fact leads one to conclude that the steep slope of the bluffs, on which the light-house stands, extends for at least two hundred meters beneath the surface of the ground, for these loose materials are not the plateau beds in place, but the later deposits laid down since the depression of this region.

*Stone Reef.*—About three kilometers north-east of the Barra de São Miguel on the Alagôas coast is a beautiful example of a stone reef. The accompanying panorama (Plate III) made by my assistant, Mr. Roderic

Crandall, shows the entire length of this reef, and gives a good idea of its remarkable appearance. This reef is of hard sandstone, and varies in width from ten to seventy meters. It is barely covered at times of high tide, but at low tide it rises above the water like a broad flat wall against the outer face of which the surf breaks.

Reefs like this of São Miguel are found at several places along the north-eastern coast of Brazil, but this is among the most beautiful of them all.

The origin of these reefs of rock has been discussed at length elsewhere,<sup>6</sup> and it only remains to explain this particular one.

As pointed out in the paper on the stone-reefs of Brazil the existence of these remarkable natural breakwaters is due to a peculiar combination of circumstances. These are the distribution of the rain through the year, the size of the streams, and the geographic conditions where the streams enter the ocean. The São Miguel reef lies in front and across the mouth of the Rio de São Miguel, a stream which is only about seventy-five kilometers in length.

The banks of this stream are everywhere covered with vegetation, and along the lower part of its course the waters pass through grassy marshes and mangrove swamps. During the rainy season there is water enough in this river to cause its prompt discharge into the ocean, but during the dry seasons the stream is so enfeebled that it has not always been able to prevent the waves of the sea from completely stopping it by throwing up the beach sands across its mouth. At such times the sluggish water of the streams becomes highly charged with the acids derived from the organic matter decomposing in and along it, and this water has escaped largely by seeping through the sand bank across the river mouth. The acid water coming in contact with shell fragments and other limy materials in the sand dissolves the lime and carries it forward until it comes in contact with the dense sea waters within the sand bank, where the lime is precipitated. The sands that were thrown across the river's mouth are by this process turned into a sandstone so compact that it often rings under the hammer like a bell.

The shells found in the rock of the reef are those of mollusks which are now living in the sea alongside, and may be found loose in the sands of the beach. The accompanying photograph (Plate IV) shows a specimen of the rock containing shells.

<sup>6</sup>J. C. Branner, "The stone reefs of Brazil, etc.," *Bull. Mus. Comp. Zool.*, XLIV. Cambridge, 1904, 171-200.



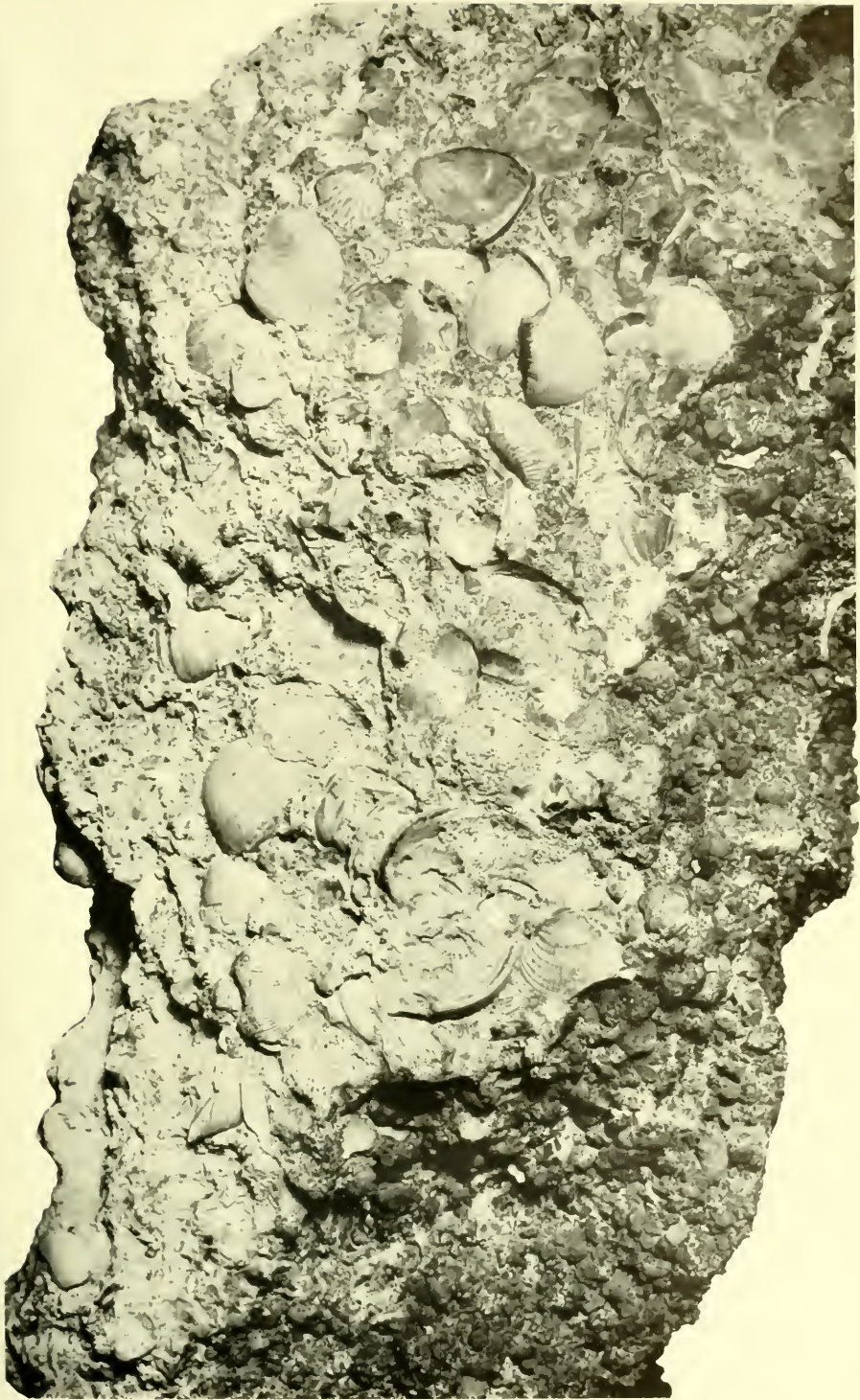






Panorama of the stone reef three kilometers northeast of the Barra de São Miguel on the Alagôas coast.





Specimen of rock of the reef, about  $\frac{3}{4}$  nat. size.



II. DESCRIPTION OF A COLLECTION OF FOSSIL FISHES  
FROM THE BITUMINOUS SHALES AT RIACHO DOCE,  
STATE OF ALAGÓAS, BRAZIL.

BY DAVID STARR JORDAN.

The collection of fossil fishes described below was made under the direction of Dr. John Casper Branner in 1907 for the Carnegie Museum of Pittsburgh. The types described in this paper belong to that museum. Duplicates of the species are in the paleontological collections of the Department of Geology at Stanford University, California. The accompanying drawings are by Mr. Sekko Shimada.

Family CLUPEIDÆ.

Genus DIPLOMYSTUS Cope.

*Diplomystus* COPE, Bull. U. S. Geol. Surv. Terr., III, 1877, 808 (*dentatus*) (not *Diplomystus* Bleeker, a genus of catfishes).

*Copeichthys* DOLLO, Results Voyage Belgica, 1904, 159 (*dentatus*) (substitute for *Diplomystus*, considered as preoccupied).

A large, deep-bodied compressed herring from the Green River Eocene shales in Wyoming has been made the type of the genus *Diplomystus*. The characteristic features of the genus are the very strong ventral plates, and the presence of similar smaller plates on the dorsal line before the dorsal fin. At the same time another herring, obviously related, but differing in the slender form, short anal, and fewer vertebræ, besides other characters, was associated with this species. This species, *Clupea humilis* Leidy = *Clupea pusilla* Cope, both names preoccupied, became later, under the name of *Knightia eocæna*, the type of the genus *Knightia*. More or less intermediate between *Diplomystus* and *Knightia* are several species from the fossil beds of Europe and Asia.

Among Dr. Branner's Brazilian collections from Riacho Doce, are two new species allied to *Diplomystus*. Another, related to these, called *Diplomystus longicostatus*, has been already known from the Cretaceous of Brazil. These Brazilian species have the general traits of *Diplomystus dentatus*, with the short anal and fewer vertebræ of *Knightia*, while at the same time their squamation seems to be different from both. For this group I suggest the name of *Ellipes*. We may thus recognize among

American forms three types of double-armored herrings, representing two, or perhaps three, distinct genera. These groups may be thus compared:

DIPLOMYSTUS<sup>1</sup> (type *Diplomystus dentatus* Cope). (Plates V and VI.)

Vertebrae forty-two in typical species; the caudal vertebrae about twenty-three in number; anal fin long, with twenty-five to forty rays; ventral fins small, inserted before dorsal; ventral region very prominent, compressed; cleft of mouth very oblique, the chin prominent; teeth present, moderate; dorsal scutes pectinate; scales small, about sixty in number.

ELLIPES (type *Diplomystus branneri* Jordan).

Vertebrae about thirty-two, the caudal vertebrae twelve to seventeen; anal fin short, of about eight to twelve rays; ventral fins very small, much smaller than pectorals, inserted below or before dorsal; ventral region prominent, compressed; cleft of mouth oblique, maxillary narrow; no teeth so far as known; dorsal scutes entire; ventral scutes not serrate; scales apparently large, very thin, and deciduous.

KNIGHTIA<sup>2</sup> (type *Knightia cocæna* Jordan). (Plate VII.)

Vertebrae about thirty-six, the caudal vertebrae twenty-three; anal fin short, of about fourteen rays; ventral fins well-developed, as large as pectorals, inserted opposite front of dorsal; ventral region not at all prominent, body more or less elongate; mouth little oblique; maxillary narrow; no teeth so far as known; dorsal scutes entire; ventral scutes long; scales large, smooth, about thirty-five.

<sup>1</sup>In the fine specimen of *Diplomystus dentatus*, figured in Plate V by the courtesy of Dr. John P. Merriam of the University of California, the opercle is covered with large irregular scales. As no scales occur on the head in any other known herring, these are probably loose scales out of place in the specimen?

[EDITOR'S NOTE. In December, 1898, I received from Mr. Henry L. Ward of Rochester, N. Y., as a Christmas present, a slab from the Green River Shales at Fossil, Wyoming, containing, as he humorously wrote me, "a painting by the oldest of masters." This slab represents a specimen of *Diplomystus dentatus* Cope, in even finer preservation than the one figured by Dr. Jordan, and represented in Plate V. I have had the slab photographed and take the liberty of annexing a reproduction of the photograph as Plate VI to this article, and trust that Dr. Jordan will forgive me for the act.—W. J. HOLLAND.]

<sup>2</sup>*Histiurus* COSTA, Atti Accad. Pontan., V, 1850, 288 (*elatus*); not *Histiurus* Agassiz, an emendation of *Istiurus*.

*Knightia* JORDAN, Univ. Cal. Publ., V, No. 7, 136 1907, (type *Knightia cocæna* Jordan = *Clupea humilis* Leidy, 1856, not of Meyer, = *Clupea pusilla* Cope, 1877, not of Mitchell).



HYPERLOPHUS Ogilby. (Rec. Austr. Mus., II, 1892, 26. Type *Hyperlophus spratellides*, the "Sandy Sprat" of streams of New South Wales.)

Maxillary broad; no teeth; mouth very small; mandible projecting; branchiostegals four; dorsal inserted behind middle of body; ventrals inserted before dorsal; dorsal scutes small; ventral scutes moderate; anal of about nineteen rays; scales pectinate. Dr. Woodward regards *Hyperlophus* as a synonym of *Diplomystus*, which is quite unlikely. One may be too hasty in regarding living forms as identical with extinct genera, as well as too hasty in separating them.

POTAMALOSA Ogilby. (Proc. Linnean Soc. N. S. W., XXI, 1897, 504.

Type *Clupea novæ-hollandiæ* C. & V. of streams of Australia.)

Maxillary narrow; teeth present in jaws and palate; branchiostegals eight; dorsal inserted before middle of body; anal small; ventrals under front of dorsal scales large, smooth; dorsal scutes small; ventral scutes moderate.

Allied to *Potamalosa* are certain American species, typified by "*Potamalosa*" *notacanthoides* (Steindachner) of Chile. This species has the form of an alewife; maxillary rather broad; no teeth; scales rather large and firm, cuneate; dorsal and ventral scutes small; ventrals moderate, under front of dorsal; anal short; fourteen rays; caudal scaly. This species stands between *Ellipes* and *Potamalosa*.

In any event, I think that we are justified in recognizing *Ellipes*, *Potamalosa*, *Hyperlophus*, and *Knightia* as distinct subgenera, even if we should wish to place all double-armored herrings in the single genus, *Diplomystus*.

1. *Ellipes branneri* sp. nov. (Plate VIII, fig. 3.)

Type, a small, much compressed herring pressed flat in black shale, from Riacho Doce, Alagôas, Brazil, J. C. Branner, collector. Total length 2 to  $3\frac{1}{5}$  inches.

Head 3 in length to base of caudal; depth 2; length of longest rib a shade more than length of head. Distance from snout to nape equal to distance from nape to dorsal fin. Length of caudal portion of abdominal column equal to length of head and two-thirds greatest depth. Body short and deep, the back not elevated; the belly very convex and sharply keeled, with about twenty sharp plates; plates in front of dorsal mostly lost; those present small and entire; caudal peduncle deeper in front than long. Head rather deeper than long. Maxillary more or less crushed

in all examples, about  $2\frac{1}{2}$  in length of head reaching to below the front of eye, about 2 in head in the larger and extending below posterior part of eye. Lower jaw oblique, about as long as upper, slightly projecting in the larger example. No trace of teeth. Eye small, a little longer than snout, about  $3\frac{1}{2}$  in head; preopercle widened below; opercle deep, about as long as eye; sharply striated in the larger examples, smooth in the smaller. In the larger specimens the opercle is longer than the eye.

Dorsal fin low, median, its rays uncertain, about twelve; caudal deeply and evenly forked, the lobes a little longer than head; anal short, its rays lost in the type example, but perfectly preserved in No. 51, the fin low, even, with twelve rays, usually one to each interspinal bone, but sometimes two; pectorals short, placed low, the bases of about eight rays showing; ventrals lost in most specimens, in others very small and inserted behind front of dorsal, under the thirteenth rib. Only the base is preserved, but the fin must have been very short. In most of the specimens, the interspinal bones behind the anal end in little knobs, to which the rays are jointed.

Vertebrae about  $15 + 17 = 32$ , or  $16 + 17 = 33$ . Ribs about 20, 24 in larger examples; scales thin, large, nearly all gone, traces of a few on lower part of belly. Some of these seem quadrate in form and plate-like, but of thin texture.

Of this species the type is a small specimen, Collector's No. 1, very perfectly preserved, except for the fin-rays (Plate VIII, fig. 3). It is 2 inches long, with the caudal, and it is represented by an equally perfect duplicate, Collector's No. 2.

Almost equally perfect is another specimen,  $3\frac{1}{5}$  inches long, Collector's No. 29, also figured (Plate VIII, fig. 4). This has an equally perfect duplicate, Number 27. Other relatively perfect examples are Numbers 65 and 66 (duplicates), both showing the anterior half of body. Another, 28, shows the relatively large mouth and rather broad, striated opercle. Other examples broken but in parts perfect, are the following: 30, 31, 32, 33, 34, 38, 40, 41, 42, 45, 46, 47, 48, 49, 50, 51, 52, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 65, 66, 92, 98, 125, 130.

In 46, the ventral scutes are especially well preserved. In none is there any trace of the dorsal scutes. In No. 51, the upper half of the body is lost, the belly with the anal fin very well preserved. This anal fin is restored in fig. 4. Number 125, and its duplicate Number 130, are very small, about an inch long, but very perfectly preserved. We present a figure of Number 125 (Plate IX, fig. 6). Other fragments very badly broken are Numbers 144, 175, 177, 194, 201, 204, 222, 221, 238, 257.

This species apparently belongs to the same group as *Diplomystus longicostatus* Cope, but the latter is readily distinguished by the much elevated back, on which the dorsal fin is perched, and by the much longer ribs, as well as by the great enlargement of the posterior ventral plate.

In both species the ventral fins are very small and median, but in *Ellipes longicostatus* they are inserted well before the dorsal under the eleventh rib, the dorsal being thrown backward by the oblique setting of the body. The insertion of the ventrals behind the front of the dorsal separates *Ellipes branneri* and *E. riacensis* from *E. longicostatus*, as well as from *Diplomystus dentatus* of the North American Eocene.

I have submitted specimens of *Ellipes branneri* to Prof. T. D. A. Cockerell, of the University of Colorado. Professor Cockerell says:

"I have examined the scales of *Ellipes* with very great interest. In no one case can I see the outline of a complete scale, but the transverse circuli are very well developed, and the scales are evidently large. I cannot distinctly determine that they differ in any respect from those of the common herring, except perhaps that the sculpture is not quite so uniform. I cannot see the transverse radii, but these might not be visible in preserved material, and possibly the radii did not exist in these ancient herrings."

We refer to *Ellipes branneri*, with some doubt, two other specimens well preserved, Number 3 described below, with another specimen of the same size, well preserved, but broken into two (Number 24 and Number 25). These agree with the type of *Ellipes branneri* in all technical characters, but the body is more elongate, especially posteriorly, and the ventral region less gibbous and more angulated. The belly is deeper, and the mouth larger than in *Ellipes riacensis*.

Number 3 is a little fish  $2\frac{3}{4}$  inches long, very perfectly preserved in black shale, collected at Riacho Doce, state of Alagôas, Brazil. (Plate VIII, fig. 5.)

Head  $3\frac{1}{2}$  in length to base of caudal; depth  $2\frac{1}{5}$ ; length of longest rib considerably more than length of head. Distance from snout to nape about equal to distance from nape to dorsal fin. Length of caudal part of vertebral column equal to greatest depth, and half more than head. Body deep mesially, the caudal region produced. Belly very convex and sharply keeled, the plates strong and sharp, about 17 in number; trace of four or five scutes before dorsal. These are subacute, smooth, and entire. Caudal peduncle longer than deep in front; head deeper than long maxillary about 2 in its length, reaching to below middle of eye; lower

jaw thin, oblique, projecting beyond upper. No trace of teeth. Eye small, rather shorter than snout;  $3\frac{1}{4}$  in head, longer than opercle; opercle short and deep, more or less striated, and shining black (the bones more or less crushed and obliterated).

Dorsal fin lost; caudal fin equally and sharply forked, half longer than head; anal short, its rays lost, about 14 in number. Pectorals low, not very short; about seven rays evident; ventrals obliterated, probably behind front of dorsal. Vertebræ  $14 + 19 = 33$ . Ribs about 18. Traces of shining scales between the ribs.

## 2. *Ellipes riacensis* Jordan, sp. nov. (Plate X.)

Type a fish pressed flat in black shale, and well preserved, Collector's Number 4. Length  $4\frac{7}{8}$  inches. From Riacho Doce, Alagôas, Brazil, Branner Collection.

Back little convex, the belly more curved but not prominent. Head  $2\frac{1}{3}$  in length to base of caudal; depth  $2\frac{2}{5}$ ; length of longest rib a shade less than length of head; distance from snout to nape a little less than from nape to dorsal; length of caudal part of vertebral column equal to greatest depth and a shade more than length of head. Body moderately deep mesially, about as in species of *Sardinella*, the back scarcely elevated. Belly sharply keeled, the plates strong, about 23 in number, the hindmost not enlarged. Scutes before dorsal mostly lost, apparently entire and with flexible edges. Caudal peduncle longer than deep. Head rather longer than deep. Maxillary  $2\frac{1}{2}$  in head, not reaching front of eye; mouth small, the lower jaw in the type apparently shorter than upper, its position apparently due to distortion; as in other specimens, the chin projects. Eye small, shorter than snout, 4 in head, not longer than opercle. Opercle moderate, its surface polished and striated; subopercle evident, nearly as large as opercle. Dorsal fin preserved, apparently of about 15 rays. Caudal fin a shade longer than head, equally and sharply forked. Anal fin short, probably of about 14 rays, most of them obliterated. Pectorals present, crushed. Ventrals small, inserted behind front of dorsal. Traces of small smooth shining scales between the ribs and on various parts of the body. Vertebræ  $13 + 18 = 31$ . Ribs about 19. Interspinal bones behind anal mostly ending in little knobs to which the rays are joined.

This fish is formed much like an alewife, but with the ventral plates much stronger. From *Ellipes branneri* it differs in the longer head, smaller mouth, shorter lower jaw, shorter ribs, more elongate body, and broader striate opercle.

The type is a fine example, Collector's Number 4, of which Collector's Number 5 is the duplicate, equally well preserved. In numerous others, Collector's Numbers 5 to 23, also 26, 35, 36, 37, 39, 43, 44, 49, 70, 80, 81, and 104, the whole or a part of the body is preserved. Other fragments are Numbers 152 and 171. All are of about the same size, and in all the mouth seems to be small, though the shortness of the lower jaw in the type may be in part due to "telescoping." Only one specimen, the type, shows the ventral fins.

Collector's Number 6 is fairly preserved, and shows the mouth closed, the jaws subequal, the mouth apparently small. Number 7, with two specimens, shows the mouth small, the lower jaw projecting. The sides show a few shining scales, thin and small. Number 9 and Number 20 show a projecting chin, the mouth being small. Number 10 shows the mouth much as in type. In all, the posterior ventral scutes are distinct. They show none of the enlargements peculiar to *Ellipes longicostatus* (Cope). In Number 21 the posterior scutes are broadened, but not much enlarged.

#### *Ellipes longicostatus* Cope.

*Diplomystus longicostatus* COPE, Proc. Amer. Phil. Soc. XXIII, 1886, 3 (Upper Cretaceous, Bahia, Brazil).—WOODWARD, Ann. Mag. Nat. Hist., (6), II, 1888, 134 (Itacaraha).—WOODWARD, Ann. Mag. Nat. Hist. (6), XV, 1895, 2, pl. 1, fig. 1 (Upper Cretaceous beach between Itacaraha and Plataforma, Brazil).—WOODWARD, Cat. Fossil Fishes, IV, 1901, 143 (same specimens).

We found no specimens of this species, but present for comparison with the others a copy of Woodward's figure (1895). (Plate XI.)

The greatest elevation of the dorsal region and the great length of the ribs, as well as the position of the ventrals, will separate this from the other Brazilian species of *Ellipes*.

DASTILBE Jordan, genus nov. (type, *Dastilbe crandalli* Jordan).

? *Halecopsis* AGASSIZ, Poisson Fossiles, V, pt. 2, 1844, 139 (*lævis*), name only.

? *Halecopsis* WOODWARD, Cat. Fossil Fishes, IV, 1901, 133; type, *Osmeroides insignis* Delvoux and Ortlieb.

In this collection are very many well-preserved specimens of a species of herring-like fish not closely related to the genus *Diplomystus*, and apparently forming a new genus which we call *Dastilbe*.

The following are the apparent characters of the genus: body moderately elongate, moderately compressed, the back but little less gibbous than the belly. No evidence of ventral scutes, the belly perhaps rounded. No trace of dorsal scutes. No trace of anal finlets. Head probably

moderately acute, the mouth not very large, oblique, the jaws subequal. Opercle very large, longer than eye, smooth and convex; subopercle distinct; preopercle well developed but not expanded; scales small, even, represented by depressions or pits; about 50 in lateral series. Dorsal fin median, short and high, of about 12 rays. Anal short and rather low, of about 12 rays; 2nd interhæmal strong. Ribs short. Ventrals well developed, about as large as pectorals, inserted under front of dorsal. Pectorals moderate. Vertebræ about  $17+13=30$ . Caudal deeply forked. The opercle, nearly round, very large, smooth or slightly striated, shining black as preserved, is a most conspicuous feature of the broken specimens of this species. We are not able to place this fish in any of the recognized genera. Assuming that it is a herring, which is most probable, its nearest relative would seem to be the genus *Halecopsis* of the Eocene of Europe. But *Halecopsis* has the preopercle greatly expanded, while the opercle is moderately developed. The reverse is true in *Dastilbe*, in which the large opercle shining black in the fossil state is a most conspicuous feature of the fragments in the rocks.

We name our species of this group *Dastilbe crandalli*. We are reasonably certain that it is distinct from a Brazilian fish described by Woodward as *Scombroclupea scutata*, as that species has forty vertebræ, a lower dorsal, and no traces of the very conspicuous opercle characteristic of *Dastilbe*. In any event, our fish cannot be a *Scombroclupea*. The generic traits of *Scombroclupea*, the finlets and scutes behind the anal, and the strong short plates along the ventral line are wanting in *Dastilbe crandalli*.

### 3. *Dastilbe crandalli* Jordan (sp. nov.)

?*Scombroclupea scutata* WOODWARD, Quart. Journ. Geol. Society, LXIV, No. 255, 1908, 360, pl. XLIII, fig. 3, 4. (Ilhéos, Brazil.)

The following account is drawn particularly from No. 91,  $2\frac{3}{4}$  inches in length, collected by Dr. J. C. Branner, at Riacho Doce (Plate IX, fig. 9).

Body moderately elongate, compressed, the depth  $3\frac{1}{5}$  in length to base of caudal. Head  $3\frac{1}{5}$  in length. Head badly crushed in all specimens, especially anteriorly, the eye apparently about as long as the snout; snout moderately acute, but crushed; mouth not very large, oblique, its structure apparently as usual in herrings. Opercle unusually large, forming nearly two-fifths length of head; about as deep as long, convex, and nearly smooth. It is shining black as seen in the rocks, and is recognizable, however crushed the specimen may be. Subopercle rather large, evident

n some specimens, crushed under the opercle in others. Preopercle preserved in one or two examples only, normally formed, rather large, but not expanded, its angle about a right angle. Some shining bones or plates on top of head. Vertebrae  $17 + 13 = 30$  (to 32), those of the caudal portion relatively few, the caudal region barely half as long as the abdominal region. Distance from snout to nape rather more than from nape to front of dorsal.

Dorsal rays not to be accurately counted, about 12 in number, perfect in one specimen, Number 71. very high, twice as high as long; anal rays apparently about 12. Ventrals well developed, about as large as pectorals, inserted below front of dorsal, and distinct in all specimens, the rays apparently 8. Pectoral short, placed low. Body marked with depressions, the imprint of small rounded scales, these about 50 in a linear series. Anterior interspinal bones of dorsal and anal better developed than usual in herrings. Caudal long, sharply forked, the lobes equal,  $1\frac{1}{5}$  in head. No trace of ventral nor of dorsal scutes. No trace of finlets behind anal. Ribs short, rather straight, about 19 in number.

The type of this specimen mentioned is pressed flat in black shale, the head interiorly crushed, and not clearly shown. Its salient traits are its form, the development of its ventral fins, the absence of the scutes so well developed in Brazilian species of *Diplomystus*, the development of its interhæmals and the shortness of the ribs and the large size of the opercle.

Besides No. 91, here figured, we have 92. its duplicate, equally well preserved,  $2\frac{3}{4}$  inches long. No. 112, also figured (Plate IX, fig. 12), is very small, scarcely more than an inch long, and Numbers 67, 68, 69, 71, 72, 73, 75, 76, 77, 74, 78, 82, 86, 87, 84, 88, 89, 90, 91, 93, 94, 95, 96, 97, 102, 103, 105, 107, 110, 111, 112, 113, 118, 119, 120, 121, 122, 123, 124, 126, 127, 128, 129, 131, 132, 133, 134, 195, 196, 197, 198, 199, 200, are of various sizes up to 3 inches, and in fair condition of preservation. In Number 71 the dorsal fin is well preserved, and is unusually high, twice as high as long, the longest ray nearly as long as head. In Number 195, a crushed head, the opercle and preopercle are conspicuous. This specimen we figure (Plate IX, fig. 11). In Number 200 (Plate IX, fig. 10) the head is lost, but the body is very well preserved and the scale imprints are very evident. We figure this specimen also. In many specimens the large opercle, crushed and dislocated, smooth and shining black, is conspicuous.

Broken fragments, mostly identifiable by the large opercles, or by the ventral fins, are the following Numbers: 135, 136, 137, 138, 139, 140, 143

146, 147, 149, 150, 151, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 172, 173, 174, 176, 178, 179, 180, 181, 182, 183, 184, 185, 187, 188, 189, 190, 191, 192, 193, 203, 205, 207, 209, 210, 208, 212, 213, 214, 215, 216, 217, 218, 220, 223, 224, 225, 227, 229, 230, 231, 232, 233, 234, 235, 237, 239, 241, 242, 243, 245, 246, 247, 248, 250, 254, 255, 256, 257, 258, 260, 261, 262, 265, and 266.

Of these, all numbers above 202 are very fragmentary and of little value. In none of these is there any trace of the small scutes at the ends of the interhæmal bones mentioned and figured by Dr. Woodward.

This species agrees in many respects with the two fragmentary specimens from Ilhéos, named *Scombroclupea scutata* by Dr. Woodward. But in none of our specimens, although fairly perfect, do we find any trace of the little scales or scutes at the tip of each interspinal bone behind the anal fin figured by Dr. Woodward and considered by him to be the bases of finlets nor do we find any trace of ventral scutes, and there could have been none of these in life. Moreover, *Scombroclupea scutata* has 40 vertebræ instead of about 30, as in *D. crandalli*.

It is evident that our species cannot belong to *Scombroclupea*, as in that genus finlets are present behind the anal fin, and the ventral ridge is armed with strong plates, as in *Diplomystus*. The genus *Halecopsis* seems nearer to our specimens, but the character of the enlarged preopercle, which defines *Halecopsis*, cannot be verified on any of them. In Woodward's scheme, they might be referable to *Clupea*, but none of the fossil fishes called *Clupea* are congeneric with the Common Herring, *Clupea harengus*. Among other points of difference, *Clupea* has over 50 vertebræ, and no Tertiary or Cretaceous fish with 30 vertebræ belongs in the same genus as the common living herring.

If the detached ventral ridge scale figured by Woodward really came from the specimen on which it lies, his species, *scutata*, may be really a *Scombroclupea*, in which case our species is unquestionably different.

This species is named for Mr. Roderic Crandall, of Stanford University, assistant to Dr. Branner on this expedition, and now geologist to the Geological Survey of Brazil.

#### Family CHIROCENTRIDÆ.

##### 4. *Chiromystus alagoensis* Jordan, (sp. nov.)

In the collection are several fragments of a large fish, about a foot long, apparently belonging to the genus *Chiromystus*, figured by Allport (without name) and later described by Cope and by Woodward from the Upper Cretaceous at Bahia.



Our species, from the Eocene, seems somewhat different from *Chiromystus mawsoni* Cope, and we give it the name of *Chiromystus alagoensis*.

The type, Number 100, with its duplicate, Number 106, represents the jaws and part of the skull, with other crushed structures, the broad and strong pectoral fins being attached. The first ray of the pectoral is very broad and flat, and there are five other rays well defined, with traces of two or three more. The membranes connecting the first three rays are represented and are distinctly striate. The mouth is very large, with a long, curved maxillary, extending to the articulation of the lower jaw and extending far beyond the point where the eye seems to have been located. In the front of the maxillary are moderate teeth. The jaws are subequal, the cleft of the mouth oblique, the lower jaw very heavy, with a prominent lateral ridge and a longitudinal depression below. There are a number of moderate, subequal teeth preserved.

Number 116 (Plate IX, fig. 15), with its duplicate, Number 117, represent the pelvis of a fish, with two ventral fins, each with about six broad, articulated rays, the first two or three very wide, and all much branched towards their tips. As these fins are about an inch long, they must have belonged to a large fish, certainly the same as number 100, and probably to the same species as number 114 also.

According to Woodward, the ventral fins in *Chiromystus mawsoni* are very small. If *C. alagoensis* is also a *Chiromystus*, the size of these fins will indicate a specific difference. The form of the jaws in this fish agrees very fairly with Allport's figure (Quart. Journ. Geol., XVI, 1860, Pl. XIV, fig. 4).

Collector's Number 114 (Plate XIII) and its duplicate, Number 115, represent the posterior part of a long vertebral column, containing 30 vertebræ and indicating that the total number must have been 50 or 60. The vertebræ are about as long as deep, double concave, each posteriorly, with three coarse ridges on each side between these two deep, longitudinally extended pits. The caudal fin is slender, the lower half preserved, apparently deeply forked, the anterior rays springing from the last five of the vertebræ. The caudal seems to have been deeply forked, and sharp at tips, the rays stout at base and jointed. There are traces of a long anal fin, with here and there a ray preserved, and in the surface of the specimen there are traces of what may have been small cycloid scales, but possibly only fragments of skin.

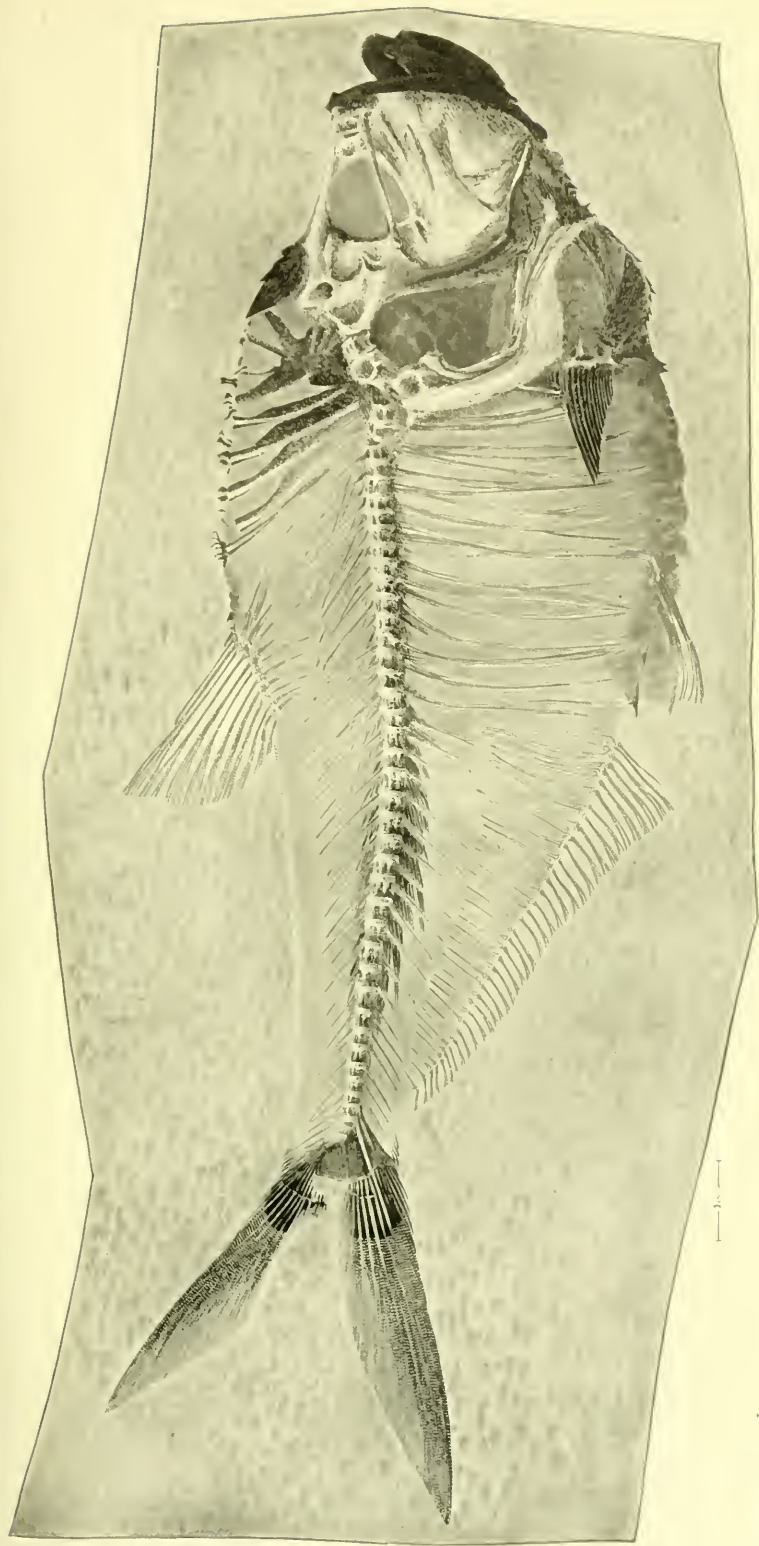
Number 202 is a part of the vertebral column of a smaller example of the same species, but in such bad condition as to show nothing. The

caudal fin of Number 114 suggests at first sight the figure of *Mawsonia minor*, as given by Woodward, Quart. Journ. Geol., LIV, 1908, 358, Plate XLIV, a Brazilian Cretaceous fish. But that species is a *Cælacanth*, with imperfect or cartilaginous vertebræ, and it can have no real affinity with this species, which is doubtless one of the Chirocentrid herrings.

#### AGE OF DEPOSITS AT RIACHO DOCE.

Judging from our knowledge of similar fishes among the existing species, it is probable that the shales of Riacho Doce were deposited in an estuary, and that their age is Lower Eocene, possibly but not probably Upper Cretaceous.

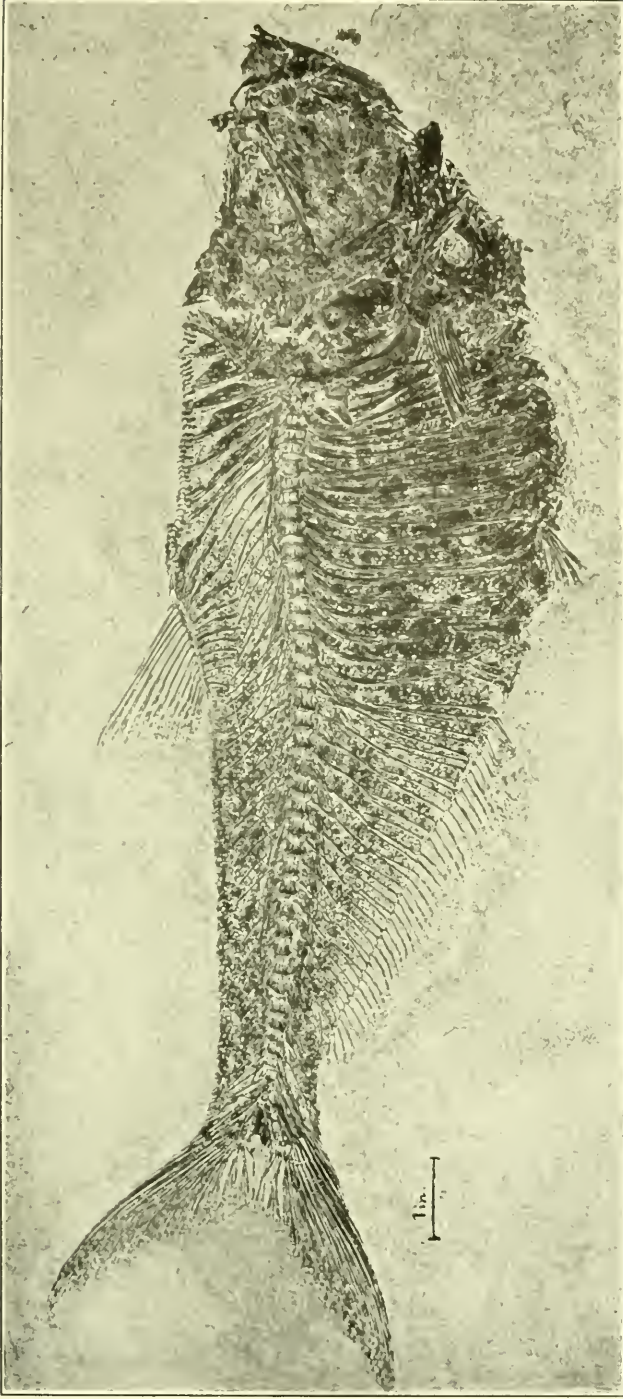
Most of the known species of *Diplomystus* are of later than Cretaceous date. It is also noteworthy that in the Cretaceous about Bahia and about Ceará, none of the species here noted from Riacho Doce were taken. On the other hand, the species found at Riacho Doce are all unlike any yet seen in the Cretaceous. All this would seem to show that the rocks examined in the state of Alagoas are Eocene, while those about Bahia are of the Upper Cretaceous.



*Diplomystus dentatus* Cope.

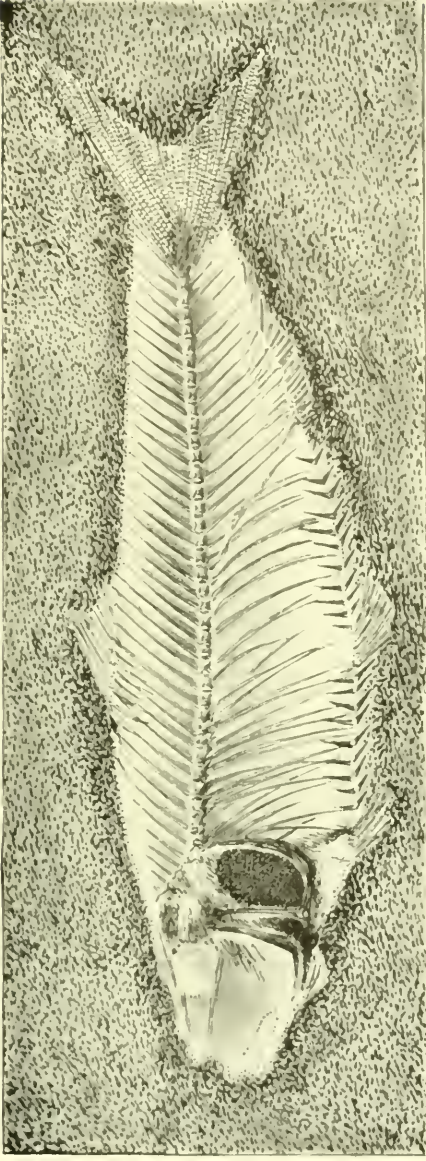
From a specimen in the University of California, from the Eocene (Green River Shales), Fossil Station, Wyoming.





*Diplomystus dentatus* Cope.  
Specimen from Green River Shales, Fossil, Wyoming, in possession of Dr. W. J. Holland.



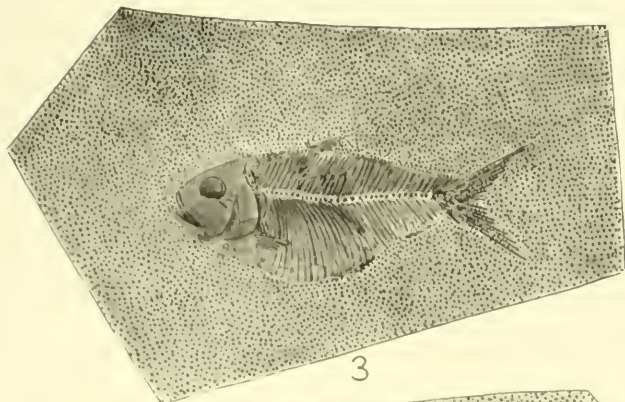


*Knightia cocana* Jordan.

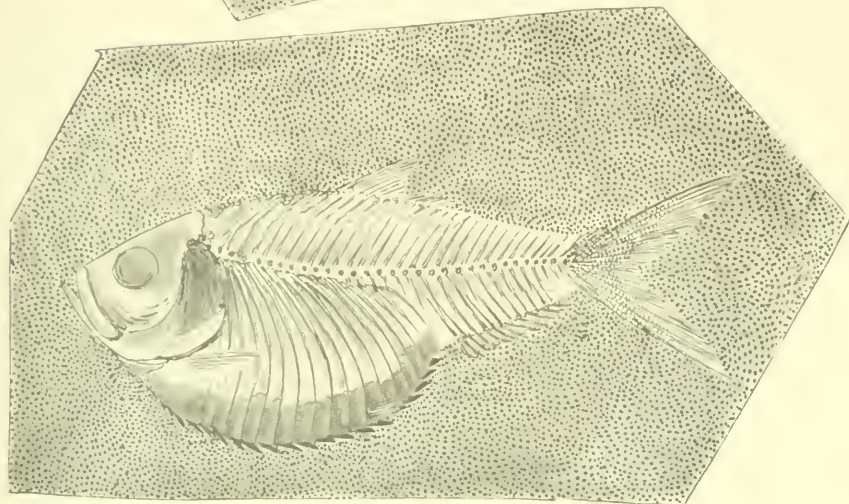
Specimen in Stanford University from Green River Shales of Wyoming.



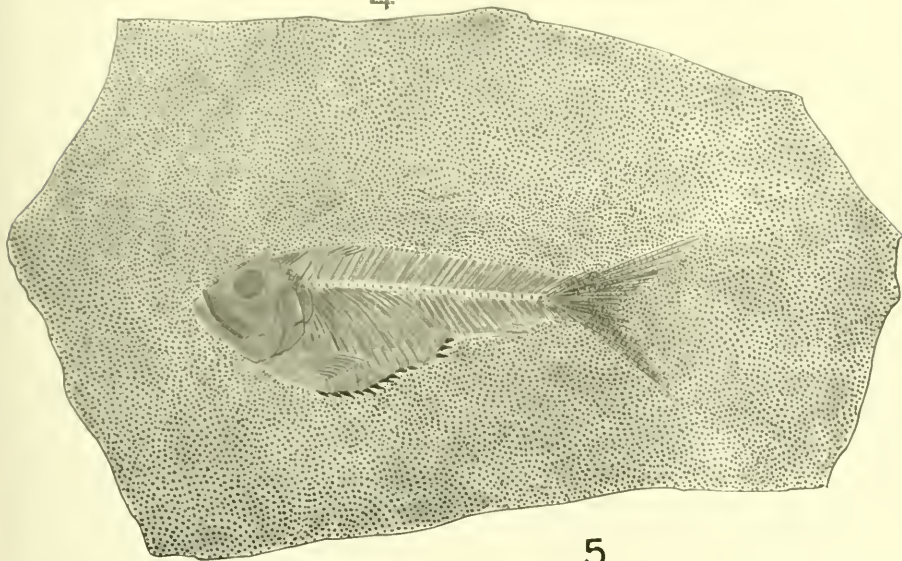




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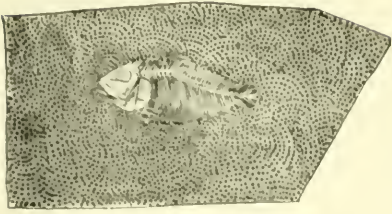
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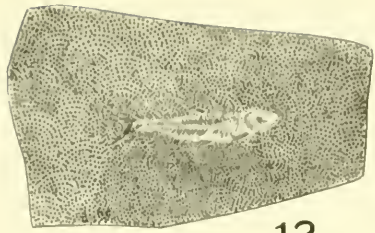
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3. *Ellipes branneri* Jordan, sp. nov. Type. From Riacho Doce, Alagóas, Brazil. (Coll. No. 1; C. M. No.  $5\frac{2}{3}1^{19}$ .)
4. *Ellipes branneri* Jordan, sp. nov. (Coll. No. 29; in Leland Stanford Jr. Univ. Museum.)
5. *Ellipes branneri* Jordan, sp. nov. (Coll. No. 3; C. M. No.  $5\frac{2}{3}1^{19}$ .)

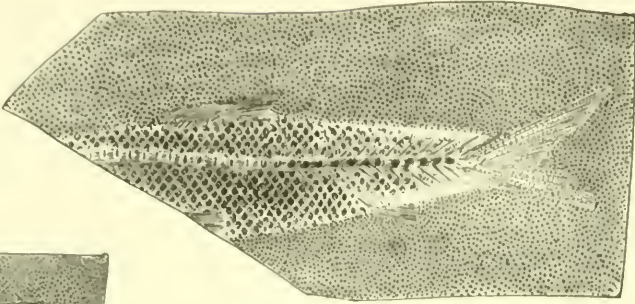




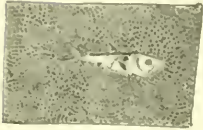
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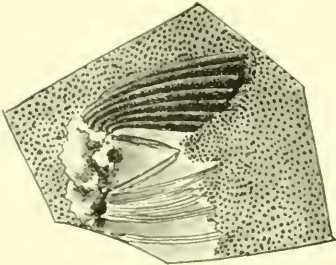
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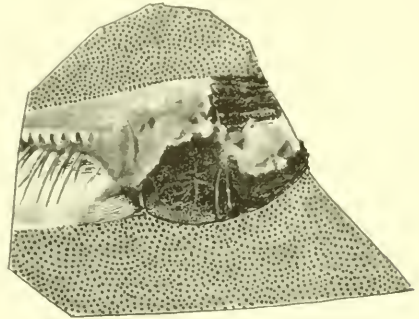
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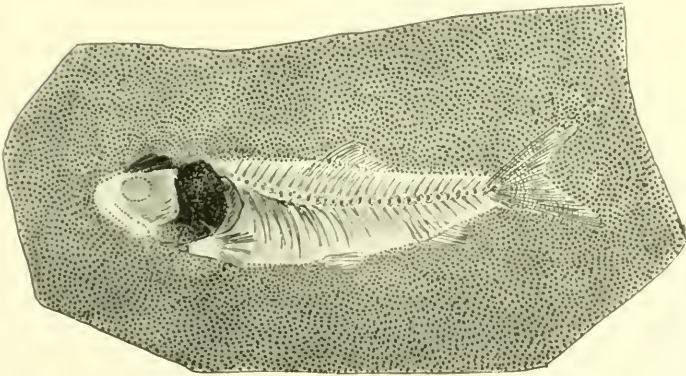
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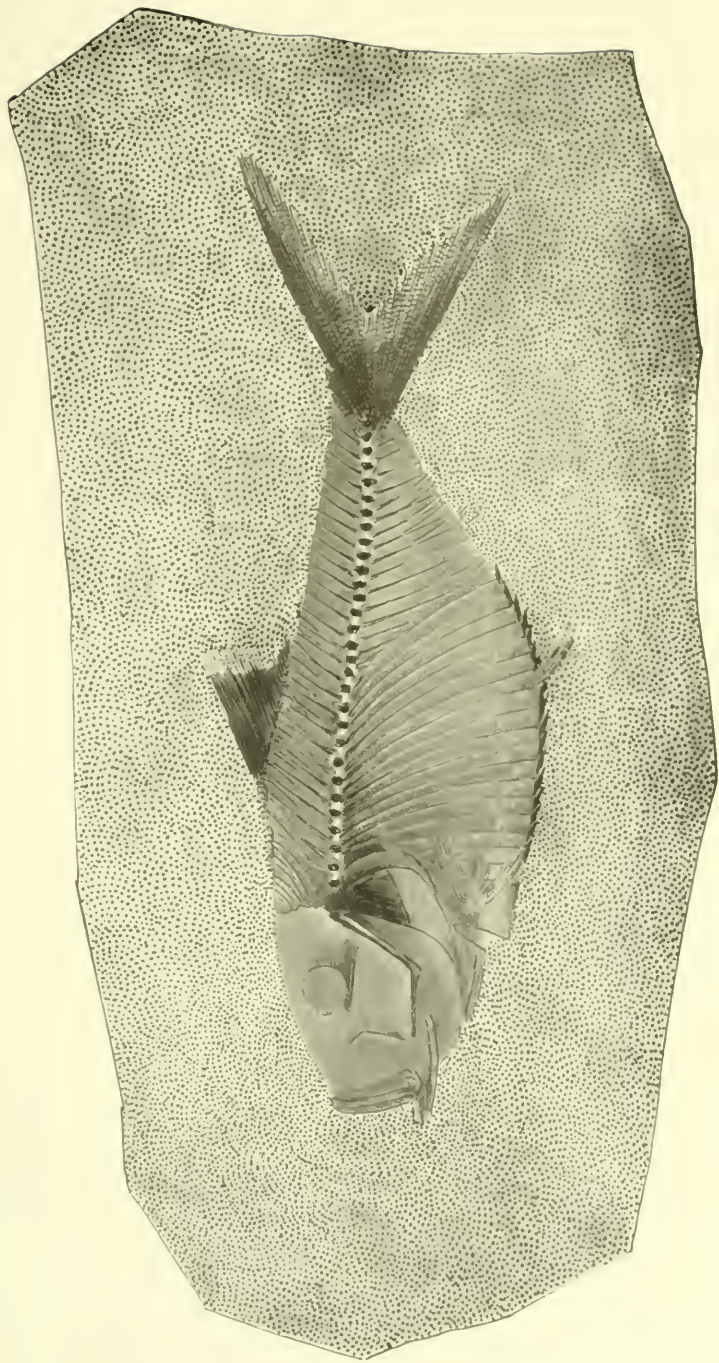
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6. *Ellipes branneri* (Coll. No. 125; C. M. No.  $\frac{5215}{125}$ ). 9. *Dastilbe crandalli* (Coll. No. 91; C. M. No.  $\frac{5217}{125}$ ). 10. *Dastilbe crandalli* (Coll. No. 200; C. M. No.  $\frac{5217}{200}$ ). 11. *Dastilbe crandalli* (Coll. No. 195; C. M. No.  $\frac{5217}{195}$ ). 12. *Dastilbe crandalli* (Coll. No. 112; C. M. No.  $\frac{5217}{112}$ ). 13. *Dastilbe crandalli* (Coll. No. 155; C. M. No.  $\frac{5217}{155}$ ). 15. *Chironomystus alagoensis* (Coll. No. 116; C. M. No.  $\frac{5216}{116}$ ).





*Ellipes ritacensis* Jordan. Type. From Riacho Doce, Alagoás, Brazil. J. C. Brammer Coll. (Coll. No. 4; C. M. No. 1215.)

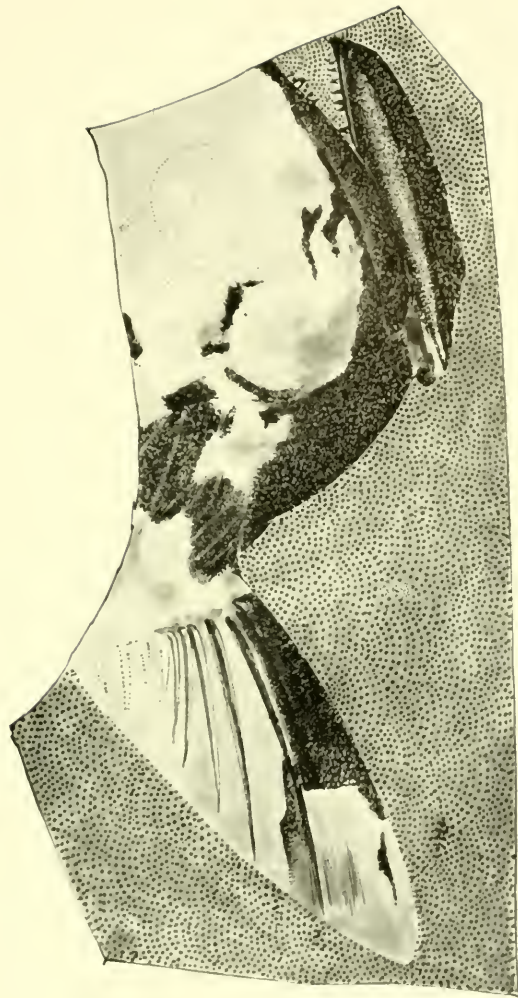




Reproduction of figure of *Ellipnes longicostatus* Cope. Ilácaranha, Brazil. (After Woodward, from Ann. and Mag. Nat. Hist., 6 ser., Vol. XV, pl. 1.)







*Chromomystus atlagensis* Jordan. Type. From Riacho Doce, Brazil. (Coll. No. 100; C. M. No. 5,945.)





*Chironomystus alagoensis* Jordan. Riacho Doce, Brazil. (Coll. No. 114; Car. Mus. No. 5246.)



### III. NOTES ON ORDOVICIAN TRILOBITES. II.

#### ASAPHIDÆ FROM THE BEEKMANTOWN.

BY PERCY E. RAYMOND.

Asaphids first become prominent in American faunas in the Beekmantown, but few species have been described from that formation, it being the usual custom to refer any smooth-tailed species to *Asaphus canalis*. A closer study of some of the material shows that the hypostoma of two of the Beekmantown Asaphids is not forked, so that they can not belong to the same genus as *Asaphus canalis* Whitfield, nor even to the same section of the family. As for the *Asaphus canalis* of Whitfield, the writer will attempt to show that it is more nearly related to *Isotelus* than to *Asaphus*, but that it can not be placed in either genus.

#### Family ASAPHIDÆ Emmrich.

##### ISOTELOIDES Genus nov.

This genus is proposed to include *Asaphidæ* with forked hypostoma, long and narrow form, narrow axial lobe, feebly outlined glabella which does not reach front of cephalon, glabellar furrows faint or absent, neck furrow nearly obsolete, and a small median tubercle present on the glabella. Pygidium with prominent, narrow axial lobe, but with slight traces of segmentation. Flattened border present on pygidium and front of cephalon. Type, *Asaphus canalis* Whitfield.

This genus is separated from *Asaphus* because the glabella does not reach to the front of the cephalon, nor does it expand toward the front, because of the almost obsolete neck and dorsal furrows, the long and narrow form, and the presence of a flattened border on cephalon and pygidium. It agrees with *Asaphus* in the form of the hypostoma, which has the wings separated from the convex body by deep grooves. It also agrees with *Asaphus* in possessing a narrow axial lobe, a defined glabella, and a median pustule on the posterior portion of the glabella. These are, however, characters common to several genera among the *Asaphidæ*. The most important characteristics of the typical *Asaphus* seem to be the short and wide form of the cephalon and pygidium, the absence of a depressed border at either extremity, the fact that the glabella expands

toward the front and reaches the anterior margin, the form of the hypostoma, and the absence of spines at the genal angles. In all these points (except in the form of the hypostoma) *Isoteloides* is unlike *Asaphus*.

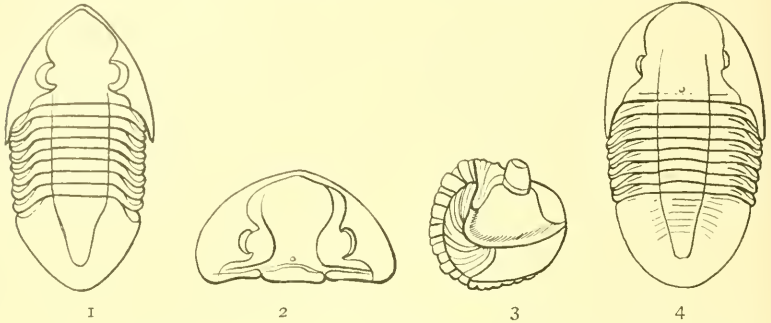


FIG. 1. *Isotelus gigas* Dekay. Outline drawing of young specimen, for comparison with fig. 4.

FIG. 2. *Asaphus expansus* (Linné). Compare proportions of cephalon and shape of glabella with 1 and 4.

FIG. 3. *Asaphus expansus* (Linné). Side view of an enrolled specimen. Notice the lack of a concave border round the cephalon and pygidium. 2 and 3 after Salter.

FIG. 4. *Isoteloides whitfieldi* Raymond. Outline drawing of a specimen in the Carnegie Museum.

*Isoteloides* agrees with *Isotelus* in having the dorsal furrows and neck ring very faint on the cephalon, in the almost entire absence of segmentation on the pygidium, in having a depressed border on the pygidium, and in the presence of spines at the genal angles. It differs from *Isotelus* in the form of the hypostoma, in having a defined glabella and a median tubercle, and in having a narrow axial lobe.

*Isotelus angusticaudus* Raymond of the Chazy and *Asaphus homalnooides* Walcott of the Black River and Trenton appear to belong to this genus.

#### *Isoteloides whitfieldi* nomen nov.

Plate XIV, figures 1-4.

*Asaphus canalis* WHITFIELD, Bulletin American Museum Natural History, I, 1886, 336, pl. 34, figs. 1-8. (not of Conrad or Hall).—WHITFIELD, Bulletin American Museum Natural History, II, 1889, 64, pls. 11, 12.

Not *Asaphus* or *Isotelus canalis* of Conrad, Hall, Billings, Clarke, Cleland, or Weller.

The first mention of the specific name *canalis* as applied to an Asaphid was by Hall in the "Paleontology of New York," Vol. I, p. 25. Hall

credits the name to Conrad, in manuscript, and describes and figures the hypostoma and doublure of a large trilobite. These fragments and the brief description do not serve to define a species. The specimens were from the upper part of the Chazy a little west of Chazy village, New York. From what is now known of the *Asaphidæ* of the Chazy it seems most probable that these fragments belong to what is now known as *Isotelus harrisi* Raymond. As this can not be determined, the name *Asaphus canalis* has no meaning. The species described by Whitfield, coming as it does from a much lower horizon, can not by any possibility be the species of which Hall had fragments, and the name *canalis* should not be applied to it. I therefore propose to name it for the late Professor R. P. Whitfield, to whom we owe a full and accurate description of the species.

Genus ASAPHELLUS Callaway.

*Asaphellus* Callaway, Quarterly Journal Geological Society London, XXXIII, 1877, 663.

This name was proposed by Callaway for *Asaphus homfrayi* Salter, chiefly on account of the entire hypostoma. It has been considered by Brogger and Schmidt as a subgenus of *Niobe*, and is indeed very similar to that genus, but differs fundamentally in the course of the suture in

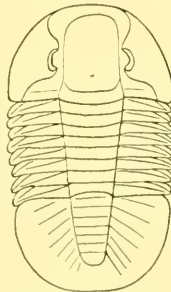
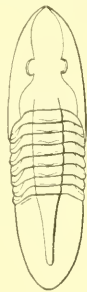


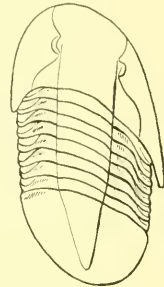
FIG. 5. *Niobe insignis* Linnarsson. Outline to show course of facial suture. Thorax supplied. Cephalon and pygidium after Brogger.

front of the eye. In *Asaphellus* the course of the suture is entirely on the dorsal surface of the cephalon and the two sutures meet in a point in the middle of the anterior margin as in *Asaphus* and *Isotelus*. For the sake of brevity this will be referred to hereafter as the *Isoteliform* suture. In *Niobe* the suture cuts the anterior margin in front of the eye, and follows around the frontal margin as in *Nileus*. This will be called the *Niobiform* suture. Among the *Asaphidæ* with forked hypostomas the *Isoteliform* suture prevails, *Asaphus*, *Onchometopus*, *Ptychopyge*, *Isoteloides*, and *Iso-*

*telus* all having this type, while *Basilicus* is the only member of the group with the *Niobiform* suture. On the other hand those trilobites with an undivided hypostoma usually have the *Niobiform* suture, it being present in *Ogygia*, *Ptychocheilus*, *Asaphelina*, *Niobe*, *Symphysurus*, *Illæurus*, *Nileus*, *Barrandia*, *Homalopteon*, and *Platypeltis*. A few genera which have the undivided hypostoma do have the *Isoteliform* suture, namely, *Megaaspis*, *Megalaspides*, *Asaphellus* (as here restricted) and *Ogygia corudensis*, a species which Salter and Brogger have both said was not an *Ogygia*, but which they could not refer to any existing genus. Taking into consideration these facts, it does not seem possible to place *Asaphellus* as a subgenus of *Niobe*, or to place in one subgenus species having both types of suture, as Brogger has done in emending *Asaphellus* so as to include *Asaphus affinis* McCoy, *Ogygia desiderata* Barrande, and other species which are here referred to a new subgenus of *Niobe*.<sup>1</sup>



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FIG. 6. *Asaphellus homfrayi* (Salter). Outline of compressed specimen. After Salter.

FIG. 7. *Hemigyraspis affinis* (McCoy). Outline of a somewhat distorted specimen. After Salter.

The genus *Asaphellus* is here restricted to trilobites having the same characteristics as the type species, *Asaphus homfrayi* Salter. The facial suture is entirely on the dorsal surface as in *Isotelus*, the glabella is smooth and hardly defined, also as in *Isotelus*, but there is a median pustule on the glabella, the hypostoma is not forked, and the thorax has a narrow axial lobe. There is no neck ring, the neck furrow is extremely shallow, and the spines at the genal angles are long and nearly circular in cross-

<sup>1</sup>"Ueber die Ausbildung des Hypostomes bei einigen Skandinavischen Asaphiden," *Bihang till K. Svenska Vet. Akad. Handlingar*, Band XI, 1886, p. 55. Also his article on the "Euloma-Niobe Fauna," *Nyt Mag. for Naturvidensk.*, Band XXXV, 1896.



section. The pygidium is nearly smooth, the axial lobe being only faintly defined, and nearly all traces of segmentation lost.

Beside the type species, the genus as restricted will include *Asaphellus homfrayi* Matthew var. from the Tremadoc of Cape Breton, and the two new species here described.

***Asaphellus gyracanthus* sp. nov.**

Plate XIV, figures 5-7.

*Asaphus canalis?* CLELAND, Bulletin American Paleontology, III, 1900, 128, pl. 16, figs. 7, 8.—CLELAND, Bulletin American Paleontology, IV, 1903, 38.  
*Isotelus canalis* WELLER, Paleontology New Jersey, III, 1902, p. 132, pl. 5, figs. 5, 6.

This asaphid is very abundant in the Beekmantown at Fort Hunter, New York, but no complete specimens have been found. From the general shape of the pygidia and free cheeks Cleland concluded that the trilobite was probably *Asaphus canalis*, but the discovery of an unforked hypostoma of the *Asaphellus* type associated with the specimens shows that it belongs to another section of the family.

Only one fairly complete cranidium, that mentioned by Cleland, seems to have been found. Through the kindness of Professor Harris I have been able to see this specimen. There are hardly any traces of dorsal furrows, so that the glabella is as flat as in *Isotelus*. In front of the glabella is a narrow depressed border. While there are no entire cephalons known, the shape of the anterior end of the cranidium is such as to indicate that the facial sutures met in a point on the margin and that the whole course of the suture is on the dorsal surface. The eyes are not so far forward as in *Hemigyraspis collicana* and are closer together. Between them is a minute pustule. The free cheeks are broad, flat and bear long spines at the genal angles. The pygidium is semicircular in outline, evenly convex with a narrow depressed border. The axial lobe is not prominent, but there are traces of three or four rings at the anterior end. The hypostoma, of which there is a single specimen in the Carnegie Museum, is similar to that of *Hemigyraspis collicana*, a figure of which is given on the plate.

The pygidium of this species differs from that of *Isoteloides whitfieldi* in having the axial lobe much less clearly outlined and in being shorter in proportion to the width, as well as in the general contour, the whole surface being evenly convex in the specimens of *Asaphellus gyracanthus*, while in *Isoteloides whitfieldi* the axial and pleural lobes are prominent.

The pygidia resemble more closely those of *Hemigraspis colliciana*, but are a little longer in proportion to the width, and have a less prominent axial lobe. The genal spines are very unlike those of *Isoeloides whitfieldi*, being circular in section and very long.

It appears from Weller's figures that this same species occurs in New Jersey.

***Asaphellus monticola* sp. nov.**

Plate XIV, figure 8.

In a collection of fossils recently acquired by the Carnegie Museum there is a nearly complete specimen of an *Asaphellus* collected by Monsieur Jean Miquel at the Montagne Noire, Herault, France. It is such an excellent example of the genus as restricted, that I can not refrain from describing it.

The form is long and narrow, the cranium flat, the glabella not outlined, the dorsal furrows not present on the cephalon except as depressions on the posterior margin. The eyes are small, situated one-third the length of the head from the posterior margin. There is a very shallow neck-furrow, but no neck-ring, and there is a small median pustule on the posterior portion of the glabella.

The thorax has eight segments, the axial lobe is one-third the total width, and the pleura are deeply grooved. The pygidium is subtriangular with a narrow concave border, the axial lobe is only faintly defined, and there are scarcely any traces of segmentation.

The total length of the specimen is 47 mm.; the width at the middle of the thorax 23 mm. The cranium is 18 mm. long; the pygidium 16 mm. long and 23 mm. wide.

This species differs from *Asaphellus homfrayi* Salter chiefly in the pygidium, which is narrower and has a much narrower concave border. Our specimen is not distorted, but the form is much more like the compressed specimen figured by Salter ("British Trilobites," Pl. 24, fig. 6) than like any of the other specimens figured. The French specimen is much narrower than the *Asaphellus homfrayi* var. figured by Matthew.

There is another species associated with this at the Montagne Noire with a smooth cranium, and which might be confused with the one here described. This second species has, however, a short and wide cephalon and pygidium, and the facial suture is of the *Niobe* type. It is probably *Hemigraspis desiderata* (Barrande).

*Locality*.—The specimen here described was collected at Le Priou, near

Pierrerie and L'Chinian, Herault, France, by Monsieur Jean Miquel. The horizon was in the middle of the Tremadoc. The holotype is in the Carnegie Museum.

Genus *NIOBE* Angelin.

Subgenus *Hemigyraspis* nov.

This subgenus is proposed for *Asaphidæ* with entire hypostoma, smooth, undefined glabella which does not reach to the anterior margin, no glabellar furrows and no neck-ring, facial sutures whose anterior limbs cut the frontal margin in front of the eye (Niobiform), thorax with narrow axial lobe, pygidium semicircular and nearly ribless. Type, *Asaphus affinis* McCoy, as described by Salter, "Monograph British Silurian Trilobites," Pl. XXIV, figs. 13, 14, p. 164.

Members of this subgenus are very similar to the species of *Asaphellus*, but the facial sutures are of different types in the two. *Hemigyraspis* is similar to *Niobe*, but the glabella is not defined by dorsal furrows as in that genus, there is no neck-ring, there are spines at the genal angles, and the pygidium is nearly smooth.

Beside the type species, *Ogygia desiderata* Barrande, *Niobe menapiensis* Hicks, and *N. solvensis* Hicks, all of which have been referred to *Asaphellus* by Brogger, and *Asaphellus? planus* Ma thew appear to belong to this subgenus.

*Hemigyraspis collieana* sp. nov.

Plate XIV, figures 9-13.

*Asaphus marginalis* COLLIE, Bulletin Geological Society of America, XIV, 1903, 413. (In faunal lists.) Not of Hall.

In the section at Bellefonte, Center County, Pennsylvania, Professor Collie found a zone 937 feet above the base of the exposed Beckmantown, and 3,866 feet below the top of that formation, in which an Asaphid was very abundant. The trilobite was supposed to be *Asaphus marginalis* Hall, a species which was very imperfectly known at that time. Professor Collie very kindly gave the writer a number of specimens of this trilobite, and among them I find a small unforked hypostoma, showing that this species can not be referred to the same genus as *Asaphus marginalis* (*Basilicus*).

#### DESCRIPTION.

Cephalon short and wide, glabella smooth, not outlined, no glabellar furrows. Neck-furrow shallow, hardly visible. Eyes nearly halfway to the front of the cephalon, large, very far apart. Between the eyes is a small median tubercle. Free cheeks short, wide, with long narrow spines



at the genal angles. The anterior limb of the facial suture meets the frontal margin in front of the eye. There is a narrow depressed border on the front of the cranium.

Axial lobe of thorax one-third the total width; pleura grooved. Pygidium short, wide, semicircular in outline. Axial lobe narrow, rather prominent, showing traces of two or three rings. Pleural lobes convex, without traces of ribs. Border narrow, concave; doublure narrow, convex. Hypostoma quadrangular, widest in front, central portion convex, with a furrow and narrow border around the sides and posterior end. Surface of all parts, including the hypostoma, covered with imbricating striæ.

One pygidium is 9.5 mm. long and 18 mm. wide; a larger one is 14 mm. long and 28 mm. wide.

This species differs from the only other American species of the subgenus now known (*Asaphellus? planus* Matthew)<sup>2</sup> in having a more prominent axial lobe on the pygidium, and in having the median tubercle between the eyes instead of back of them. The genal spines are also longer and more rounded in section.

This species is also much like *Asaphellus gyracanthus*, but beside the difference in the course of the facial suture, the cephalon of the species here described is shorter and wider, the eyes are farther apart, and the axial lobe of the pygidium is much more prominent.

*Locality*.—This species is described from specimens from a layer 3,866 feet below the top of the Beekmantown at Bellefonte, Center County, Pennsylvania. It is named for Professor George L. Collie, Dean of Beloit College, who collected the specimens. Cotypes in the Carnegie Museum.

### **Symphysurus convexus** (Cleland).

Plate XIV, figures 14-16.

*Asaphus convexus* CLELAND, Bulletin American Paleontology, III, 1900, 128, pl. 16, fig. 4.

*Bathyurus* sp. CLELAND, Ibidem, 1900, pl. 16, fig. 9.

*Illænurus columbiana* WELLER, Paleontology of New Jersey, III, 1902, 133, pl. 5, figs. 1-4.

*Bathyurus? levis* CLELAND, Bulletin American Paleontology, IV, 1903, 36, pl. 2, figs. 1, 2.

This species was first described from a pygidium obtained by Cleland in the Beekmantown at Fort Hunter, New York. Later Weller obtained

<sup>2</sup>*Bulletin Natural History Society New Brunswick*, IV, 1902, 413, pl. 18, fig. 11

specimens from the same horizon at Columbia, New Jersey, and referred the species to *Illænurus*. In this genus Cleland's name was preoccupied, and therefore Weller was forced to give a new name.

The genus *Illænurus* was proposed by Hall<sup>3</sup> for a trilobite found near the middle of the Potsdam sandstone near Osceola Mills, Wisconsin. This genus appears to be closely related to *Symphysurus*, as Brogger has already suggested ("Euloma-Niobe Fauna," p. 72). There is, however, a real difference between the two genera, for *Symphysurus* has a narrow axial lobe in the thorax, and a pygidium nearly as long as wide, with a distinct axial lobe. In *Illænurus* the axial lobe of the thorax is very wide, as in *Nileus*, the pygidium is twice as wide as long, and has no trace of an axial lobe.

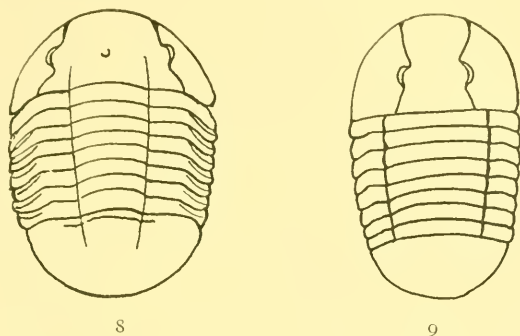


FIG. 8. *Symphysurus sicardi* (Bergeron). Outline of a specimen in the Carnegie Museum.

FIG. 9. *Illænurus quadratus* Hall. Outline restored from the various parts figured by Hall. The axial lobe of anterior thoracic segments has been made a little too wide.

The pygidium of the species described by Cleland and Weller is nearly as long as wide and has a distinct axial lobe, thus agreeing with *Symphysurus* rather than *Illænurus*. The thorax of this species is not known, but it is highly probable that the axial lobe is narrow, as it is in all trilobites whose pygidia have narrow axial lobes. It will be noticed that the glabella in *Hemigyraspis* and *Asaphellus* is broad, but the axial lobe on the pygidium is narrow, as is the axial lobe of the thorax also. In *Isotelus*, *Nileus*, and *Illænurus quadratus*, where the axial lobe of the thorax is very broad, there is almost no trace of an axial lobe on the pygidium.

*Symphysurus convexus* is very similar to *Symphysurus angustatus* Sars

<sup>3</sup>16th Report New York State Cabinet Natural History, 1863, 176, pl. 7.

and Boeck<sup>4</sup> of Norway and to *S. sicardi* (Bergeron) of southern France. A figure of the latter species, drawn from a specimen in the Carnegie Museum, is introduced for comparison. The dorsal furrows are more prominent on the cephalon of the European species, but otherwise they are very much alike.

Through the kindness of Mr. Henry B. Kummel, State Geologist of New Jersey, the writer has been able to study the fine cranidium figured by Dr. Weller, and to compare it with material from Fort Hunter. The specimens from the two localities are alike in all particulars except size, and the specimen from New Jersey shows the small median tubercle between the eyes described by Cleland in specimens from New York.

*Illænurus eurekaensis* Walcott from the lower portion of the Pogonip group<sup>5</sup> should also be referred to *Symphysurus*, as Brogger has already suggested.

*Illænurus convexus* Whitfield<sup>6</sup> has a pygidium much more like that of the typical *Illænurus* than either of the above species. The pygidium is described by Whitfield as being twice as broad as long and the dorsal furrows indicated only by slight constrictions on the anterior margin. This is probably a true *Illænurus*, though the cranidium is more like that of the species here discussed than it is like that of *Illænurus quadratus*.

*Asaphus illænoides* Billings (Paleozoic Fossils of Canada, Vol. I, p. 414) is another American species of *Symphysurus*.

All specimens with the exception of the originals of figs. 5, 6, and 14 are in the Carnegie Museum.

#### EXPLANATION OF PLATE XIV.

1. *Isoteloides whitfieldi* Raymond. A small specimen from the Beekmantown at Crown Point, New York. Natural size. This figure does not show the flattened anterior margin as well as figure 2. Natural size.

2. The same specimen. A little less than natural size.

3. The same species. A pygidium from Fort Cassin, Vermont.

4. The same species. An hypostoma from Ft. Ticonderoga, New York. Natural size.

5. *Asaphellus gyracanthus* Raymond. An imperfect cranidium from Fort Hunter, New York. Natural size. Specimen in the Cornell University Museum.

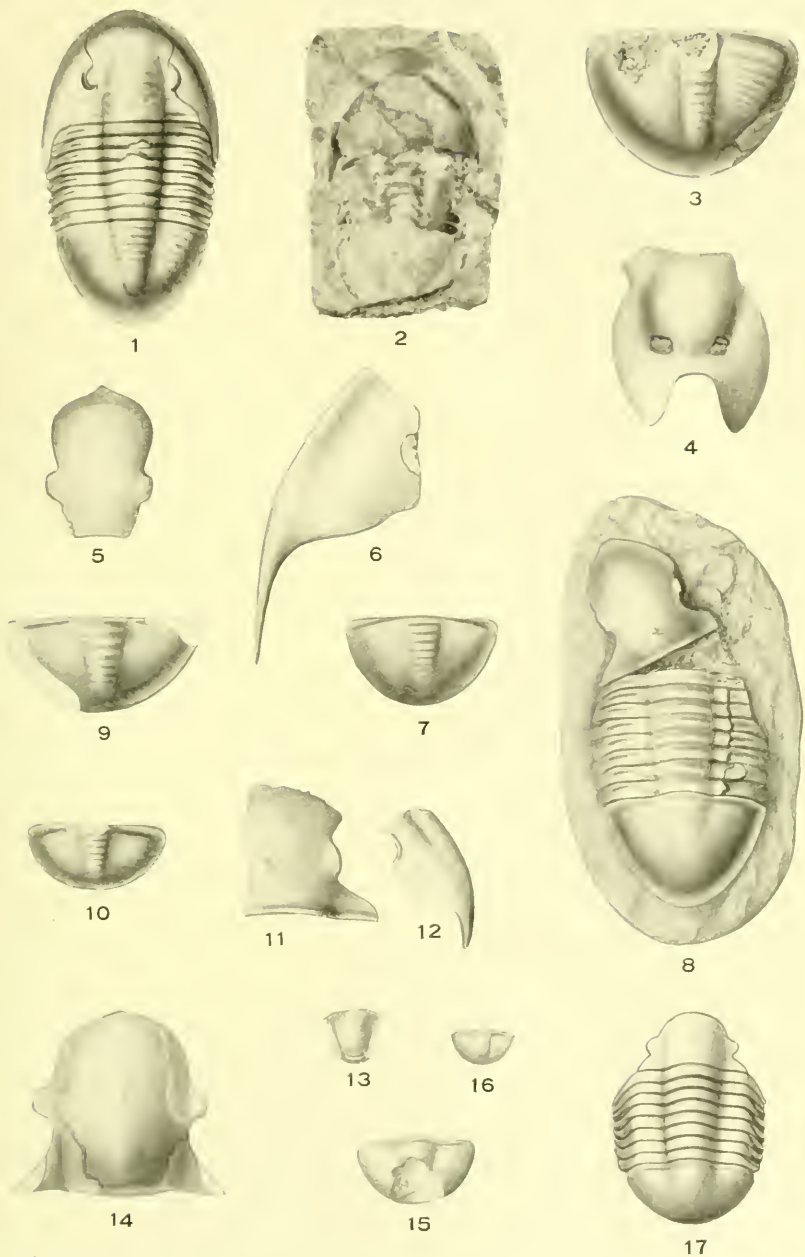
6. The same species. A free cheek from the same locality and same collection as the last. Natural size.

7. The same species. A pygidium from Fort Hunter in the Carnegie Museum. Natural size.

<sup>4</sup>Brogger, "Die Silurischen Etagen 2 und 3," 1882, 60, pl. 3, figs. 9-11

<sup>5</sup>*Paleontology of the Eureka District*, 97, pl. 12, figs. 4, 4a.

<sup>6</sup>*Geology Wisconsin*, IV, 203, pl. 4, figs. 3-5



Sydney Prentice, del.

Beekmantown Trilobites.





8. *Asaphellus monticola* Raymond. This holotype is from the Tremadoc at the Montagne Noire, Herault, France. Natural size.
9. *Hemigyraspis colliciana* Raymond. A pygidium from Bellefonte, Pennsylvania. Natural size.
10. The same species. Another pygidium from the same locality. Natural size.
11. The same species. An imperfect cranidium from the same locality as the last. Natural size.
12. The same species. A free cheek from the same locality. Twice natural size.
13. The same species. An hypostoma from the same locality. Natural size.
14. *Symphysurus convexus* (Cleland). From the specimen figured by Weller as *Illænurus columbiana*. Specimen in the collection of the Geological Survey of New Jersey. Natural size.
- 15, 16. Two small pygidia of the same species from Fort Hunter, New York. Natural size.
17. *Symphysurus sicardi* (Bergeron). A specimen from the Tremadoc at the Montagne Noire, Herault, France, for comparison with *S. convexus*. Natural size.

#### IV. NOTES ON ORDOVICIAN TRILOBITES. III.

##### ASAPHIDÆ FROM THE LOWVILLE AND BLACK RIVER.

BY PERCY E. RAYMOND AND J. E. NARRAWAY.

In a previous paper in these Annals we dealt with the *Illænidæ* collected by Mr. Narraway in the vicinity of Ottawa, Canada. The present paper is based largely on fossils collected by him in the same region, but the majority of the specimens figured are in the Carnegie Museum. The *Asaphidæ* of these formations are less numerous and diversified than the *Illænidæ*, and the specimens are not so well preserved. In the present paper *Bathyurus longispinus*, the hypostoma of *Bathyurus extans*, the free cheek of *Bathyurus spiniger*, and the cephalon of *Isoteloides homalnotoides* are figured for the first time. The cephalon, thorax, and hypostoma of *Basilicus romingeri* have not previously been figured or described, and a new species of Schmidt's genus *Onchometopus* is recognized. This latter genus has not previously been reported in this country.

To the list of trilobites published in our previous paper as occurring in the Black River at Ottawa should be added *Cyphaspis trentonensis* Weller and *Isoteloides homalnotoides* (Walcott). *Bathyurus extans* should be removed from the list, and *Asaphus romingeri* Walcott should read *Basilicus romingeri* (Walcott).

The drawings on the plates were made by Mr. Sydney Prentice, and the photographs are by Messers. A. S. and L. S. Coggeshall.

##### Family BATHYURIDÆ Miller

##### Genus BATHYURUS Billings.

##### *Bathyurus extans* (Hall).

Plate XV, figures 7, 8; Plate XVI, figure 5.

- Asaphus ? extans* HALL, Paleontology New York, I, 1847, 228, pl. 60, figs. 2a-2c;  
Third Annual Report New York State Cabinet Natural History, 1850, 174,  
pl. 3, figs. 1a-1c.
- Asaphus ? nodostriatus* HALL, Paleontology New York, I, 1847, 248, pl. 61, figs.  
1a, 1b.
- Bathyurus extans* BILLINGS, Canadian Naturalist and Geologist, IV, 1859, 364;  
Geology Canada, 1863, 153, fig. 114.—CLARKE, Paleontology Minnesota, III,  
ii, 1897, 722, fig. 37.

This well-known species is very abundant in the buff dolomite of the Lowville at Mechanicsville, Pelton's quarry and other places near Ottawa. At some localities this is the only trilobite found in certain layers of the Lowville. In one layer at Mechanicsville where this is true, a few detached hypostomas have been found. Two of them are figured on the plates which accompany this article. In his original description of the genus Billings described the hypostoma as "oblong, not forked, somewhat oval, an elevated margin around the posterior two-thirds in some species, muscular impressions two, transverse or oblique, situated behind the middle." He did not give a figure, but in the "Paleozoic Fossils of Canada," Volume I, page 408, he states that the hypostoma is exactly like that of *Ogygia*. The hypostomas here figured are certainly similar to that of *Ogygia*, but they do not answer well to Billings' description. However, as *Bathyurus extans* is very abundant in the layer from which these specimens were obtained, and is the only trilobite present, it is believed that they belong to that species.

The glabella of this species is strongly convex, and is outlined by deep dorsal furrows and a very narrow concave anterior border. There are two pairs of shallow glabellar furrows, and in well preserved specimens the test shows a very few fine pustules scattered over the surface, as well as numerous, fine, wavy striæ. The neck-ring bears a low median pustule. The eyes are large and situated near the neck-ring. The free cheeks have narrow concave borders and the genal angles are drawn out into long spines.

The thorax has nine segments, is strongly convex, the axial lobe narrow, the pleura flat on top and sloping gently at the sides.

The pygidium is very convex, roughly triangular, and about three-fourths as long as wide. The axial lobe has two rings and a trace of a third on its anterior end. Otherwise it is smooth. The pleura slope rather abruptly to the narrow concave border, and show four pairs of broad segments, the fourth pair not well defined. On the first two pairs are slightly impressed lines.

This species does not seem to occur in the Black River, being replaced in that formation by *Bathyurus longispinus* and *B. spiniger*.

### ***Bathyurus longispinus* Walcott.**

Plate XVI, figures 12-14.

*Bathyurus longispinus* WALCOTT, Twenty-eighth Annual Report New York State Museum, 1879, 94.

?*Ptychopyge jerseyensis* WELLER, Paleontology New Jersey, III, 1902, 193, pl. 14, fig. 16.

Through the kindness of Curator Henshaw of the Museum of Comparative Zoology we are able to present figures of the fine fossil which is the type of this species. The species has not previously been figured and has therefore been confused with *Bathyrurus extans*. In *B. longispinus* the glabella is more pustulose, the brim<sup>1</sup> is wider and less concave, and the genal spines longer than in *B. extans*. The pygidia of the two species are quite different, that of *B. extans* being long and roughly triangular, while that of *B. longispinus* is nearly semicircular in outline, short and wide, and with a rather wide concave margin. The axial lobe of the pygidium is also shorter in this species than in *B. extans*, and has only two rings on the anterior end.

The cephalon of the type is 26 mm. long, measured along the axis to the back of the neck-ring, and 50 mm. to the tips of the spines. The pygidium is 13 mm. long and 25 mm. wide.

The fragment of a pygidium from the lower part of the Trenton of New Jersey which Weller described as *Ptychopyge jerseyensis* was very kindly loaned by Mr. Henry B. Kummel, State Geologist. It proves to belong to the genus *Bathyrurus*, and while hardly specifically identifiable, its short wide form and its geological position indicate that it is *B. longispinus*.

*Locality*.—This species is rather common in the Black River at Newport, New York, but has not been reported elsewhere, perhaps because it has been identified as *Bathyrurus extans*. It is not surely known to occur at Ottawa.

### **Bathyrurus spiniger** (Hall).

Plate XV, figures 4-6.

*Acidaspis spiniger* HALL, Paleontology New York, I, 1847, 241, pl. 64, fig. 5.

*Bathyrurus spiniger* CLARKE, Paleontology of Minnesota, III, ii, 1897, 723, figs. 38-40. — RAYMOND, Bulletin American Paleontology, III, 1902, pl. 19, figs. 1-3.

In the Black River at Ottawa *Bathyrurus extans* is replaced by *Bathyrurus spiniger*, a species which ranges from the upper part of the Lowville to the middle of the Black River.

The glabella is very convex, covered with sharp tubercles, and the neck-ring bears a short stout spine which projects upward and backward. On young specimens there are two pairs of glabellar furrows whose direction is at almost right angles to the axis of the glabella. The furrows can be found on adults, but they are exceedingly faint. The eyes are large, the

<sup>1</sup>This term is proposed by Bather for the flattened border on the cephalon of *Harpes*. (*Revista Italiana di Paleontologia*, 1910, 4.)

free cheeks rather small, the part below the eye being studded with sharp tubercles. The genal angles are produced into long spines.

The pygidium is shorter than that of *Bathyurus extans*, and the axial lobe even more prominent. There are four pairs of strongly marked ribs on the pleural lobes, all but the last pair showing an impressed median line. The axial lobe shows two distinct rings and from one to three indistinct ones, the smaller specimens showing the more rings. The first two rings bear median and lateral tubercles, and from the third and fourth rises a large spine which tapers rapidly and is curved backward. Back of this spine the axial lobe is nearly smooth, there being no strong rings, but there are usually a number of small tubercles arranged in rows parallel to the axis.

Family ASAPHIDÆ Emmerich.

Genus BASILICUS Salter.

***Basilicus romingeri* (Walcott).**

Plate XV, figures 9-10; Plate XVI, figures 1-4.

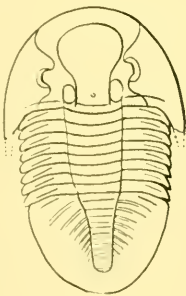
*Asaphus romingeri* WALCOTT, Twenty-eighth Annual Report New York State Museum, 1879, 96.

*Asaphus wisconsensis* WALCOTT, *ibidem*, 1879, 97.

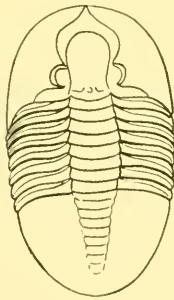
*Ptychopyge romingeri* CLARKE, Paleontology Minnesota, III, ii, 1897, 709.

*Ptychopyge ulrichi* CLARKE, *ibidem*, 1897, 709, figs. 12, 13.

This species is fairly common in the Black River at Ottawa, though no complete specimens have been found. The facial suture proves to be marginal in front, and therefore this species belongs to *Basilicus* and not to *Ptychopyge*.



1



2

FIG. 1. *Basilicus tyrannus* (Murchison). Outline drawing to show course of facial suture. After Salter.

FIG. 2. *Ptychopyge angustifrons* (Dalman). Outline drawing to show facial suture. After Brogger.

In 1905 Messrs. Douglass and Raymond collected a large number of cranidia and free cheeks of a *Basilicus* from the "buff" limestone about 20 feet above the top of the St. Peter sandstone on Straight River, two miles south of Faribault, Minnesota. Associated with these portions of head shields were a couple of fragmentary pygidia which appear to agree with the description of *Ptychopyge ulrichi* Clarke. Comparing these specimens with those from the Black River of New York and Canada, we are unable to find differences of specific value. *Ptychopyge ulrichi* was described from pygidia, the axial lobes of which bore eight or nine annulations, only three or four of which were well defined, and on the pleura were five pairs of ribs and a trace of a sixth, two or three more showing on the cast. This corresponds exactly with the specimens from New York and Canada.

Walcott states that *Asaphus wisconsensis* differs from *A. romingeri* "by having a wider and less concave margin, with the glabella more convex and subquadrate in front." These variations are noticeable on the specimens from Ottawa and those from Minnesota, but it is always the small specimens which have the wide margin and the more convex glabella, so that these are probably characters of immaturity. While we have not seen the types, we are inclined to believe that the two names represent the same species.

#### DESCRIPTION.

*Specimens from Ottawa.*—Cranidium convex, expanded in front of the eyes, concave around the anterior margin. Glabella prominent, definitely outlined, constricted between the eyes, marked by a pair of diagonal glabellar furrows between the eyes and obscure basal lobe back of the eyes. Neck-ring narrow and convex, neck-furrow shallow. Just in front of the furrow is a prominent median tubercle. From the front of the glabella a low ridge crosses the concave border and ends in a blunt point on the margin. Palpebral lobes large. The whole surface of the test is covered with fine irregular striations. In young specimens the concave border is proportionally broader, the anterior portion of the glabella more tumid, and the glabellar furrows more deeply impressed than in mature ones. The pygidia are nearly semicircular, with wide concave borders. Axial lobe prominent, showing about eleven rings on the cast of a young specimen and seven on a larger one. On the pleura are five or six pairs of prominent ribs.

*Specimens from New York.*—A single pygidium was collected by Mr.

Raymond from the Black River at the typical locality at Newport. This is larger than any of those found by Mr. Narraway at Ottawa, the rings are very faint on the axial lobe, and there are only four pairs of nearly flat ribs on the pleura.

In the collection at the Cornell University Museum there is a specimen labeled *Asaphus canadensis* from the "Bird-eye" at Poland, New York. This specimen, which is figured on Plate XV, fig. 10, is *Basilicus romingeri*, and a large part of the pygidium, seven segments of the thorax, the hypostoma, and a large, but incomplete free cheek are preserved. The pygidium, which is largely exfoliated, shows six fairly distinct rings on the axial lobe, with three or four faint ones behind them, and there are six pairs of broad, low ribs on the pleura. The axial lobe of the thorax is narrow, gently convex. The pleural lobes are broad, flat, gently curved at the sides. The pleura are broad, and have wide shallow furrows which begin at the edge of the axial lobe and extend diagonally backward and outward. Free cheek large, with broad concave margin and a wide genal spine. Hypostoma short and broad, forked, the posterior lobes short and wide, and the scars of muscular attachment strong. Its form is shorter and wider than that of *Isotelus*, and the body is definitely outlined from the wings. The test on all parts, including the hypostoma, is covered with irregular striæ.

*Specimens from Minnesota.*—The cranidia found in Minnesota do not differ in any way from those from Canada. A small specimen shows that the diagonal furrows between the eyes are distinct from those which isolate the basal lobes. The free cheeks have wide concave margins and broad genal spines. One of the two pygidia obtained is small and imperfect, but shows eight rings on the axial lobe and six pairs of ribs on the pleura. The large specimen is still more imperfect, but shows a wide concave margin and rather flat ribs.

Genus *ASAPHUS* Brongniart.

Subgenus *ONCHOMETOPUS* Schmidt.

*Onchometopus simplex* sp. nov.

Plate XVI, figures 6-8.

Associated with the preceding in Minnesota is a trilobite which may be referred to *Onchometopus*, as both the cephalon and pygidium lack the concave border seen on almost all our American asaphids, and at the same time have a smoother glabella and a wider axial lobe than *Asaphus*. *Basilicus romingeri*, *Isotelus gigas*, and a species of *Cybele* with a glabella

like that of *C. ella* Narraway and Raymond were found in the same stratum as the species here described.

#### DESCRIPTION.

Cranidium moderately convex, slightly incurved at the front. Glabella flat, obscurely defined, expanding in front of the eyes and extending to the anterior margin; glabellar furrows absent, dorsal furrows present back of the eyes, very shallow. Neck-furrow absent. Eyes of medium size, situated a trifle more than their own length in front of the posterior margin. Behind the eyes there is a small median tubercle on the glabella. Free cheeks rounded at the genal angles.

Thorax of eight flat segments. Axial lobe a little more than one-third the total width. Pleura with shallow grooves.

Pygidium rounded in outline, three-fifths as long as wide. Axial lobe obscurely defined, the posterior end usually a little more prominent than the other portions. There are no annulations. The surface is uniformly convex, without concave border.

This species is similar to *Onchometopus obtusus* (Hall) of the Chazy, but the shell lacks the very coarse punctæ of that form, and there are fewer traces of glabellar furrows. It differs from *Onchometopus susæ* (Whitfield) in having a longer pygidium with a narrower and more distinct axial lobe.

*Onchometopus* may be readily distinguished from *Isotelus* by the presence of a median tubercle on the glabella, the absence of a concave border on both cephalon and pygidium, and by the somewhat narrower axial lobe in the thorax.

*Locality*.—This species is quite abundant in the "buff" limestone, 20 feet above the top of the Saint Peter sandstone on Straight River, two miles south of Faribault, Minnesota. A single specimen was found in a quarry at Franklin Forge, Pennsylvania, and donated to the Carnegie Museum by Mr. Ernst W. Greiner.

#### Genus ISOTELOIDES Raymond.

#### *Isoteloides homalnotoides* (Walcott).

Plate XVI, figures 9-11.

*Asaphus homalnotoides* WALCOTT, Advanced Sheets Thirty-first Report New York State Museum, 1877, 20; Thirty-first Report New York State Museum, 1879, 71.—WHITFIELD, Geology of Wisconsin, IV, 1882, 237, pl. 5, fig. 4.

*Asaphus triangulatus* WHITFIELD, Annual Report Geological Survey of Wisconsin, 1880, 59.



A single cranidium belonging to this species has been found in the Black River at Ottawa. It is fairly common in the Black River at Pattersonville, New York, and in the lower part of the Trenton (zone with *Parastrophia hemiplicata*), at Smith's Basin. Both cephalae and pygidia are apt to be confused with *Isotelus gigas*, but the pygidia are more convex, more triangular, and have a narrow, prominent axial lobe. The glabella is obscurely outlined, there is a small median tubercle just in front of the neck-ring, and a pair of shallow, oblique glabellar furrows between the eyes. On the casts of the interior three pairs of glabellar furrows are faintly indicated. The axial lobe of the thorax is not so wide as in *Isotelus*, being about one-third the total width.

This species is referred to *Isoteloides* instead of *Isotelus* because of its faintly outlined glabella, the presence of glabellar furrows and a median pustule, and because of the narrow axial lobe. The hypostoma has not yet been seen.

This species is more closely allied to *Isoteloides angusticaudus* Raymond of the Chazy than to the type of the genus.

#### Genus ISÖTELUS Dekay.

#### *Isotelus gigas* Dekay.

Plate XV, figures 1, 2.

*Isotelus gigas* DEKAY, Annals Lyceum Natural History New York, I, 1824, 176, pl. 12, fig. 1.—HALL, Paleontology New York, I, 1847, 231, pls. 60-63.

No attempt is made to give the full synonymy of this species.

#### ONTOGENY.

The collections made by Mr. Narraway from the Black River near Ottawa contain a number of small and nearly complete specimens of this species which make it possible to observe with some completeness the later stages of growth.

The smallest specimen consists of a pygidium with four thoracic segments attached. The pygidium is three millimeters long and five wide, and the axial lobe of the thorax occupies exactly one-third the total width. The pygidium is nearly semicircular in outline, with a concave border. The axial lobe is very prominent and extends to this concave border. There are traces of six rings on the axial lobe, and three pairs of faintly outlined ribs on the pleura. Some pygidia a millimeter longer than this one show the segmentation more strongly than this particular specimen.

A pygidium from Trenton Falls has the same size and proportions as the one from the Black River just described.

The smallest specimen retaining the cephalon is slightly larger, as the pygidium is 3.5 mm. long. This specimen is, unfortunately, slightly imperfect, so that the length and breadth of the cephalon can not be accurately measured, but the cephalon appears to be about 1 mm. longer than the pygidium. The glabella is slightly convex, indistinctly outlined by dorsal furrows, and there are traces of three pairs of glabellar furrows and a neck-furrow. The furrows are not, however, much more strongly impressed than they are on some adults. In the middle of the neck-ring there is a slight swelling, suggesting a median tubercle. The eye which is preserved on this specimen is very large, being one-fourth the total length of the head, and situated slightly less than its own length from the posterior margin. Its actual position is, therefore, about the same as in the adult, but relatively it is a little further forward, its posterior margin being at a distance from the border of the cephalon equal to one-fourth the length of the head. An adult, with cephalon 50 mm. long, has eyes 7.5 mm. long, and they are situated 8 mm. from the posterior margin. Genal spines were present on this specimen, but are broken off. The smallest specimen retaining a complete genal spine has a cephalon about 8 mm. long, and the genal spine is 4.5 mm. long, and very narrow.

Twenty-one specimens of various sizes were measured, and it was found that with the increase in size, the width of the axial lobe of the thorax increased from one-third to one-half the total width, the maximum being reached on specimens with the pygidium 20 mm. long and a total length of about 57 mm. On all specimens larger than this the axial lobe occupied about one-half the width. The form of the pygidium was found to change from approximately semicircular in small specimens, to subtriangular in large ones. Thus, in the smallest specimens the length is .60 of the width, while in a specimen 55 mm. long, the length is .81 of the width. The change is a gradual one, but pygidia 11 mm. long have a distinctly triangular form, and the sides are straightened instead of being rounded as in the smaller specimens. Pygidia more than 50 mm. in length seem as a rule to be about three-fourths as long as wide, although exceptional specimens have been seen in which the length and breadth were equal. The subtriangular form of the pygidium is one of the most distinctive characters of this species. The axial lobe of the pygidium flattens out rapidly as the size increases. On pygidia 11 mm. long it is still distinct, but not bounded by sharp furrows as in the smallest speci-

mens, and there are almost no traces of rings or ribs. On pygidia 20 mm. long the axial lobe is very faint indeed.

The changes on the cephalon can not be so well observed for lack of good material. The outline becomes more triangular and the length and width change in the same way as in the pygidium. The eyes become relatively smaller and move backward, as already indicated, and the dorsal furrows become obscure. The spines at the genal angles become shorter, being 3 mm. long on a specimen with a cephalon about 20 mm. long, and being absent on specimens slightly larger.

*Isotelus gigas* is common in the Black River near Ottawa, but most of the specimens are small as compared with those found in the Trenton of New York. The species is less common in the Lowville, but typical pygidia have been found in that formation at Mechanicsville, near Ottawa, at Newport, and on Valcour Island, New York.

Pygidia less than 3 mm. long have not so far been seen by the writers, but on specimens of that length the segmentation is so faint that it seems improbable that a pygidium of this species 2 mm. long would be so strongly segmented as the pygidia described by Clarke as *Gerasaphes ulrichana*. (Paleontology Minnesota, Vol. III, pt. 2, p. 711, figs. 15, 16). Our studies do not, then, give any support to the suggestion of Miller that Clarke's specimens were the young of *Isotelus*. Strongly segmented pygidia of small size occur in the Chazy, but they have been found to belong to a species whose pygidia are strongly segmented when fully grown. Very small pygidia of *Isotelus*, some of them less than 3 mm. long, are common in the Chazy, but they show no more traces of segments than do the young of *Isotelus gigas*. The development of the species thus shows that the smooth surface was acquired earlier in the phylogeny than the broad axial lobe, and is thus a character of more profound importance.

Hall states (Paleontology New York, Vol. I, p. 231) that the pygidia of the young of *Isotelus gigas* are more pointed than in the adult, but our study shows a condition exactly opposite to this, the young pygidia being more rounded.

*Isotelus maximus* Locke is in many respects more primitive than *Isotelus gigas*. An incomplete specimen, a photograph of which is here presented, was about 95 mm. long, and has a genal spine 13 mm. long, which, when complete, reached at least as far back as the middle of the fourth segment. The specimen of *Isotelus gigas* represented as Figure 1 on Plate XV is 57 mm. long and the genal spine is only 3 mm. long. The pygidium of *Isotelus maximus* is short and rounded in outline like the young of *I. gigas*.

On the specimen here figured the length of the pygidium is only .64 of the width, and the axial lobe of the thorax is narrow for an *Isotelus*, being only .42 of the total width instead of .50 as in *I. gigas*.



FIG. 3. *Isotelus maximus* Locke. Photograph of a specimen in the Carnegie Museum, to show long genal spines and rounded pygidium.

***Isotelus* sp.**

Plate XV, figure 3.

Two specimens obtained by Mr. Narraway at Mechanicsville differ from the typical form of *Isotelus gigas* in having nearly semicircular pygidia, relatively narrower thoracic axes, and smaller eyes.

The larger specimen retains the cranidium, seven thoracic segments, and the pygidium. The cranidium is smooth, without glabellar furrows. The dorsal furrows are shallow and extend a little ahead of the eyes. Palpebral lobes small, a little further forward than in specimens of *Isotelus gigas* of this size.

Axial lobe of thorax more than one-third and less than one-half the total width, only slightly convex.

Pygidium evenly convex, rounded in outline, seven-tenths as long as wide. The margin has a wide concave border. The axial lobe is distinct but not prominent.

Length of cranidium, 30 mm.; width of thorax at back of fourth segment 44 mm.; width of axial lobe at same point, 19 mm.; length of pygidium, 32 mm.; width 45 mm. This specimen is from the Lowville at Mechanicsville.

The second specimen is slightly smaller and retains the posterior part of the cephalon with one eye, all the thorax and the pygidium. There are no spines at the genal angles, the eye is small and high, and the axial lobe of the pygidium is distinct and shows seven pairs of shallow pits on the anterior half.

The axial lobe of the thorax at the back of the fourth segment is 15 mm. wide, the total width being 35 mm.; the pygidium is 25 mm. long and 34 mm. wide. This specimen is from the Black River at Mechanicsville. Both specimens are in Mr. Narraway's collection.

These two specimens retain characters lost early in life by *Isotelus gigas*, namely, the narrow axial lobe of the thorax and the rounded pygidium. It is significant that they were found in the Lowville and Black River. A pygidium from the Lowville at Newport, New York, seems to belong to this species. Its dimensions are: length 31 mm., width 44 mm.; the length being .70 the width, as in the specimens from Mechanicsville. The pygidia of *Isotelus gigas* having this same ratio are from 10 to 20 mm. long.

## EXPLANATION OF PLATES.

### PLATE XV.

1. *Isotelus gigas* DeKay. A specimen from the Black River at Pattersonville, New York. This specimen shows the hypostoma in position, the subtriangular outline of cephalon and pygidium, and the small genal spine of an almost mature individual. About natural size. Specimen in the Carnegie Museum.

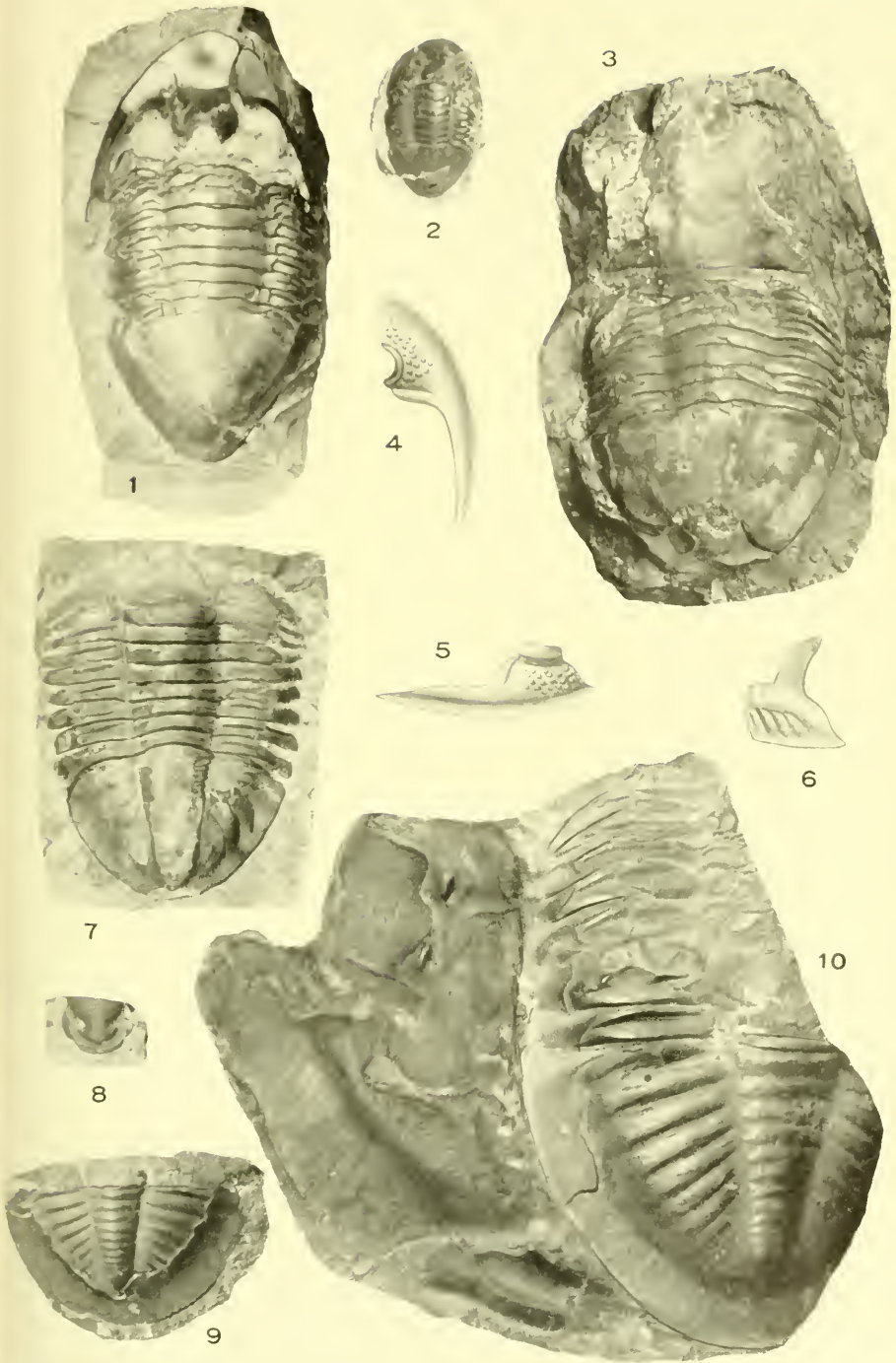
2. The same species. A small specimen from the Black River at Ottawa, Canada, in Mr. Narraway's collection. Three-fourths natural size.

3. *Isotelus gigas?* A specimen with a narrower axial lobe and a wider, shorter, and more rounded pygidium than is usually seen in *Isotelus gigas*. The specimen is from the Lowville limestone at Ottawa, and is in Mr. Narraway's collection. About natural size.

4. *Bathyurus spiniger* (Hall). Dorsal view of a free cheek from the Black River limestone at Mechanicsville, near Ottawa, Ontario. Nearly twice natural size. Specimen in the Carnegie Museum.
5. The same specimen; side view.
6. The same species. Side view of a well preserved pygidium from the same locality as the last. From Mr. Narraway's collection.
7. *Bathyurus extans* (Hall). A large specimen in the Carnegie Museum from the Lowville at Black River, New York. About natural size.
8. The same species. An hypostoma from the Lowville at Mechanicsville, Ontario. About natural size. In Mr. Narraway's collection. Collected by Mr. J. S. Hale.
9. *Basilicus romingeri* (Walcott). A small pygidium from the Black River at Mechanicsville. The specimen is in Mr. Narraway's collection, and the figure is about natural size.
10. The same species. A specimen from the Black River at Poland, New York. This specimen shows parts of seven segments of the thorax, the hypostoma, and parts of the free cheek and pygidium. It is in the Museum of Cornell University, and the figure is about natural size.

## PLATE XVI.

1. *Basilicus romingeri* (Walcott). An incomplete free cheek from Faribault, Minn., now in the Carnegie Museum. The shell is exfoliated from the portion in front of the eye, and the anterior limb of the facial suture shows as a line on the inner surface of the doublure. Natural size.
2. The same species. A cranium from the Black River at Mechanicsville, Ontario. Twice natural size. In the collection of the Carnegie Museum.
3. The same species. A cranium from Faribault, Minnesota. Specimen in the Carnegie Museum. Natural size.
4. The same species. A small specimen from Faribault, Minnesota. This specimen shows a low axial ridge in front of the glabella such as is seen in specimens of *Basilicus marginalis* of all sizes. Twice natural size.
5. *Bathyurus extans* (Hall). A hypostoma from the Lowville limestone at Mechanicsville, Ontario. Twice natural size. Specimen in the Carnegie Museum.
6. *Onchometopus simplex* Raymond and Narraway. An imperfect cranium from Faribault, Minnesota. Natural size. Specimen in the Carnegie Museum.
7. The same species. A pygidium from the same locality as the last. Natural size.
8. The same species. An incomplete specimen in the Carnegie Museum from Franklin Forge, Pennsylvania. Natural size.
9. *Isoteloides homalnotoides* (Walcott). A pygidium from the Black River limestone at Pattersonville, New York. A little less than natural size. Specimen in the Carnegie Museum.
10. The same species. A cephalon drawn from a nearly complete specimen from the same locality as the last.
11. The same species. An exfoliated cranium from the lower part of the Trenton at Smith's Basin, New York. Notice the small eyes and the two shallow pits which are vestiges of glabellar furrows. Natural size. Specimen in the Carnegie Museum.

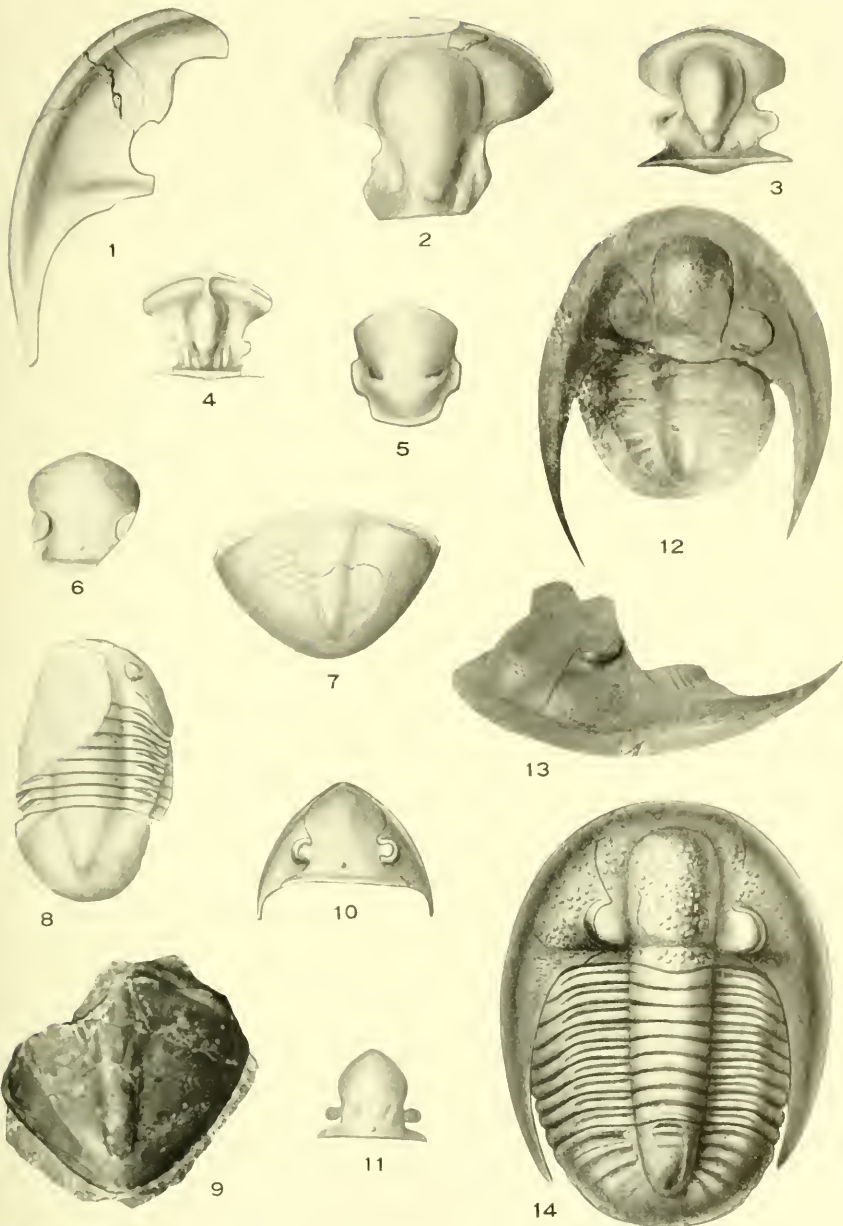


Louis S. Coggeshall, photo.

Black River Trilobites.







Sydney Prentice, del.

Arthur S. Coggeshall, photo.

Black River Trilobites.



12. *Bathyurus longispinus* Walcott. A photograph of the type. Somewhat less than natural size.

13. The same specimen. An oblique side view to show the profile of the cephalon.

14. The same species. A drawing of the cephalon and pygidium of the type, with the thorax restored from the crushed segments of the same specimen. Natural size.

## V. NOTES ON ORDOVICIAN TRILOBITES. IV.

NEW AND OLD SPECIES FROM THE CHAZY.

BY PERCY E. RAYMOND.

Since my article on the "Trilobites of the Chazy Limestone" was published in these ANNALS, Vol. III, 1905, a number of new species and new facts about old species have come to light, making it possible to add to and correct the previous article in a number of ways. The material on which the present article is based is in two collections, one made for the Carnegie Museum by the writer in 1905 and 1906, and the other a small but very important collection from Isle La Motte, made and submitted by Professor George H. Perkins, State Geologist of Vermont. The latter collection forms the basis of an article which will appear in the next report of the State Geologist of Vermont, but Professor Perkins has very generously permitted me to describe the new material at this time. My thanks are due him the more as he had intended describing these forms himself, but he has, with great unselfishness, turned them over to me.

### ARTHROPODA.

#### Subclass Trilobita.

ORDER *Hypoparia* Beecher.

Genus *Eoharpes* Raymond.

*Eoharpes antiquatus* (Billings).

The writer has shown elsewhere that the name *Harpina* was preoccupied when used by Novak, and the name *Eoharpes* was suggested to take its place.<sup>1</sup>

ORDER *Opisthoparia* Beecher.

Family *OLENIDÆ* Salter.

Genus *REMOPLEURIDES* Portlock.

*Remopleurides canadensis* Billings.

The thorax and pygidium of this species are very much like those of *Remopleurides salteri* var. *girvanensis* Reed from the Llandeilo of the

<sup>1</sup>*American Journal of Science*, Series 4, XIX, 1905, 377.

Girvan District. The whole structure of the free cheeks,<sup>2</sup> thorax, and pygidium is very different from that of *Caphyra radians* Barrande and *C. striatulus* Walcott.

#### Family ASAPHIDÆ Emurich.

It is difficult to subdivide this family satisfactorily, but there are a few facts that can not be overlooked in the classification of the genera. The character of the hypostoma separates two great groups, one including those forms with an entire hypostoma, while in the other group the hypostoma is forked. Geologically, the forms with the entire hypostoma are the more ancient, and this group includes the species in which the lobation of the glabella and the segmentation of the pygidium are most marked. It is in this group also that the anterior limb of the facial suture is generally marginal, while in the group with forked hypostomas the anterior limb of the suture is generally on the dorsal surface. In both groups there is a tendency for the glabella to become flat and to merge into the general contour of the cephalon. The glabellar furrows become faint and finally obsolete, the axial lobe of the thorax becomes broader, and the ribs on the pygidium tend to disappear, giving the whole animal a smooth upper surface. This "smoothing out" reaches its culmination in *Nileus* among the more primitive forms, and in *Isotelus* in the other group. Of the first group only *Vogdesia* survives as late as the Black River, the earlier forms appearing in the Cambrian. The earliest member of the second group now known appears (in America) in the Upper Beekmantown, and the subfamily is very abundantly represented in the Chazy, Black River, and Trenton, continuing throughout the Ordovician.

#### Subfamily OGYGINÆ nov.

*Asaphidæ* with hypostoma entire and eight segments in the thorax.

Section 1. *Ogyginæ* with anterior limb of facial suture marginal. *Ogygia*, *Niobe*, *Asaphellus*, *Symphysurus*, *Nileus*, *Vogdesia*, *Illænurus*.

Section 2. *Ogyginæ* with anterior limb of suture intra-marginal. *Megalaspis*, *Megaaspides*.

#### Subfamily ASAPHINÆ nov.

*Asaphidæ* with hypostoma forked.

Section 1. *Asaphinæ* with anterior limb of facial suture marginal. *Basilicus*.

<sup>2</sup>The Lower Paleozoic Trilobites of the Girvan District, Ayrshire, pt. I, 1903, 39, pl. 6, figs. 11-14.

Section 2. *Asaphinæ* with anterior limb of suture intra-marginal. *Ptychopyge*, *Pseudasaphus*, *Asaphus*, *Onchometopus*, *Isotelus*, *Isoteloides*.

Genus *BASILICUS* Salter.

This genus includes the most primitive of the Asaphids with fringed hypostomas. The pygidium is strongly annulated, the glabella retains some of the glabellar furrows, the genal angles are spine-bearing, and the facial suture is marginal in front. Many of the species usually referred to *Ptychopyge* belong to this genus. Only three species are known in America, these being *Basilicus marginalis* (Hall) of the Chazy, *B. romingeri* (Walcott) of the Black River, and *B. canadensis* (Chapman) of the Utica. As figured, *Asaphus canadensis* would be a *Ptychopyge*, but the writer has examined numerous specimens in the Museum of the Geological Survey of Canada without finding a single specimen showing an intra-marginal suture.

*Basilicus marginalis* (Hall).

Plate XVII, figure 6, Plate XIX, figures 1, 2.

*Asaphus marginalis* HALL, Paleontology New York, I, 1847, 24, pl. 4bis, fig. 15.

—EMMONS, American Geology, I, ii, 1855, 235, pl. 3, fig. 16. —RAYMOND, Annals Carnegie Museum, III, 1905, 339, pl. 10, figs. 17-20; pl. 11.

*Asaphus alpha* RAYMOND, Annals Carnegie Museum, III, 1905, 342, pl. 12, fig. 9.

*Asaphus gamma* RAYMOND, Annals Carnegie Museum, III, 1905, 342, pl. 12, fig. 10.

This species is closely allied to *Basilicus tyrannus* (Murchison), and the character of the facial suture, the glabellar furrows, and the great number of ribs on the pleura of the pygidium show that it should be referred to *Basilicus*.

The shape of the distal end of the pygidium is still in doubt. The accompanying text figure is from a large specimen in the Yale University Museum. The lobes at the side are due to the fracture of the shell, but the posterior lobes, which are not strictly symmetrical with respect to the axis of the pygidium, are natural.

In the crystalline limestone at McCullough's sugar-bush at Chazy the pygidia described as *Asaphus alpha* in my previous paper are quite common, and with them occur cranidia of small size which have the surface marked by very numerous fine granulations. This is the peculiar surface which characterizes *Basilicus marginalis*, and distinguishes it at once from all the other Asaphids of the Chazy. The cranidia are very small, from 1.5 to 3 mm. in length. The glabella is depressed convex, definitely outlined, with three pairs of shallow glabellar furrows. In front of the glabella there is a wide flattened border which is crossed by a narrow ridge,

as in adult specimens of *B. marginalis*. From these characters it is believed that the small specimens called *Asaphus alpha* and *gamma* in my previous paper are really only the young of *marginalis*. No adult specimens of *B. marginalis* have been found with these small specimens by the writer, but Hall's type was from the "crystalline and highly fossiliferous mass of the Chazy limestone, below the portion containing *Maclurea magna*, at Chazy village," a description which exactly fits the layers from which these minute specimens were obtained.

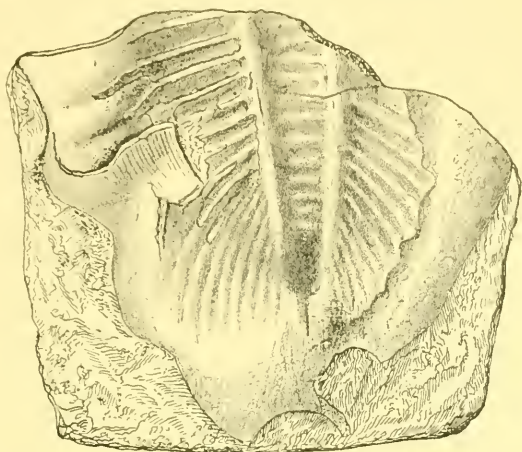


FIG. 1. *Basilicus marginalis* (Hall). A pygidium, natural size, showing lobes at the posterior end.

It will be noted that these specimens correspond in many respects with the minute trilobite described by Clarke as *Gerasaphes ulrichana* (Paleontology Minnesota, Vol. III, pt. II, p. 710, figs. 14-16). The lobation of the glabella is not the same, however, and Dr. Clarke states that the surface of his specimens is smooth, not granulated. The specimens recorded as *Gerasaphes ulrichana* by Ruedemann (New York State Museum, Bulletin 49, 1901, p. 6) may well have been the same as the ones here described, as there were a few Chazy species in the pebbles at Rysedorph Hill.

#### Genus ASAPHIUS Brongniart.

##### Subgenus ONCHOMETOPUS Schmidt.

In erecting the subgenus *Onchometopus* for his species *volborthi*, Schmidt placed a special emphasis upon the hooked character of the doublure of the front of the cephalon, but there are other peculiarities which make

the term a useful one. The axial lobe is somewhat wider than in *Asaphus* and the glabella is much smoother than in that genus. The form of the trilobites to which this term is applied is much like that of *Isotelus*. In fact, the parallelism is so close that the differences may not be evident to many persons until they have examined well preserved specimens. The close relationship to *Asaphus* is at once revealed by the absence of a concave border on cephalon and pygidium. Beside the *Onchometopus* of the Chazy, the subgenus is represented in America by *O. simplex* Raymond and Narraway of the Black River, and *Asaphus susæ* Whitfield and *Asaphus alcer* Billings of the Cincinnati.

### *Onchometopus obtusus* (Hall).

Plate XVIII, figures 2, 3, 4.

*Asaphus ? obtusus* HALL, Paleontology New York, I, 1847, 24, pl. *abis*, fig. 14.

*Isotelus obtusus* RAYMOND, Annals Carnegie Museum, III, 1905, 344, pl. 12, figs.

I, 2.

This species, which can now be more fully described from a nearly complete specimen sent by Professor Perkins, should be removed to the genus *Onchometopus*, the most striking generic character being the absence of a channeled border on the cephalon and pygidium.

#### DESCRIPTION.

Entire animal oval in outline, rather broad and only slightly convex. The entire test is very coarsely punctate, making the identification of the species easy.

Cephalon nearly semicircular in outline, being about one-half as long as wide. It is gently and regularly convex, and lacks the depressed or concave border seen in the associated *Isotelus harrisi* and *Isoteloides angusticaudus*. The glabella is faintly defined, nearly smooth, three pairs of very shallow furrows being visible on the cast. The neck-furrow is shallow, and hardly visible on the free cheeks. Just in front of it is a small median tubercle. The eyes are small and are situated about their own length in front of the posterior margin. Free cheeks with rounded genal angles.

The thorax has eight rather broad flat segments which are abruptly deflected at the sides. The median lobe is about one-third the total width of the thorax, being wider than in *Asaphus* and less wide than in *Isotelus*. In figure 1, of Plate XII, of my previous article the axial lobe



is represented as wider than it really is, the correct proportions being given in the text.

Pygidium two-thirds as long as wide, uniformly convex, without channeled border. Axial lobe broad at the anterior end, tapering rapidly, and becoming obscure on the middle of the pygidium. On the cast it is more prominent. There are no traces of segments on the axial lobe or on the pleura.

*Locality.*—This species is most common in the upper part of the Chazy, but it has been found in all portions. Specimens have been obtained at Crown Point, Valcour Island, Plattsburgh, and Chazy, New York, and on Isle La Motte, Vermont.

Genus ISOTELUS Dekay.

*Isotelus harrisi* Raymond.

Plate XVII, figure 1.

*Isotelus harrisi* RAYMOND, Annals Carnegie Museum, III, 1905, 343, pl. 12, figs. 3, 5-7; not fig. 4.—SCHMIDT, Memoirs of the Imperial Academy of Sciences of St. Petersburg, XX, 1907, 75.

Specimens of *Isotelus* are abundant in the collection made by Prof. Perkins, and it appears that there are two species in the buff dolomite of the reef at the base of the Upper Chazy. The cranidium figured on Plate XII, figure 4, of my previous paper does not belong to *Isotelus harrisi*, but to a new species which is described in this paper. The cranidium of

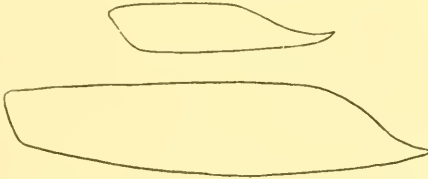


FIG. 2. Upper figure. *Isotelus platymarginatus*. Lower figure. *Isotelus harrisi*. Profiles of pygidia of the two species, one-half natural size, to show the much wider border of *I. platymarginatus*.

*Isotelus harrisi* has a short broad form, is very wide between the eyes, and the eyes are situated far forward. The portion of the cranidium in front of the eyes is evenly convex, and not depressed as in the new species. The pygidium of *I. harrisi* is also wider in proportion to the length than in *I. platymarginatus*, the concave margin is narrower, and the posterior end of the axial lobe is much more prominent. The cephalon of this species

is quite different from that of the typical *Isotelus*, being shorter and more evenly convex, and the hypostoma, as pointed out by Schmidt, differs markedly from the typical form in having a constriction at the front.

#### DESCRIPTION.

Cephalon short, wide, gently convex, with a narrow concave border in front. The eyes are situated nearly half-way to the front, and very far apart. Dorsal furrows broad and shallow, extending to the palpebral lobes. Glabella not defined, and glabellar furrows absent. Free cheeks large, with strong spines at the genal angles.

Thorax of eight flat segments, the axial lobe a little more than one-half the total width.

Pygidium broader than long, with rounded outline. It is strongly convex, with a steep, concave border. Axial lobe wide at the anterior end, scarcely defined by dorsal furrows, but rather prominent at the posterior end. There are very slight traces of rings and ribs.

Length of a cranidium in the collection of the Geological Survey of Vermont, 65 mm.; width between eyes, 50 mm.; back of eyes 19 mm. from the posterior border of the cephalon. These measurements correspond rather closely with the measurements of a cranidium from Valcour Island given in the original description. The type pygidium is 67 mm. long and 95 mm. wide. One of the pygidia from Isle La Motte is 85 mm. long and 125 mm. broad.

*Locality*.—This species is found at Crown Point, Valcour Island, Chazy, and Cooperville, New York, and on Isle La Motte, Vermont.

#### *Isotelus platymarginatus* sp. nov.

Plate XVII, figures 2-5; Plate XIX, figure 3.

*Isotelus harrisi* RAYMOND, Annals Carnegie Museum, III, 1905, pl. 12, fig. 4.

Associated with the preceding there is a smaller and more typical *Isotelus*. This species has a nearly circular pygidium, the concave border is very wide and almost flat, and the eyes are situated well back on the cephalon and are not farther apart than in *Isotelus gigas*. In the collection made by Prof. Perkins is a natural mould of a small but nearly complete specimen.

#### DESCRIPTION.

Cephalon gently convex, with a wide concave border. The cranidium is depressed in front of the eyes, the glabella smooth, not defined, glabellar furrows absent. Eyes large, situated a little more than their own

length in front of the posterior margin of the cephalon. Free cheeks drawn out into spines which extend back to the middle of the thorax.

Thorax of eight segments, the axial lobe slightly less than one-half the total width.

Pygidium subcircular in outline, gently convex, with a wide flattened border. The axial lobe is very obscurely defined.

The best specimen was, when entire, about 50 mm. long. The pygidium is 18 mm. long and 22 mm. wide; the thorax 16 mm. long and the median lobe is a little less than one-half the total width (.45). A larger pygidium in the Carnegie Museum is 46 mm. long and 52 mm. wide.

This species differs from *Isotelus gigas* in having a subcircular instead of a subtriangular pygidium, and in having longer genal spines. In some ways it is like *Isoteloides whitfieldi* of the Beekmantown, but the axial lobe is wider, the cephalon lacks the median tubercle, and the glabella is not defined as in that species.

*Locality.*—This species occurs in the buff dolomite of the reefs at the base of the Upper Chazy on Valcour Island, New York, and on Isle La Motte, Vermont. The mould of the nearly complete specimen is in the collection of the Geological Survey of Vermont, and the large pygidium figure is in the Carnegie Museum.

### **Isotelus beta** Raymond.

Plate XIX, figures 4-7.

*Asaphus beta* RAYMOND, Annals Carnegie Museum, III, 1905, 342, pl. 12, fig. 9.

The little pygidia called *Asaphus beta* in my previous paper are very abundant at McCullough's sugar bush at Chazy, and are there associated with cranidia and free cheeks of an *Isotelus* of corresponding size. These little trilobites agree with *Isotelus harrisi* in having the eyes rather far forward, but the cranidium is not so short and wide as in that species. The pygidia are less broadly bordered and the genal spines are shorter and less flattened than in *Isotelus platymarginatus*. The name *beta* is therefore retained for the present. The thorax is unknown.

### GENUS ISOTELOIDES Raymond.

This genus was proposed in a previous article in this number of these ANNALS for trilobites with the smooth form and concave borders of *Isotelus* but with a narrower axial lobe, a somewhat definitely defined glabella, and an *Asaphus*-like hypostoma. The type is *Asaphus canalis* as described by Whitfield (*Isoteloides whitfieldi* Raymond). *Isoteloides*

*homalnotoides* (Walcott) and the species here described are not exactly similar to the type-species, but they seem to fit in this genus better than in *Isotelus*. The hypostoma figured is thought from the association to belong to *I. angusticaudus*, and its hemispheric body is certainly much like that of the type of the genus.

#### *Isoteloides angusticaudus* Raymond.

Plate XVII, figure 7; Plate XVIII, figure 1; Plate XIX, figure 8.

*Isotelus angusticaudus* RAYMOND, Annals Carnegie Museum, III, 1905, 345, pl. 13, figs. 3, 4.

An entire specimen and a good cephalon of this species were obtained by Professor Perkins. The species was originally described from the pygidium.

#### DESCRIPTION.

Entire animal oval, somewhat pointed at the extremities, about twice as long as broad. Body compressed, strongly convex; shell finely punctate.

Cephalon about three-quarters as long as wide, strongly convex, depressed and rather pointed at the anterior margin. Eyes large, about their own width from the posterior margin. Glabella nearly smooth, the cast showing two pairs of very faint furrows. Genal angles rounded, without spines. The neck-furrow is slightly impressed, and in front of it is a small median pustule.

Thorax of eight segments. Axial lobe rather broad for this genus; pleura abruptly deflected.

Pygidium narrow, strongly and uniformly convex, tapering rapidly. Sides nearly straight, the margin slightly concave and very steep; axial lobe not strongly defined, wide at the anterior end, but tapering rapidly. In the cast there are traces of annulations on the axis and faint indications of ribs on the pleura.

The entire specimen is 58 mm. long, and 27 mm. wide. One pygidium is 18 mm. long and 19 mm. wide, while a large one is 35 mm. long and 36 mm. wide. A large cephalon is 35 mm. long and 50 mm. wide.

This species differs from all other *Asaphidæ* in the Chazy in its long narrow form. It is very closely related to *Isoteloides homalnotoides* (Walcott) of the Trenton, but that species seems to have a more strongly defined glabella and smaller eyes.

*Locality.*—*Isoteloides angusticaudus* is a rare fossil on Valcour Island, New York, but is common in the buff dolomite of the reef on Isle La Motte, Vermont.

Subfamily *OGYGINÆ* nov.

Genus *NILEUS* Dalman.

*Nileus perkinsi* sp. nov.

Plate XVIII, figures 7, 8.

This species is so far known from only two specimens, one collected by Professor Perkins on Isle La Motte, and the other a specimen from the same locality in the U. S. National Museum.

#### DESCRIPTION.

Cephalon about three-fourths as long as wide, strongly and evenly convex, sloping gently to the sides without any depressed border. Eyes very large, situated far apart and close to the posterior border of the cephalon. The glabella is not differentiated from the remainder of the cephalon, and is smooth except for a very small median tubercle. The genal angles are not well preserved on either of the specimens at hand, but appear to be regularly rounded and aspinose. The surface of the test is marked by very minute punctæ.

Of the thorax only five segments are preserved. It is strongly convex and dorsal furrows appear to be absent. The pygidium is as yet unknown.

This species differs from *Nileus vigilans* (Meek and Worthen) as described by Clarke from Minnesota in several particulars, but principally in respect to the eyes, which are much larger and farther back in our species. The species from the Chazy is much more closely allied to *Nileus scrutator* Billings, but differs from that species in having the cephalon longer in proportion to the width. One of the cephalons of *Nileus perkinsi* is 25 mm. long and 35 mm. wide, while Billings gives the measurements of one of his specimens as 9 lines long and 17 lines wide. According to Billings' figure the anterior portion of the cephalon of *N. scrutator* is abruptly incurved, while the axial portion of the cephalon of the species here described is almost flat. Both *Nileus macrops* Billings and *N. affinis* Billings have eyes much larger and placed further forward than in our species.<sup>3</sup>

*Locality.*—Both specimens are from the buff dolomite at the base of the upper Chazy on Isle La Motte, Vermont. The species is named for Professor George H. Perkins, the eminent State Geologist of Vermont.

<sup>3</sup>Paleozoic Fossils of Canada, Vol. I, pp. 273-275, figs. 259-261, and Paleontology of Minnesota, Vol. III, pt. II, p. 712, figs. 17-19.

Subgenus *VOGDESIA* nov.

*Vogdesia bearsi* Raymond.

Plate XIX, figures 10-12.

*Isotelus ? bearsi* RAYMOND, Annals Carnegie Museum, III, 1905, 345, pl. 10, figs. 21-24, not 25.

Material collected since the publication of my previous paper makes it possible to place this species more satisfactorily than was done at that time. A few thoracic segments which appear to belong to this species have been found. They show an extremely wide axial lobe, and the dorsal furrows are very shallow. The thorax is thus similar to that of *Nileus*, as is the pygidium. The cephalon, which is short and broad, is also similar to that of *Nileus*, but differs from it in having smaller and much more elevated eyes and deeper dorsal furrows. In these particulars it is sufficiently different from *Nileus* to be put in a separate subgenus, of which it is the type.

#### DESCRIPTION.

Cephalon broad, flattened on top, with abruptly rounded slopes. Glabella slightly convex, extending to the frontal margin, which is abruptly incurved. Between the glabella and the free cheeks are quite deep dorsal furrows. The lobation of the glabella is very obscure, four pairs of very faint furrows being visible on small specimens. Some of the exfoliated specimens show a very faint median tubercle which is situated back of the eyes as in *Asaphus*, not between them as in *Nileus* and *Symphysurus*.

The eyes are far apart and project high above the general level of the head. They are situated a little behind the middle of the cephalon. The genal angles are rounded.

The thorax is known only from isolated segments. The axial lobe is very wide, and the dorsal furrows only slightly impressed. Pygidium rounded in outline, gently convex, the axial lobe almost obsolete. Around the posterior end is a rather wide depressed margin.

*Nileus vigilans* (Meek and Worthen) is another species which belongs to this subgenus. It has small eyes, and a faint median tubercle back of them. Clarke (Paleontology of Minnesota, Vol. III, pt. II, p. 713) has already pointed out that that species is not a typical *Nileus*, differing from *Nileus armadillo* and *N. palpebrosus* in having smaller eyes. Dr. Clarke considers the smaller and higher eyes as the accompaniment of phyletic maturity in the group, and states that another name "might be useful as indicating the different state of development attained by these later forms."

The name *Vogdesia* is given in acknowledgment of the debt which students of the trilobites owe to Brig. Gen. A. W. Vogdes for his work on the bibliography of the subject.

Family ILLÆNIDÆ.

Genus ILLÆNUS Dalman.

Subgenus THALEOPS Conrad.

**Thaleops arctura** (Hall).

*Illænus arcturus* HALL, Paleontology of New York, I, 1847, 23, pl. 4bis, fig. 12. — EMMONS, American Geology, I, ii, 1855, 235, pl. 3, fig. 12. — BILLINGS, Canadian Naturalist and Geologist, IV, 1859, 379.

*Illænus ovatus* RAYMOND, Bulletin American Paleontology, III, 1902, pl. 18, fig. 9.

*Thaleops ovata* RAYMOND, Annals Carnegie Museum, III, 1905, 352, pl. 13, fig. 5.

*Thaleops arctura* RAYMOND and NARRAWAY, Annals Carnegie Museum, IV, 1908, 248, pl. 61, fig. 8.

*Thaleops arctura* and *T. ovata* were united as one species in my paper of 1905, but later it was found by Mr. Narraway and myself that *T. arctura* had longer and more angular genal spines and more elevated eye-stalks than *T. ovata*.

Subgenus BUMASTUS Murchison.

**Bumastus globosus** (Billings).

Plate XIX, figure 9.

On account of its broad axial lobe this common species is referred to *Bumastus*.

**Bumastus erastusi** Raymond.

*Illænus erastusi* RAYMOND, Annals Carnegie Museum, III, 1905, 351, pl. 13, figs. 8, 9.

This species, which is quite common in the reefs at Valcour Island, was found by Professor Perkins to be extremely abundant at the same horizon on Isle La Motte.

**Bumastus limbatus** sp. nov.

*Illænus indeterminatus* RAYMOND, (*non* WALCOTT), Annals Carnegie Museum, III, 1905, 347, pl. 13, figs. 1, 2.

This species was first described as *Illænis indeterminatus*, a species which had never been adequately figured, but when Mr. Narraway sent specimens of the real *Bumastus indeterminatus* from the Black River, it was at once seen that there were important differences between the two species. The dorsal furrows of *B. limbatus* are much less arcuate than

those of *B. indeterminatus*, and the genal angles of the latter species are rounded, while the free cheeks of the former are drawn out into broad spines.

Family LICHADIDÆ Barrande.

Genus LICHAS Dalman.

Subgenus AMPHILICHAS Raymond.

***Amphilichas minganensis*** (Billings).

Plate XVIII, figure 6; Plate XIX, figures 13, 14.

The name *Platymetopus* given to this subgenus by Angelin being pre-occupied, Professor Reed suggested *Paralichas* to replace it. That name also having been used previously, the writer suggested *Amphilichas*.<sup>4</sup>

Among the specimens collected by Professor Perkins on Isle La Motte is one retaining one of the eyes. The eye is large, and the visual area occupies a semi-circle, giving a large range of vision.

It is to be noted that all the pygidia so far found in the Chazy are of the type with two complete rings on the axial lobe, three pairs of pleural segments with free ends, and a pointed, triangular axial lobe. Similar pygidia found in Russia are assigned by Schmidt to *Metalichas cicatricosus*, while the pygidium assigned by him to *Amphilichas lineatus* does not have a pointed axial lobe and the two median pleural segments are more or less coalesced. It can hardly be doubted that the cranidia and pygidia found associated in the Chazy belong to the same genus and species, and it is equally unlikely that Schmidt was mistaken in associating the cranidia and pygidia which he referred to *A. lineatus*. The glabella of *Amphilichas* is one which might have been developed along parallel lines in different sections of the *Lichadidæ*, and it is therefore possible that our American species is not congeneric with *Amphilichas lineatus*. Reed finds an association of parts in *Lichas hibernicus* Portlock similar to that in the American species, and, following Schmidt, he at one time referred the thorax and pygidium originally described by Portlock to *Metalichas*, and the associated cranidia to a new species of *Amphilichas*.<sup>5</sup> In a more recent paper, however, he returns to the older association, and refers both parts to *Amphilichas*.<sup>6</sup>

From the locality at McCullough's sugar-bush which has proved so prolific in small trilobites a number of small specimens of an *Amphilichas* have been obtained. On account of their uniformly small size it is

<sup>4</sup>*American Journal of Science*, Series 4, XIX, 1905, 377.

<sup>5</sup>*Quarterly Journal Geological Society London*, LVIII, 1902, 74.

<sup>6</sup>*Paleontographical Society*, 1906, 106.



thought that they are the young of *Amphilichas minganensis*, although a typical example of that species has never been found with them. The glabellar furrows of these specimens do not extend back to the neck-ring as in *Amphilichas minganensis*, but die out a short distance in front of it. At their posterior ends they turn slightly outward, ending in a sort of pit. In one specimen there is another pit on each furrow about halfway between the posterior end of the furrow and the frontal border. These pits are probably the remnants of the inner portions of the second and third pairs of glabellar furrows, and the development of the glabella seems to have been similar to that of the *Encrinuridae* and *Acidaspidae*. Reed has shown that in the section of the *Lichadidae* to which *Amphilichas* belongs the side lobes are the fused, second, third, and fourth glabellar lobes, and that the glabellar furrows are the first pair prolonged by the uniting of the inner ends of all three pairs of furrows. The anterior portion of a glabellar furrow, back to the first pit shown on these small specimens, would be interpreted as the original first glabellar furrow. As the animal grew, the muscular attachment became localized in one point, the inner end of each furrow. The shell being thin, the side lobes bulged, obliterating most of the furrow, and a secondary furrow was produced, connecting the inner ends of the original furrows with the anterior furrow. That the glabellar furrows originated in this way is shown by the fact that in the adult they are not straight, but there is a slight off-set marking the position of each of the pits seen on these immature specimens. According to this theory of the development of the glabella, the uniting of the ends of the furrows proceeding from the front backward, the specimens here discussed might represent a step either in the ontogeny or the phylogeny. As they are all small, it is most probable that they are immature individuals.

Reed has described as *Amphilichas* sp. a large cranidium from the Llandeilo of Girvan which has glabellar furrows which die out before the neck-furrow is reached,<sup>7</sup> and the same character is seen in some specimens of *Amphilichas lineatus* (Angelin).<sup>8</sup>

Family ACIDASPIDÆ Barrande.

Genus CERATOCEPHALA Warder.

*Ceratocephala narrawayi* sp. nov.

Plate XVIII, figure 5; Plate XIX, figure 15.

In a fragment of limestone from the middle Chazy at Chazy, New York, was found a minute glabella of a species of *Ceratocephala*. This is of

<sup>7</sup>*Paleontographical Society*, 1906, 109, pl. 15, figs. 4, 5.

<sup>8</sup>Revision der Ostbaltischen Silurischen Trilobiten, II, 1885, pl. 6, fig. 5.

particular interest as it is the only representative of this genus as yet definitely known from the American Ordovician. This specimen belongs to a species very closely related to *Ceratocephala coalescens* van Ingen, a species found in the Silurian limestone at St. Clair Spring, near Batesville, Arkansas.<sup>9</sup> The glabella here described differs from that of *C. coalescens* in being slightly shorter and wider, and in having the surface covered with minute granules instead of being smooth.

#### DESCRIPTION.

Cranidium, disregarding the spines, nearly circular in outline, slightly and regularly convex, surface granulose. The second pair of glabellar furrows turn backward parallel to the axis and divide it into three longitudinal ridges, the central one large, expanding toward the front, and reaching nearly to the anterior margin. The side lobes are small, reniform, the third pair of furrows being represented only by pits, so that the second and third lobes are coalescent. The fixed cheeks are small and convex. The suture cutting close to the glabella. The neck-furrow is narrow and deep, and the neck-ring wide. The ring bears two widely divergent spines whose bases are separated. There are also two lateral pustules and a median pustule on the upper surface of the ring.

The cranidium, without the spines, is 1.5 mm. long, and the more perfect spine is of about the same length.

*Locality*.—The specimen is from McCullough's sugar-bush at Chazy, New York, and is in the Carnegie Museum. The name is in honor of Mr. J. E. Narryway, who has obtained many new and rare trilobites from the vicinity of Ottawa.

Genus GLAPHURUS Raymond.

#### **Glaphurus pustulatus** (Walcott).

Plate XVIII, figures 9-11.

One of the specimens found by Professor Perkins on Isle La Motte is the largest and finest ever obtained, and it is the only one now known which retains the free cheeks in position. The course of the suture as shown by this specimen indicates that the species belongs to the *Acidaspidæ*, but the remainder of the animal is so different from other members of the family that it seems best to elevate *Glaphurus* to generic rank, rather than to consider it as a subgenus as was done in my previous paper.

<sup>9</sup>*School of Mines Quarterly*, XXIII, 1901, 48, fig. 11.

ORDER *Proparia* Beecher.

## Family ENCRINURIDÆ Linnarsson.

## Genus CYBELE Loven.

*Cybele prima* Raymond.

Plate XIX, figure 19.

*Glaphurus primus* RAYMOND, Annals Carnegie Museum, III, 1905, 362, pl. 14, figs. 6, 7.*Cybele valcourensis* RAYMOND, *ibidem*, 1905, 362, pl. 14, fig. 9.*Cybele prima* NARRAWAY and RAYMOND, *ibidem*, 1906, 601.

The writer has already explained how he was led to describe the cranidia and free cheeks of this species as a species of *Glaphurus*, and how the fortunate discovery of a nearly complete specimen of *Cybele ella* by Mr. Narraway gave us our first knowledge of the glabella of an American species of this genus.

## Family CERAURIDÆ.

## Genus PLIOMERA Angelin.

## Subgenus PLIOMEROPS Raymond.

*Pliomerops canadensis* (Billings).

Plate XVIII, figure 14.

*Pliomera fischeri*, the type of the genus, differs from nearly all other species usually referred to *Pliomera* (*Amphion* of most authors), in having

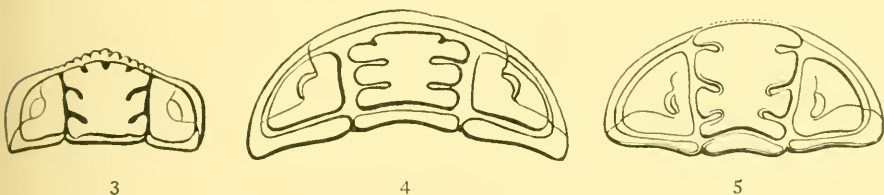


FIG. 3. *Pliomera fischeri* (Eichwald). Cephalon, showing median furrow and denticulate border. After Brogger.

FIG. 4. *Pliomerops canadensis* (Billings) Cephalon. From specimen in Carnegie Museum.

FIG. 5. *Pliomerops pseudoraticulatus* (Portlock). Cephalon. After Salter.

a median indentation or furrow in the front of the glabella. The cephalon of that species also has a denticulate frontal border, while the other species have smooth borders. For these reasons the writer has suggested

a new subgenus with *Amphion canadensis* as the type.<sup>10</sup> *Amphion pseudoarticulatus* Portlock, *A. benevolens* Salter, *A. senilis* Barrande, and possibly *A. westoni* Billings, *A. nevadensis* Walcott, and *A. barrandei* Billings,

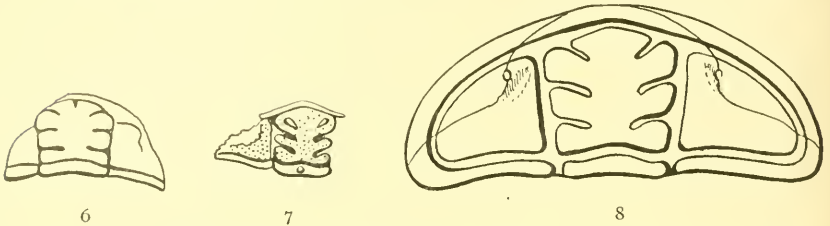


FIG. 6. *Pliomerops canadensis* (Billings). Copy of Billings' figure, twice natural size. On the specimen, which is now before the writer, the median furrow is so faint that it can hardly be seen. It is not present on mature specimens.

FIG. 7. *Pliomerops barrandei* (Billings). Copy of Billings' figure.

FIG. 8. *Pliomerops senilis* (Barrande). After Barrande.

belong to this subgenus. This last species has a peculiar glabella, the median furrow showing on the cast and the first lateral furrows being represented by pits.

### Genus CERAURUS Green.

#### Subgenus NIESZKOWSKIA Schmidt.

#### *Nieszowskia* sp. ind.

Plate XVIII, figure 13; Plate XIX, figure 20.

A single pygidium which probably belongs to one of the described species of this genus has been found at Chazy. The axial lobe shows two narrow convex rings which extend across its full width, and back of them a ring which has so fused with the terminal triangular segment as to produce a circular ridge. Within the circle so formed is the remnant of another segment, forming a small hemispheric mound. The pleura consist of two pairs of segments with free terminations.

*Locality*.—McCullough's sugar-bush, Chazy, New York. No cranidia of *Nieszowskia* have yet been found at this locality.

<sup>10</sup>*American Journal of Science*, Series 4, XIX, 1905, 377. In designating *A. canadensis* as the type it is to be understood that the species described under that name in my paper of 1905 is meant. Billings figured and described as the type of this species a small specimen with a furrow in the front of the glabella. This is an immature individual, retaining this during the early stages of the ontogeny only.

## Subgenus HELIOMERA Raymond.

*Heliomera sol* (Billings).

Plate XVIII, figure 12.

*Cheirurus sol* BILLINGS, Paleozoic Fossils of Canada, I, 1865, 288, fig. 276.*Heliomera sol* RAYMOND, American Journal of Science, series 4, XX, 1905, 381.

## DESCRIPTION.

Cephalon short, wide, the glabella very large and flattened, the cheeks small. Glabella almost semicircular, with three pairs of long narrow glabellar furrows, all of which turn backward on their inner ends, each joining the one back of it, and the third pair joining the neck-furrow, thus

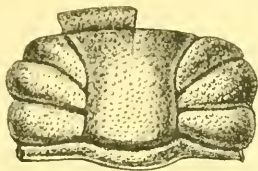


FIG. 9. *Heliomera sol* (Billings). Glabella and fragments of frontal border,  $\times 4$ .

producing a central lobe like that of *Amphilichas*. This central lobe is of uniform width up to the inner ends of the first pair of glabellar furrows, but expands suddenly in front of them. Toward the front of the median lobe there is a slight depression, suggesting the median furrow in *Pliomera*. The first pair of glabellar furrows run backward at an angle of about  $45^\circ$ , the second pair at a smaller angle, while the third pair are nearly parallel to the neck-furrow. The glabellar lobes are narrow and club-shaped. The neck-ring is wide, flat, and separated from the glabella by a deep furrow which extends the whole width of the cephalon. The cheeks are not sufficiently well preserved to be described, but enough of the test remains to show that the outline of the cephalon was similar to that of *Pseudospharexochus vulcanus*. There is a narrow smooth border all around the front, and the surface of the glabella is covered with fine tubercles.

The relations of this species are rather doubtful. From the form of the cephalon it seems to belong close to *Pseudospharexochus*, but there has not been seen in any of the species of that subgenus a tendency to vary in the direction of an isolated central lobe and long isolated glabellar lobes. The glabellar furrows in the various species are usually faint, never deeply

impressed as in this species. In this last character and the presence of a median depression on the frontal lobe it resembles *Pliomera*. It was for trilobites of this type of glabellar structure that the name *Heliomera* was proposed, with *Cheirurus sol* Billings as the type.

*Locality*.—Upper part of the lower Chazy at Chazy, New York. The plesiotype is in the Museum of Yale University. The original specimens described by Billings were from Table Head and near Portland Creek, Newfoundland.

Genus SPHÆROCORYPHE Angelin.

**Sphærocoryphe goodnovi** Raymond.

Plate XIX, figures 16-18.

Since this species was published more material has been obtained, which makes it possible to give somewhat better figures. The genal angles are found to bear long, round, slightly curved spines.

EXPLANATION OF PLATES.

Unless otherwise indicated, figures are natural size, and the specimens are in the Carnegie Museum.

PLATE XVII.

1. *Isotelus harrisi* Raymond. A cranidium from Isle La Motte, now in the Vermont State Museum.
2. *Isotelus platymarginatus* Raymond. A cast taken from the natural mould shown in figure 3.
3. The same species. A natural mould from Isle La Motte, Vermont. Vermont State Museum.
4. The same species. A large pygidium from Acidaspis Point, Valcour Island, New York.
5. The same species. A free cheek from the lower part of the Chazy at the southern end of Valcour Island. About three times natural size.
6. *Basilicus marginalis* (Hall). A large pygidium showing the peculiar notch in the posterior margin. Sloop Bay, Valcour Island, New York. Yale University Museum.
7. *Isotelooides angusticaudus* Raymond. A cephalon from Isle La Motte, Vermont. Vermont State Museum.

PLATE XVIII.

1. *Isotelooides angusticaudus* Raymond. An entire, but imperfect specimen from Isle La Motte. Slightly larger than natural size. Vermont State Museum.
2. *Onchomelopus obtusus* (Hall). Cephalon and thorax of an enrolled individual in the Vermont State Museum. From Isle La Motte, Vermont.
3. The same specimen. Thorax and pygidium.
4. The same species. A pygidium from Valcour Island showing the large punctæ of the shell.

5. *Ceratocephala narrawayi* Raymond. The cranidium of the only specimen known. From McCullough's sugar-bush at Chazy, New York. About three and one-half times natural size.
6. *Amphilichas minganensis* (Billings). A young individual whose dorsal furrows do not reach the neck-furrow. About three and one-half times natural size. From McCullough's sugar-bush at Chazy, New York.
7. *Nileus perkinsi* Raymond. The cephalon and part of thorax. This specimen is from Isle La Motte, and is now in the Vermont State Museum. Holotype.
8. *Nileus perkinsi* Raymond. Paratype in the U. S. National Museum. From Isle La Motte, Vermont.
9. *Glaphurus pustulatus* (Walcott). A photograph of one of the specimens figured in my previous paper. From Chazy, New York.
10. The same species. A large entire specimen from Isle La Motte, Vermont. Vermont State Museum.
11. The same species. Another of the specimens figured in my previous article.
12. *Helimera sol* (Billings). A glabella from the lower part of the Chazy at Chazy, New York. About three and one-half times natural size. Yale University Museum.
13. *Nieszkowskia* sp. A pygidium from McCullough's sugar-bush at Chazy, New York. About three and one-half times natural size.
14. *Pliomerops canadensis* (Billings). A small specimen from Valcour Island, New York.

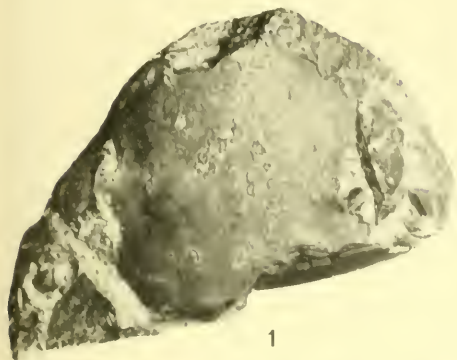
## PLATE XIX.

1. *Basilicus marginalis* (Hall). A very small and somewhat imperfect cranidium from McCullough's sugar-bush at Chazy, New York.  $\times 4$ .
2. The same species. A pygidium from the same locality.  $\times 4$ .
3. *Isotelus platymarginatus* Raymond. A drawing made from the cast of the natural mold shown in figure 3, Plate XVII.  $\times 2$ .
4. *Isotelus beta* Raymond. A pygidium.  $\times 2$ .
5. The same species. Pygidium and one thoracic segment.  $\times 2$ .
- 6, 7. The same species. Two free cheeks.  $\times 2$ . 4 to 7 are from specimens collected at Chazy, New York.
8. *Isoteloides angusticaudus* Raymond. Hypostoma found associated with, and supposed to belong to this species. Natural size.
9. *Bumastus globosus* (Billings). Hypostoma supposed to belong to this species. Natural size. Valcour, New York.
10. *Vogdesia bearsi* Raymond. A small pygidium. Natural size.
11. The same species. Side view of a free cheek and eye. Natural size.
12. The same species. A pygidium, natural size. 10, 11, 12 are from specimens collected at Sloop Bay, Valcour Island.
13. *Amphilichas minganensis* (Billings). Part of the pleuron of a thoracic segment.  $\times 2$ .
14. The same species. A small imperfect cranidium with dorsal furrows which do not meet the neck-ring.  $\times 4$ .
15. *Ceratocephala narrawayi* Raymond. The cranidium of the holotype.  $\times 4$ .
16. *Spharocoryphe goodnori* Raymond. A cephalon.  $\times 4$ .



17. The same species. A free cheek.  $\times 4$ .
18. The same species. A glabella.  $\times 4$ .
19. *Cybele prima* Raymond. A glabella.  $\times 4$ .
20. *Nieszkowskia* sp. A pygidium.  $\times 4$ .
21. *Nieszkowskia* or *Pseudospherexochus*. Hypostoma supposed to belong to one of these genera.  $\times 2$ .
22. A large hypostoma belonging to one of the *Cerauridae*, but too large to belong to any of the known species in the Chazy. Natural size. From Cooperville, New York.





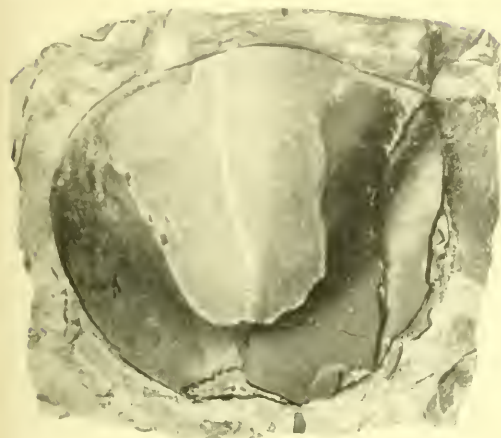
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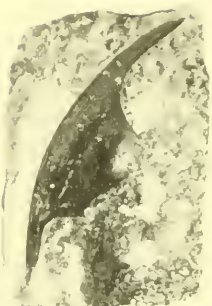
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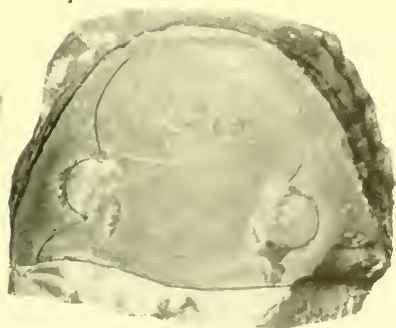


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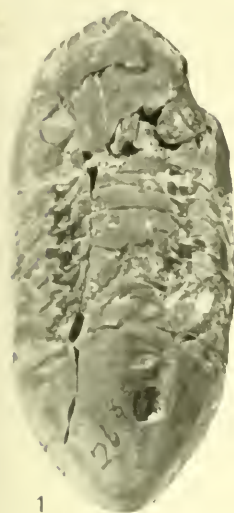
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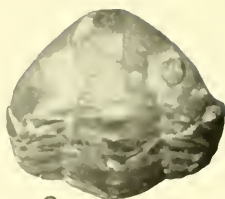
Louis S. Coggeshall, photo.

Chazy Trilobites.

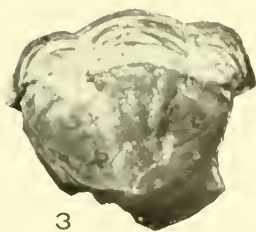




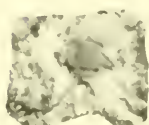
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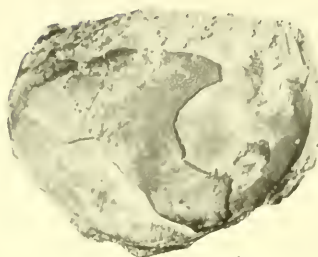
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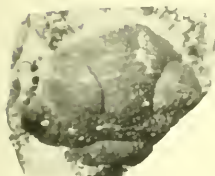
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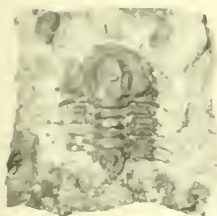
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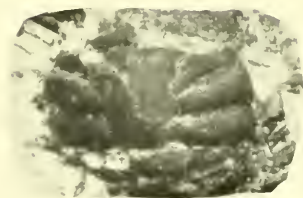
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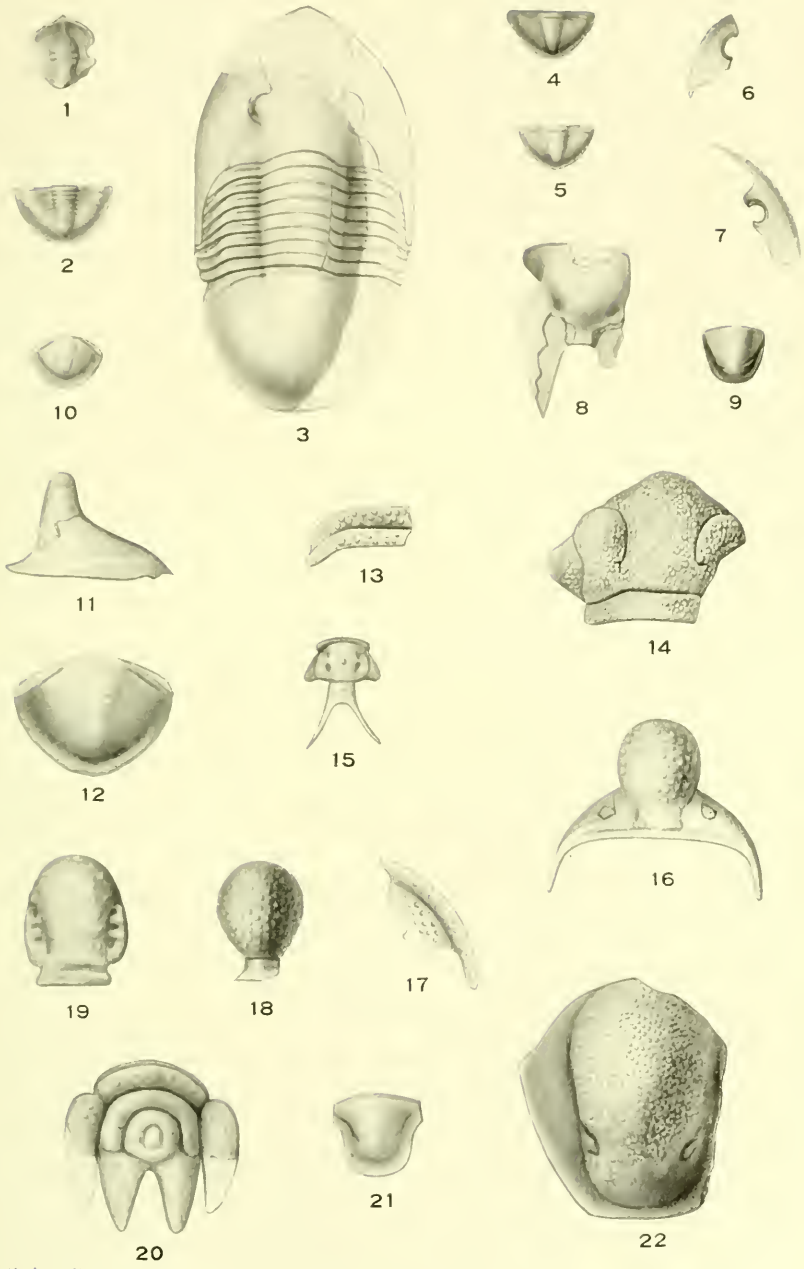


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Louis S. Coggeshall, photo

Chazy Trilobites.





Sydney Prentice, del

Chazy Trilobites.



VI. NOTES ON A COLLECTION OF FISHES MADE BY  
JAMES FRANCIS ABBOTT AT IRKUTSK, SIBERIA.

BY DAVID STARR JORDAN AND WILLIAM FRANCIS THOMPSON.

In the year 1904 a collection of fishes was made by Mr. James Francis Abbott, then Professor in the Japanese Naval Academy at Etajima, at Irkutsk in Siberia, in the Rivers Angara and Irkutsk, the outlets of Lake Baikal.

In the collection are eleven species, none of them new, but some of special interest. We present here an annotated list. The drawings are by William Sackston Atkinson. The specimens in question are in the Museum of Stanford University, in the Carnegie Museum, and in the United States National Museum.

Family SALMONIDÆ.

1. *Brachymystax lenok* (Pallas). (Plate XX.)

*Salmo lenok* PALLAS, Reise, II, Appendix, 1776, 716 (mountain torrents of the Altai).  
*Salmo coregonoides* PALLAS, Zoogr. Ross.-As., III, 1811, 362 (Rivers of Irtes,  
Yenesi, Angara, Seleuka, Lena, Witem, Kovyma; Lake Baikal).

*Brachymystax coregonoides* GÜNTHER, Cat., VI, 1866, 163.

Ten specimens, 14 to 350 mm. in length.

Head  $4\frac{1}{2}$  in body without caudal; depth 5; eye 6 in head; 2 in interorbital space,  $1\frac{1}{2}$  in snout. B. 10-12. D. 12 or 13 (developed rays). A. 10 or 11. V. 10 or 11. P. 14 to 17. Pyloric cæca about 90. Gill-rakers 23 to 25. Scales 34-146 to 156-21.

Body somewhat compressed, its breadth about one-half its depth, stout, convex on the ventral side and on the dorsal anterior third. Head somewhat conical, arched dorsally from the snout; snout broad, rounded, and of moderate length; lower jaw, measuring from the articulation with the quadrate, one-ninth shorter than the upper; maxillaries broad, 2 to  $2\frac{1}{2}$  in their length, extending to below the anterior third of the eye; lower limb of preoperculum long. Dentition is rather feeble, but complete, the teeth on the tongue, in two rows of 4 to 5 each, stronger than the remainder; vomer with teeth anteriorly only; gill rakers numerous, moderately long and stiff; dorsal fin low, truncate, the last ray one-half length of first, its base  $7\frac{1}{2}$  to 8 in body length; adipose fin large, its base opposite

to that of anal; anal short, its base 11 in body, its height equal to that of dorsal; caudal deeply emarginate; the ventrals behind the middle of the dorsal, and as long as its height. Lateral line straight, ascending anteriorly, and slightly dorsal in position. Scales are small, their breadth about one-fourth the eye diameter; oval anteriorly but becoming much elongated, 2 to  $2\frac{1}{2}$  times their breadth, posteriorly; very small between the pectorals and largest dorsally. Body dark above, light below, with numerous dark brown or black spots, 4 or 5 scales in extent, above and on the sides a little below the lateral line. Dorsal, anal, and ventral fins dusky on the distal half, the caudal edged with dark, the adipose with 4 to 7 spots similar to those on the body, and the pectorals uncolored.

According to Pallas, this singular fish, intermediate between a Whitefish and a Trout, reaches the weight of 60 to 80 pounds.

**Stenodus leucichthys** (Güldenstädt). (*Salmo nelma* Pallas.)  
(Plate XXI.)

This Siberian species was not taken at Irkutsk by Professor Abbott, but specimens were obtained from the Volga River at Sammara in Russia. In view of the interest attaching to this interesting fish, intermediate between the Trout and the Vendace or Lake Herring, we here present a figure of it.

2. **Coregonus pidschian** (Pallas). (Plate XXII.)

*Salmo pidschian* PALLAS, Reise, III, 1776, 705 (River Obi).—GMELIN, Syst. Nat., 1788, 1377 (after Pallas).

*Salmo shokur* GMELIN, Syst. Nat. 1788, 1378 (River Obi).

*Salmo polcur* PALLAS, Zoogr. Ross.-As., III, 1811, 400 (River Obi).

*Coregonus polcur* GÜNTHER, Cat., VI, 1866, 178 (after Pallas).—SMITH, Salmoniden, 1886, 271, Tab. XVIII, no. 412, 428, fig. 99-100 (Yenesei R. to Nikandrovei and Mirna; good figures of head).

One specimen 315 mm. in length without caudal.

Head  $5\frac{1}{2}$  in length, without caudal; depth 4, at base of caudal  $2\frac{1}{2}$  in head. Eye  $4\frac{1}{2}$  in head,  $1\frac{1}{3}$  in snout,  $1\frac{1}{2}$  in interorbital space. B. 10. D. 12 (developed rays). A. 14. Scales 11-90-9; gill-rakers 22.

Body compressed, the ventral outline convex, the dorsal less so. Head small, strongly arched between snout and interorbital space, the latter rounded from eye to eye. Snout slightly narrowed, projecting a third of its length beyond the very small ventral mouth, measuring it from the posterior edge of the adipose eyelid to its tip. Premaxillaries forming a flat, obliquely-placed spiral plate, a little broader than high, between the



tip of the snout and the mouth. Maxillaries short, over half as broad as long, and extending to center of adipose eyelid. Supplementaries ovate and two-thirds the breadth of maxillaries; mandible articulating with quadrate below posterior edge of pupil, slightly longer than the snout and contained  $3\frac{1}{3}$  in the head. Seventh or eighth developed ray of the dorsal midway between the snout and base of the caudal. The longest ray is nearly length of head, and when supine extends beyond tip of last ray; edge of fin concave; base two-thirds length of the ray. Adipose fin small, above the center of anal fin. Caudal is as long as head, deeply emarginate. Base of anal three-fifths length of head, its longest ray slightly longer than its base, its shortest one-sixth the head, and its edge concave; ventrals slightly longer than pectorals, which are two-thirds the length of the longest dorsal ray. Lateral line, slightly curved ventrally from both ends, is nearer the dorsal. Scales rather large, about half the diameter of the eye, and as broad as long. Color is light, olive-silvery, darker above, the dorsal and caudal fins edged with black, the others clear.

Family THYMALLIDÆ.

3. **Thymallus arcticus** (Pallas). *Siberian Grayling*. (Plate XXIII.)  
*Salmo arcticus* PALLAS, Reise, III, 1776, 35, 70 (Sob, Kobyma, Obi Rivers).  
*Thymallus arcticus* SMITH, Salmoniden, 1886, 199, tab. VIII, no. 27-28 (Yenisei River).—BERG, Ann. Mus. Zool. Petersb., XII, 1907, 507 (west Siberia, Kobdo River, northwestern Mongolia).  
*Salmo digitalis* BLOCK & SCHEIDER, Syst. Ichth., 1901, 421 (after Pallas).  
*Thymallus pallasi* CUVIER & VALENCIENNES, Hist. Nat. Poiss., XXI, 1848, 449 (after Pallas).—GÜNTHER, Cat., VI, 1866, 201 (after Pallas).—BERG, Ann. Mus. Petersburg, XII, 1907, 509 (Kolyma, Jana River).—DYBOWSKI, Verh. Ges. Wien, XIX, 1869, 509 (Kolyma, Jana River).  
*Thymallus grubei* DYBOWSKI, Verh. Ges. Wien, XIX, 1869, 955, tab. XVIII, fig. 9 (Ohon, Ingoda, Amur Rivers).—BERG, Assn. Mus. Zool. St. Petersburg, XII, 1907, 509 (Amur Basin).  
*Thymallus grubeii* var. *baicalensis* DYBOWSKI, Verh. Ges. Wien, XXIV, 1874, 391 (Lake Baikal).  
*Thymallus baicalensis* GRATIANOW, (Russian publication), Moskow, No. 3, 1902, 58.  
*Thymallus arcticus baicalensis* BERG, Wiss. Erg. Baikalsee, Exp. Lief., III, Cata-phracti, St. Petersburg, 1907, 67 (Lake Baikal).—BERG, Ann. Mus. Zool. Patent 1907, 507 (Lake Baikal, Amgun River).  
*Thymallus baicalensis* DYBOWSKI, Verh. Ges. Wien, XIX, 1869, 509 (Lake Baikal, Amgun River).  
*Thymallus microstoma* HERZENSTEIN, (Russian publication), 1883, 244 (Koschagatsch, Tschuja River, Altai, upper course of the Obi; name only).  
*Thymallus nikolskyi* KASCHCHENKO, (Russian publication at Tomsk), 1899, 131 (Altai, Tscharysch River, Katun River, Tom River, at Kusnatz).

*Thymallus nikolskyi* var. *ongudajensis* KASCHCHENKO, *ibid.*, 134 (Altai, Urusul River).

*Thymallus sellatus* KASCHCHENKO, *ibid.*, 135, tab. II, fig. 6 (Altai, Tengo River, Urusul River).

Fifty-seven specimens.

Among these great variation was shown, leaving it highly probable that there is but one species of grayling in the basin of Lake Baikal, and that the grayling of the Amur is not distinct from it. It seems necessary to unite with *Thymallus arcticus* Pallas the forms called *T. arcticus baicalensis* Dybowski, *T. pallasii* Valenciennes, and (probably) *T. grubei* Dybowski also. The two former are said to be distinguished from the two latter by the dorsal length being more than 22.5 per cent of the body length, and the distance of the snout from the dorsal not less than 34 per cent, the dorsal length being not less than 23.5 per cent and the dorsal from the snout not more than 32.5 per cent in *T. pallasii* and *T. grubei*. These distinctions are given by Dr. Leo Berg in his paper "Provisional Notes on the Eurasian Salmon," published in the *Annuaire of the Zoological Museum of the St. Petersburg Academy of Sciences*, T. XII, 1907.

In the present collection there is shown not only every variation between these nominal species, but there is little correlation between the two sets of measurements. Some specimens show both the shorter dorsal fin and the shorter distance from the snout to the dorsal. The number of scales is held to separate *T. baicalensis* from *T. arcticus*, *baicalensis* having more than 90 scales in the lateral line and *arcticus* less than 90. Such a division is evidently entirely artificial, as shown by the accompanying table. *Thymallus grubei* of the Amur is probably synonymous with *Thymallus arcticus*, but there are some grounds for believing it a distinct species. None of our specimens have so small a number of scales (83-87 in the lateral line) as is ascribed by Berg to *Thymallus grubei*, and the species is from a different water basin. The jaws are said to be subequal, and the maxillary extending farther back than in *Thymallus arcticus*.

Measurements were made of all our specimens (57), from 133 mm. to 325 mm. in length. In the attached table only those above 210 mm. in length are given. The remainder fully conform to these measurements. No other distinguishing characters set off the specimens representing the extremes of this species.

The male specimens are much darker in color than the females, the spots in both becoming obscure with age. The dorsal fin is much higher

in the males, as usual among graylings. The length of the dorsal is greatest, and in the sexually mature males the last anal ray is thickened.

Number.	Dorsal Rays. <sup>1</sup>	Anal Rays. <sup>1</sup>	Scales l. lat.	Percent Dorsal in Body.	Percent Dorsal to Snout in Body.	Height Dorsal.	Sex.	Max. in Head.	Length of Body.	Gill-rakers.	Classification by L. Berg.
5232	19	12	88	18	36	10.6	?	25	282	16	<i>arcticus</i> .
5236	18	12	95	18	34	11.9	♀	27	295	19	<i>baicalensis</i> .
5250	19	12	94	18.2	35.8	12.6	♀	28	285	18	<i>baicalensis</i> .
5249	19	12	98	18.2	35.8	11.2	♀	27.5	285	18	<i>baicalensis</i> .
5252	20	12	98	18.7	33.7	8.0	?	27	255	15	<i>baicalensis</i> .
5245	18	12	92	18.9	33.9	13.0	?	28.2	265	18	<i>baicalensis</i> .
5233	19	12	91	19.1	36.6	10.0	♀	27.5	240	17	<i>baicalensis</i> .
5234	19	12	98	19.2	34.3	18.8	♀	25.5	280	17	<i>baicalensis</i> .
5242	20	12	99	19.2	34.7	5.0	♀	28.5	260	17	<i>baicalensis</i> .
5243	19	13	99	19.2	34.6	9.5	♀	27	265	17	<i>baicalensis</i> .
5238	20	12	91	20.0	34.4	10.4	♀	28.7	250	18	<i>baicalensis</i> .
5248	20	13	95	20.2	33.1	16.0	♂	27.5	296	18	<i>baicalensis</i> .
5251	20	12	92	20.3	34.0	15.9	♂	24.5	265	19	<i>baicalensis</i> or <i>pallasi</i> ?
5141	18	13	96	20.8	33.0	16.5	?	28	257	17	{ <i>baicalensis</i> or <i>pallasi</i> ?
5222	20	12	98	21.5	36.0	9.8	♀	28.5	255	18	<i>baicalensis</i> .
5239	20	12	95	21.8	32.2	14.2	♂	29	270	17	{ <i>baicalensis</i> or <i>pallasi</i> ?
5244	20	12	93	21.8	33.2	15.7	♂	31	280	18	<i>baicalensis</i> .
5235	19	12	92	21.9	34.5	16.4	?	26.5	275	18	<i>baicalensis</i> .
5223	20	13	90	21.9	35.7	16.6	?	26	210	16	<i>baicalensis</i> .
5230	19	12	87	22.0	32.0	19.0	♂	28.3	265	18	{ <i>arcticus</i> or <i>grubei</i> .
5226	20	13	97	22.3	34.2	10.4	♀	30	260	18	<i>baicalensis</i> .
5228	20	13	97	22.4	32.9	16.6	♂	30	325	17	{ <i>baicalensis</i> or <i>pallasi</i> ?
5136	20	12	92	22.7	35.0	16.3	♂	28.5	265	17	{ <i>baicalensis</i> or <i>pallasi</i> ?
5237	20	13	93	23.9	31.7	18.7	♂	28.5	315	19	<i>pallasi</i> .
5241	22	13	95	24.8	33.0	15.4	♂	29.2	266	19	<i>pallasi</i> .

Family CYPRINIDÆ.

4. *Carassius carassius* (Linnæus).

One specimen, evidently belonging to this species, but varying much from the ordinary Crucian Carp of Europe.

Head  $3\frac{1}{2}$  in body without caudal, depth  $2\frac{1}{2}$ . A. I, 5. P. 13. V. 9.

<sup>1</sup>Counting rudiments.

Scales 7-30-6. The body is compressed less strongly, and is more elongate, than in European examples; ventrals inserted before first ray of dorsal.

5. *Gobio gobio* (Linnæus).

Many large specimens not clearly different from the ordinary Gudgeon of Europe, with which the Russian naturalists have identified it.

6. *Leuciscus leuciscus* (Linnæus).

Numerous specimens, not different from this common European species.

7. *Rutilus rutilus* (Linnæus).

*Cyprinus lacustris* PALLAS, Zoog. Ross.-As., III, 1811, 314 (all Siberia, Lena River).

S. 12. W. 4. A. 12. W. 4. V. 10. Scales 8-40 to 44-5½.

Numerous specimens, corresponding to *Rutilus lacustris* of Pallas. Most Russian authorities regard *lacustris* as identical with the Common Roach of Europe, *Rutilus rutilus*, and we see no reason to question this determination. The American species called *Rutilus* seem hardly congeneric with it. These should probably stand as *Myloleucus* Cope.

Family LUCIIDÆ.

8. *Lucius lucius* (Linnæus).

*Esox reicherti* var. *baicalensis* DUBOWSKI, Verh. Ges. Wien, XXIV, 1874, 391 (Lake Baikal).

Nine specimens from 280 to 440 mm. in length.

Head 3⅛ to 3¼; depth 5½ to 6; eye 7 to 9 in head. B. 14 or 15. D. 20 or 21. A. 17 to 19. Scales 122 to 137.

We see no reason to question the identity of this species, "*baicalensis*," with the Common Pike of Europe, *Lucius lucius*; nor can we separate the Northern Pike of America, *Lucius estor* (Le Sueur), from either. In these Siberian examples, the dark bar under the eye is a shade more distinct than usual, and the pale spots on the sides show a greater tendency to array themselves in pale cross-bands, especially on the tail. The anal rays are 17 in 4 specimens, 18 in 3, and 19 in 2.

In the description of *Esox baicalensis* the vertical fins are described as unspotted, which is not the case in our examples, nor in any other specimens of *Lucius lucius*. The lesser diameter of the eye is said to be 10 to 15 times in the head in a specimen a meter in length.

*Lucius reicherti* of the Amur River is said to be spotted with dark. It is probably therefore a species of the Maskinongé group, to which the subgeneric name of *Mascalongus* has been applied.

MEASUREMENTS OF EXAMPLES FROM IRKUTSK.

	Branch.	D	A	P	V	Scales in l. lat.	Head in Body.	Depth.	Eye in Head.	Eye in Snout.	Length.
1.	14	IV 17	III 14	15	11	125	3 $\frac{1}{2}$	6	8	3 $\frac{1}{2}$	440 mm.
2.	15	IV 18	III 16	15	11	126	3 $\frac{1}{2}$	6	8 $\frac{1}{2}$	4	400 mm.
3.	14	IV 17	III 15	15	11	137	3 $\frac{1}{4}$	6	7	3 $\frac{1}{2}$	280 mm.
4.	15	IV 19	III 16	16	11	122	3 $\frac{1}{4}$	6	7	3	290 mm.
5.	15	IV 17	III 15	15	11	125	3 $\frac{1}{8}$	6	7	3	260 mm.
6.	15	IV 17	III 14	16	11	136	3 $\frac{1}{4}$	5 $\frac{1}{2}$	7	3 $\frac{1}{2}$	330 mm.
7.	15	IV 16	III 15	15	11	136	3 $\frac{1}{4}$	5 $\frac{1}{2}$	9	4	400 mm.
8.	15	IV 17	III 14	16	11	129	3 $\frac{1}{8}$	5 $\frac{1}{2}$	8	3 $\frac{1}{2}$	320 mm.
9.	15	IV 17	III 14	15	11	121	3 $\frac{1}{8}$	5 $\frac{1}{2}$	7 $\frac{1}{2}$	3 $\frac{1}{2}$	280 mm.

Specimens from Lake Erie show:

B. 15. D. IV, 18. A. III, 15. P. 14. V, 11. Scales 118. Head 3 $\frac{1}{2}$  X. Eye 3 in snout, 7 in head. Brownish vertical suborbital band less distinct. Maxillary of same relative length, but extending a very little farther back.

Family PERCIDÆ.

9. *Perca fluviatilis* (Linnæus).

Many specimens, not evidently different from the Common Perch of Europe, with which the Russian authors identify the species.

Family COTTIDÆ.

10. *Cottus kneri* (Dybowski).

*Cottus kneri* DYBOWSKI, Verh. Ges. Wien, XXIV, 1874, 385 (Lake Baikal).

Thirteen specimens, agreeing well with Dybowski's account.

11. *Cottus sibiricus* (Kessler).

*Cottus sibiricus* KESSLER, WARPACHOWSKI, Ann. Mus. Petersburg, 1897, 249, tab. XI, fig. 6.

*Cottus haitej* DYBOWSKI, Verh. Ges. Wien, XIX, 1869, 949, tab. XIV, fig. 2 (Amur Basin).

One specimen, 87 in. long, referred with some doubt to this species (Onon, Ingda, Amur).

Head 3 in body, without caudal; depth at operculum 6; eye 5 in head, 1 $\frac{1}{2}$  in interorbital space. P. 7—17. A. 12. V. I, 4. P. 15.

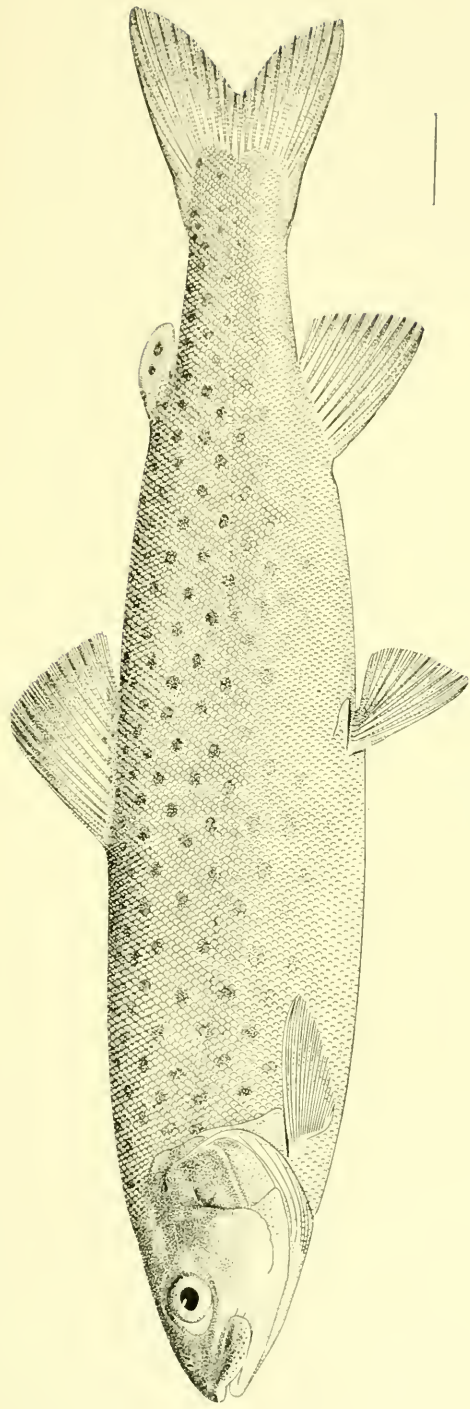
Body flattened, greatly at the head, but cylindrical at the anus. Skin smooth except above the lateral line, on the flanks, where it is thickly beset with small spicules. The maxillary extends to below the anterior margin of the eye-orbit. Four spines are present on the opercular bones,

covered by the skin. The largest is in length equal to the diameter of the eye, strongly recurved dorsally and posteriorly, and situated on the posterior and outward angle of the preoperculum. At the anterior base of this is a much smaller sharp spine pointing outward. The others are on the inter- and sub-opercular bones respectively, and so situated near the junction that they point toward each other. They are moderate in size, sharp and curved. The first dorsal is low, one-half the height of the second and the anal, which are equal and twice the height of the caudal peduncle. The pectorals are large, extending to beyond the second dorsal, while the ventrals extend to the vent, which is midway between the snout and base of the caudal. The latter is narrow and rounded, the rays branched. The lateral line is well developed and extends to the base of the caudal, with about 35 large pores.

We have not seen Kessler's original description of this species.

Our specimen agrees with the scanty account of *Cottus sibiricus* given by Warpachowski. Warpachowski makes no reference to the form of the preopercular spine, but in his figure the species is essentially as in our specimen. He ascribes to the species D. VIII, 17; A. 12, VI, 4; P. 14. Head about 3 in length; depth about 5, upper parts with minute rough prickles; ventrals reaching vent.

Dybowski's account of *Cottus haitej* from the Amur is more complete, but the preopercular spine is merely noted as turned upwards, "sursum." In the short anal these nominal species agree with each other and with our specimen.

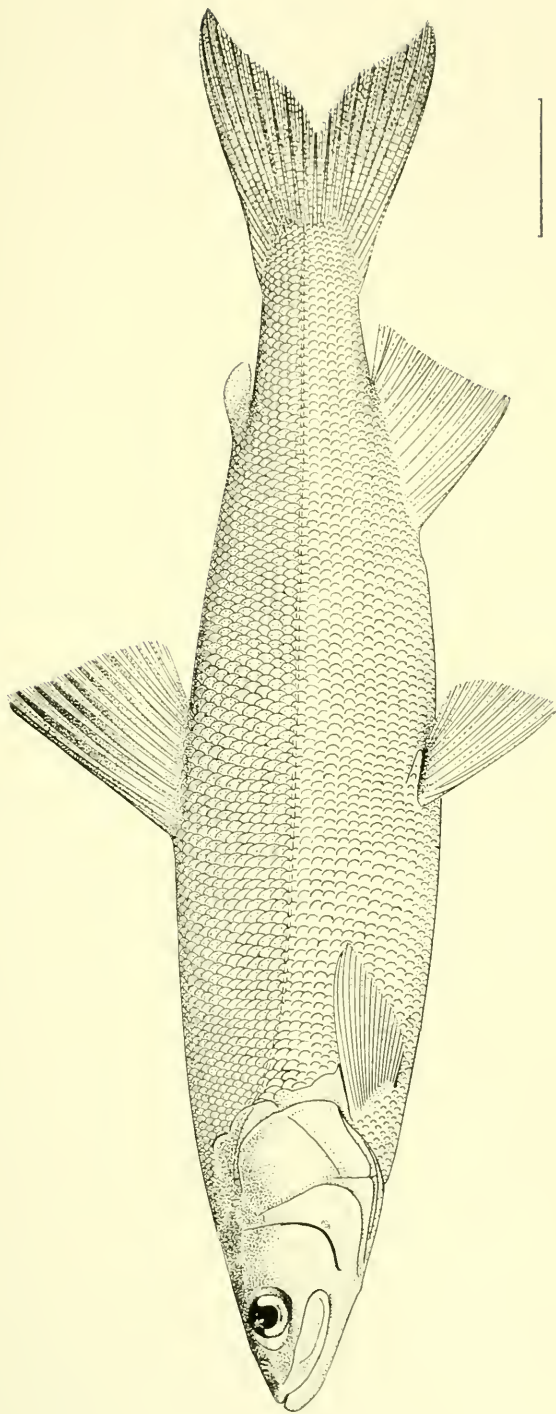


*Brachymystax lenok* (Pallas).

From Angara River, Irkutsk, Siberia. James Francis Abbott, collector.



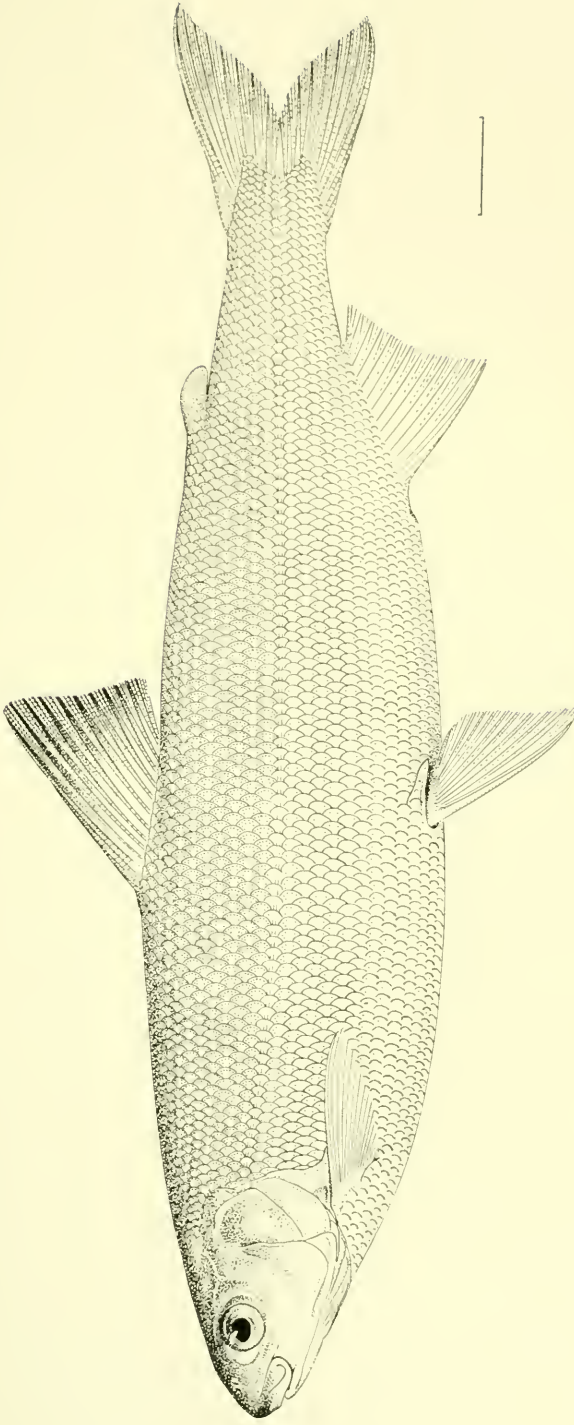




*Stenodus leucichthys* (Güldenstädt).

From the Volga River, Sammara, Russia. James Francis Abbott, collector.

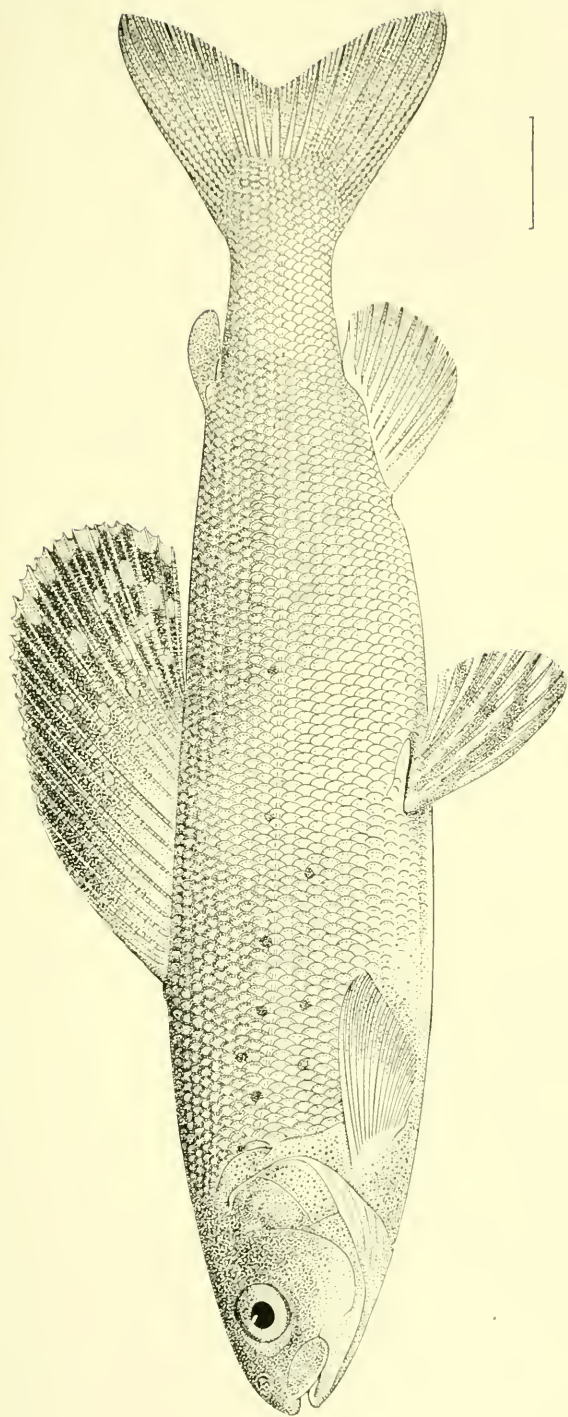




*Coregonus pidschian* (Pallas).

From the Angara River, Irkutsk, Siberia. James Francis Abbott, collector.





*Thymallus arcticus* (Pallas).

From the Angara River, Irkutsk, Siberia.™ James Francis Abbott, collector.



## VII. SOUTH AMERICAN TETRIGIDÆ.

BY LAWRENCE BRUNER,

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Some time ago the extensive collection of saltatorial Orthoptera made by Mr. H. H. Smith in Brazil and adjoining parts of South America was placed in my hands by Dr. W. J. Holland, the Director of the Carnegie Museum, for study. Among the material thus submitted are many representatives of the family of "grouse-locusts." In fact, the collection contains such a large percentage of the described species of South America and at least a score of new ones, that the writer has decided to make this report a review of the family so far as South American forms are concerned.

While in nowise a monograph or even synopsis of the group, the paper gives brief synopses of the subfamilies and genera, lists all the species, and in many instances also adds synoptic tables for the separation of the species of the larger genera. Of course all new forms are quite fully characterized. The arrangement of the subfamilies, genera, and species is intended to convey, as far as possible, the author's opinion as to the proper sequence of the various forms. An occasional reference is also made to some feature in connection with the life-history or distribution of certain forms with the hope that it may add something to our general knowledge of these interesting little locusts.

It might be added that the majority of the representatives of the family are to a great degree either aquatic or semi-aquatic in their habits. Hence they should be sought for at the margins of streams and bodies of water, or in very humid localities, rather than in arid places. A few of them live among the mosses and lichens which grow on trunks of trees and rocks, to which their general color conforms to such an extent as to be strongly protective.

### TABLE FOR THE SEPARATION OF THE SUBFAMILIES AND GENERA OF SOUTH AMERICAN TETRIGIDÆ.

A. Frontal costa widely forked, the rami forming a frontal scutellum.

CLADINOTINÆ.

b. Pronotum very greatly compressed, above wholly foliaceous.

c. Pronotum viewed in profile subrhombic-angulate, ampliate posteriorly; first and third joints of the posterior tarsi subequal, or the first slightly longer.

*Phyllolettix* Hancock.

- cc. Pronotum with the dorsum very greatly compressed, above angulato-  
rounded, posteriorly truncate; first article of the posterior tarsi a little  
longer than the third . . . . . *Choriphyllum* Serville.
- bb. Pronotum little or slightly compressed, very often depressed, or above not  
wholly foliaceous, or to a certain degree anteriorly compresso-produced.
- c. First and third joints of the hind tarsi subequal in length. Body nearly  
smooth; pronotum acute tectiform, in profile arcuate, posteriorly little  
depressed, the apex widely rounded. . . . . *Eleleus* Bolivar.
- cc. First joint of the hind tarsi longer than the third. Pronotum nodulose,  
middle distinctly depressed; the vertex strongly produced in advance  
of the eyes . . . . . *Cota* Bolivar.
- AA. The frontal costa furcillate, but the rami diverging only gently forward, or  
remaining parallel, very frequently separated only in a slight degree by a  
sulcus.
- b. Posterior angles of the lateral lobes of the pronotum but little produced out-  
wards, obliquely truncate behind, very rarely acute spinose; first and  
third joints of the hind tarsi nearly equal in length. . . . . *METRODORINÆ*.
- c. Vertex truncate, the middle rarely provided with a produced central tooth.
- d. Vertex very narrow, about half the width of one of the eyes; posterior  
angles of the lateral lobes of the pronotum flattened outwards, trian-  
gularly produced, subspiniform or uncinatè. . . . . *Plesiolettix* Hancock.
- dd. Vertex subequal to, or wider than, one of the eyes.
- e. Antennæ inserted between the lower part of the eyes. Vertex not pro-  
duced in advance of the eyes; the frontal costa roundly elevated  
between the antennæ . . . . . *Cotys* Bolivar.
- ee. Antennæ situated below or rarely on a level with the inferior margin  
of the eyes.
- f. Body strongly depressed; anterior and middle femora expanded or  
clypeate, the carinæ sinuato-lobate or foliaceo-laminate.
- g. Tegmina and wings wanting. Antennæ inserted on a level with  
the lower margins of the eyes; first joint of the hind tarsi  
longer than the third . . . . . *Platythorus* Hancock.
- gg. Tegmina and wings present.
- h. Anterior femora clypeate. Lateral ocelli placed between the  
inferior part of the eyes. Antennæ shorter than the head  
and inserted distinctly below the eyes. . . . . *Amorphopus* Serville.
- hh. Anterior femora not at all clypeate. Lateral ocelli placed  
between the middle of the eyes. Antennæ longer than the  
head and inserted on a line with the inferior margin of the  
eyes . . . . . *Eomorphopus* Hancock.
- ff. Body little depressed, or dorsum bearing gibbosities, or the median  
carina of the pronotum more or less cristulate-undulate.
- g. Posterior or lateral ocelli placed below the eyes. . . . . *Chiriquia* Morse.
- gg. Posterior or lateral ocelli placed distinctly between the eyes,  
h. Dorsum longitudinally compresso-elevated forward, flattened  
posteriorly, rugose-reticulose, apex of process acute. Teg-  
mina and wings wanting . . . . . *Platylettix* Hancock.



lh. Dorsum somewhat depressed.

i. Median carina of the pronotum compresso-elevated between the shoulders; the vertex very wide, transverse, fully twice the width of one of the eyes. . . *Gladiolettix* Hancock.

ii. Median carina of the pronotum not compresso-elevated between the shoulders; the vertex narrower, but little, if any, wider than one of the eyes.

j. Middle femora about one-half as wide as long.

k. Stature very small . . . . . *Crimisus* Bolivar.

kk. Stature medium, or larger. Pronotum with the median carina interrupted or undulate . . . *Sclerotettix* Bruner.

jj. Middle femora much longer than wide.

k. Vertex with the median carina distinctly produced in advance of the eyes; posterior angles of the lateral lobes of the pronotum outwardly flattened, somewhat acute; body without tegmina or wings.

*Metrodora* Bolivar.

kk. Vertex with the median carina not at all produced beyond the eyes.

l. Posterior ocelli placed between the inferior part of the eyes.

m. Posterior femora of normal form. First and third joints of hind tarsi of equal length.

*Otumba* Morse.

mm. Posterior femora triquetrous, the genicular spine triangular, strongly elevated, produced.

*Trigonofemora* Hancock.

ll. Posterior ocelli placed near the middle of the eyes.

m. Lower posterior angles of sides of pronotum little flattened outwards and angulate, truncate behind, or acutely produced but not at all spined. Body rugose . . . *Scabrotettix* Hancock.

mm. Lower posterior angles of sides of pronotum turned down, not at all obliquely truncate. Body subrugose . . . . . *Allotettix* Hancock.

cc. Vertex acute and lengthily produced in advance of the eyes, armed on each side with one or two denticles . . . . . *Mitritettix* Hancock.

bb. Posterior angles of the lateral lobes of the pronotum turned down, more or less rounded, not at all obliquely truncate; third joint of the hind tarsi shorter than the first.

c. Anterior and middle femora carinate above; pronotum truncate anteriorly, rarely angulately produced. Antennæ fewer jointed . . . TETRIGINÆ.

d. Vertex strongly narrowed forward, drawing the eyes very near together anteriorly. The pronotum subcylindrical, smoothly granulate, the carinæ very low or flattened . . . . . *Teredorus* Hancock.

dd. Vertex somewhat narrowed toward the front but the anterior border truncate, about one-half to quite the breadth of one of the eyes or even a little more.

- e. Middle femoral margins strongly carinate-clypeate, their length a little more than the breadth. Head very short, somewhat retracted under the pronotum. . . . . *Clypeotettix* Hancock.
- ee. Middle femoral margins not clypeate, but sometimes the carinae are compressed but then the length is much more than the breadth.
- f. Vertex truncate, not advanced beyond the eyes, narrower or subequal to one of them; dorsum advanced upon the head to the eyes.  
*Paratettix* Bolivar.
- ff. Vertex produced beyond the eyes, usually wider than one of them, in profile very often angulately produced. . . . . *Tetrix* Latreille.
- g. Antennæ inserted between the inferior part of the eyes. Body somewhat rugose, slender prolonged; dorsum subdepressed, very narrow between the shoulders. . . . . *Stenoderus* Hancock.
- gg. Antennæ inserted little below the eyes.
- h. Body usually abbreviated, comparatively robust, the median carina of the pronotum cristulato-undulate, the anterior margin truncate; wings often imperfectly developed, rarely macropterous; antennæ filamentous, elongate.  
*Micronotus* Bolivar.
- hh. Body having the surface of the dorsum rugose or tuberculose. Antennæ short and stout.
- i. Hind tibiæ normal, pleurispinose. Wings perfectly explicate, passing the apex of the hind femora.  
*Apotettix* Hancock.
- ii. Hind tibiæ distinctly ampliate towards the apex, lightly spinose. Wings not longer than the pronotum or somewhat abbreviate. . . . . *Protettix* Bolivar.
- cc. Anterior usually and middle femora above always distinctly sulcate. Pronotum anteriorly more or less produced above the head, often uncinatè or acuminate or to a certain degree obtusangulate. Antennæ with sixteen to twenty-two joints . . . . . BATRACHIDIINÆ.
- d. Vertex anteriorly distinctly carinate disposed obliquely or transversely, middle carinate, more or less compressed, produced.
- e. Pronotum with the posterior angles of the lateral lobes turned down; elytral sinus and elytra normal.
- f. Top of head between the eyes more or less longitudinally convex and provided in front with a rather prominent median carina; the vertex viewed in profile advanced but little in front of the eyes.  
*Tettigidea* Scudder.
- ff. Top of head between the eyes rather widely longitudinally sulcate, the anterior portion also provided with a median carina of varying prominence; vertex viewed in profile considerably advanced in front of the eyes as in the genus *Tetrix*.
- g. Anterior femora very faintly sulcate; middle of vertex provided with a minute carina, the frontal costa narrowly sulcate between the ocelli and below. Antennæ long and slender, 21- or 22-jointed. Valves of the ovipositor short and somewhat robust. . . . . *Lophotettix* Bruner.

- gg. Upper edge of the anterior femora plainly sulcate; the anterior middle of vertex provided with a very prominent carina, the frontal costa quite widely sulcate to the summit. Antennæ rather short, slender and composed of 15 or 16 joints. Valves of the ovipositor very long and slender. . . . *Lophoscirtus* Bruner.
- ee. Pronotum with the posterior angles of the lateral lobes turned a little outwards.
- f. Elytral sinus subobsolete, tegmina present but minute. Body scabrous. . . . . *Plectronotus* Morse.
- ff. Elytral sinus altogether wanting, tegmina as well as the wings absent. Body granulose . . . . . *Apteropodon* Bruner.
- dd. Vertex anteriorly not or imperfectly carinate, each side bearing small abbreviated lobes next to the eyes, or tumid, median carina wanting, or when present the facial costa roundly produced.
- e. Frontal costa very narrowly sulcate.
- f. Body slender; pronotum lengthily subulate, median carina distinctly ascendent forward near the anterior margin. . . . *Scaria* Bolivar.
- ff. Body somewhat grosser; pronotum having the median carina viewed in profile horizontal, posterior process and wings dimorphic in length. . . . . *Batrachidea* Serville.
- ee. Frontal costa widely sulcate.
- f. Pronotum anteriorly truncate; first joint of the posterior tarsi strongly elongate—twice the length of the third; frontal costa roundly produced . . . . . *Paurotarsus* Hancock.
- ff. Pronotum anteriorly acute uncinately; tarsal joints normal.

*Puiggaria* Bolivar.

Subfamily CLADONOTINÆ.

Genus PHYLLOTETTIX Hancock.

*Phyllotettix* HANCOCK, Ent. News, XIII, June, 1902, 188.

*Phyllonotus* HANCOCK, Tettigidæ of N. Am., 1902, 45.

The various representatives of the present genus appear to be confined wholly to the West Indies.

SYNOPSIS OF THE SPECIES OF PHYLLOTETTIX.

- A. Superior marginal carina of the hind femora lobate. . . . . *westwoodi* Hancock.
- AA. Superior marginal carina of the hind femora not lobate.
- b. Pronotum viewed in profile distinctly enlarged posteriorly. Body larger. . . . . *foliatus* Hancock.
- bb. Pronotum viewed in profile only subenlarged posteriorly. Body small. . . . . *rhombus* Baker.

*Phyllotettix foliatus* Hancock.

*Coriphylum foliatum* HANCOCK, Tettigidæ of N. Am., 1902, 42-43, pl. 1, fig. 1.

*Phyllotettix foliatus* HANCOCK, Genera Insectorum, fasc. 48, 1906, 12.

*Habitat*.—This very odd appearing locust is found on the island of Jamaica in the West Indies. These islands are usually included with

South America rather than with the faunal areas of adjoining portions of North America.

**Phyllotettix westwoodi** Hancock.

*Choriphyllum westwoodi* HANCOCK, Tettigidæ of N. Am., 1902, 42, pl. 1, fig. 2.

*Phyllotettix westwoodi* HANCOCK, Genera Insectorum, fasc. 48, 1906, 12.

*Habitat.*—Like the preceding, this insect comes from the island of Jamaica.

As indicated by Hancock in the table given on page 42 of his Tettigidæ of North America the present species is separable from the other two forms by the lobate upper carina of the hind femora.

**Phyllotettix rhombeus** (Baker).

*Cicada rhombea* BAKER, Trans. Linn. Soc. Lond., LIV, 1764, 55, pl. 6.

*Membracis rhombea* LINN., Syst. Nat., ed. 12, I, 1767, 704.

*Acridium (Hymenotes) rhombeum* DE HANN, Bijdr., 1842, 165, pl. 12, fig. 11.

*Choriphyllum rhombeum* WALKER, Cat. Derm. Salt. Brit. Mus., V, 1871, 845.

*Phyllotettix rhombeus* HANCOCK, Genera Insectorum, fasc. 48, 1906, 12.

*Habitat.*—Jamaica and Cuba, West Indies.

Genus **CHORIPHYLLUM** Serville.

*Choriphyllum* SERVILLE, Hist. Nat. Ins. Orthopt., 1839, 754.

*Hymenotes* STÅL.

*Chorophyllum* FIEBER.

This genus, like the preceding, is confined in its distribution to the West Indies.

SYNOPSIS OF THE SPECIES OF CHORIPHYLLUM.

- A. The leaf-like median carina of the pronotum highest over the head.  
*sagrai* Serville.
- AA. The leaf-like median carina of the pronotum most prominent near its middle.  
 b. Body small (♀, 7 mm.); the highest point of the pronotum at the middle.  
*saussurei* Bolivar.
- bb. Body larger (♀, 10 mm.); the highest point of the pronotum a little back of the middle . . . . . *plagiatum* Walker.

**Choriphyllum sagrai** Serville.

*Chorophyllum sagrai* SERVILLE, Hist. Nat. Ins. Orthopt., 1839, 755, pl. 8, fig. 5.—

HANCOCK, Genera Insectorum, fasc. 48, 1906, 18.

*Habitat.*—This species has been recorded only from the island of Cuba, West Indies.

**Choriphyllum plagiatum** Walker.

*Choriphyllum plagiatum* WALKER, Cat. Dermapt. Salt. Brit. Mus., V, 1871, 845.

—HANCOCK, Genera Insectorum, fasc. 48, 1906, 13.

*Habitat.*—West Indies, the island of Jamaica.

**Choriphyllum saussurei** Bolivar.

*Choriphyllum saussurei* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 203, pl. 1, fig. 5.—HANCOCK, Genera Insectorum, fasc. 48, 1906, pl. 1, fig. 7.

*Habitat*.—Like the preceding this insect comes from the island of Jamaica, West Indies.

**Genus ELELEUS** Bolivar.

*Eleleus* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 205.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 16.

**Eleleus curtus** Bolivar.

*Eleleus curtus* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 206, pl. 1, figs. 7-7a, b.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 16, pl. 1, fig. 7.

*Habitat*.—This insect is recorded only from Brazil. No specimens are at hand.

**Genus COTA** Bolivar.

*Cota* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 32.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 18.

## SYNOPSIS OF THE SPECIES OF COTA.

- A. Anterior and middle femora strongly undulately carinate.  
 b. Lateral lobes of the vertex rounded . . . . . *strumosa* Bolivar.  
 bb. Lateral lobes of the vertex acute . . . . . *saxosa* Bolivar.  
 AA. Anterior and middle femora with the carinæ weakly undulate.  
*bispina* Saussure.

**Cota strumosa** Bolivar.

*Cota strumosa* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 206.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 18.

*Habitat*.—According to Bolivar this insect comes from the Upper Amazon. The present collection contains specimens bearing the labels "Benevides, July." Carnegie Museum, Pittsburgh.

**Cota saxosa** Bolivar.

*Cota saxosa* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 207, pl. 1, figs. 8, 8a.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 18, pl. 1, fig. 13.

*Habitat*.—Given by Bolivar as Peru. Not contained in the present collection.

? **Cota bispina** (Saussure).

*Tettix bispina* SAUSSURE, Orthopt. Nov. Am., ser. 2, 1861, 32.

? *Cota bispina* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 207.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 18.

*Habitat*.—Bahia, Brazil. Not in the collection now being reported upon.

Subfamily *METRODORINÆ*.Genus *PLESIOTETTIX* Hancock.

*Plesiotettix* HANCOCK, Genera Insectorum, fasc. 48, 1906, 34.

The two species of this genus are very similar but may be separated as follows:

A. Front end of the pronotum just back of the margin a little upturned.

*uncinatus* Hancock.

AA. Front end of the pronotum just back of the margin not so upturned.

*spinosa* Hancock.

***Plesiotettix uncinatus* Hancock.**

*Plesiotettix uncinatus* HANCOCK, Genera Insectorum, fasc. 48, 1906, 34, pl. 3, fig. 22.

*Habitat*.—Pachitea, Peru. Not contained in the material studied.

***Plesiotettix spinosus* Hancock.**

*Plesiotettix spinosus* HANCOCK, Genera Insectorum, fasc. 48, 1906, 34.

*Habitat*.—Marcapata, Peru.

This second species differs from the preceding in being decidedly smaller and in not having the lower posterior lateral angles of the pronotum hooked or curved forwards. It too is missing from the Smith collection.

Genus *COTYS* Bolivar.

*Cotys* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 247.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 35.

***Cotys antennatus* Bolivar.**

*Cotys antennatus* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 247.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 35, pl. 4, fig. 34.

*Habitat*.—Peru, S. America.

Genus *PLATYTHORUS* Morse.

*Platythorus* MORSE, Biol. Centr.-Am., Orthopt., II, 1900, 8.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 36.

***Platythorus camurus* Morse.**

*Platythorus camurus* MORSE, Biol. Centr.-Am., Orthopt., II, 1900, 8.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 36.

*Habitat*.—Nicaragua and Costa Rica, where it is to be met with on the trunks of trees, among lichens and mosses, the colors of which it imitates to a remarkable degree. The writer has collected it in the vicinity of Juan Viñas at an altitude of between 2,500 and 3,000 feet above sea-level. There is but little doubt of its occurring also in the adjoining northern portions of South America.

## Genus AMORPHOPUS Serville.

*Amorphopus* SERVILLE, Hist. Nat. Ins. Orthopt., 1839, 756.—BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 250, *part.*—HANCOCK, Genera Insectorum, fasc. 48, 1906, 36-37.

The species of this genus as at present restricted are at home in the Neotropical region of America. Four or five forms are recognized. They may be separated by the subjoined table.

## SYNOPSIS OF THE SPECIES OF AMORPHOPUS.

- A. Posterior extremity of the pronotum attenuate, considerably surpassing the apex of the abdomen and tips of the hind femora.
- b. Size smaller (♀, 13-14 mm.).
- c. Dorsum of the pronotum grayish, smooth; the median carina of the pronotum back of the humeri somewhat compressed. . . . . *griseus* Bolivar.
- cc. Dorsum of the pronotum fusco-variegated, rugulose, the median carina not sinuose. . . . . *notabilis* Serville.
- bb. Size larger (♀, 15.5-16 mm.).
- c. Color above fuscous conspersed with white. . . . . *cnemidotus* Burmeister.
- cc. Color above grayish, tessellated with fuscous. . . . . *caïman* Saussure.
- AA. Posterior extremity of pronotum not extending beyond the tip of the abdomen. Tegmina and wings hidden or aborted. . . . . *testudo* Saussure.

***Amorphopus griseus* Bolivar.**

*Amorphopus griseus* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 251-252.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 37.

*Habitat.*—Upper Amazon, South America.

***Amorphopus notabilis* Serville.**

*Amorphopus notabilis* SERVILLE, Hist. Nat. Ins. Orthopt., 1839, 757, pl. 2, figs. 20, 20a-b.—BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 252.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 37, pl. 4, fig. 38.

*Habitat.*—This insect has been recorded from Brazil, Peru, Bolivia, Venezuela, Guiana, and the island of Trinidad. The present collection contains specimens taken at Para and Benevides, Brazil, during the months of June and July. Collection Carnegie Museum, Pittsburgh.

***Amorphopus cnemidotus* Burmeister.**

*Tetrix cnemidotus* BURMEISTER, Handb. Ent., II, 1838, 650.

*Paratettix cnemidotus* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 274.—GIGLIOTTOS, Boll. Mus. Zool. Anat. Comp. Torino, XII, no. 302, 1897, 28.

*Amorphopus cnemidotus* HANCOCK, Genera Insectorum, fasc. 48, 1906, 37.

*Habitat.*—Brazil.

***Amorphopus caïman* Saussure.**

*Amorphopus caïman* SAUSSURE, Orthopt. Nov. Am., ser. 2, 1861, 33.

*Habitat.*—Brazil.

Whether or not this and the preceding species are distinct is uncertain until a number of specimens from various parts of South America are critically studied.

**Amorphopus testudo** Saussure.

*Amorphopus testudo* SAUSSURE, Orthopt. Nov. Am., ser. 2, 1861, 32.

*Habitat*.—Guiana, S. America.

Genus **EOMORPHOPUS** Hancock.

*Eomorphopus* HANCOCK, Genera Insectorum, fasc. 48, 1906, 37.

The species of this genus are confined to South America. They may be separated as follows:

A. Dorsum of the pronotum rugulose; anterior femora above biundulate.

*antennatus* Bolivar.

AA. Dorsum of the pronotum nearly smooth granulate; the anterior femora strongly carinate, above triundulate.....*granulatus* Hancock.

**Eomorhopus antennatus** (Bolivar).

*Amorphopus antennatus* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 251, pl. 2, figs. 19, 19a-b.

*Eomorphopus antennatus* HANCOCK, Genera Insectorum, fasc. 48, 1906, 38.

*Habitat*.—This insect is credited to the Upper Amazon by Bolivar and Hancock. The Smith collection contains specimens taken at Chapada, near Cuyaba, Matto Grosso, Brazil. Collection Carnegie Museum, Pittsburgh. There are specimens in the writer's collection which were taken on the island of Trinidad.

**Eomorphopus granulatus** Hancock.

*Eomorphopus granulatus* HANCOCK, Genera Insectorum, fasc. 48, 1906, 38, pl. 4, figs. 35, 35a.

*Habitat*.—Dutch Guiana, South America. The present collection also contains specimens taken at Benevides and Santarem, Brazil. Collection Carnegie Museum, Pittsburgh.

This last species may be recognized from *antennatus* by its much smoother body and slightly slenderer form.

Genus **CHIRIQUIA** Morse.

*Chiriquia* MORSE, Biol. Centr.-Am., Orthopt., II, 1900, 7.—HANCOCK, Tettigidae N. Am., 1902, 49; Genera Insectorum, fasc. 48, 1906, 39.

The two species of the genus are confined to the extreme southern parts of North America and to South America. They may be distinguished as follows:



- A. Posterior lateral lobes of the pronotum lamellate, squarely truncate at the apex; the median carina strongly undulate for two-thirds of its length.  
*serrata* Morse.
- AA. Posterior lateral lobes of the pronotum with their apex acutely produced; the median carina in front bicristate. . . . . *concinna* Bolivar.

**Chiriquia serrata** Morse.

*Chiriquia serrata* MORSE, Biol. Centr.-Am., Orthopt., II, 1900, 7.

*Habitat*.—This insect has been recorded from Nicaragua, Costa Rica and Panama in North America. There is no doubt in the writer's mind but that its distribution also extends into South American territory as well.

**Chiriquia concinna** (Bolivar).

*Metradora concinna* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 249.

*Chiriquia concinna* HANCOCK, Genera Insectorum, fasc. 48, 1906, 39.

*Habitat*.—Recorded heretofore from Paramaribo, Dutch Guiana and Peru. Represented by a single specimen in the present collection coming from Para, Brazil. Collection Carnegie Museum, Pittsburgh.

Genus **PLATYTETTIX** Hancock.

*Platytettix* HANCOCK, Ent. News, XVII, 1906, 88; Genera Insectorum, fasc. 48, 1906, 39.

Three species of the genus *Platytettix* at least have come to light thus far. They may be separated in this manner:

- A. Larger (8-9 mm.). Pronotum strongly reticulate and gibbous.
- b. Apex of the anterior edge of the posterior lateral lobes of the pronotum greatly produced and acuminate. . . . . *reticulatus* Hancock.
- bb. Apex of the posterior lateral lobes but little produced . . . *gibbinotus* sp. nov.
- AA. Smaller (7 mm.). Pronotum comparatively smooth. Posterior angles of the pronotum roundly angulate. . . . . *uniformis* sp. nov.

**Platytettix reticulatus** Hancock.

*Platytettix reticulatus* HANCOCK, Ent. News, XVII, 1906, 88-89; Genera Insectorum, fasc. 48, 1906, 40, pl. 3, figs. 23, 23a.

*Habitat*.—Peru.

**Platytettix gibbinotus** sp. nov.

Very similar to *P. reticulatus* Hancock, but somewhat smaller, and with the lower posterior angles of the pronotum shorter and less acute. It also differs from that species in having the upper and lower carinæ of the anterior femora quite differently lobate than shown in Hancock's figure (*vide* Genera Insectorum, fasc. 48, pl. 3, fig. 23) the upper one being scarcely lobate, while the lower is strongly developed into two acute

lobes which occupy the middle third, the outer or apical lobe being twice as prominent as the basal one. The first joint of the posterior tarsi is distinctly longer than the third. The general color of the present series is dark fusco-ferruginous, with the apical joints of the antennæ testaceous.

Length of body, ♂, 7.5 mm., ♀, 8 mm.; of pronotum, ♂ and ♀, 7.55 mm.; of hind femora, ♂, 4.5 mm., ♀, 4.85 mm.; length to tip of pronotum, ♂, 8.5 mm., ♀, 8 mm.

*Habitat*.—One male and one female, Para, Brazil, taken in August by H. H. Smith. The collection also contains what is apparently a nymph of this same species from Benevides, Brazil, collected in July. Collection Carnegie Museum, Pittsburgh.

The dorsum of the pronotum back of the humeral gibbosity is rounded in the female but flattened in the male.

#### *Platyttix uniformis* sp. nov.

Considerably smaller than the preceding species and *P. reticulatus* Hancock, from both of which it differs in the non- or less strongly reticulate and less gibbous pronotum, and in having the lower posterior angles of the pronotum roundly angulate instead of acute. The carinæ of the anterior and middle femora, while prominent, are not undulate above and scarcely lobate below, but notched so as to produce an acute tooth in advance of the apex. Head small, the eyes separated above by a space greater than the diameter of one of them. The vertex is slightly advanced in front of the eyes, where the upper extremity of the frontal costa is quite prominent and when viewed from above appears as an acute median anteriorly projecting tooth; the space between the eyes above is provided in the middle with a continuation of the frontal costa as a longitudinal carina reaching nearly or quite to the anterior edge of the pronotum. The latter elevated, somewhat inflated and rounded between the humeri and anterior edge, but not especially rugose, on the disk between the median and humeral carinæ provided on each side with a short supplementary carina, posteriorly with several short irregular longitudinal rugæ, the apex broadly acuminate. Hind femora robust, the upper edge and outer face comparatively smooth.

General color dark fuscous, indistinctly mottled with paler. Hind tibiæ, and in fact the anterior and middle ones also, showing traces of annulation.

Length of body, ♂ and ♀, 6 mm.; of pronotum, 6 mm.; length to tip of pronotum, 7 mm.; of hind femora, 4 mm.

*Habitat*.—Four specimens, two from Para and two from Benevides, Brazil, collected in July by H. H. Smith. A nymph, apparently of this species, also from Benevides, is before me. Carnegie Museum, Pittsburgh.

Genus GLADIOTETTIX Hancock.

*Nephele* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 252.

*Gladiotettix* HANCOCK, Genera Insectorum, fasc. 48, 1906, footnote 40.

*Gladiotettix turgida* (Bolivar).

*Nephele turgida* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 252-253.

*Gladiotettix turgida* HANCOCK, Genera Insectorum, fasc. 48, 1906, 40.

*Habitat*.—Brazil, Upper Amazon, Peru.

The H. H. Smith collection contains specimens taken at Para and Benevides, Brazil. They were collected during the month of July. Carnegie Museum, Pittsburgh.

*Gladiotettix unicristata* Hancock.

*Nephele unicristata* HANCOCK, MS., Genera Insectorum, fasc. 48, 1906, 40.

*Gladiotettix unicristata* HANCOCK, *loc. cit.*, footnote.

The annexed description was prepared by Dr. J. L. Hancock and submitted to the present writer for insertion in a paper on British Guiana Orthoptera which has not been published as yet. The species should be credited to him in bibliographic references.

*Characters*.—A well marked species. ♂, body moderately robust, strongly rugoso-granulose, and provided with tubercles; color fusco-ferruginous, legs somewhat interspersed with lighter ferruginous, apical half of the tarsal articles fuscous. Face nearly vertical; vertex very wide, at the front margin barely more than twice the breadth of one of the eyes, crown very much shortened, the lateral margins little convergent forward, median carina obsolete with the exception of a barely elevated tubercle anteriorly; on either side the anterior half of the vertex fossulate, the front transversely carinate and truncate, viewed from in front barely concave, from above not advanced so far as the eyes, outwardly on either side next to the eyes the frontal carinæ little oblique, elevated tuberculiform; frontal costa viewed in profile lightly protuberant but flattened, viewed from in front the rami widely separated between the antennæ and parallel. Eyes prominent, globose, viewed from above somewhat reniform and sub-stylate; ocelli minute, placed between the inferior fourth of the eyes; antennæ situated distinctly below the ventro-anterior border of the eyes, the distance between them equal to about that from the eyes; last two articles of palpi strongly depresso-ampliate. Pronotum anteriorly trun-

cate, but the margin at the middle excavate, posteriorly subulate, distinctly passing the femoral apices, the apex of process little upturned, dorsum between the shoulders strongly compresso-elevated; the median carina strongly compressed forwards and formed into an elevated serrato-angulate crest, very thin and translucent when held against the light; the anterior margin of the crest situated before the shoulders, concave, and provided with tubercles, the posterior margin convex, serrato-crenulate, and extending backward to the anterior fifth of the hind femora; highest point of crest situated between the shoulders, the apex acute, and little produced forward; median carina posteriorly thin and inconspicuous, the dorsal surface strongly rugoso-subreticulate; humeral angles obtuse, interrupted anteriorly; supraelytral margin narrow, little convex; humero-apical carinæ very thin, enclosing a wide longitudinal scapular area above the supraelytral margin; anterior carinæ just behind the front border obsolete, and instead presenting minute tubercles; posterior angles of the lateral lobes little laminate outward, dentate produced, behind oblique and serrate; elytral sinus shallow. Elytra oval, punctate; wings fully explicate, barely longer than the pronotal process. Femora compressed, anterior femoral margins above undulate, inferior margins barely undulate; middle femoral margins sinuato-lobate; posterior femora stout, inflated, external pagina provided with many tumose elevations, the superior margin strongly arcuate, minutely serrulate and furnished with about four tubercles, the inferior margins straight, provided with two minute denticles, the ante-genicular denticle above large and elevated subobtusely; the genicular denticle strongly distinct and serrate but not produced backward; lateral margins of posterior tibiæ straight, scarcely at all expanded at the apices, regularly dentate, the denticles being very small, the canthi between the denticles minutely serrulate; first article of the posterior tarsi having the first and second pulvilli small and of equal length, the third much longer and subobsolete or flat below." (The third tarsal article as well as the antennæ of the "type" missing.)

Total length, ♂, 12.3 mm; of pronotum, 11.5 mm.; of posterior femora, 5.5 mm.

*Habitat*.—Demarara, British Guiana, collected by R. J. Crew. The type is in the collection of Professor L. Bruner.

***Gladiotettix hancocki* sp. nov.**

Rather closely related to the preceding species but differing from it in its somewhat larger size and in having the median carina even more

elevated and foliaceous, with its anterior edge reaching the front margin of the disk of the pronotum, straight and tridentate, the hind part of the crest less abrupt and serrato-crenulate. Surface of the pronotum rather closely punctate, less rugose than in the species with which it has just been compared. Frontal costa less prominent and the rami not so widely separated between the antennæ as described for *unicristata*. Lower posterior angles of the pronotum less prominent than in the preceding species, the anterior angle produced into a blunt tooth, back of this very gently crenulate. Tegmina elongate oval, the apex rounded. Wings complete, a trifle surpassing the apex of the pronotal process, which is smooth above instead of serrato-undulate as in the preceding species. Legs much the same as in the species with which it is being compared, possibly with the carinæ a trifle stronger and the teeth more pronounced. General color dark fuscous, with the apical half of the pronotum and hind femora tinged with ferruginous, the latter especially noticeably so.

Length of body, ♂, 8.5 mm.; of pronotum, 12.5 mm.; of hind femora, 5.35 mm.; length to tip of wings, 14.25 mm.; height of pronotal crest above humeri, 3 mm.

*Habitat*.—The type and only specimen of the present species comes from Para, Brazil, where it was taken during the month of July by H. H. Smith. The type is in the Carnegie Museum, Pittsburgh.

The three species of the present genus may be separated as follows:

- A. Median carina of the pronotum only gently compresso-elevated between the humeri; apical joint of the antennæ pallid; carinæ of anterior femora scarcely undulate. . . . . *turgida* Bolivar.
- AA. Median carina of the pronotum greatly compresso-elevated or foliaceous; carinæ of the anterior and middle femora undulate.
  - b. Crest of pronotum not reaching its anterior margin, not ascending abruptly in front but gradually, its height about equaling the width of dorsum between the base of the tegmina . . . . . *unicristata* Hancock.
  - bb. Crest of pronotum reaching its anterior margin and ascending abruptly in front, its height decidedly greater than the width of the dorsum between the base of the tegmina. . . . . *hancocki* sp. nov.

#### Genus CRIMISUS Bolivar.

*Crimisus* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 246. — HANCOCK, Genera Insectorum, fasc. 48, 1906, 40.

The two species of this genus, neither of which is represented in the material at hand for study, may be separated by the annexed table.

- A. Pronotum posteriorly lengthily subulate. . . . . *patruus* Bolivar.
- AA. Pronotum posteriorly acuminate, not produced beyond the apex of the hind femora . . . . . *contractus* Bolivar.

**Crimisus patruus** Bolivar.

*Crimisus patruus* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 246.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 40.

*Habitat*.—Upper Amazon.

**Crimisus contractus** Bolivar.

*Crimisus contractus* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 246.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 40.

*Habitat*.—Peru.

## SCLEROTETTIX gen. nov.

As noted in the synopsis of subfamilies and genera on preceding pages this genus falls between *Crimisus* and *Metrodora* in the subfamily *Metrodorina*. It is characterized by having the body but little depressed, of moderate robustness, and more or less strongly carinate and rugose, in being winged and also having the posterior extremity of the pronotum acuminate and more or less elongated to or beyond the extremity of the hind femora. The vertex does not extend so far and is about as wide as the shortest diameter of one of the moderately prominent eyes, depressed at middle and provided at sides with quite prominent carinæ which when viewed from in front appear as small horns. The frontal costa is roundly prominent between the antennæ, but less so above, the sides only moderately divergent, the sulcation fairly deep. The lateral or posterior ocelli are situated near the middle of the eyes, while the antennæ are attached just below a line connecting their lower edges. Tegmina and wings present, the former of moderate size, the latter shorter than (*abbreviatus*) or plainly longer than the elongate or subulate pronotum (the remainder of the species). Anterior and middle femora with prominent carinæ which are either entire or else more or less lobed. Hind femora of medium length, fairly robust and rather strongly nodose-rugulose and granulose, their superior carina quite strong and produced into one or two rather prominent pregenicular and an apical tooth. Hind tibiæ but gently enlarged apically, most numerous and strongly spined on the external margin, where the number varies from 7 to 12, the inner edge with no spines on the apical third, the number on other portion varying from 3 to 5.

The species *tibialis*, herewith characterized, may be considered the type of the genus. All of the known species are South American, and come from the tropical regions.

## SYNOPSIS OF THE SPECIES OF SCLEROTETTIX.

- A. Body rather strongly carinated and rugose; the disk of the pronotum more or less strongly depressed; median carina compresso-elevated in front, undulate and interrupted posteriorly; lateral carinæ very prominent.

- b.* Pronotum and wings abbreviated, little if any longer than the abdomen, the wings decidedly shorter than the pronotum. . . . . *abbreviatus* sp. nov.
- bb.* Pronotum long and slender, the wings fully developed and extending beyond the apex of the pronotum.
- c.* Lower posterior angles of the pronotum strongly turned outwards, somewhat rounded. Middle femora with the lower carina straight, the apical portion of the thigh provided with a strong, long tooth; upper carina of hind tibiæ strongly lobate. All the tibiæ decidedly annulated with fuscous. . . . . *tibialis* sp. nov.
- cc.* Lower posterior angles of the pronotum less strongly turned outwardly, decidedly rounded. Median femora with the lower carina somewhat undulate, the tooth on the apical portion of the thigh less prominent, the upper carina of middle tibiæ not lobate. Tibiæ less conspicuously annulate. . . . . *variegatus* sp. nov.
- AA.* Body less strongly carinated and rugose; the disk of the pronotum a little rounded; median carina for the most part rather faint, only slightly compresso-elevated anteriorly and not at all or but gently undulate posteriorly; lateral carinæ less prominent.
- b.* Larger (♀, 13 mm. to tip of wings). Lower carina of middle femora straight. General color fuscous . . . . . *infuscatus* sp. nov.
- bb.* Smaller (♀, 9.5 mm. to tip of wings). Lower carina of middle femora undulate. General color ferruginous. . . . . *minor* sp. nov.

The members of the present genus also resemble somewhat closely those of the genus *Otumba*, but differ from them in the much more strongly carinated and rugulose pronotum and the clypeate median femora.

***Sclerotettix abbreviatus* sp. nov.**

The present species is characterized by having the surface of the pronotum coarsely rugulose at its sides and on the disk, and by being depressed above between the tegmina. The median carina of the pronotum is compresso-elevated anteriorly and undulate and interrupted back of the transverse sulcus. The apex of the pronotum only reaches to the tips of the hind femora at most, while the wings are still more abbreviated. The lower carina of the middle femora is very prominent and strongly lobed, while the hind femora are robust and rugoso-nodulose.

General color very dark brownish ferruginous, more or less varied above and on the legs with paler mottlings and maculations, below brownish testaceous, the tibiæ and tarsi plainly fasciate with fuscous. In some specimens the disk of the pronotum shows traces of the typical triangular velvety black markings so frequently seen on members of this family of locusts.

Length of body, ♂, 7 mm., ♀, 8 mm.; of pronotum, ♂, 7 mm., ♀, 8.5 mm.; of hind femora, ♂, 4.35 mm., ♀, 5.2 mm.

*Habitat*.—Chapada, near Cuyaba, Matto Grosso, Brazil, collected during April and May. Collection Carnegie Museum, Pittsburgh.

In the character of the lobe formation of the lower carina of the middle femora the present species and *minor* are quite similar, as are the lower posterior angles of the pronotum, but the comparative smoothness and the development of the pronotal process and wings are quite unlike.

***Sclerotettix tibialis* sp. nov.**

This insect may be recognized at once from the other species of the genus by the very prominent lateral pronotal carinæ and the depressed disk which gives to the dorsum of the pronotum the appearance of being inclosed by a wall. The median carina of the pronotum back of its anterior end is rather inconspicuous, while the pronotal process and wings are slenderly extended greatly beyond the apex of the hind femora.

Vertex about as wide as one of the eyes, depressed or sulcate anteriorly, provided with a narrow but plainly visible median carina, advanced but little if at all ahead of the front edge of the eyes, the antero-lateral carinæ gently curved, the outer end abruptly bent backwards and extended to the middle of the inner margins of the eyes,—these when viewed from in front appearing as minute horns; frontal costa inconspicuous above, and but gently advanced beyond the front edge of the vertex, quite prominently and roundly produced between the antennæ; evenly and moderately divergent, the sulcus profound. Lateral ocelli fairly prominent, located between the middle of the anterior edge of the eyes. Antennæ attached just without a line drawn from between the lower margin of the eyes, slender, of moderate length. Palpi in nowise conspicuous either by color or enlarged or depressed apical joints. Occiput provided with two rugosities, the head inserted into the anterior edge of the pronotum nearly to the eyes. Pronotum with the surface of sides and disk decidedly rugose and carinated, strongly depressed back of the shoulders. Lateral carinæ widely interrupted by the transverse sulci, which are profound, nearly parallel in front of these, continuous around the humeral angles to the apex of the tegmina or a little beyond, arched over the elytra and terminating beyond their apices; just within and a trifle in advance of the apices of these arise the very prominent bordering carinæ of the lengthily drawn out process. Disk of the pronotum between the shoulders gently convex and transversely rugose, back of this depressed and furnished along the middle with three or four elongate nodules or rugæ representing the otherwise almost obliterated median carina;



elytral sinus deeply and acutely emarginate, the scapular area very marked; lower posterior angles quite strongly turned outwards, their apices subrotund. Upper carina of the anterior femora fairly prominent, scarcely undulate; the lower carina more prominent and gently lobate or clypeate; the carinæ of the middle femora very prominent, clypeate, the lower one evenly increasing in width apically, provided with a strong tooth just in advance of the knee. Posterior femora robust, irregularly strongly rugose, the carinæ robust, the upper edge provided with three rather large wart-like elevations; hind tibiæ adorned externally with 11-12 and internally with 7 strong spines.

General color dark fuscous somewhat varied with testaceous and ferruginous on the disk and apex of the pronotum. Tibiæ pallid, strongly annulated with fuscous.

Length of body, ♂ and ♀, 8.5 mm.; of pronotum, 11.5-12 mm.; of hind femora, ♂ and ♀, 6 mm.

*Habitat*.—Chapada, Brazil, May, August, and November. Carnegie Museum, Pittsburgh.

#### ***Sclerotettix variegatus* sp. nov.**

Very similar to the preceding, but differing from it in the comparatively smoother pronotum and legs, and the less depressed dorsum of the pronotum, which in the present species has the lateral carinæ lower and the median one faint but continuous even between the nodose undulations. It also differs from *tibialis* in lacking the lobiform superior carina on the middle tibiæ, while the lower posterior angles of the pronotum in *variegatus* are less strongly turned outwards and more rounded than in the species with which compared.

Length of body, ♂ and ♀, 7.5 mm.; of pronotum, 9.5-10 mm.; of hind femora, 5 mm.

*Habitat*.—Chapada, Brazil, April, July, and October, collected by H. H. Smith. Carnegie Museum, Pittsburgh.

This insect while approaching *tibialis* in color and general appearance has the lower carina of the middle femora somewhat narrower and less foliaceous and at the same time showing a tendency towards being undulate.

#### ***Sclerotettix infuscatus* sp. nov.**

Body and pronotum much smoother and with carinæ lower than in the three preceding forms, about the size of *variegatus* but having the two sexes

very noticeably different in size. General color dark fuscous, conspicuously varied with testaceous on the pronotum and legs.

Summit of head finely granulose, depressed between the rather prominent eyes, a trifle narrower than the width of one of them, narrowing gently toward the vertex and provided with a low but distinct median carina; vertex gently depressed, not quite reaching the front edge of the eyes, the antero-lateral carinæ somewhat obliterated near the middle, their posterior ends bent back and extending along the inner margin of the eyes to about their middle. Frontal costa continuous with the median carina of the summit of the head but very slender and depressed above the point where it branches, fairly prominent between the antennæ and when viewed laterally roundly arcuate, profoundly but narrowly sulcate, the walls thin. Posterior ocelli small, situated a little below the middle of the front edge of the eyes; antennæ inserted just below the level of the lower edges of the eyes, slender, short, composed of about twelve joints. Pronotum granulose and more or less rugose at sides and on the disk anteriorly, produced in a slender point that extends considerably beyond the apex of the hind femora, the disk anteriorly gently convex, posteriorly somewhat flattened but not depressed, the median carina only briefly prominent just back of the anterior edge, back of this slender, low, very gently undulate but continuous; lateral carinæ on the front lobe inconspicuous, short, gently convergent posteriorly, widely interrupted in advance of the humeral angle, the scapular area inconspicuous; the disk between the humeri provided with several inconspicuous elongate rugæ or carinæ. Anterior and middle femora rather strongly carinated and more or less lobate, the lower edge of the latter especially so, the carina very wide and lobate beyond its middle, the subapical tooth present but not nearly so prominent as in the species *tibialis*; tibiæ weakly lobate on superior carina; posterior femora fairly robust and somewhat rugose, the upper edge not especially nodulose, the superior carina terminating in a weak tooth just in advance of the knee; hind tibiæ but little enlarged apically, weakly spined, the outer margin bearing 5 or 6 and the inner one either 4 or 5; the first and third tarsal joints about equal in length. Valves of the ovipositor moderately robust, both the upper and lower quite strongly serrated.

Length of body, ♂, 6.5 mm., ♀, 8 mm.; of pronotum, ♂, 8.25 mm., ♀, 10.5 mm.; of hind femora, ♂, 4.5 mm., ♀, 5 mm.

*Habitat*.—Corumba and Chapada, near Cuyaba, Matto Grosso, Brazil,

the former during April and the latter in June. Carnegie Museum, Pittsburgh.

**Sclerotettix minor** sp. nov.

The present species is quite similar in its general structure to the preceding, but differs from it in being much smaller in size, in the much paler color, the more prominent median carina of the pronotum, the more decidedly lobate lower carina of the middle femora, and the smoother hind femora.

The general color of this insect is testaceo-ferruginous, relieved by a pair of triangular velvety black patches on the disk between the scapular areas. The thighs and tibiæ are also more or less varied by fuscous markings.

Length of body, ♂, 4.5 mm., ♀, 6.25 mm.; of pronotum, ♂, 7 mm., ♀, 8 mm.; of hind femora, ♂ and ♀, 4 mm.

*Habitat*.—The single pair at hand is from Chapada, Brazil, where they were collected during April and May by H. H. Smith. They are deposited in the Carnegie Museum, Pittsburgh.

Genus **METRODORA** Bolivar.

*Metrodora* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 247-248, *part.*—HANCOCK, Genera Insectorum, fasc. 48, 1906, 41.

This genus has been greatly restricted by Hancock (see Genera Insectorum, fasc. 48, p. 41, footnote). Other species have been referred to the genera *Otumba*, *Chiriquia*, and *Scabrotettix*.

**Metrodora rana** Bolivar.

*Metrodora rana* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 248.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 41.

*Habitat*.—Upper Amazon. Not contained in the Smith collection or other South American material submitted for study by the Carnegie Museum.

**Metradora lutosa** Bolivar.

*Metrodora lutosa* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 248.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 41.

*Habitat*.—Brazil. Not at hand to be included in the present report.

These two species of the genus *Metrodora* may be separated as follows:

- A. The median carina of the vertex only gently produced; the posterior femora unarmed above ..... *rana* Bolivar.  
 A.A. The median carina of the vertex greatly produced; the posterior femora denticulate above ..... *lutosa* Bolivar.

## Genus OTUMBA Morse.

*Otumba* MORSE, Biol. Centr.-Am., Orthopt., II, 1900, 7.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 43.

The genus *Otumba* belongs to tropical America and is composed of a number of species, only a few of which have thus far been characterized. The following table will assist in their determination:

## SYNOPSIS OF THE SPECIES OF OTUMBA.

- A. Pronotum not provided with accessory abbreviated carinæ between the shoulders.
- b. Posterior angles of the lateral lobes of the pronotum rectangulate, not at all acute; humero-apical carinæ very strongly expressed, leaving a deep groove between them and the lateral carinæ.....*scapularis* Morse.
- bb. Posterior angles of the lateral lobes of the pronotum acute.
- c. Lateral lobes having the posterior angles little dentate, produced outwards, lightly angularly excavate behind; humero-apical carinæ of dorsum enclosing narrow grooves; vertex nearly quadrate; face below the eyes and lower part of lateral lobes of pronotum light yellow.  
*dentata* Hancock.
- cc. Lateral lobes with the posterior angles acute produced; median carina of the vertex strongly produced; superior carina of the hind femora irregularly undulate.....*spinifrons* Stål.
- AA. Pronotum bearing accessory abbreviated carinæ on each side between the shoulders.
- b. Dorsum with the abbreviated and humero-apical carinæ between the shoulders moderately distinct; tegmina fuscous, with or without a large yellow oblique macula on the posterior half; posterior angles of the lateral lobes rectangulate acute.
- c. Tegmina immaculate; the supplemental carinæ on the disk of the pronotum short, with a second pair likewise short, forming the apices of decussate lines thus:  $\times$  .....*peruviana* Bruner.
- cc. Tegmina flavo-maculate; the supplemental carinæ on the disk of the pronotum arcuate, of moderate length.....*lobata* Hancock.
- bb. Dorsum with the abbreviated humero-apical carinæ between the shoulders strongly expressed; posterior angles of the lateral lobes of the pronotum flattened, subobtusely angulate.
- c. Dorsum of the pronotum opposite the apex of the tegmina profoundly depressed; the disk beyond without the supplemental longitudinal carinæ; tegmina brownish testaceous.....*basalis* sp. nov.
- cc. Dorsum of the pronotum opposite the apex of the tegmina gently depressed; the disk beyond provided on each side with prominent longitudinal carinæ; tegmina grayish, streaked below with fuscous.  
*marcapata* Hancock.

**Otumba scapularis** Morse.

*Otumba scapularis* MORSE, Biol. Centr.-Am., Orthopt., II, 1900, 7-8, fig.—  
HANCOCK, Genera Insectorum, fasc. 48, 1906, 44.

*Habitat*.—Recorded from Nicaragua only, but undoubtedly occurring throughout Costa Rica and Panama as well.

**Otumba dentata** Hancock.

*Otumba dentata* HANCOCK, Genera Insectorum, fasc. 48, 1906, 44.

*Habitat*.—Costa Rica, Central America, and quite likely extending farther southward into northern South America.

**Otumba spinifrons** (Stål).

*Tetrix spinifrons* STÅL, Freg. Eugen. Resa., Ins. Orthopt., 1860, 346.

*Tettix spinifrons* STÅL, Recens. Orthopt., I, 1883, 151.

*Metrodora spinifrons* BOLIVAR, Ann. Soc. Ent. Belg., XXI, 1887, 249.

*Otumba spinifrons* HANCOCK, Genera Insectorum, fasc. 48, 1906, 44.

*Habitat*.—Brazil. A single individual contained in the H. H. Smith collection from Santarem is referred here. Carnegie Museum, Pittsburgh.

**Otumba peruviana** Bruner.

*Otumba peruviana* BRUNER, MS.

This species was represented among other Acridids collected in Peru by Professor Nicholas Iconnicoff of the University of Moscow, Russia, and submitted to the author of the present paper for determination. The full description will appear shortly in some European publication. In the meanwhile it may be recognized by the characterization given in the accompanying synoptic table of the species of the genus.

*Habitat*.—A point about 50 miles south and east of Cerro de Pasco, Peru, at an elevation of 1,800 meters above sea level. Zoological Museum of the University of Moscow.

**Otumba lobata** Hancock.

*Otumba lobata* HANCOCK, MS., Genera Insectorum, fasc. 48, 1906, 44.

The following is Dr. Hancock's description of this insect:

"*Characters*.—♂; Body moderately small, granulose, color fusco-ferugineous, sides of pronotum and legs lighter, slightly clouded with fuscous, hind femora above yellow, below fuscous, the hind tibiæ dark with light annulation near the knees; elytra fuscous, the posterior half marked by large oblique yellow macula. Head little compresso-elevated; face oblique; vertex little narrower than one of the eyes, distinctly longer than

wide, the lateral margins very slightly convergent forward, frontal carinæ on either side rounded, little elevated and abbreviated, median carina very low and thin, little more conspicuous anteriorly, the front border advanced almost as far as the eyes, viewed in front concave; between the eyes on either side of the median carina of the vertex little longitudinally canaliculate; occiput declivous; frontal costa barely protuberant between the antennæ, thinly compressed above between the eyes, and narrowly sulcate, the rami little thickened and barely widened forward to the median ocellus. Eyes globose, little elevated above the dorsum of the pronotum; ocelli moderately conspicuous, and placed between the ventro-anterior fourth of the eyes; palpi slender, little depressed apically. Pronotum anteriorly truncate, posteriorly straight subulate, passing the femoral apices, dorsum distinctly flattened; median carina percurrent, lightly compressed, thin, but distinct; humeral angles obtuse carinated, distinctly compressed before the shoulders; humero-apical carinæ distinct, inclosing a moderately wide scapular area on each side; dorsum behind the shoulders between the carinæ subfossulate; the anterior carinæ situated behind the anterior margin distinct and subparallel; the principal median sulcus of the lateral lobes conspicuous; elytral sinus very small; the inferior sinus large and angularly incised; posterior angles of the lateral lobes outwardly flattened rectangulate, the lateral margins before the acute apices barely convex, behind obliquely truncate, the middle of the lobes indistinctly transversely carinated to apices. Tegmina elongate, acuminate forward; wings perfectly explicate, as long as the pronotal process. Femoral carinæ entire, little compressed; posterior femora moderately robust, genicular denticles indistinct, the antegenicular denticles very small; posterior tibial margins nearly straight, barely ampliate near the apices, and sparingly acute dentate; the first and third articles of the posterior tarsi equal in length, the first and second pulvilli small and acute, the third pulvillus nearly as long as the first and second united; and flat below."

"Total length 10 mm.; pronotum 9 mm.; posterior femora 4.7 mm."

"*Habitat*.—Demarara, British Guiana, South America. The type is in Professor Bruner's collection."

**Otumba basalis** sp. nov.

Most nearly related to *O. marcajata* Hancock in its general size and form but differing from it chiefly in being more closely and sharply granulose on the pronotum and in the absence of the short longitudinal carinæ

or rugæ which in the former species are so prominent on the disk of the pronotum back of the depressed area which lies above the tegmina.

General color uniformly dull wood-brown, the sides of abdomen, meso- and metasternum, the lower outer third of hind femora and the apex of tibiæ and apical half of last tarsal joints dull black.

Length of body, ♂, 7.5 mm.; of pronotum, 10.5 mm.; of hind femora, 5 mm.; to tip of pronotum and wings, 11.35 mm.

*Habitat*.—A single male specimen bearing the labels Para, July, collected by H. H. Smith. Carnegie Museum, Pittsburgh.

#### **Otumba marcapata** Hancock.

*Otumba marcapata* HANCOCK, *Genera Insectorum*, fasc. 48, 1906, 44.

*Habitat*.—Marcapata, Peru. In the present collection are a number of specimens from both Para and Chapada, Brazil. Other specimens of the species have been examined from near Cerro de Pasco, Peru. Carnegie Museum, Pittsburgh.

#### Genus TRIGONOFEMORA Hancock.

*Trigonofemora* HANCOCK, *Ent. News*, XVII, 1906, 89; *Genera Insectorum*, fasc. 48, 1906, 46.

#### **Trigonofemora fossulatus** Hancock.

*Trigonofemora fossulatus* HANCOCK, *Ent. News*, XVII, 1906, 89-90; *Genera Insectorum*, fasc. 48, 1906, 46, pl. 3, fig. 30.

*Habitat*.—Peru. Not represented in the material now being reported upon.

#### Genus SCABROTETTIX Hancock.

*Scabrotettix* HANCOCK, *Genera Insectorum*, fasc. 48, 1906, 46.

The known species of this genus, none of which are contained in the present collection, are all South American, and may be separated by the following table, modified from that given by Dr. Hancock (*loc. cit.*).

#### SYNOPSIS OF THE SPECIES OF SCABROTETTIX.

- A. Vertex much wider than one of the eyes; pronotum with the dorsum strongly scabrous, broadly depresso-fossulate behind the shoulders; median carina very low and thin, in profile distinctly unevenly sinuate.
- b. Posterior angles of the lateral lobes of pronotum very little flattened outwards. angulate. . . . . *scabrosus* Hancock,
- bb. Posterior angles of the lateral lobes of the pronotum acute.
- c. Smaller (♀, 15 mm.); lateral lobes of pronotum strongly and acutely produced outwards; wings reaching the apex of the pronotal process.
- magistralis* Brunner.

cc. Larger (♂, 16.5 mm.); lateral lobes of pronotum not greatly produced outwards, wings extending beyond the pronotal process.

*acutibolus* Hancock.

AA. Vertex subequal in width to one of the eyes; dorsum lightly scabrous, granulate.

b. Tegmina black marked with a median whitish macula; posterior angles of the lateral lobes of pronotum to a slight extent angulate. . . . . *amazonus* Bolivar.

bb. Tegmina plain ferruginous, immaculate; posterior angles of the lateral lobes of the pronotum flattened outwards, the apices a little rounded.

c. Wings not longer than the pronotal process. . . . . *bolivianus* Hancock.

cc. Wings longer than the pronotal process. . . . . *bolivianus extensus* Hancock.

### Scabrotettix scabrosus Hancock.

*Scabrotettix scabrosus* HANCOCK, Genera Insectorum, fasc. 48, 1906, 47.

*Habitat*.—Bolivia.

### Scabrotettix magistralis Brunner.

*Metrodora magistralis* BRUNNER V. WATTENWYL, Berl. Ent. Zeit., XIV, 1900, 254-255, pl. 3, fig. 1.

*Scabrotettix magistralis* HANCOCK, Genera Insectorum, fasc. 48, 1906, 47.

*Habitat*.—Colombia, South America.

### Scabrotettix acutibolus Hancock.

*Scabrotettix acutibolus* HANCOCK, Genera Insectorum, fasc. 48, 1906, 47, pl. 4, figs. 37, 37a.

*Habitat*.—Mapiri, Bolivia.

### Scabrotettix amazonus Bolivar.

*Metrodora amazona* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 249.

*Scabrotettix amazonus* HANCOCK, Genera Insectorum, fasc. 48, 1906, 47.

*Habitat*.—Upper Amazon; Ecuador.

### Scabrotettix bolivianus Hancock.

*Scabrotettix bolivianus* HANCOCK, Genera Insectorum, fasc. 48, 1906, 47.

*Habitat*.—Bolivia.

### Scabrotettix bolivianus extensus Hancock.

*Scabrotettix bolivianus extensus* HANCOCK, Genera Insectorum, fasc. 48, 1906, 47.

*Habitat*.—Mapiri, Bolivia.

### Genus ALLOTETTIX Hancock.

*Allotettix* HANCOCK, Ent. News, X, 1899, 276.—MORSE, Biol. Centr.-Am., Orthopt., II, 1900, 12.—HANCOCK, Tettig. N. Am., 1902, 126-127; Genera Insectorum, fasc. 48, 1906, 48.

The genus *Allotettix*, which is practically confined to South America and the extreme southern parts of North America, is composed of several



species of very long-winged slender insects. Five species have been recognized heretofore and two are now added. They may be separated by the subjoined table.

SYNOPSIS OF THE SPECIES OF ALLOTETTIX.

- A. Sides of frontal costa rather strongly divergent below. Posterior angles of lateral lobes of the pronotum angulate and directed gently outward. Tegmina unicolorous, fuscous. Maxillary palpi with outer joints strongly dilated. . . . . *fuscipennis* sp. nov.
- AA. Sides of frontal costa only gently divergent. Posterior angles of the lateral lobes of the pronotum turned down. Terminal joints of the maxillary palpi only gently dilated.
- b. Vertex decidedly narrower than one of the eyes. Pronotum lacking considerable of reaching the tips of the wings. . . . . *americanus* Hancock.
- bb. Vertex little, if at all, narrower than one of the eyes. Pronotum extending caudad nearly or quite as far as the greatly lengthened wings.
- c. Smaller (11-14.5 mm.).
- d. Middle femora with the carinæ not at all foliaceous or undulate, always fully three times or more as long as wide.
- e. Pronotum on disk back of the humeri concave. . . . . *peruvianus* Bolivar.
- ee. Pronotum on disk back of the humeri not concave. . . . . *chipmani* Bruner.
- dd. Middle femora with the carinæ somewhat foliaceous or undulate, sometimes little more than twice as long as wide.
- e. Middle femora undulate but not at all foliaceous, about three times as long as wide. . . . . *cayennensis* Bolivar.
- ee. Middle femora with the carinæ somewhat foliaceous, but a trifle more than once again as long as broad. . . . . *chapadensis* sp. nov.
- cc. Larger (16-17.5) . . . . . *prolongatus* Hancock.

**Allotettix fuscipennis** sp. nov.

A moderately large and comparatively robust species in which the vertex is nearly or quite as wide as one of the prominent eyes, and the posterior lateral edges of the pronotum are angulate and turned outward. General color brownish testaceous, the tegmina fuscous.

Head of moderate size; eyes large, prominent, subglobose, separated above by a space nearly or quite equal to the width of one of them; top of head granulose, depressed, provided at the middle with a fairly prominent longitudinal carina beginning at a point a little in advance of a line drawn between the back edge of the eyes and extending forward, uniting roundly with the upper end of the frontal costa; the latter not very prominent, viewed laterally roundly produced between the antennæ, profoundly sulcate and with the walls quite widely divergent below; vertex depressed, not advanced as far as the eyes, the lateral carinæ rather

prominent, arcuate, their outer end reaching backward to near the upper edge of the middle of the eyes. Antennæ arising decidedly below the eyes; the posterior ocelli between the lower edge of the eyes. Pronotum lengthily subulate and reaching the tips of the wings; anterior margin truncate, embracing the head nearly to the eyes; the surface granulose, somewhat uneven, the median carina plain throughout, slightly elevated between the humeri and again between the sulci; lateral carinæ prominent and arcuate in advance of the first sulcus, interrupted between the sulci, prominent at the rounded humeri and beyond. Legs moderately long and slender, the middle femora more than three times their greatest diameter, hind pair with the outer disc rugose; hind tibiæ almost destitute of spines, the first and third tarsal joints about equal in length. Antennæ approximately 13-jointed, coarsely filiform about reaching the middle of the tegmina. Latter of moderate size, oblong ovate.

General color uniformly dirty, pale brown or brownish testaceous, with piceous traces on sides of pronotum anteriorly. Tegmina uniformly fuscous. Hind femora faintly clouded with fuscous, while the anterior and middle tibiæ show faint traces of dusky annulation. Tips of antennæ only infuscated.

Length of body, ♂, 7.5-8 mm.; of pronotum, 11.5 mm.; to tip of wings, 12 mm.; of hind femora, 5.2 mm.

*Habitat*.—Three males, one from Para, in June, another from Chapada, near Cuyaba, Matto Grosso, the same month, and the third from Benevides, Brazil, taken in July. These presumably were all taken by H. H. Smith. Collection Carnegie Museum, Pittsburgh.

This insect does not quite agree with the present genus in some of its characters, nor does it seem to belong in *Scabrotettix*, to which it appears to be related also. The wide furcation of the frontal costa is unique for both genera, while the angulate, outwardly turned hind margins of the pronotum are not found in other species of *Allotettix*.

#### **Allotettix americanus** Hancock.

*Allotettix americanus* HANCOCK, Trans. Ent. Soc. Lond., 1907, 234.

*Habitat*.—Cachabi, Ecuador.

#### **Allotettix peruvianus** Bolivar.

*Paratettix peruvianus* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 272.

*Allotettix peruvianus* HANCOCK, Genera Insectorum, fasc. 48, 1906, 48, fig. 18.

*Habitat*.—This species is found from Costa Rica in North America through Panama into Colombia, Peru, Bolivia, and the extreme north-

western parts of Argentina. No specimens seem to be at hand among the H. H. Smith collection now being studied.

**Allotettix chipmani** Bruner.

*Allotettix chipmani* BRUNER, Journ. N. Y. Ent. Soc., XIV, 1906, 146.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 48.

*Habitat*.—Trinidad Island, West Indies and British Guiana, South America.

**Allotettix cayennensis** Bolivar.

*Paratettix cayennensis* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 273.

*Allotettix cayennensis* HANCOCK, Genera Insectorum, fasc. 48, 1906, 48.

*Habitat*.—Originally described from Cayenne, French Guiana. There are several specimens at hand which were taken at Santarem, Brazil. They were collected in the month of August. Carnegie Museum, Pittsburgh.

**Allotettix chapadensis** sp. nov.

This insect seems to be most closely related to *A. cayennensis* of Bolivar, from which it differs most notably in the form of the middle femora, which are somewhat clypeate or foliaceous in the present species.

Head small, the summit depressed, tricarinate, coarsely granulate; fastigium not advanced in front of the eyes, the lateral carinæ only moderately prominent, abruptly bent to the rear and following the inner edge of the eyes to their middle; frontal costa quite abruptly prominent between the antennæ, its sides rather widely divergent and profoundly sulcate; posterior ocelli situated just below the middle and the antennæ below the lower edge of the eyes. Pronotum lengthily caudate, the surface closely granulose and provided on the disk between the somewhat angulate humeri with a few irregular rugosities, the surface back of this and between the apical half of the tegmina gently depressed; median carina slender but prominent, anteriorly elevated between the transverse sulci, very low just in advance of the humeri, viewed laterally gently undulate; posterior lateral edges widely rounded and little turned out. Tegmina of moderate size, elongate oval, the surface rather evenly and coarsely punctate. Anterior femora normal, middle femora with the upper and lower carinæ somewhat clypeate, more or less undulate, not much more than twice as long as their extreme width; hind femora normal, the tibiæ irregularly spined, the first joint of the tarsi a little longer than the third.

General color dull fuscous, becoming a little paler at sides of pronotum,

in face and below. Lower edge of hind femora dark brown or dull black, the tibiæ plainly fasciate.

Length of body, ♂, 5.5 mm.; of pronotum, 10 mm.; to tip of wings, 11.25 mm.; of hind femora, 4 mm.

*Habitat*.—Chapada, near Cuyaba, Matto Grosso, Brazil, two male specimens, collected by H. H. Smith. Type in the Carnegie Museum, Pittsburgh.

**Allotettix prolongatus** Hancock.

*Allotettix prolongatus* HANCOCK, Ent. News, X, 1899, 276-277; Genera Insectorum, fasc. 48, 1906, 48.

*Habitat*.—Bolivia, S. America.

Genus MITRITETTIX Hancock.

*Mitraria* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 253.

*Mitritettix* HANCOCK, Genera Insectorum, fasc. 48, 1906, 57, footnote.

**Mitritettix productus** Bolivar.

*Mitraria producta* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 253.

*Mitritettix productus* HANCOCK, Genera Insectorum, fasc. 48, 1906, 51.

*Habitat*.—Upper Amazon. Not contained in the present collection.

Subfamily TETRIGINÆ.

Genus TEREDORUS Hancock.

*Teredorus* HANCOCK, Genera Insectorum, fasc. 48, 1906, 52-53.

**Teredorus stenofrons** Hancock.

*Teredorus stenofrons* HANCOCK, Genera Insectorum, fasc. 48, 1906, 53, pl. 4, fig. 42.

*Habitat*.—Pachitea, Peru. Not in the collection made by H. H. Smith and now being reported upon.

Genus CLYPEOTETTIX Hancock.

*Clypeotettix* HANCOCK, Tettig. N. Am., 1902, 124; Genera Insectorum, fasc. 48, 1906, 54.

**Clypeotettix schochi** (Bolivar).

*Paratettix schochii* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 274.

*Clypeotettix schochi* HANCOCK, Tettig. N. Am., 1902, 124-125, pl. 7, fig. 1; pl. 9, figs. 10, 11; Genera Insectorum, fasc. 48, 1906, 54, pl. 3, fig. 24.

*Habitat*.—Mexico, Central America and Venezuela in South America.

Genus PARATETTIX Bolivar.

*Paratettix* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 240.—MORSE, Biol. Centr.-Am., Orthopt., II, 1900, 11.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 55.

The genus *Paratettix* like *Tetrix* is a rather large one and the species are widely distributed over the earth's surface. Only a very few of them, however, are found in South America. These may be separated as follows:

- A. Body rather robust; pronotum not extending beyond the apex of hind femora.  
*borelli* Giglio-Tos.
- A.A. Body somewhat slender; the apex of the pronotum extended decidedly beyond the tips of the hind femora.
- b. Larger (♂, 7.5 mm., ♀, 11 mm.); the apex of pronotum not greatly extended beyond the apex of the hind femora and tip of abdomen. *simoni* Bolivar.
- bb. Smaller (♂, 6 mm., ♀, 8 mm.); the apex greatly surpassing the tip of the abdomen and apex of hind femora. . . . . *gracilis* Bruner.

#### *Paratettix borelli* Giglio-Tos.

*Paratettix borelli* GIGLIO-TOS, Boll. Mus. Zool. Anat. Comp. Torin., XII. no. 302, 1897, 28-29.—BRUNER, Locusts of Argentina, 1900, 16.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 56.

*Habitat*.—This species is common throughout Argentina, especially northward of Buenos Aires, and occurs also in Bolivia, Paraguay, and adjoining portions of Brazil. Individuals are at hand from Corumba and nearby localities. Some of these latter bear the label "highlands." Carnegie Museum, Pittsburgh.

#### *Paratettix simoni* Bolivar.

*Paratettix simoni* BOLIVAR, Ann. Soc. Ent. Fr., (6), X, 1900, 138-139.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 56.

*Habitat*.—Venezuela, Co'ony Tovar.

#### *Paratettix gracilis* (Bruner).

*Nephele gracilis* BRUNER, Locusts of Argentina, 1900, 15.

*Paratettix gracilis* HANCOCK, Genera Insectorum, fasc. 48, 1906, 57.

*Habitat*.—Paraguay, Argentina, Southwestern Brazil.

This insect approaches some of the species of the genus *Allotettix* in its general appearance, but has the posterior lateral angles of the pronotum turned down, as shown by an examination of typical specimens in the writer's collection.

#### Genus TETRIX Latreille.

*Tetrix* LATREILLE, Hist. Nat. Crust. Ins., III, 1802, 284, *part.*

*Acrydium* GEOFFROY, Hist. Ins., I, 1762, 390.—FABRICIUS, Syst. Ent., 1775, 278.—LEACH, Edinb. Encycl., IX, 1815, 120.

*Tetrix* FISCHER, Orthopt., Russ., 1846, 346, and others.

The species of this genus are both numerous and widely scattered over the world, but are confined for the most part to the regions north of the

equator. As now restricted only a single species of the genus, and it not quite typical, is found in South American territory.

***Tetrix gracilis* (Bruner).**

*Tetrix gracilis* BRUNER, Journ. N. Y. Ent. Soc., XIV, 1906, 145.

*Habitat.*—Island of Trinidad, West Indies. It very likely inhabits the mainland of South America in British Guiana as well.

This species seems to have been overlooked by Dr. J. L. Hancock in his write-up of the family for Genera Insectorum. He previously examined the type specimen and agreed that it was a member of the genus *Tetrix*, though not quite typical.

Genus **STENODORUS** Hancock.

*Stenodorus* HANCOCK, Ent. News, XVII, 1906, 90; Genera Insectorum, fasc. 48, 1906, 59-60.

Only a single species of the genus is known.

***Stenodorus extenuatus* Hancock.**

*Stenodorus extenuatus* HANCOCK, Ent. News, XVII, 1906, 91; Genera Insectorum, fasc. 48, 1906, 60, pl. 4, fig. 39.

*Habitat.*—Peru, South America.

Genus **MICRONOTUS** Hancock.

*Micronotus* HANCOCK, Tettig. N. Am., 1902, 97; Genera Insectorum, fasc. 48, 1906, 63.

This is a South American genus composed of several species. It is rather closely related to *Tetrix*, from which it differs as indicated in the synoptic table of subfamilies and genera on preceding pages of this paper. The subjoined table will assist in the recognition of the species:

SYNOPSIS OF THE SPECIES OF MICRONOTUS.

- A. Pronotum somewhat abbreviated posteriorly, the apex not passing the tips of the hind femora.
  - b. Median carina of the pronotum very prominent and quadriundulate, surface rugoso-granulate ..... *quadriundulata* Redtenbacher.
  - bb. Median carina of the pronotum less prominent and inconspicuously triundulate, the surface simply granulate..... *hancocki* sp. nov.
- AA. Pronotum elongated, its apex extending beyond the tips of the hind femora.
  - b. Form moderately robust, the carinae of the anterior femora strongly compresso-undulate; apex of the hind edge of the pronotum not greatly lengthened beyond the tips of hind femora; the third joint of the hind tarsi longer than the first and second combined..... *asperulus* Bolivar.

*bb.* Form more slender, the carina of the middle femora dentato-lobate; apex of the hind edge of the pronotum greatly lengthened beyond the tips of the hind femora; the first joint of the hind tarsi slightly longer than the others ..... *caudatus* Saussure.

**Micronotus quadriundulatus** (Redtenbacher).

*Tettix quadriundulatus* REDTENBACHER, Proc. Zool. Soc. Lond., 1892, 208-209, pl. 16, fig. 10.

*Micronotus quadriundulatus* HANCOCK, Tettig. N. Am., 1902, 98; Genera Insectorum, fasc. 48, 1906, 63.

*Habitat.*—Islands of Grenada, Haiti, Trinidad, and St. Vincent, West Indies.

**Micronotus hancocki** sp. nov.

About the same size and of the same general form as the preceding, from which it differs chiefly in having the body smoother, and in having less prominent and only three instead of four undulations in the median pronotal carina.

*Habitat.*—This species, or form, comes from the island of Trinidad.

**Micronotus asperulus** Bolivar.

*Tettix asperulus* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 260.

*Micronotus asperulus* HANCOCK, Genera Insectorum, fasc. 48, 1906, 63.

*Habitat.*—Aphiahy, Brazil. Not recognized among the material studied.

**Micronotus caudatus** (Saussure).

*Tettix caudatus* SAUSSURE, Rev. et Mag. Zool., 1861, 31.

*Paratettix caudatus* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 274-275.

*Micronotus caudatus* HANCOCK, Genera Insectorum, fasc. 48, 1906, 63.

*Habitat.*—This species appears to be rather widely distributed over tropical South America, since it has been reported from the island of Trinidad, the Guianas, various localities in Brazil, Paraguay, and Argentina.

Unless specimens in the Carnegie Museum that have been referred to *Allotettix* and described as *chapadensis* are really the present form the Smith collection does not contain any examples of *M. caudatus*.

Genus **APOTETTIX** Hancock.

*Apotettix* HANCOCK, Tettig. N. Am., 1902, 99-100; Genera Insectorum, fasc. 48, 1906, 64.

Representatives of the present genus occur in both North and South America. The two belonging to the latter country are separated as follows:

A. Vertex nearly twice the breadth of one of the eyes; dorsum of pronotum rugososcabrous, the posterior lateral angles subproduced, obliquely truncated.

*bruneri* Hancock.

AA. Vertex little wider than one of the eyes; dorsum of pronotum little rugosogranulate, lateral lobes little reflexed outward, the posterior angles distinctly rounded or obtuse . . . . . *proximus* Hancock

#### **Apotettix bruneri** Hancock.

*Apotettix bruneri* HANCOCK, in BRUNER, List Paraguayan Locusts, 1906, 614; Genera Insectorum, fasc. 48, 1906, 65.

*Habitat*.—Paraguay, South America.

#### **Apotettix proximus** Hancock.

*Apotettix proximus* HANCOCK, Trans. Ent. Soc. Lond., 11, 1907, 237-238.

*Habitat*.—Cachabi and Paramba, Ecuador. Not contained in the material before me.

#### Genus **PROTOTETTIX** Bolivar.

*Prototettix* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 255.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 65.

Representatives of this genus occur both in the Neotropical and Ethiopian regions. Two forms are known from South America. They are separated thus:

A. Tegmina minute, almost hidden beneath the pronotum, the median carina of the latter sinuate; anterior femora subfusiform, the middle one compressed and with their carinae undulately lobate. . . . . *fossulatus* Bolivar.

AA. Tegmina small but conspicuous, the median carina of the latter bisinuate; anterior femora compressed, their carinae undulato-lobate. . . *lobulatus* Stål.

#### **Prototettix fossulatus** Bolivar.

*Prototettix fossulatus* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 256.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 65.

*Tettix miserabilis* BLANCHARD, in GAY, Hist. fis. Chile, 1852, 85, pl. 3, fig. 10.

*Habitat*.—Ariahy, Brazil, and Chile. The present collection contains two specimens which are referred here, one of them ( $\sigma$ ) from "Rio" (in all probability Rio de Janeiro) in November, the other ( $\varphi$ ) from Chapada, taken in December. Carnegie Museum, Pittsburgh.

#### **Prototettix lobulatus** (Stål).

*Tettix lobulatus* STÅL, Freg. Ugen. Resa, Ins. Orth., 1860, 347.

*Tettix lobulatus* STÅL, Recens. Orthopt., I, 1873, 152.

*Prototettix lobulatus* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 256.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 65.



*Habitat*.—This insect has been recorded from both Argentina and Brazil. It is not represented in the present collections.

Subfamily *BATRACHIIDINÆ*.

Genus *TETTIGIDEA* Scudder.

*Tettigidea* SCUDDER, Bost. Journ. Nat. Hist., VIII, 1862, 476.—BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 299.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 67.

The genus *Tettigidea* is confined entirely to the Occident, where the species are distributed over the Neotropical, Sonoran, lower part of the Upper Sonoran, Austroriparian, Carolinian, and Transition regions. About two score of species are already recognized if the ten that are described as new in the present paper are included. These species are readily separated into two distinct groups by the construction of the anterior edge of the pronotum. They are also separable into an equal number of groups either by having the dorsum of the pronotum simply granulose or rugose, or by having its disk supplied with supplemental longitudinal carinæ. Since about one-half of the species belong to South America the annexed synoptical table has been prepared to show the relationship of all of them.

SYNOPSIS OF THE SPECIES OF *TETTIGIDEA*.

- A. Middle of the anterior margin of the pronotum at most angulate, but in nowise provided with a spine.
- b. Dorsum of pronotum furnished with prominent, or at least well-defined longitudinal supplemental carinæ.
- c. Tegmina more or less conspicuously marked apically with a pallid dash, band, or macula.
- d. Frontal costa very prominent and strongly visible from above.
- e. Vertex of the head but little advanced in front of the eyes.
- f. Larger (length of ♀ body 12 or more mm.). Anterior margin of the pronotum broadly rounded.
- g. Form somewhat slender, the wings and pronotal process extending plainly beyond the tips of the hind femora.
- h. Rugulæ of the pronotum fairly prominent and quite regular (U. S., southeasterly) . . . . . *lateralis* Say.
- hh. Rugulæ of the pronotum faint, short, and irregular (southern Mexico) . . . . . *plagiata* Morse.
- gg. Form more robust, the pronotum and wings abbreviated (U. S., east of the great plains) . . . . . *polymorpha* Scudder.
- ff. Smaller (length of the ♀ body 9.5–10 mm.). Wings fully developed (southern Mexico) . . . . . *parvula* Morse.
- ee. Vertex of the head rather strongly advanced in front of the eyes. Front margin of the pronotum obtusangulate (U. S. and Canada, east of the plains) . . . *parvipennis* Harris, *parvipennis pennata* Morse, and *medialis* Hancock.

- dd.* Frontal costa less prominent and not at all conspicuous when viewed from above.
- e.* Disk of the pronotum furnished with two or more well-defined supplemental carinæ on each side of the middle.
- f.* Apex of the pronotum and wings scarcely reaching to the tips of the hind femora (North Carolina and Georgia) . . . . . *prorsa* Scudder.
- ff.* Apex of the pronotum extending beyond the tips of the hind femora (Georgia) . . . . . *prorsa elongata* Morse.
- cc.* Disk of the pronotum provided with but a single inconspicuous carina on each side parallel with the humeral angles.
- f.* Pronotal process little, if any, longer than the abdomen, scarcely reaching the hind femora; the wings somewhat abbreviated (Mexican Plateau, southward) . . . . . *chichimeca* Saussure.
- ff.* Pronotal process subulate, surpassing the apex of the hind femora; wings fully developed and exceeding the pronotum in length (Cuernavaca, Morelos, Mexico) . . . *chichimeca australis* Hancock.
- cc.* Tegmina unicolorous, immaculate apically.
- d.* Size medium, the body robust, with abbreviated pronotal process and wings.
- e.* Disk of the pronotum granular and provided on each side with at least two well-marked supplemental carinæ. Top of the head depressed and without a pair of supplemental carinæ that parallel the median (Ciudad, Mexico) . . . . . *tecta* Morse.
- ee.* Disk of the pronotum rugoso-glabrous and provided on each side with but a single inconspicuous supplemental carina. Top of the head a little convex and provided on each side of the middle with a strong longitudinal carina that is both heavier and longer than the median (Chapada, Brazil) . . . . . *annulipes* sp. nov.
- dd.* Size small (♀, 8 mm.). Pronotum and wings surpassing the hind femora (Upper Amazon) . . . . . *scudderi* Bolivar.
- bb.* Dorsum of the pronotum simply granulose or rugose, not provided with well-defined supplemental, longitudinal carinæ.
- c.* Size of insects variable, but usually rather large. Tegmina marked at or near the apex with an oblique line or band.
- d.* Median carina of the pronotum alternately pallid and fuscous. The dorsum somewhat rugose.
- e.* Pronotum and wings abbreviated. General color brownish testaceous. Median carina of pronotum somewhat undulate (southern Mexico).  
*bruneri* Morse.
- ee.* Pronotum and wings variable. Color also variable.
- f.* Size moderately small (♀, 10 mm.). Color pale gray. Pronotum extending a little beyond the apex of the hind femora (Guatemala) . . . . . *guatemalica* Bolivar.
- ff.* Size larger (♀, 12-14 mm.). Color chiefly fuscous.
- g.* Legs ferrugino-testaceous quite conspicuously annulated with fuscous.

- h. Pronotum and wings lengthily subulate, extending well beyond the tips of the hind femora (Nicaragua). . . . . *nicaraguas* Bruner.
- hh. Pronotum and wings abbreviated, not quite reaching to the apex of the hind femora (Costa Rica).  
*nicaraguas brevis* Hancock.
- gg. Legs pale throughout, not annulate with fuscous (Jalapa, Mexico).  
*jalapa* Hancock.
- dd. Median carina of the pronotum unicolorous, fuscous; the dorsum finely granulose. Tegmina and wings more or less strongly abbreviated.
- e. Form robust; face, venter and apical two or three segments of the male abdomen pallid (Guerrero, Mexico). . . . . *nigra* Morse.
- ee. Form moderately slender; face and abdomen of female at least concolorous, fuscous (Island of Trinidad, West Indies).  
*imperfecta* Bruner.
- AA. Middle of anterior margin of the pronotum both angulate and provided with a prominent anteriorly projecting spine.
- b. Dorsum of the pronotum granulose or scabrous, scarcely rugose, without any well-defined supplemental longitudinal carinæ.<sup>1</sup>
- c. Pronotum and wings more or less strongly abbreviated, scarcely reaching the apex of the abdomen.
- d. Body and disk of the pronotum finely granulose, scarcely rugose.
- e. Antennæ of normal length.
- f. Size large (length of ♀ body 17.5 mm.) (Eastern slopes of Peruvian Andes) . . . . . *cuspidata* Scudder.
- ff. Size smaller (length of ♀ body 12.8 mm.) (Paramba, Ecuador).  
*planus* Hancock.
- ee. Antennæ excessively long and slender, fully as long as or longer than the hind femora (Para and Chapada, Brazil) . . . . . *gracilicornis* sp. nov.
- dd. Body and disk of the pronotum rather strongly granulose or even rugulose, the rugæ gathering into more or less well-defined longitudinal ridges, but in nowise giving the impression of supplemental longitudinal carinæ (Georgia and Florida). . . . . *spicata* Morse.
- cc. Pronotum and wings fully developed and extending beyond the apex of the ovipositor or even well beyond the apex of the hind femora.
- d. Surface of the pronotum scabrous, the apex of the pronotal process not quite reaching the tips of the hind femora (British Guiana).  
*pulchella* Rehn.
- dd. Surface of the pronotum at most coarsely granulose, some of the granules on the disk gathered into short irregular longitudinal rows.
- e. Anterior lateral carinæ of pronotum parallel (Chapada, Brazil).  
*chapadensis* sp. nov.
- ee. Anterior lateral carinæ of the pronotum distinctly convergent posteriorly (Island of Trinidad, West Indies). . . . . *trinitatis* Bruner.

<sup>1</sup>The *Tetrix purpurascens* Serville may possibly be a *Tettigidea* and belong to this section. (See Hancock, Genera Insectorum, fasc. 48, 1906, 69.)

- bb. Dorsum of the pronotum more or less strongly granulose or rugose and provided on either side of the disk with one or more well-defined supplementary carinae.
- c. Tegmina maculate (North American).
- d. Disk of the pronotum smoothly granulated, the sides provided with weak but well-defined supplemental carinae. Vertex but little advanced in front of the eyes (New York).....*acuta* Morse.
- dd. Disk of the pronotum coarsely and distinctly rugulose.
- e. Vertex considerably advanced in front of the eyes as in *T. prorsa* Scudder, rather wide. Pronotum granulose between the shoulders (Florida and Louisiana).....*apiculata* Morse.
- cc. Vertex but little advanced in front of the eyes. The pronotum strongly rugose throughout.
- f. Pronotum and wings complete, surpassing the tips of the hind femora (southeastern U. S. east of the Mississippi)....*armata* Morse.
- ff. Pronotum and wings abbreviated, the former not quite reaching the tips of the hind femora (same locality as preceding).  
*armata depressa* Morse.
- cc. Tegmina immaculate [South America].
- d. Pronotal process always lengthily subulate, the wings fully developed.
- e. Disk of the pronotum quite strongly longitudinally rugose as well as provided with supplemental longitudinal carinae. Upper end of the frontal carina prominent, the median sulcus of the top of the head profound (Corumba, Brazil).....*hancocki* sp. nov.
- ee. Disk of the pronotum coarsely granulose, the supplemental carinae variable. Upper end of the frontal carina inconspicuous, the median sulcus of the top of the head only moderately excavated.
- f. Supplemental longitudinal dorsal carinae not very marked, the general form of the insects quite similar in appearance to *T. lateralis*.
- g. Median carina of pronotum not at all arched in advance of the humeri; the frontal costa sulcate but little above the lateral ocelli (Chapada, Brazil).....*australis* sp. nov.
- gg. Median carina of the pronotum arched in advance of the humeri. the frontal costa sulcate almost to its summit (Chapada).  
*intermedia* sp. nov.
- ff. Supplemental carinae of the pronotum very marked. General form of insect rather slender (Chapada, Brazil).....*costalis* sp. nov.
- dd. Pronotal process nearly always much abbreviated, not extending beyond the apex of the hind femora; wings seldom complete.
- e. Dorsum of the pronotum only gently rounded, never tectate, the median carina straight (Chapada, Brazil).....*subaptera* sp. nov.
- ee. Dorsum of pronotum more or less strongly tectate, the median carina prominent and arcuate.
- f. Median carina of the pronotum very prominent and strongly arcuate, the dorsum strongly tectate. Wings sometimes complete (Chapada, Brazil).....*arcuata* sp. nov.
- ff. Median carina of the pronotum less prominent and arcuate. Wings always abbreviated.

- g. Smaller (♀, 11-12 mm. in length); the supplemental, longitudinal carinæ visible but inconspicuous (Bolivia, Paraguay, Argentina, and southwestern Brazil) . . . . . *multicostata* Bolivar.  
 gg. Larger (♀, 15-16 mm. in length); the supplemental carinæ very conspicuous (Chapada, Brazil) . . . . . *corrugata* sp. nov.

***Tettigidea annulipes* sp. nov.**

Very similar in size and general form to *T. subaptera*, which is described on a succeeding page, but differing from it in being a little more robust, in having the anterior edge of the pronotum spineless and in having the entire surface glabrous or more or less varnished in appearance, although the disk of the pronotum is quite strongly rugose instead of granulose as in *subaptera*. Wings abbreviated or wanting. Vertex reminding one of that of the North American *T. prorsa* Scudder.

Head high and narrow, the front somewhat oblique; top of head between the eyes with prominent longitudinal rugæ and deep sulcus; the vertex strongly projecting in front of the eyes, the lateral oblique carinæ partially obliterated or low next to the eyes; frontal costa prominent, coarse, not very deeply but narrowly sulcate, viewed in profile broadly rounded. Pronotum short, subangulate in front, without the spine so commonly found in the South American species of the genus, subtectate anteriorly, the median carina coarse and prominent, viewed laterally arcuate between the shoulders and front edge; rather strongly rugose at sides and on the disk and on the latter between the shoulders tending to form a longitudinal carina on each side midway between the median and lateral carinæ; apex blunt, reaching to the base of the supra-anal plate, which is long and acuminate, the basal half formed of two leaf-like lobes, cerci long, rather heavy, and adorned with a number of long stiff hairs; valves of the ovipositor long and slender, strongly serrated. Hind femora robust, smooth, reaching the tips of the ovipositor. Two outer joints of the maxillary palpi broadly dilated and sulcate externally.

General color above and on the sides of abdomen piceous, all the legs (including hind femora) prominently fasciate with dull testaceous; lower side pallid, apical joints of palpi dirty white. Tegmina fuscous, unicolorous.

Length of body, ♀, 12 mm.; of pronotum, 8.75; of hind femora, 7 mm.

*Habitat*.—A single female specimen, the type, is before me. It was collected by H. H. Smith during the month of May at Chapada, near Cuyaba Matto Grosso, Brazil. Carnegie Museum, Pittsburgh.

There is also a single male among the large number of specimens of

*Tettigidea* taken at or near Chapada which I was at first inclined to place here. It differs from the female, however, in the less advanced vertex, the less prominent frontal costa and in having the pronotum both spined in front and strongly attenuate behind.

***Tettigidea scudderi* Bolivar.**

*Tettigidea scudderi* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 299.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 68.

*Habitat.*—Upper Amazon. Not contained in the collection made by H. H. Smith.

***Tettigidea nicaraguæ brevis* Hancock.**

*Tettigidea nicaraguæ brevis* HANCOCK, Tettig. N. Am., 1906, 158.

*Habitat.*—This form of *T. nicaraguæ* occurs on the Atlantic side of Costa Rica, where it is fairly common in suitable localities. It may continue southward into the adjoining parts of South America.

Other species of the genus are evidently to be met with in the same general region, because the present collection indicates that the genus is equally common in both continents, where its representatives are distributed throughout the tropical and warmer parts of the temperate zones.

***Tettigidea imperfecta* Bruner.**

*Tettigidea imperfecta* BRUNER, Journ. N. Y. Ent. Soc., XIV, 1906, 147.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 68.

*Habitat.*—Island of Trinidad, off the coast of Venezuela, South America.

***Tettigidea cuspidata* Scudder.**

*Tettigidea cuspidata* SCUDDER, Proc. Bost. Soc. Nat. Hist., XVII, 1874-1875, 31-32.—BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 296.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 68.

*Habitat.*—Peruvian Andes, South America.

***Tettigidea planus* Hancock.**

*Tettigidea planus* HANCOCK, Trans. Ent. Soc. Lond., Sept., 1907, 243-244.

*Habitat.*—This species has been reported but once. It comes from Paramba, Ecuador, and tends to show that representatives of the genus are to be found across the South American continent from the Andes to the Atlantic.

***Tettigidea gracilicornis* sp. nov.**

Comparatively robust with abbreviated pronotum and wings, but with very long and slender antennæ. A species above the medium in size and approaching *Batrachidea* in the vertex and pronotal structures.

Head with the summit comparatively plane and depressed below the prominent subglobular eyes, the surface sparsely granulose, only about two-thirds the width of one of the eyes; the vertex not advanced in front of the eyes and with the lateral carinæ abbreviated and inconspicuous; frontal costa rather profoundly sulcate nearly to the very top, the upper end of the costa not following the median sulcus of the summit of the head towards the occiput. Antennæ long and slender, nearly or quite as long as the hind femora. Pronotum finely granulate, only gently tectate, the median carina slender but quite prominent, viewed laterally gently undulate a trifle ascending just before the front edge, which is angulated at middle and terminates in an acute downwardly curved spine; the apex or hind border bluntly acuminate, not quite reaching the tip of the abdomen in either sex. Tegmina small, oblong, wings very abbreviate or entirely wanting. Hind femora rather robust and passing the tip of the abdomen in both sexes.

Dark mahogany brown above, in some specimens with darker mottlings on the carinæ and disk of pronotum. Face, cheeks, and lower lateral edges of pronotum obliquely testaceous. Pleura, sides of abdomen and hind femora both interiorly and exteriorly fuscous varied with irregular paler markings, the tibiæ and tarsi annulate. Tegmina of males and some of the females provided near the apex with a small testaceous or flavous circular spot. Underside of male abdomen dirty white, the pectus marked as in *T. hancocki*, in the female the meso- and metasternum black.

Length of body, ♂, 7.5 mm., ♀, 10 mm.; of pronotum, ♂, 6.5 mm., ♀, 8.5 mm.; of hind femora, ♂, 5.25 mm., ♀, 7.5 mm.

*Habitat*.—Para and Rio de Janeiro, Brazil, during September. Also at Chapada during the months of March, April, August, and November. Both sexes taken by H. H. Smith. Carnegie Museum, Pittsburgh.

Possibly this insect should be referred to the genus *Batrachidea*, in which case it would come closest to the species *B. mucronata* of Serville, which has the pronotum much longer and in some instances has the wings even exceeding the pronotum in length.

#### *Tettigidea pulchella* Rehn.

*Tettigidea pulchella* REHN, Proc. Acad. Nat. Sci. Phila., 1904, 669.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 68.

*Habitat*.—British Guiana.

*Tettigidea chapadensis* sp. nov.

A medium sized, rather slender; dark-colored insect, in which the pronotum is destitute of supplemental carinæ and extends considerably beyond the apex of the abdomen and tip of hind femora in both sexes. Tegmina provided with an oblique subapical flavous patch.

Head small, rather deeply sunken into the front edge of the pronotum, the vertex a little advanced beyond the eyes. the transverse carinæ blunt and inconspicuous: frontal costa fairly prominent and profoundly sulcate nearly to the upper extremity, viewed laterally broadly and evenly rounded to the ocellus. Antennæ slender, of moderate length, situated just within a line drawn from the lower edge of the eyes. Top of head between the eyes but gently undulate, only slightly granulated. Pronotum long and slender, anteriorly angulate and provided with a slender spine that reaches to the middle of the upper edge of the fairly prominent eyes; disk finely granulate and furnished with irregular, fine rugæ and lines which are inclined to run lengthwise, especially on its widest part; the median carina is slender, straight, and most prominent anteriorly; lateral carinæ in front also slender, reaching the transverse sulcus, beyond the interruption nearly as prominent as the median. Legs slender, the hind femora extending beyond the tip of the abdomen in both sexes. Tegmina moderately large, elongate oval or sub-spatulate, rather smooth; wings fully developed and extending considerably beyond the tip of the pronotum in both sexes.

General color above brownish, fuscous, or black, very seldom dull ferruginous; below pallid, anterior and middle femora pallid, the tibiæ and sometimes the hind femora of the females maculate with testaceous: face. lower part of cheeks, lower edges of pronotum obliquely, base of hind femora, the tibiæ, and under side generally flavous or dull testaceous. Sides of abdomen also more or less vittate with pallid. The paler colored females, and occasionally the darker ones, show a tendency towards having the hind femora marked externally with a rather large pallid patch.

Length of body, ♂, 6.35 mm., ♀, 10 mm.; of pronotum, ♂, 9 mm., ♀, 11 mm.; of hind femora, ♂, 5 mm., ♀, 7 mm.

*Habitat*.—Chapada, near Cuyaba, Matto Grosso, Brazil, and also Corumba and Para, Brazil. Collected at various times from September to April by H. H. Smith. Carnegie Museum, Pittsburgh.

The species is represented by several specimens of both sexes. As may be observed by a reference to the accompanying synoptical table of



the species of the genus this insect is related to both *pulchella* Rehn and *trinitatis* Bruner.

***Tettigidea trinitatis* Bruner.**

*Tettigidea trinitatis* BRUNER, Journ. N. Y. Ent. Soc., XIV, 1906, 147.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 68.

*Habitat*.—Island of Trinidad.

If the *Tetrix purpurascens* of Serville (Ann. Soc. Nat., XX, p. 291) proves to be a *Tettigidea* it will be found to closely resemble the present species, if it is not the same. It too comes from Trinidad.

***Tettigidea hancocki* sp. nov.**

A large but slender insect with small head, coarsely rugose but glabrous spicate and longly attenuate pronotum and slender hind femora, reminding one at first glance of *Tettigidea lateralis* Say, and its near allies of North America.

Head of moderate size, the eyes rather prominent, vertex somewhat but angulately advanced in front of the eyes, the occipital carinæ or rugæ uniting with the oblique prominent lateral carinæ of the front which reach the eyes; frontal costa broad, not prominent, the upper extremity nearly filling the longitudinal sulcus of the head between the eyes, sulcate from a point a little above the ocelli; outer joints of the palpi gently spatulate, not strongly or noticeably sulcate. Pronotum attenuate and uncinatè, the dorsum gently rounded, rugose, the median carina coarse but not prominent, in no part arcuate, the prominent rugæ tending to form one or two longitudinal ridges on each side between and for some distance back of the humeri. Hind femora adorned above and on outer face with comparatively few but prominent smooth elevations. Hind tarsi long and slender, the third joint noticeably longer than the first. Wings greatly surpassing the tips of the hind femora and the apex of the pronotum.

General color of the pronotum above brownish testaceous, at the sides piccous; sides of abdomen, pleura and most of pectus fuscous, the latter provided in the center and laterally with raised, roughened, leaf-like testaceous patches. Legs without definite traces of annulation or maculation, the abdomen and femora below and the tibie becoming paler.

Length of body, ♂, 10.25 mm.; of pronotum, 11.5 mm.; to tip of wings, 15 mm., of hind femora, 6 mm.

*Habitat*.—Corumba, Brazil, on highlands, a single male, collected in March by H. H. Smith. Carnegie Museum, Pittsburgh.

**Tettigidea australis** sp. nov.

A small species with attenuate pronotum in which the dorsum of this portion is coarsely granulate and shows definite traces of longitudinal supplemental carinae both in front and between the humeri, formed chiefly by the alignment of some of the granulations.

Head nearly normal, or possibly a trifle high, the front somewhat oblique; eyes large, a little prominent; the top of the head only moderately deeply sulcate and furnished with blunt longitudinal rugae, the vertex slightly advanced in front of the eyes, the lateral carinae strong and gently arcuate, almost touching the upper carina of frontal costa; the latter not prominent, profoundly sulcate and continued above nearly to a point opposite the middle of the eyes; antennae located just within a line drawn between the lower edges of the eyes. Pronotum moderately slender, its anterior edge angulate and spined at middle, the posterior portion reaching the tips of the hind femora. Tegmina small, the disk sparsely granulose, the granules arranged into irregular rows. Hind thighs somewhat robust, the carinae strong but the general surface not especially rough.

General color brownish testaceous above, at the sides varied with piceous and fuscous; face, cheeks, lower lateral edges of the pronotum, and underside dull testaceous; tegmina immaculate, fuscous; hind femora and sides of abdomen fuscous somewhat mottled and varied with testaceous, anterior and middle legs very faintly annulate.

Length of body, ♂, 7 mm.; of pronotum, 8 mm.; of hind femora, 4.6 mm.; total length to tip of wings, 9.85 mm.

*Habitat*.—Chapada, near Cuyaba, Matto Grosso, Brazil, a single male, collected by H. H. Smith during the month of April. Carnegie Museum, Pittsburgh.

Only for the presence of the spine on the anterior edge of the pronotum this insect would remind one strongly of a diminutive *T. lateralis* and a couple of its North American allies.

**Tettigidea intermedia** sp. nov.

Slightly below the medium in size and somewhat closely related to *chapadensis*, from which it differs most markedly in the glossy and more robust form, the more nearly equal size of the sexes, and the different structure of the summit of the head, the vertex and frontal costa.

Head normal, the summit depressed a little below the eyes, the sulcus and longitudinal rugae inconspicuous, the latter granulose; the vertex

gently and roundly advanced in front of the eyes, the oblique carinæ blunt; frontal costa only moderately prominent, slender and low above, widening below, the narrow sulcation beginning midway between the summit and ocelli with the walls coarse, whereas in *chapadensis* the rather broad sulcation begins near the summit, and has the walls fine. Pronotum rather broad, roundly arched transversely between the shoulders; the anterior edge angulate, spined, hind edge wedge-shaped, reaching the tip of the abdomen; median carina rather prominent and a little arcuate in front, straight or gently undulate behind, the surface both rugose and granulose with indications of accessory carinæ on the disk; sides of pronotum in advance of the humeri with glabrous patches. Hind femora robust, the pinnæ regular.

General color brownish ferrugineous varied with fuscous and piceous above, on the sides piceous or fuscous, the males darker with paler face; cheeks and lower lateral anterior edges of pronotum testaceous. Hind femora mottled with testaceous; anterior and middle legs dimly annulate with fuscous. Underside testaceous. Tegmina immaculate, but with the lower edge a little pallid.

Length of body, ♂, 8.25 mm., ♀, 11 mm.; of pronotum, ♂, 7 mm., ♀, 9.35 mm.; to tip of wings, ♂, 11 mm., ♀, 12.5 mm.; of hind femora, ♂, 5.2 mm., ♀, 6.5 mm.

*Habitat*.—One male and two female specimens collected from April to November by H. H. Smith. Chapada, near Cuyaba, Matto Grosso, Brazil. Carnegie Museum, Pittsburgh.

#### ***Tettigidea costalis* sp. nov.**

About the size and form of *T. lateralis* of middle North America, but at once separable from it by the presence of a spine on the anterior margin of the pronotum above, by the narrower and less projecting vertex, by the deeper and coarser median longitudinal sulcus and prominent granulated ridges on top of the head, by the less coarse and less prominent frontal costa and the more ampliate terminal joint of the palpi. *T. costalis* may also be known by the more prominent supplemental longitudinal carinæ of the pronotum, which are only two in number on each side, straight, parallel, continuing to a point almost opposite the middle of the hind femora. The tegmina of *costalis* are somewhat smaller and less definitely marked than in *lateralis* and its North American allies, while the spines on the hind tibiæ are smaller and fewer in number.

The general color of the only specimen at hand is dull brownish testa-

ceous with a trace of piceous along the sides immediately below the lateral carinae of the pronotum. The hind femora also show traces of darker mottlings, while the anterior and middle tibiae are faintly fasciate. The face, cheeks and lower anterior edges of the pronotum are not especially pallid as in the same sex of *lateralis*.

Length of body, ♂, 8.5 mm.; of pronotum, 10.5 mm.; to tip of wings, 12.25 mm.; of hind femora, 5.85 mm.

*Habitat*.—A single male, taken by H. H. Smith at Chapada, Brazil, in September. Carnegie Museum, Pittsburgh.

#### ***Tettigidea subaptera* sp. nov.**

An insect below the medium in size and with abbreviated pronotum and wings, reminding one at first sight of some of the short-winged North American species. Anterior edge of the pronotum angulate and uncinata at tip, the disk provided with longitudinal supplementary carinae. Hind femora comparatively robust and short. Head and body somewhat coarsely granulated.

Head rather small, deeply set into the front edge of the pronotum, the vertex gently advanced beyond the eyes, rounded or subangulate, the sides well carinated and the top of the head provided with deep, coarse longitudinal sulci and rounded ridges that reach from the pronotum to the carina of front edge; frontal costa prominent, viewed laterally widely bowed between the antennae, narrowly sulcate, the walls coarse and granulated internally. Antennae short, situated on a level with the lower edge of the prominent eyes. Pronotum in both sexes not quite reaching the apex of the abdomen, median carina coarse and somewhat prominent but not arcuate, the lateral carinae also prominent but interrupted for a short distance back of the first transverse groove, the supplemental carinae of the disk, two or three on each side, not much broken. Tegmina immaculate, of medium size, the lower edge broadly rounded and comparatively smooth; wings usually rudimentary, in no case reaching the tip of the pronotum. Hind femora robust, comparatively smooth, extending nearly or quite one-third of their length beyond the apex of the abdomen.

General color variable above, in some specimens pale testaceous varied with fuscous, in others nearly uniformly dark fuscous, below testaceous. Males with the face and lower cheeks as well as the under side and lower edge of femora pale testaceous; the tibiae and tarsi and sometimes the femora of both sexes fasciate or blotched with the pale shades. Outer joints of the palpi very broad, dirty white.

Length of body, ♂, 7.5 mm., ♀, 9 mm.; of pronotum, ♂, 6 mm., ♀ 8.5 mm.; of hind femora, ♂, 4.65 mm., ♀, 7 mm.

*Habitat*.—Chapada, Brazil, a number of specimens of both sexes, collected by H. H. Smith from April to July. Carnegie Museum, Pittsburgh.

***Tettigidea arcuata* sp. nov.**

A moderately robust insect, a little above the medium in size and with the apex of the tectate pronotum just about reaching the tips of the hind femora in the typical form.

Median carina very prominent, evenly arcuate and accompanied by two or three well-defined supplemental carinæ on each side of the disk. Body and legs granulose, the surface for the most part glabrous. The sexes not greatly differing in size.

Head large, considerably higher than wide, deeply set into the front edge of the pronotum; vertex very slightly advanced beyond the eyes, the lateral carinæ well-defined, a little coarse; the occiput or summit of the head profoundly grooved and ridged; frontal costa very prominent, deeply but narrowly sulcate, continued caudad above to a point midway between the eyes; antennæ short and coarse, situated on a line with the lower edge of the eyes, the latter of fair size but not prominent. Pronotum tectate anteriorly, variable in length but usually reaching the tip of the hind femora in both sexes, its anterior edge angulate and advanced upon the occiput, where its apex terminates in a short but acuminate tooth that nearly reaches the posterior limitation of the frontal costa; lateral carinæ in front interrupted by the first transverse sulcus but insensibly merging with the outer one of the supplemental or discal series, which latter extend to opposite the apex of the tegmina; the latter rather large, broadly rounded below, carinated above, immaculate but with the lower margin paler than the disk and upper area. Legs robust, especially the femora, the hind pair of which are nearly two-fifths as broad in their widest place as long, the pinnae of outer disk distinct and regular but not prominent. Wings in the typical form considerably surpassing the apex of the pronotum, in the brachypterous form sometimes only half as long.

General color above varying from pale brownish testaceous to fuscous and in some specimens showing mottlings of light and dark tints on the pronotum and hind femora. Lower side paler but not so apparent as in the males of several other species, as for example *subaptera*, *chapadensis*, and *pulchella*. Tibiæ and tarsi of anterior and middle legs usually conspicuously annulated with testaceous and fuscous.

Length of body, ♂, 9.5 mm., ♀, 12 mm.; of pronotum, ♂, 9 mm., ♀, 11.5 mm.; of hind femora, ♂, 6 mm., ♀, 7 mm.; length to tip of wings, ♂, 12.5 mm., ♀, 14.75 mm.

*Habitat*.—A considerable series of both sexes taken at Chapada, Brazil, during the months of April, May and June, H. H. Smith collector. Carnegie Museum, Pittsburgh.

#### ***Tettigidea multicostata* Bolivar.**

*Tettigidea multicostata* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 299.—BRUNER, Locusts of Argentina, 1900, 17; Proc. U. S. Nat. Mus., XXX, 1906, 616.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 68.

*Habitat*.—Brazil, Paraguay, Bolivia, and northern Argentina. Corumba, Brazil, and Paraguay. Carnegie Museum, Pittsburgh.

While this insect is quite widely distributed over several South American countries it does not appear to vary much in pronotal length or size. On the other hand it is quite markedly variable in the prominence of the supplemental longitudinal carinæ of the disk of the pronotum and in its coloration.

#### ***Tettigidea corrugata* sp. nov.**

A large, robust species with coarse hind femora and abbreviated pronotum and wings in which there are present on the disk of the former a number of supplemental, longitudinal carinæ, and where the median carina is very prominent, coarse, and evenly arcuate.

Head very deeply sunken into the front edge of the pronotum, the occiput being completely hidden by the strongly angulate anterior portion of its dorsum; eyes rather small, not prominent; vertex well advanced in front of the eyes, the lateral or transverse carinæ coarse and prominent; frontal costa also coarse and prominent, narrowly sulcate but with heavy lateral walls, originating above opposite the middle of the eyes in a fairly deep sulcus between two coarse longitudinal granulated ridges. Antennæ filiform, of moderate length. Pronotum abbreviated tectate, granulose, the median carina prominent, coarse, arcuate, lateral carinæ scarcely interrupted, sinuose in advance of the shoulders, the disk provided with rather prominent supplemental carinæ which are present even in advance of the transverse sulci; anterior edge forming nearly a right angle and ending in a prominent spine that projects slightly beyond the upper part of the frontal costa. Hind femora robust, rugose, extending a trifle beyond the tip of the ovipositor, the valves of which are rather long and slender. Tegmina small, elongate, unicolorous.

General color brownish testaceous obscurely varied with darker blotches, especially above and on the hind femora. Anterior and middle tibiæ obscurely annulate.

Length of body, ♀, 15.5 mm.; of pronotum, 13 mm.; of hind femora, 9.5 mm.

*Habitat*—Three females, Chapada, Matto Grosso, Brazil, October to January, H. H. Smith collector. Carnegie Museum, Pittsburgh.

This insect is very similar to *multicostata* Bolivar from the same locality, but much larger and coarser.

#### LOPHOTETTIX gen. nov.

Related to *Tetrix* in the form of the vertex and to *Tettigidea* in having the anterior femora plainly sulcate above. It differs from the former in the elongate antennæ, the presence on the pronotum above of several strongly developed uninterrupted supplemental carinæ, and in the elongate, robust, but comparatively smooth hind femora, and from the latter as described in the synoptic table on page 92.

Head of moderate size, wider below than above; the eyes not prominent, subglobular, separated above by a gently depressed space about equal to the diameter of one of them; the vertex subangulate, advanced somewhat in front of the eyes, the lateral carinæ strong; top of the head between the eyes broadly and shallowly longitudinally canaliculate at the sides, the surface decidedly granulose. Frontal costa moderately prominent, above and between the antennæ, narrowly sulcate nearly to the upper extremity. Posterior ocelli situated between the middle of the eyes. Antennæ long, filiform, composed of about 20 joints, located between the lower extremity of the eyes or a trifle below them. Pronotum elongate, rounded, not angulate at the shoulders or sides: the anterior edge angulately produced upon the occiput; transverse sulci scarcely apparent, the posterior extremity attenuate. Tegmina oblong, their apex rounded. Wings fully developed, reaching the tip of the pronotum or beyond. Legs smooth, the anterior and middle ones in nowise clypeate but plainly sulcate above; the hind femora robust, elongate, smooth. First and third joints of hind tarsi subequal, the first possibly a trifle the shorter; hind tibiæ somewhat dilated apically, the spines well defined.

#### *Lophotettix lineatus* sp. nov.

Entire insect quite closely and finely granulose. The dorsum of the pronotum provided on each side of the disk with two or three longitudinal

supplemental carinæ, as found in several species of the nearly related genus *Tettigidea* coming from the same general region. Anterior to the transverse sulci only a single one of these supplemental carinæ is present, while between the humeri two and sometimes even a third are found. Lower posterior angles somewhat acute and turned down.

General color variable, ranging from dull testaceous to dark fuscous or dull black, the sides or deflexed lobes of the pronotum obliquely pallid, the femora and tibiæ together with the tarsi strongly fasciate with testaceous and fuscous. Tegmina usually unicolorous but in some specimens marked apically with a minute smooth pallid spot. Under surface of the body pale testaceous or dirty yellowish white.

Length of body, ♀, 7.75–8.25 mm.; of pronotum, 9.75 mm.; to tip of wings, 11 mm.; of hind femora, 5.25 mm.

*Habitat*.—Chapada, Brazil, four female specimens taken by H. H. Smith during the months of April, May, and June. The type is in the Carnegie Museum, Pittsburgh.

#### LOPHOSCIRTUS gen. nov.

Related to both *Tettigidea* and *Batrachidea*, from which genera its members differ chiefly in the characters of the vertex and frontal costa. General form slender.

Top of head gently depressed, usually as wide as or a little wider than the diameter of one of the not very prominent eyes; the vertex viewed laterally considerably advanced beyond the anterior margin of the eyes, from above broadly rounded, its middle somewhat emarginate, the antero-lateral carinæ prominent, continued to and bent to the rear along the inner edges of the eyes; median carina very prominent and high, forming an arcuate crown in continuation with the prominent frontal costa, the latter narrowly but deeply sulcate to its very summit. Antennæ short, 15- or 16-jointed, located between the middle of the lower half of the eyes; lateral ocelli small and situated just above the middle of the eyes. Maxillary palpi with the two terminal joints greatly flattened and enlarged,—pallid and therefore very prominent. Pronotum elongate, narrow, the anterior margin angulate and extending forward upon the occiput at middle, where it terminates in a strong spine; lateral carinæ very prominent in advance of the transverse sulcus, median carina also quite prominent throughout, the dorsum furnished with a series of continuous supplementary carinæ. Tegmina of moderate size, elongate, narrow. Anterior and middle femora slender, plainly sulcate, their carinæ in no wise undulate or clypeate; hind femora also slender, comparatively smooth, the upper carina ter-



minating in a pregenicular tooth, the apex at center also provided with a prominent tooth; hind tibiæ somewhat enlarged apically, provided with about six moderately strong spines externally and seven internally; first joint of the hind tarsi as long as the second and third combined. Valves of the ovipositor acuminate, very long and straight, the upper ones moderately heavy, serrate above; the lower pair much shorter and slenderer, their inferior margin nearly smooth.

**Lophoscirtus gracilis** Bruner.

*Tettigidea gracilis* BRUNER, Locusts of Argentina, 1900, 17; Proc. U. S. Nat. Mus., XXX, 1906, 616.

*Habitat*.—The only specimen of this species known to the writer, the type, was collected on a river steamer near the borders of Paraguay. It is in his collection.

Genus **PLECTRONOTUS** Morse.

*Plectronotus* MORSE, Biol. Centr.-Am., Orthopt., II, 1900, 14.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 69.

While we have no reference of any representative of this genus having been discovered in South American territory it is quite as likely to occur there as in Costa Rica, from which country the only described species is known.

**Plectronotus scaber** Morse.

*Plectronotus scaber* MORSE, Biol. Centr.-Am., Orthopt., II, 1900, 14, fig.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 69.

*Habitat*.—So far only reported from Costa Rica, Central America.

**APTEROPEDON** gen. nov.

Related to both *Batrachidea* and *Tettigidea*, but falling in that section of Hancock's synoptic table of genera "With the frontal costa very narrowly sulcate" 7. (10), although the body is quite large and robust.

Body entirely apterous. the posterior sinus of the lateral lobes of the pronotum wanting. Head large, set into the front edge of the pronotum to the eyes and covered above by the prominent and angulate front edge of the pronotum, the spine of which extends forward nearly or quite as far as the front edge of the fairly prominent eyes. Vertex a little wider than one of the eyes, provided at the sides with inconspicuous indications of carinæ; the median carina present only as a starting point for the fairly prominent frontal costa, which is narrowly but deeply sulcate. Ocelli opposite the middle of the eyes; the antennæ, which are long and slender, inserted barely below their lower edge, and composed of 17 or 18 joints,

the apical 5 or 6 of which are pallid. Posterior femora large and coarse, projecting slightly beyond the tip of the abdomen. Hind tibiæ heavily spined. Valves of the ovipositor slender and quite conspicuously toothed.

**Apteropedon apicale** sp. nov.

Quite uniformly fuliginous save at the edges posteriorly and the apex of the pronotum, where it fades into ferruginous, the venter testaceous, as are the tips of the antennæ. Pronotum rugosely granulate, its median carina very prominent subcristate and evenly arched anteriorly. The lateral carinæ nearly continuous, slender and beaded. First and third joints of hind tarsi about equal in length.

Length of body, ♀, 15 mm.; of pronotum, 13 mm.; of hind femora, 9.35 mm.; of antennæ, 6.25 mm.

*Habitat*.—Two females, Rio de Janeiro, October. Carnegie Museum, Pittsburgh.

Genus **SCARIA** Bolivar.

*Scaria* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 301.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 69.

The genus *Scaria* appears to be confined to the extreme southern parts of North America and to the South American continent, where it is represented by at least four distinct species. These may be separated by the following synoptic table:

- A. Apex of elytra flavo-maculate.
  - b. Sides striated with black ..... *hamata* De Geer.
  - bb. Sides not striated with black ..... *producta* Hancock.
- AA. Tegmina not flavo-maculate.
  - b. Dorsum of pronotum furnished with a pallid median line; length of body, ♂ ♀, 8-10 mm. .... *lineata* Bolivar.
  - bb. Dorsum of pronotum at middle ornamented with an oblong ferruginous macula; length of body, ♂ ♀, 9-11.5 mm. .... *maculata* Giglio-Tos.

**Scaria hamata** (De Geer).

*Acrydium hamatum* DE GEER, Mem., III, 1773, 503, 22, pl. 42, fig. 13.

*Tettix hamatus* STÅL. Recens. Orthopt., I, 1873, 146.

*Scaria hamata* BOLIVAR, Ann. Soc. Ent. Belg. XXXI, 1887, 301.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 69.

*Habitat*.—Guiana, Upper Amazon, Nicaragua, etc. Not among the material now being studied.

**Scaria producta** Hancock.

*Scaria producta* HANCOCK, Genera Insectorum, fasc. 48, 1906, 70.

*Habitat*.—Peru, S. America, Para and Santarem. Collection Carnegie Museum, Pittsburgh.

**Scaria lineata** Bolivar.

*Scaria lineata* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 302.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 69.

*Habitat*.—Upper Amazon.

Not contained in the Carnegie Museum collection now being reported upon.

**Scaria maculata** Giglio-Tos.

*Scaria maculata* GIGLIO-TOS, Boll. Mus. Zool. Anat. Comp. Torin, XIII, no. 311, 1898, 35-36.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 70.

*Habitat*.—Ecuador.

Genus **BATRACHIDEA** Serville.

*Batrachidea* SERVILLE, Hist. Nat. Ins. Orthopt., 1839, 764.—BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 126.—Not the genus *Batrachidea* as meant by Scudder, Thomas, or Saussure.

This is a South American genus that extends northward to the West Indies and possibly also into the southern portions of Central America. Only three species have thus far been described. They may be separated as follows:

- A. Tegmina never with more than a minute or indistinct subapical pallid spot, sometimes entirely fuscous . . . . . *mucronata* Serville.
- AA. Tegmina provided with a large and very distinct subapical macula.
  - b. The macula or tegmina large, rotund, flavous. . . . . *flavo-notata* Bolivar.
  - bb. The macula on tegmina oval, ivory-white. . . . . *notata* Hancock.

**Batrachidea mucronata** Serville.

*Tetrix (Batrachidea) mucronata* SERVILLE, Hist. Ins. Orthopt., 1839, 764.

*Tetrix mucronata* SERVILLE, Encycl. Méth., X, 1839, 600.

*Acridium (Tetrix) mucronatum* DE HAAN, Bjdrag. tot de Kennis Orthopt., 1842, 166.

*Batrachidea mucronata* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 300.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 70.

*Habitat*.—Brazil, Peru. Carnegie Museum, Pittsburgh.

In the present collection there are four specimens which are referred here with some doubt, since the frontal costa is decidedly widely furcillate instead of narrowly so, as described in the generic diagnosis given by Hancock in his Genera Insectorum article. Aside from this character, however, it is a typical *Batrachidea*. These specimens come from Chapada, Brazil, where they were taken during August and October. Both sexes are represented.

**Batrachidea flavo-notata** Bolivar.

*Batrachidea flavo-notata* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 300.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 70.

*Habitat*.—New Granada, Colombia.

Not contained in the present collection.

#### **Batrachidea notata** Hancock.

*Batrachidea notata* HANCOCK, in BRUNER, Proc. U. S. Nat. Mus., XXX, 1906, 616-617.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 70.

*Habitat*.—Sapucay, Paraguay.

There are two females at hand that were collected, the one in Paraguay and the other at Chapada, near Cuyaba, Matto Grosso, Brazil. The former was taken in December and the latter in July. They both have the wings considerably longer than the pronotal process, which itself passes the apex of the hind femora nearly two millimeters. Carnegie Museum, Pittsburgh.

#### Genus **PAUROTARSUS** Hancock.

*Paurotarsus* HANCOCK, Psyche, IX, 1900, 42; Genera Insectorum, fasc. 48, 1906, 70-71.

The genus *Paurotarsus* so far as at present known is confined to tropical South America and the adjoining island of Trinidad. Only two species have been described. The subjoined table will separate them.

- |     |   |                          |
|-----|---|--------------------------|
| A.  | Carinæ of the frontal costa very heavy, almost obliterating the otherwise moderately wide sulcus; dorsum of the pronotum anteriorly gently arcuate (Brazil).....              | <i>amazonus</i> Hancock. |
| AA. | Carinæ of the frontal costa only moderately heavy, leaving the sulcus fairly wide; dorsum of the pronotum anteriorly strongly arcuate (island of Trinidad, West Indies) ..... | <i>rugosus</i> Bruner.   |

#### **Paurotarsus amazonus** Hancock.

*Paurotarsus amazonus* HANCOCK, Psyche, IX, 1900, 42-43, figs. 1a-1d; Genera Insectorum, fasc. 48, 1906, 71, fig. 26.

*Habitat*.—Amazon, South America.

The H. H. Smith collection contains specimens of what I take to be this species. They were taken at Para and Santarem, Brazil. Those from the former locality were captured during the month of July. Carnegie Museum, Pittsburgh.

#### **Paurotarsus rugosus** Bruner.

*Paurotarsus rugosus* BRUNER, Journ. N. Y. Ent. Soc. XIV, 1906, 148.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 71.

*Habitat*.—The types (♂ and ♀), which are in the writer's collection, come from the island of Trinidad.

## Genus PUIGGARIA Bolivar.

*Puiggaria* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 301-302.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 71-72.

This is a South American genus related to *Batrachidea*, *Scaria*, etc., and contains only a single tropical species.

***Puiggaria antennata* Bolivar.**

*Puiggaria antennata* BOLIVAR, Ann. Soc. Ent. Belg., XXXI, 1887, 302-303, pl. 2, figs. 26, 26a-26b.—HANCOCK, Genera Insectorum, fasc. 48, 1906, 72, fig. 27.

*Habitat*.—Aphiahy, Brazil.

This insect is not contained in the collection being reported upon, unless the four specimens referred to as doubtfully belonging to *Batrachidea mucronata* (Serville) are the present species. Should this latter surmise prove correct, then the genus *Puiggaria* must precede *Paurotarsus* and the diagnosis changed so as to include perfectly developed winged forms as well as those with these organs greatly abbreviated.



A PRELIMINARY LIST OF THE FAUNA OF THE  
ALLEGHENY AND CONEMAUGH SERIES IN  
WESTERN PENNSYLVANIA.

BY PERCY E. RAYMOND.

ALLEGHENY SERIES, VANPORT LIMESTONE.

In the Allegheny series there is, so far as is now known, only one horizon at which marine fossils may be obtained. The Vanport is usually a limestone, although in places it is replaced by a fossiliferous shale. The thickness varies from 1 to 25 feet and the base is usually about 250 feet below the top of the Allegheny series. This limestone is very persistent west of the Chestnut Ridge and north of the latitude of Pittsburgh. Fossils are abundant at nearly all exposures but good specimens can be obtained only where there are shaly layers. Collections have been made at Rochester, Beaver Falls, Wampum, New Castle, Kittanning, and Roaring Run, and the commoner species are listed in the accompanying table.

While there has not yet been enough collecting done to determine accurately the range of the various species in the Pennsylvanian, it is probable that the commoner species have been noted. So far the following common species have not been seen at any horizon higher than the Vanport:

<i>Fusulinella</i> sp.,	<i>Astartella varica</i> ,
<i>Cyathaxonia distorta</i> ,	<i>Pleurotomaria spironema</i> ,
<i>Campophyllum torquium</i> ,	<i>Euconispira bicarinata</i> ,
<i>Chonetes mesolobus</i> ,	<i>Naticopsis torta</i> ,
<i>Productus nanus</i> ,	<i>Naticopsis altonensis</i> ,
<i>Spirifer rockymontanus</i> ,	<i>Strophostylus remex</i> ,
<i>Squamularia perplexa</i> ,	<i>Porcellia peoriensis</i> ,
<i>Dielasma bovidens</i> ,	<i>Trachydomia wheeleri</i> .
<i>Composita girtyi</i> ,	

Of these species, *Spirifer rockymontanus*, *Chonetes mesolobus*, and *Squamularia perplexa* are known to occur in the Mercer limestones of western Pennsylvania, so they can not be called strictly characteristic of the Vanport. Just what species are restricted to the Vanport will not be known until the fauna of the limestones in the Pottsville is further studied.

Enough is at hand, however, to indicate that the fauna of the Vanport is much more like that of the Pottsville than it is like the fauna found in the various marine deposits of the Conemaugh.

#### CONEMAUGH SERIES, BRUSH CREEK LIMESTONE.

Marine fossils are found at a number of horizons in the Conemaugh. In West Virginia there is a shale with a marine fauna at the base of the series, but so far as the writer knows this shale does not occur in Pennsylvania. In this State the oldest marine fauna is found in the Brush Creek, about 100 feet above the base of the series and 350 feet above the Vanport. The Brush Creek consists of both limestone and shale, the limestone usually thin and impure, the shale fine grained and black. Fossils are abundant, and, in the shale, well preserved. This formation has an even greater extent than the Vanport, as it is found from the Allegheny Front to the western border of the State, and has been recognized in Maryland, West Virginia, and Ohio.

Fossils have been collected from the Brush Creek at Bens Creek, Donohoe, Blackburn, West Apollo, Wittmer, and Allegheny. and the commoner species so far as identified are listed in the table. The locality at Bens Creek is of some historical interest, as the type locality of the first fossils described from the Coal Measures is only a few hundred yards east from that station. These first fossils, described by Conrad in 1835, are *Turbo tabulata* (*Worthenia tabulata*), *Stylifer primogenia* (*Sphaerodoma primogenia*), and *Turbo insectus*, a shell similar to, if not the same as *Pleurotomaria carbonaria*. The locality was described by Edward Miller in the Transactions of the Geological Society of Pennsylvania, Vol. I, 1835, page 251. He wrote: "The most interesting specimens found in this quarter are in a deep cutting at the head of inclined plane No. 3 [of the old Portage Railroad]. A stratum of good coal [Gallitzin] two feet thick is found at this place, having a roof of black shale four feet thick, upon which is an unstratified bed of argillaceous rock containing a great variety of shells and other marine remains."

The fossiliferous layer is not at present exposed, as the soft shales above it have crumbled down and covered it, but several loose fragments mingled with the talus show that fossils may still be obtained there. The type of *Petalodus alleghaniensis* (*P. ohioensis* Safford), described by Leidy in 1856, was also obtained at this locality.

In the fauna of the Brush Creek the mollusca predominate, the gastropoda being especially abundant. Only one common species, *Worthenia*



*tabulata*, seems to be confined to this stratum, but it is generally abundant and has been found at every locality at which the writer has seen the Brush Creek. In this connection it is interesting to note that the original specimens of this species came from this formation at Bens Creek. As will be seen in the table giving the range of the species, there are several other shells which have so far been found only at this horizon, but they are mostly rare forms, and so are not particularly useful in identifying the horizon. Mention may be made of *Bucanopsis marcouana*, which is quite common, but this shell is probably not confined to this horizon. *Cyrtoceras curtum* seems to be restricted to this layer, and though not common, it has been found at a number of localities. The great abundance of *Bellerophon percarinatus*, *Bucanopsis marcouana*, *Patellostium montfortianum*, *Euphemus carbonarius*, *Euomphalus catilloides*, *Astartella vera*, and the presence of *Worthenia tabulata* are the characteristics which usually serve to identify this formation. It will be noted that the smooth-shelled nautiloid of this stratum is a *Solenocheilus*, while the similar shell in the Vanport is an *Endobolus*, and the robust *Sphærodomæ* take the place of the fusiform *Solenisci* of the lower formation. *Marginifera wabashensis*, *Chonetes granulifer*, and *Ambocælia planoconvexa*, three species which are very common at higher horizons, make their first appearance here. Altogether there is a very great change of fauna between the Vanport and the Brush Creek.

Dr. Martin evidently found this same fauna in the Brush Creek of Maryland, as is shown by the list of the fossils obtained by him at a locality one mile north of Selbysport, Garrett County. This list, which is published on page 280 of Vol. II of the West Virginia Geological Survey, contains the characteristic species, *Worthenia tabulata*, and several of the other species which are common in the Brush Creek in Pennsylvania. The only unexpected species is *Chonetes mesolobus*, which we have not yet found above the Vanport in this State.

#### PINE CREEK LIMESTONE.

From 60 to 90 feet above the Brush Creek is another fossiliferous layer of somewhat wide distribution. While fossils are often abundant in the Pine Creek, the writer has so far found only a few localities where good specimens can be obtained, the best collecting places being at Wittmer, Powers Run, Woods Run, and Stoops Ferry, all within a few miles of Pittsburgh.

While there are a few species which appear to be restricted to this



formation it has no such characteristic species as the Brush Creek and Vanport have. In almost every locality at which fossils have been collected from this layer nautiloids have been found to be numerous, but not well preserved. The fauna is more like that of the Brush Creek than that of the Ames, but lacks the abundance of *Orthenia tubulata* and *Astartella vera* of the one and *Chonetes granulifer* and *Tainoceras occidentale* of the other.

#### WOODS RUN LIMESTONE.

In a note in Science (n. s., Vol. XXIX, 1909, 940) the writer announced the presence in the section at Pittsburgh of a previously unnoticed marine limestone between the Pine Creek and the Ames. To this limestone the name Woods Run may be applied, as it is best exposed on Woods Run within the city of Allegheny. Since the note mentioned was published the writer has found this layer at Sharpsburg on the Allegheny River, near Boston on the Youghiogheny, and at McKees Rocks. A few fossils are rather common in this layer but the number of species is small. *Lophophyllum profundum* is the commonest and often the only species found.

#### AMPHIBIA AND REPTILIA.

In the red clay which always underlies the Ames in western Pennsylvania the writer found the following species in 1907. The locality is beside the highway one mile west of Pitcairn, Pa.

<i>Desmatodon hollandi</i> Case,	<i>Naosaurus? raymondi</i> Case,
<i>Eryops</i> sp.,	Undetermined reptilian bones.

Nearly all the specimens were found imbedded about 30 feet below the Ames limestone. The bones are all small and belonged to many different individuals. They were evidently washed into the position they occupied when found. The layer from which they were taken is near the base of the red clay at a place where this clay is unusually thick, that is, they were in one of the basins in the eroded land surface on which this clay was deposited.

#### AMES LIMESTONE.

About 125 feet above the Pine Creek and 300 feet above the base of the Conemaugh is the Ames, one of the most persistent and most fossiliferous of the marine limestones. Fossils are everywhere abundant in this stratum, but it is only under favorable conditions that any variety of species can be obtained. In almost all the localities where this limestone is seen it is a mass of specimens of *Chonetes granulifer*, *Ambocœlia planoconvexa* and *Derbya crassa*, while other fossils are not apt to be seen unless the rock is considerably disintegrated.

Fossils have been collected from the Ames at Summerhill, Blairsville Intersection, Beatty, Pitcairn, and at a number of localities within the limits of the city of Pittsburgh.

The characteristics of the Ames are the abundance of *Chonetes granulifer*, *Ambocalia planoconvexa*, and *Derbya crassa*, and the presence of *Pugnax utah*, *Rhipidomella pecosi*, and *Tainoceras occidentale*. *Pugnax utah* and *Rhipidomella pecosi* seem to be restricted to this horizon, and *Tainoceras occidentale* makes its first appearance here. Fish teeth are fairly common, *Petalodus ohioensis* being the most abundant species. Brachiopods are very numerous in the Ames, just as the mollusca predominate in the Pine Creek and Brush Creek. Brachiopods are also very abundant in the Vanport, but the two limestones have only a few species in common.

There are very few published lists of the fossils of the Ames limestone. A classical one is that identified by Meek from fossils collected by Stevenson at Morgantown, West Virginia. This list<sup>1</sup> shows that the fauna at Morgantown is similar to that in Pennsylvania. In the Report on Ohio, Brooke, and Hancock Counties of West Virginia is a list of the fossils collected by Professor Grimsley from the Ames in those counties. The specimens were identified by Dr. Beede, and the species are those which are common in the Ames in Pennsylvania. In commenting on this fauna Dr. Beede discussed the probable position of the Ames in relation to the section in Kansas. While noting that most of the species listed are those which have a long range in the Pennsylvanian of that State, he is inclined to place the Ames at about the horizon of the Oread limestones, or as he says: "From the evidence at hand I should refer the Ames limestone roughly to the Shawnee division of the Kansas Pennsylvanian, as that division is limited by Haworth, or the basal part of the Shawnee."

Mr. D. Dale Condit has recently published a short list of the fossils of the Ames limestone at Carpenter, Meigs County, Ohio. This list shows that the fauna of the Ames in southern Ohio is very similar to that found in western Pennsylvania. Mr. Condit notes that *Chonetes granulifer* is so abundant as to form almost solid masses in the Ames, but is not found in the Cambridge, while *Chonetes verneuili* is extremely abundant in the Cambridge and is not found in the Ames. In Pennsylvania *C. verneuili* has not yet been found in the Ames, while it does occur in the

<sup>1</sup>Third Annual Report Board of Regents of West Virginia University, 1870, 67. Reprinted in West Virginia Geological Survey, Vol. II, 1903, 257, and in the County Reports of the same Survey, 1907, 127.

Pine Creek and Brush Creek. On the other hand, *C. granulifer* does occur, though sparingly, in the Brush Creek,<sup>2</sup>

#### BIRMINGHAM SHALE.

Thirty feet above the Ames is the base of the Birmingham, a shale which is usually from 35 to 50 feet thick. It has recently been discovered that this shale contains marine fossils.<sup>3</sup> At the base of the formation is a coal which in the region west of Pittsburgh is usually identified as the Elk Lick, though the Elk Lick is really just below the Morgantown sandstone and from 60 to 75 feet higher in the series than this coal. Both coals may be seen in the same section in Riverview Park, Allegheny. To the lower coal the name Duquesne may be applied, as it is well developed along the Monongahela River north of that town. The shale above this coal usually contains plant-stems, fragments of ferns, *Estherias*, and fish-teeth (*Diplodus*).

Along the Union Railroad below Kennywood Park, near Duquesne, crinoid columns, an undetermined gastropod, and a *Chonetes* were found in a nodule about 10 feet above the Duquesne coal. Near the top of the shale in the same locality the following species are quite plentiful:

<i>Productus cora</i> ,	<i>Edmondia aspenwallensis</i> ,
<i>Productus semireticulatus</i> ,	<i>Nucula ventricosa</i> ,
<i>Allorisma subcuneatum</i> ,	<i>Acanthopecten carboniferous</i> ,
<i>Allorisma costatum</i> ,	<i>Sphærodoma</i> sp.,
<i>Cardimorpha missouriensis</i> ,	<i>Tainoceras occidentale</i> .

The writer has found fossils in this shale at various points from Riverview Park, Allegheny, to Glassport on the Monongahela above McKeesport, but the specimens are most numerous and best preserved at Kennywood Park, East Pittsburgh, and Wilmerding.

In the second cut on the Pennsylvania Railroad east of the station at Summerhill, Pennsylvania, the Birmingham is well exposed and consists of dark gray sandy shales with a carbonaceous layer at the base. In the lower part of the shale fragments of ferns are quite abundant, and a single insect wing was found. From the upper part a small number of specimens of a new species of *Orbiculoidea* were obtained. The interest in these specimens lies, of course, in demonstrating the marine origin of these shales at a point about 75 miles from the place where marine fossils were first found in them.

<sup>2</sup>*Ohio Naturalist*, IX, 1909, 485.

<sup>3</sup>*Science*, n. s., XXIX, 1909, 940.

## MARINE SHALE AT THE HORIZON OF THE MORGANTOWN.

In Riverview Park, Allegheny, there is a thin-bedded black shale above the Elk Lick coal and 25 feet above the top of the Birmingham. This shale occupies the position of the Morgantown sandstone, and at this locality is full of specimens of *Aviculopecten* cf. *whitei*. This *Aviculopecten* has not been found by the writer in direct association with marine fossils, but specimens have been collected from the Birmingham shale, which is now known to be marine, and from the shale which overlies the Brush Creek.

## SUMMARY.

In the table given at the end of this paper 97 species of invertebrate fossils are listed. Of these 17 are found in both the Allegheny and Conemaugh series, 28 are found in the Allegheny series only, and 52 are restricted to the Conemaugh. If larger collections had been made and a greater area covered it is probable that these figures would have been materially altered, but it must be admitted that they indicate a great change of faunas during the time represented by the unfossiliferous strata between the Vanport and the Brush Creek. Considering the three highly fossiliferous limestones of the Conemaugh, the Brush Creek, the Pine Creek, and the Ames, it will be noticed that of the 67 species found in the three, 36 are found in at least two of them and 19 are common to all. In this connection the list of fossils identified by Meek from the Uffington shale near Morgantown, West Virginia, is of interest. The Uffington is at a horizon lower in the Conemaugh than the Brush Creek as it rests directly on the Upper Freeport coal. All the species named in this list are common in the Conemaugh of Pennsylvania and none of the species characteristic of the Vanport are present.

From the range of the individual species but little can be learned. It is a well-known fact that *Chonetes mesolobus* is confined to the lower portion of the Pennsylvanian in Kansas and elsewhere, and this proves to be true in Pennsylvania. In our collections there are, however, a number of species whose range terminates with that of *Chonetes solobus*, but which in Kansas extend much higher in the section than does that species. Thus in Kansas *Squamularia perplexa* extends to the Hartford limestone, *Dielasma bovidens* to the Burlingame shale, *Naticopsis altonensis* to the Howard limestone, and *Trachydomia wheeleri* to the Lecompton limestone. *Pugnax utah*, *Rhipidomella pecosi*, *Ambocælia planoconvexa*, *Worthenia tabulata*, and *Phanerotrema grayvillensis* seem to have a much wider range

in the section in Kansas than is yet known for them in Pennsylvania, where they are restricted to certain horizons in the Conemaugh. On the basis of such meager evidence it is very unsafe to venture any definite correlations, but it seems possible that the horizons of the Vanport and Parsons limestones may approximately correspond, and that the limestones of the Conemaugh were deposited at about the same time as the Lecompton and some of the limestones above it. The limestones between the Parsons and the Lecompton would then represent marine deposits in Kansas at a time when western Pennsylvania was above tide-level, and would account for the abrupt break in the sequence in faunas in this State and the greater range of the species in Kansas.

It is to be regretted that there are not more faunal lists with which to compare those here presented. Lists showing the range of the species in Ohio, Kentucky, Indiana, and Illinois might throw a great deal of light on the correlation of the coal-measures of those States.

#### DESCRIPTIONS OF NEW SPECIES.

##### Class Brachiopoda.

Family DISCINIDÆ Gray.

Genus ORBICULOIDEA d'Orbigny.

*Orbiculoidea planodisca* sp. nov.

Plate XXVIII, figures 12, 13.

Shell elliptical in outline, three-fourths as wide as long. The brachial valve is depressed convex, with the apex close to the posterior margin. The outline of the pedicle valve is not regularly elliptical, but the sides are somewhat pinched together and straightened back of the apex. On this valve the apex is low, nearly central, and the pedicle furrow extends behind it almost to the margin. The surface of both valves is marked by concentric growth lines, and the interior of the brachial valve is marked by a number of fine lines radiating from the beak.

One of the best preserved brachial valves is 24 millimeters long and 18 mm. wide.

One other *Orbiculoidea* with a submarginal beak is known from the Pennsylvanian. This is *O. munda* (Miller and Gurley) from Kansas City, Missouri. The brachial valve of that shell is much more convex than that of the species here described, and the sides are more nearly straight. The pedicle valve of *O. munda* is not known.

*Locality*.—The specimens here described were found in the upper part

of the Birmingham shale at the eastern end of the second cut on the Pennsylvania Railroad east of Summerhill, Pa.

Family ATHYRIDÆ Phillips.

Genus COMPOSITA Brown.

**Composita girtyi** sp. nov.

Plate XXVIII, figures I-II.

Shell small, almost globose, with a slight fold on the brachial and flat sinus in the pedicle valve. There is considerable variation in the outline of these shells as viewed from above the brachial valve, and in the strength of the fold and sinus. In some the outline is almost circular, while in others it is oval, as the shells are sometimes longer than wide. The sinus of some specimens is merely a flattening of the ventral valve toward the front, while in others the sinus is a narrow groove extending almost to the beak. A single specimen which probably belongs to this species has a narrow sinus in both valves, like *Composita emarginata* Girty from the Permian of Texas. This is, however, the only specimen seen which shows any trace of a sinus in the brachial valve, and may represent another species. The surface is smooth except for the strong, rather distant lines of growth. The entire interior has not been seen, but weathered specimens show rather closely coiled spiral brachidia.

This shell is much smaller than *Composita subtilita* (Hall) and is readily distinguished from the young of that species by its globose form and the contour of the front of the shell. It is more closely allied to *Composita mexicana* (Hall), but the fold and sinus are not so strongly delimited as in that species.

A large specimen is 11 mm. long, 10 mm. wide, and 9 mm. in thickness. One of the narrow shells is 10 mm. long, 8 mm. wide, and 9 mm. thick. A less tumid shell is 10.5 mm. long, 10 mm. wide, and 7 mm. thick. The majority of the shells have about the proportions of the first of these.

*Locality*.—This is one of the most common shells in the Vanport limestone in western Pennsylvania. It has been found at Wampum, New Castle, and Kittanning. The cotypes are from the abandoned quarry between New Castle and New Castle Junction. In this quarry the shell is especially abundant, over 1,200 specimens having been picked up there. The species is named for Dr. George H. Girty, whose studies have so greatly extended our knowledge of the invertebrate faunas of the Carboniferous and Permian.

## Class Amphineura.

## SUBORDER Eoplacopora Pilsbry.

## Family GRYPHOCHITONIDÆ Pilsbry.

## GLAPHUROCHITON genus nov.

Oval, depressed chitons with granular surface, short and wide valves, the terminal margins of anterior and posterior valves depressed, the sinus slight or absent. Sutural laminae small, the valves without lateral areas and not laterally excavated. Mucro of tail-valve at or behind the middle. Type, *Chiton carbonarius* Stevens.

**Glaphurochiton carbonarius** (Stevens).

Plate XXVI, figure 6; Plate XXVIII, figures 15, 16.

*Chiton carbonarius* STEVENS, American Journal of Science, (2), XXV, 1858, 264.

—MEEK and WORTHEN, Geological Survey Illinois, V, 1873, 608, pl. 29, figs. 15a-15h.

Three specimens belonging to this species have recently been found in western Pennsylvania. One from the Ames limestone at Summerhill shows the anterior and posterior valves and fragments of some of the median valves. The anterior valve is nearly semicircular, and the frontal margin is only slightly sinuate. The tail-valve is exposed from the interior and shows well the absence of the posterior sinus. The median valve figured is from the Pine Creek limestone at Stoops Ferry, and the illustration shows its short, wide form and the granulose surface. A specimen showing the anterior and two median valves was found in the Ames at the Brilliant cut-off, Pittsburgh, but the plates are not in their natural position.

This species can not be referred to *Gryphochiton* because the posterior margin of the tail-valve is depressed instead of strongly sinuate, and it differs from *Pterochiton* in not having the valves laterally excavated and in having the frontal margin of the anterior valve only slightly sinuate. The generic name here proposed is in allusion to the smooth curve of the margin of the tail-valve.

**Glaphurochiton simplex** sp. nov.

Plate XXIV, figures 11, 12, Plate XXVIII, figure 14.

Anterior valve unknown. Median valves represented by a single valve which is short and somewhat rectangular in outline, a little wider than long. Apex acute, lapping the valve behind. The jugal ridge is narrow, and the sides slope abruptly. The sutural laminae are short and wide. The surface is marked by strong lines of growth and very fine granulations.

Tail-valve ovate, wider in front than behind. Jugal ridge narrow, sharply delimited by narrow lateral furrows. The mucro is low, but sharp, situated close to the posterior margin. Posterior sinus very shallow, indented by a narrow groove. Surface marked by lines of growth and very fine granules.

As the two valves here described were found disconnected it is not certain that they belong to the same species. In any case the tail-valve is to be considered the holotype and the other valve a paratype.

The tail-valve of this species differs from that of *Glaphurochiton carboniferous* in having the mucro much further back, its position being almost median in the species described by Stevens. The surface of the new species is very finely granulose, while in the other form the granules are large.

*Locality.*—The two specimens which represent this species were found in the Vanport limestone in the abandoned quarry between New Castle and New Castle Junction, Pa.

## DISTRIBUTION OF SPECIES.

Name.	Vanport.	Brush Creek.	Pine Creek.	Woods Run.	Ames.	Birmingham.
<i>Fusulinella</i> sp. . . . .	×					
<i>Lophophyllum profundum</i> (Milne-Edwards & Haime)		×	×	×	×	
<i>Camphophyllum torquium</i> (Owen) . . . . .	×					
<i>Cyathaxonia distorta</i> Worthen . . . . .	×					
<i>Ceriacrinus craigi</i> (Worthen) . . . . .			×			
<i>Ceriacrinus</i> sp. . . . .		×				
<i>Hydreionocrinus</i> sp. . . . .					×	
Columns and plates of crinoids . . . . .	×	×	×	×	×	×
<i>Septopora biserialis</i> (Swallow) . . . . .	×		×			
<i>Thamniscus sevillensis</i> Ulrich . . . . .	×					
<i>Rhombopora nicklesi</i> Ulrich . . . . .		×	×			
<i>Lingula umbonata</i> Cox . . . . .		×				
<i>Orbiculoidea missouriensis</i> (Shumard) . . . . .			×			
<i>Orbiculoidea convexa</i> (Shumard) . . . . .					×	
<i>Orbiculoidea planodisca</i> sp. nov. . . . .						×
<i>Crania modesta</i> White and St. John . . . . .					×	
<i>Rhipidomella pecosi</i> (Marcou) . . . . .					×	
<i>Derbya crassa</i> (Meek and Hayden) . . . . .	×	×	×	×	×	
<i>Chonetes mesolobus</i> Norwood and Pratten . . . . .	×				×	
<i>Chonetes verneuillanus</i> Norwood and Pratten . . . . .	×	×	×			
<i>Chonetes granulifer</i> Owen . . . . .		×	×		×	
<i>Productus semireticulatus</i> (Martin) . . . . .	×	×	×		×	×
<i>Productus cora</i> d'Orbigny . . . . .	×	×	×	×	×	×
<i>Productus nebrascensis</i> Owen . . . . .		×	×	×	×	
<i>Productus punctatus</i> (Martin) . . . . .	×	×				
<i>Productus nanus</i> Meek and Worthen . . . . .	×					
<i>Productus perlenius</i> Meek . . . . .		×			×	



Name.	Vanport.	Brush Creek.	Pine Creek.	Woods Run.	Ames.	Birmingham.
<i>Marginifera wabashensis</i> (Norwood and Pratten) . . . . .		×	×		×	
<i>Spirifer rockymontanus</i> Marcou . . . . .	×	×				
<i>Spirifer cameratus</i> Morton . . . . .	×	×	×		×	
<i>Spiriferina kentuckiensis</i> (Shumard) . . . . .	×		×	×	×	
<i>Squamularia perplexa</i> (McChesney) . . . . .	×					
<i>Ambocalia planconvexa</i> (Shumard) . . . . .		×	×		×	
<i>Composita subtilita</i> (Hall) . . . . .	×	×	×		×	
<i>Composita girtyi</i> sp. nov. . . . .	×					
<i>Cleiothyridina orbicularis</i> (McChesney) . . . . .	×		×		×	
<i>Dielasma bovidens</i> (Morton) . . . . .	×					
<i>Hustedia mormoni</i> (Marcou) . . . . .	×				×	
<i>Pugnax utah</i> (Marcou) . . . . .					×	
<i>Deltopecten occidentalis</i> (Shumard) . . . . .		×			×	
<i>Acanthopecten carboniferous</i> (Stevens) . . . . .	×	×	×			×
<i>Pseudomonotis harvi</i> (Meek and Hayden) . . . . .					×	
<i>Yoldia carbonaria</i> Meek . . . . .		×				
<i>Nuculana bellistriata</i> (Stevens) . . . . .		×	×			
<i>Nucula ventricosa</i> Hall . . . . .		×	×		×	
<i>Edmondia aspenwallensis</i> Meek . . . . .			×		×	
<i>Allorisma subcuneatum</i> Meek and Hayden . . . . .		×	×		×	×
<i>Allorisma costatum</i> Meek and Worthen . . . . .						×
<i>Schizodus cuneatus</i> Meek . . . . .		×	×			
<i>Macrodon sangamonensis</i> Worthen . . . . .	×					
<i>Macrodon tenuistriatus</i> Meek and Worthen . . . . .			×			
<i>Macrodon obsoletus</i> Meek . . . . .					×	
<i>Astartella varica</i> McChesney . . . . .	×					
<i>Astartella vera</i> Hall . . . . .		×			×	
<i>Cardiomorpha missouriensis</i> Shumard . . . . .						×
<i>Platyceras parvum</i> (Swallow) . . . . .	×	×	×		×	
<i>Platyceras spinigerum</i> Worthen . . . . .	×	×				
<i>Euomphalus catilloides</i> (Conrad) . . . . .	×	×	×		×	
<i>Naticopsis allonensis</i> McChesney . . . . .	×					
<i>Naticopsis torta</i> Meek . . . . .	×					
<i>Trachydomia wheeleri</i> (Swallow) . . . . .	×					
<i>Bulimorpha nitidula</i> (Meek and Worthen) . . . . .		×	×			
<i>Trepostira illinoisensis</i> (Worthen) . . . . .		×	×			
<i>Worthenia tabulata</i> (Conrad) . . . . .		×				
<i>Phanerotrema grayvillensis</i> (Norwood and Pratten) . . . . .		×				
<i>Euconispira bicarinata</i> (McChesney) . . . . .	×					
<i>Pleurotomaria spironema</i> Meek and Worthen . . . . .	×					
<i>Pleurotomaria carbonaria</i> Norwood and Pratten . . . . .		×			×	
<i>Pleurotomaria granulostriata</i> Meek and Worthen . . . . .	×					
<i>Pleurotomaria perhumerosa</i> Meek . . . . .		×				
<i>Murchisonia terebra</i> White . . . . .	×					
<i>Euphemus carbonarius</i> (Cox) . . . . .		×			×	
<i>Patellostium montfortanum</i> (Norwood and Pratten) . . . . .	×	×	×		×	
<i>Bellerophon percarinatus</i> Conrad . . . . .	×	×	×		×	
<i>Bellerophon stevensanus</i> McChesney . . . . .		×			×	
<i>Bucanopsis marcouana</i> (Geinitz) . . . . .		×				
<i>Dentalium meekianum</i> Geinitz . . . . .		×				
<i>Soleniscus fusiformis</i> (Hall) . . . . .	×					
<i>Soleniscus ventricosus</i> (Hall) . . . . .					×	
<i>Soleniscus patulinaformis</i> (Hall) . . . . .					×	
<i>Sphaerodoma primogenia</i> (Conrad) . . . . .		×				

Name.	Vanport.	Brush Creek.	Pine Creek.	Woods Run.	Ames.	Birming- ham.
<i>Spharodoma texana</i> (Shumard) . . . . .					×	
<i>Loxonema scitulum</i> Meek and Worthen . . . . .	×				×	
<i>Loxonema plicatum</i> Whitfield . . . . .					×	
<i>Strophostylus remex</i> (White) . . . . .	×					
<i>Anomphalus rotulus</i> Meek and Worthen . . . . .	×					
<i>Porcellia peoriensis</i> Worthen . . . . .	×					
<i>Glaphurochiton carboniferous</i> (Stevens) . . . . .			×			
<i>Glaphurochiton simplex</i> sp. nov. . . . .	×					
<i>Orthoceras rushense</i> McChesney . . . . .		×	×		×	
<i>Orthoceras lasallense</i> Worthen . . . . .			×			
<i>Endobolus missouriensis</i> (Swallow) . . . . .	×					
<i>Metacoceras sangamonense</i> (Meek and Worthen) . . . . .	×					
<i>Domatoceras highlandense</i> (Worthen) . . . . .	×					
<i>Cyrtoceras curtum</i> Meek and Worthen . . . . .		×				
<i>Temnocheilus crassus</i> Hyatt . . . . .		×	×		×	
<i>Temnocheilus winslowi</i> Meek and Worthen . . . . .			×		×	
<i>Solenoccheilus collectus</i> Meek and Worthen . . . . .		×				
<i>Tainoceras occidentale</i> (Swallow) . . . . .					×	×
<i>Goniatites lunatus</i> Miller and Gurley . . . . .		×	×			
<i>Griſſilhides scitula</i> Meek and Worthen . . . . .		×	×			
<i>Petalodus ohioënsis</i> Safford . . . . .		×	×		×	
<i>Deltodus angularis</i> Newberry and Worthen . . . . .		×	×		×	
<i>Diplodus compressus</i> Newberry . . . . .				×		×
<i>Fissodus inæqualis</i> (St. John and Worthen) . . . . .					×	
<i>Cladodus occidentalis</i> Leidy . . . . .					×	
<i>Agassizodus variabilis</i> (Newberry and Worthen) . . . . .					×	

## EXPLANATION OF PLATES.

## PLATE XXIV.

1. *Chonetes mesolobus* Norwood and Pratten. Five pedicle valves, approximately natural size. Vanport limestone, New Castle, Pa.
2. *Chonetes verneuillanus* Norwood and Pratten. Two pedicle valves, approximately natural size. Vanport limestone, New Castle, Pa.
3. *Squamularia perplexa* (McChesney). Five specimens from the Vanport limestone at New Castle, Pa. Approximately natural size.
4. The same species. An unusually large specimen, about natural size. Vanport limestone, New Castle, Pa.
5. *Spirifer rockymontanus* Marcou. Three specimens from the Vanport limestone at New Castle, Pa. Approximately natural size.
6. *Trachydomia wheeleri* (Swallow). Four specimens from the Vanport limestone at Rochester, Pa. Approximately natural size.
7. *Soleniscus fusiformis* (Hall). A specimen from the Vanport limestone at New Castle, Pa. Approximately natural size.
- 8, 9. *Cyathoxonia distorta* Worthen. Three specimens from the Vanport limestone at New Castle, Pa. Approximately natural size.
10. *Septopora biserialis* (Swallow). Vanport limestone, New Castle, Pa. Approximately natural size. See plate XXV for an enlargement of this specimen.

11. *Glaphurochiton simplex* Raymond. Interior of the tail-valve (holotype). Notice slight notch in posterior margin. For dorsal view of this specimen, see Plate XXVIII.  $2\frac{1}{2}$  times natural size.

12. The same species. A median valve (paratype).  $2\frac{1}{2}$  times natural size. Both of these valves are from the Vanport limestone at New Castle, Pa.

13. An operculum which is found quite frequently where *Naticopsis torta* is common. It is similar to the operculum figured by Meek and Worthen (Paleontology Illinois, Vol. V, pl. 28), and believed by them to belong to *Naticopsis subovatus*. Our specimens are from the Vanport limestone at New Castle, Pa. The figure is about natural size.

14. *Naticopsis torta* Meek. Two specimens from the Vanport at New Castle, Pa. Approximately natural size.

## PLATE XXV.

1. *Septopora biserialis* (Swallow). The same specimen as is shown in figure 10, plate XXIV.  $2\frac{1}{2}$  times natural size.

2. *Lophophyllum profundum* (Milne-Edwards and Haime). A specimen from the Ames limestone at the Brilliant cut-off, Pittsburgh, Pa. Approximately natural size.

3, 4. *Astartella vera* Hall. Four specimens from the Brush Creek limestone at Donohoe, Pa. Approximately natural size.

5. *Euomphalus catilloides* (Conrad). Five specimens from the Brush Creek limestone at Donohoe, Pa. Approximately natural size.

6. "*Cyrtoceras*" *curtum* Meek and Worthen. A specimen from the Brush Creek limestone at Donohoe, Pa. Approximately natural size. The impressed lines on the surface do not mark the position of the septa nor do they follow the outline of the aperture. See the following plate for another view of this specimen.

## PLATE XXVI.

1. *Pleurotomaria carbonaria* Norwood and Pratten. A specimen from the Brush Creek limestone at Donohoe, Pa. Approximately natural size.

2. *Worthenia tabulata* (Conrad). Two specimens from the Brush Creek limestone at Donohoe, Pa. Approximately natural size.

3, 4. *Trepostira illinoisensis* (Worthen). Three specimens from the Brush Creek limestone at Donohoe, Pa. Approximately natural size.

5. *Sphaerodoma primogenia* (Conrad). A specimen from the Brush Creek limestone at Donohoe, Pa. Approximately natural size.

6. *Glaphurochiton carbonarius* (Stevens). A median valve from the Pine Creek limestone at Stoop's Ferry, Pa.  $2\frac{1}{4}$  times natural size.

7. *Petalodus ohioënsis* Safford. A specimen from the Brush Creek limestone at Donohoe, Pa. Approximately natural size. This species is known under a variety of names, *Petalodus alleghaniensis* and *P. destructor* being the ones most frequently used. Safford gave two figures and a brief description of specimens obtained at Cambridge, Ohio, from a limestone at about the same horizon as the Brush Creek, and Leidy later described *P. alleghaniensis* from a specimen obtained from the Brush Creek in Pennsylvania.

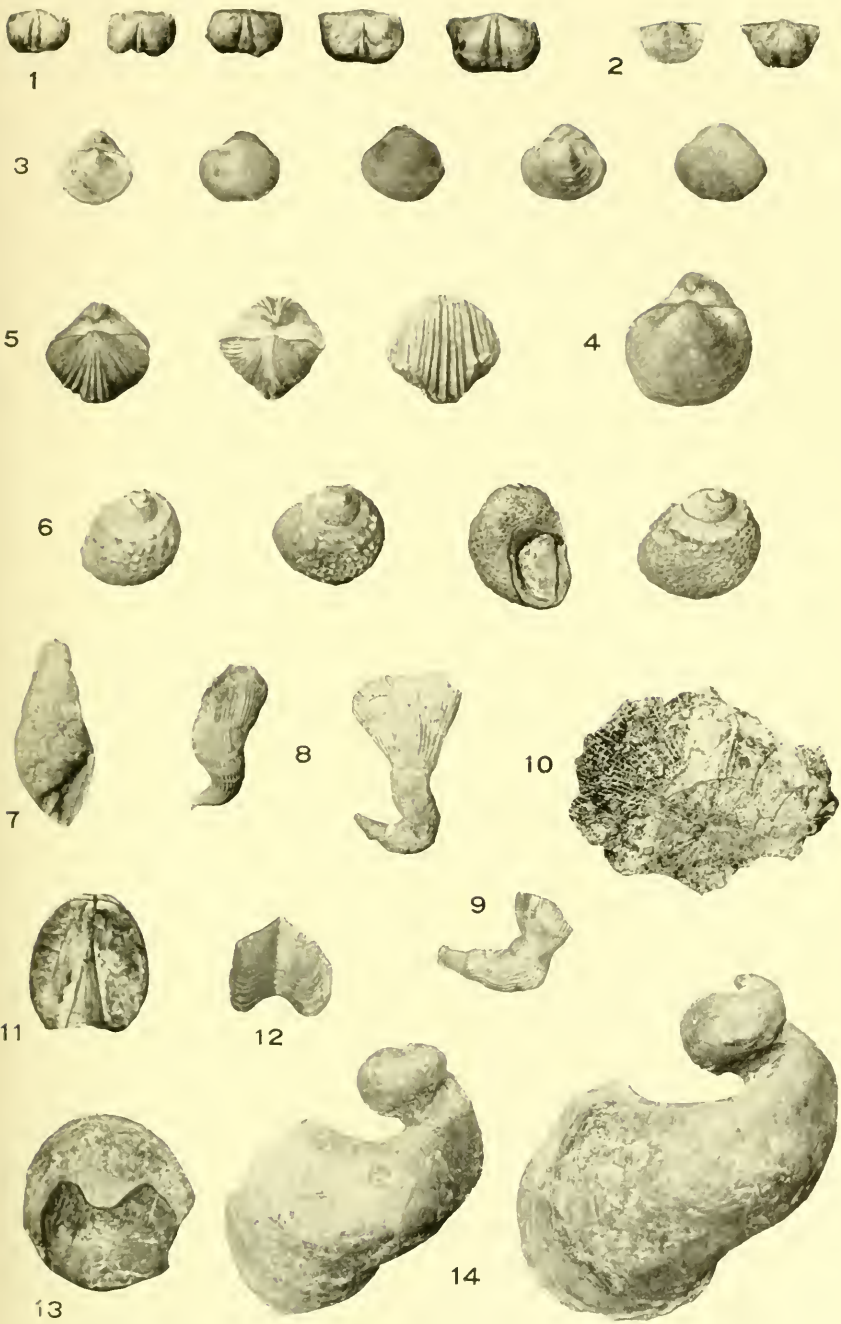
8. "*Cyrtoceras*" *curtum* Meek and Worthen. Interior of the specimen figured on the preceding plate. Notice the very deep hyponomic sinus.

## PLATE XXVII.

1. *Chonetes granulifer* Owen. Six specimens from the Ames limestone at the Brilliant cut-off, Pittsburgh, Pa. Approximately natural size.
2. *Petalodus ohioënsis* Safford. A specimen from the Ames limestone at City Farm, opposite Homestead, Pa. Approximately natural size.
3. *Pugnax utah* (Marcou). Three specimens from the Ames limestone at the Brilliant cut-off, Pittsburgh, Pa. Approximately natural size.
4. *Lophophyllum profundum* Milne-Edwards and Haime. Two specimens from the Ames limestone at the Brilliant cut-off, Pittsburgh, Pa. Approximately natural size.
- 5, 6. *Allorisma subcuneatum* Meek and Hayden. Two specimens from the Birmingham shale below Kennywood Park, near Duquesne, Pa. Approximately natural size.
7. *Tainoceras occidentale* (Swallow). View of the venter of a specimen from the Ames limestone at Pitcairn, Pa. Approximately natural size. Collected by the Rev. P. E. Nordgren.
8. *Derbya robusta* (Hall). A specimen from the Ames limestone at Glenwood, Pa. Approximately natural size.

## PLATE XXVIII.

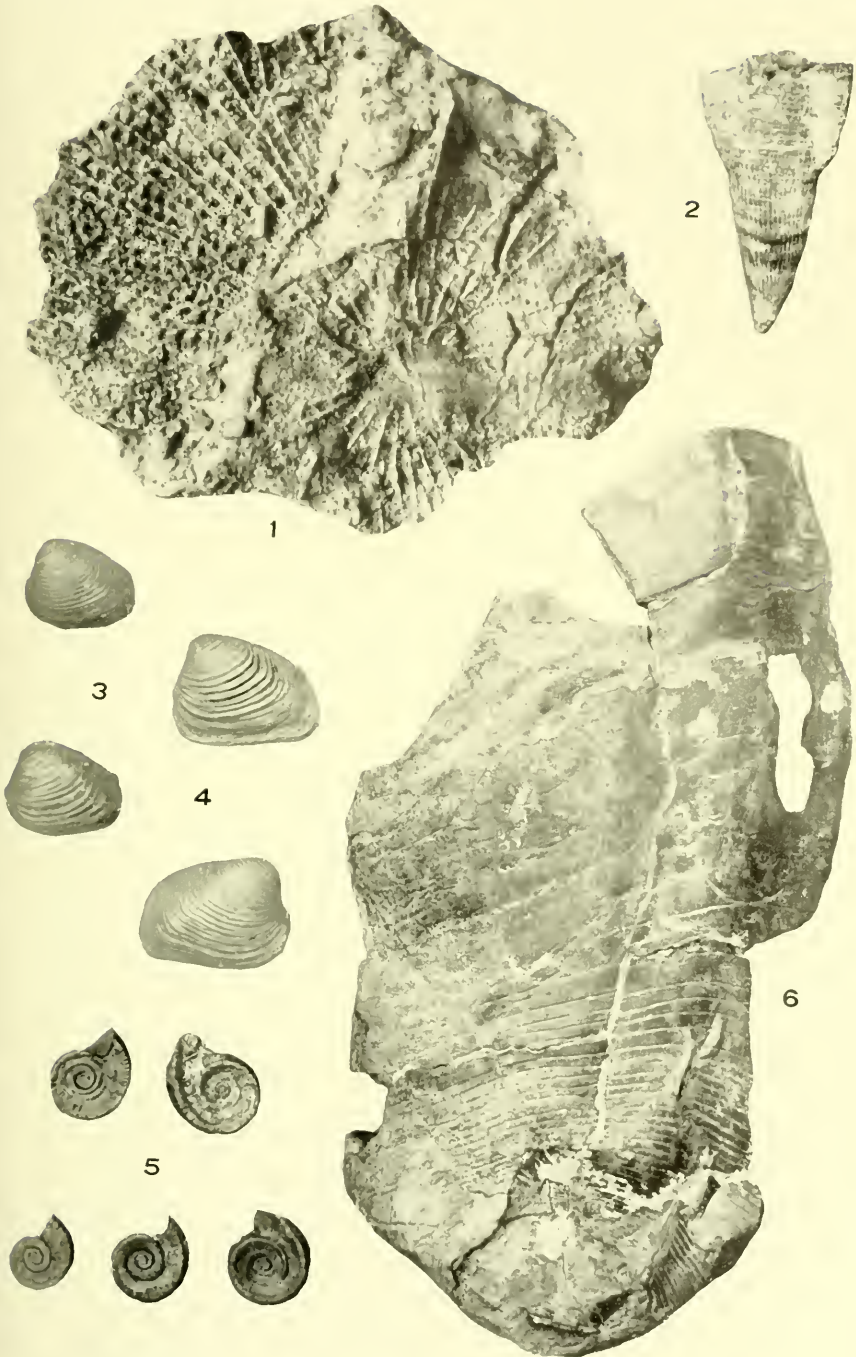
1. *Composita girtyi* Raymond. Three views of a wide individual with a shallow sinus and nearly equal valves. All of figures 1-11 are one-half larger than natural size, and are all from specimens collected from the Vanport limestone at New Castle, Pa.
2. The same species. A specimen similar to the preceding, but with a deeper sinus.
3. The same species. A narrow individual with a deep pedicle valve.
4. The same species. A narrow shell with almost no sinus.
5. The same species. A small specimen with a slight sinus in both valves.
6. The same species. A narrow individual with a very convex pedicle valve.
7. The same species. A wide specimen with subcircular outline and shallow sinus.
8. The same species. A narrow shell with pentagonal outline and convex valves.
9. The same species. Four views of a somewhat square shell with nearly equal valves and a slight sinus.
10. The same species. A narrow shell with an externally convex pedicle valve.
11. The same species. Four views of a wide shell with a pronounced sinus and nearly equal valves.
12. *Orbiculoidea planodisca* Raymond. A dorsal valve from the Birmingham shale at Summerhill, Pa. Natural size.
13. The same species. A pedicle valve from the same locality. Natural size.
14. *Glaphurochiton simplex* Raymond. A tail-valve (holotype), from the Vanport limestone at New Castle, Pa. Twice natural size.
- 15, 16. *Glaphurochiton carbonarius* (Stevens). Copies of Meek and Worthen's figures of the tail-valve to illustrate the characters of the genus and to compare with the figure of *G. simplex*.



L. S. Coggeshall, photo.

Vanport Fossils.





L. S. Coggeshall, photo.

Brush Creek Fossils.







L. S. Coggeshall, photo.

Brush Creek Fossils.





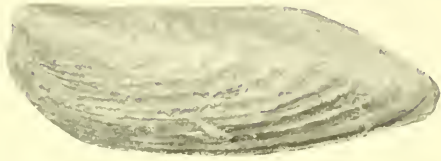
1



2



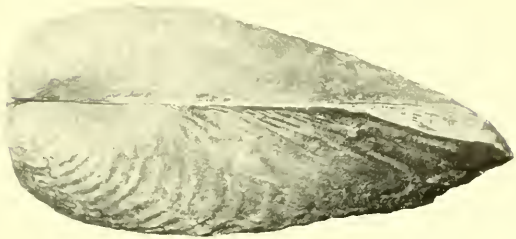
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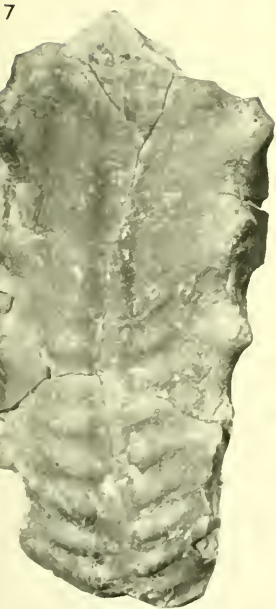
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6



7

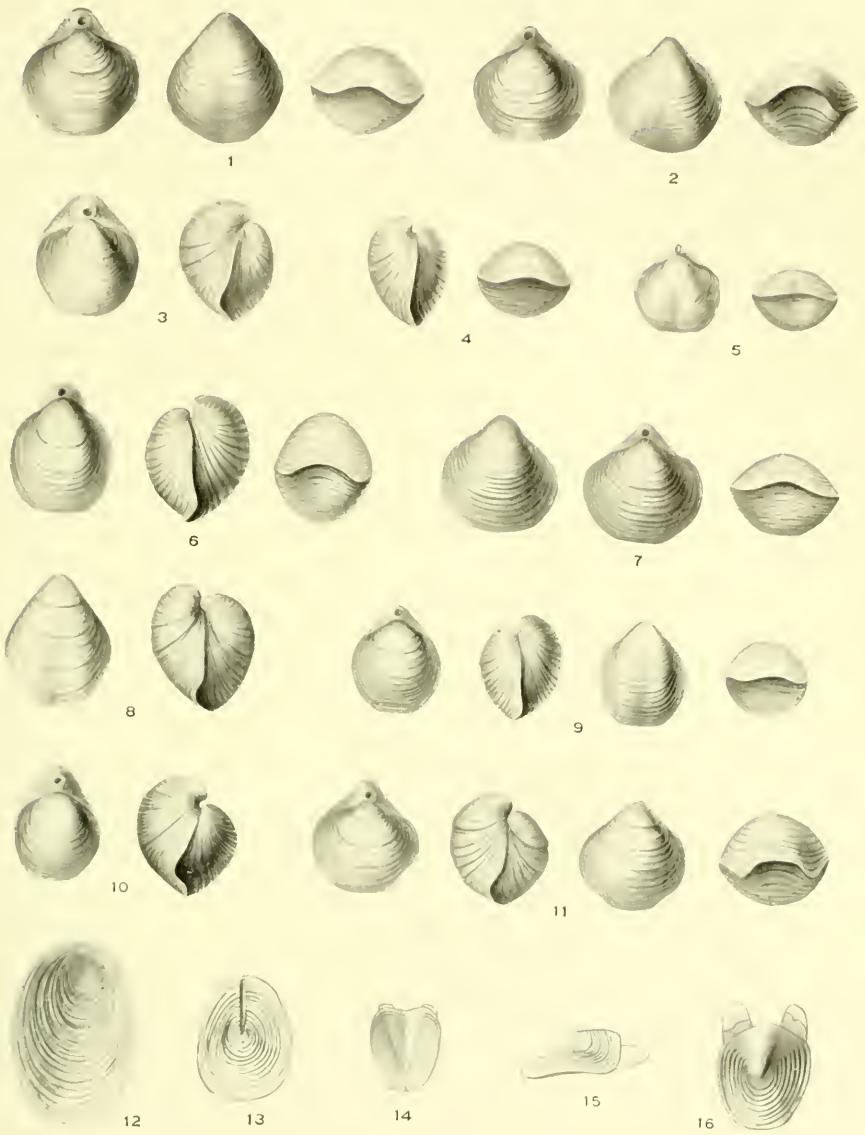


8

L. S. Coggeshall, photo.

Ames Fossils.





Sydney Prentice, del.

Vanport Fossils.



# ANNALS

OF THE

# CARNEGIE MUSEUM

VOLUME VII. NO. 2.

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## EDITORIAL NOTES.

THE Geological Society of America, the Paleontological Society, and the American Association of Geographers held their Annual Meetings during Convocation Week, Dec. 27-31, 1910, as guests of the Institute. The meetings were well attended and brought together many of the leading geologists and paleontologists of the country. Resolutions thanking the Trustees and Officers of the Institute for the courtesies displayed upon this occasion were adopted by the various societies, and many letters were received by the Director of the Museum in his capacity as Chairman of the Committee of Arrangements expressing the pleasure and satisfaction of those who were in attendance.

One of the gentlemen in attendance upon these meetings spent most of the time in the library of the Museum, and at the close of his stay he remarked to the librarian, "It is seldom I have such an opportunity to consult such a collection of books as you have here, and I have utilized every moment in examining these works, many of which I have longed for years to see." The thirst for knowledge is as keen as any other thirst, and it is a satisfaction to know that it is in our power to some extent to meet it. To be able to "give a cup of cold water" from the fountain of truth is as blessed as to be able to slake the thirst of a traveller in the desert.

---

THE members of the Geological and Paleontological Societies expressed great and continued interest in the collections of the Mu-

seum made during the past decade. The perfection and richness of the collections was the cause for many admiring utterances, which generally ended with the remark that "with the support of such a Mæcenas as Mr. Carnegie it is only to be expected that such results should have been achieved."

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THE manuscript of Professor Eigenmann's large monographic work upon the Fishes of British Guiana has been completed and will constitute the Fifth Volume of the MEMOIRS. The plates, of which there are seventy, are being engraved and the maps and text-illustrations are being made. It is hoped to put the work through the press by the end of the current year.

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DR. CHARLES R. EASTMAN has completed cataloging the fossil fishes from the Eocene of Monte Bolca, which form a part of the collection of fishes obtained through the purchase of the collection of Baron Ernst Bayet. His list, accompanied by a number of figures of fine specimens, will be published as the concluding number of Vol. IV of the MEMOIRS. A similar list of the Fossil Fishes from Solenhofen contained in the Bayet Collection is in process of preparation by the same author.

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A GREAT deal of the time of the Editor has been occupied in the revision and preparation for publication of various papers upon the Expedition of the Carnegie Museum to Central South America. The Expedition, which was under the care of Mr. John D. Haseman, has resulted in a great enlargement of our knowledge of the ichthyic fauna of the various South American river basins, and many species new to science have been acquired. Some of the first fruits of Mr. Haseman's labors will appear in this volume of the ANNALS.

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THE work of building cabinets for the Laboratory of recent invertebrates has gone forward steadily during the past six months, and it is hoped that before mid-summer the room from which Professor Ortmann has been excluded for nearly a year may be ready for reoccupation. The delay has been inevitable, owing to the inability of the Director to supply a sufficient force of workmen to advance the labor rapidly. If means can be found to provide the necessary trays for the cabinets the large collections of shells contained in the Holland,



the Hartman, and the Sterki Collections will be arranged and made accessible to students. These collections owned by the Museum for nearly ten years have hitherto been necessarily packed away and out of sight.

---

THE work of mounting the large collection of East African mammals deposited in the Museum by Mr. Childs Frick is going forward as rapidly as possible, with the limited number of persons at the command of the institution. The large Toppelkirch's Giraffe has been set up, and the manikin of the Reticulated Giraffe has been made, but it will be impossible to have both specimens finished and in shape to display them at the coming celebration of Founder's Day. The oryx group has been completed. Most of the skins have been tanned and matters are in such shape that the work might be rapidly advanced were there funds at the disposal of the Director to employ more workmen, and could competent men be found. The number of skilled taxidermists in America—for that matter in the world—is very limited.

---

A COMPLETE copy of the Ornithological Works of John Gould has been purchased for the library of the Museum. The work is one which has long been needed and the opportunity to secure a set at a very reasonable figure was promptly seized.

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By an unfortunate blunder on the part of the printer, the three plates illustrating the paper of Professor Earl Douglass upon Eocene Mammals, contained in the Sixth Volume of the ANNALS, were omitted in the bound edition of that volume, though they appeared in the reprints, which were distributed in the early summer of 1910. Copies of these plates are being issued to subscribers and regular correspondents.

---

HIS Majesty the Czar of Russia has sent his photograph, autographically signed, and beautifully framed, to Mr. Carnegie in recognition of his gift of a replica of the Diplodocus. The Director of the Museum has received the decoration of a Knight of the Order of St. Stanislas, of the Second Class, and Mr. A. S. Coggeshall, his assistant, has received the decoration of a Knight of the Order of St. Anne, of the Fourth Class.

## IX. RESULTS OF AN ICHTHYOLOGICAL SURVEY ABOUT THE SAN JUAN ISLANDS, WASHINGTON.

BY EDWIN CHAPIN STARKS.

The following pages embody the results of a study of a collection of fishes made about the San Juan Islands in the summer of 1909 by the author while a member of the Puget Sound Marine Station.

The San Juan Islands are situated just north of the Strait of Juan de Fuca, and opposite the lower end of Vancouver Island. The marine station is located at Friday Harbor on San Juan Island, but during the summer it was temporarily moved for a part of the time to Olga on Orcas Island.

Part of the equipment of the biological station was one of the powerful little steamers regularly employed as dredging boats in the shrimp-fishery. She was equipped with a shrimp-dredge or trawl, measuring twelve feet across the mouth, and with a hoisting engine and sufficient steel cable to dredge in depths up to forty-five fathoms. By this means all of the deep-water species were taken.

The author wishes to express his obligations to the individual members of the station for their interest and help in obtaining and preserving these specimens, as well as for the many courtesies and privileges of the station extended to him.

He wishes further to express his obligations to Dr. Bashford Dean for financial aid through the American Museum in New York, enabling him to carry on seining operations on the beaches and also to the two students of Stanford University, Messrs. Launce Scofield and Henry Poor, who gave assistance to that end.

Acknowledgment is also due to the members of the Department of Zoölogy of the University of Kansas, who contributed a collection of fishes largely made on the shrimp-boats, while the latter were pursuing their regular occupation of dredging for shrimps. Among these was a new species of *Sebastes*.

Besides the methods already indicated collecting was done with the aid of set-lines and gill-nets and several species were only taken in pools left by the receding tide, and under the rocks, at low tide.

The specimens are deposited in the collections of Stanford University, in the Carnegie Museum, and in the American Museum of Natural History. The types of the new species are in the Carnegie Museum.

Family HEXANCHIDÆ.

1. *Hexanchus griseus* (Gmelin).

A large specimen of this species was taken in the trawl by the collectors of the Puget Sound Marine Station near Anacortes in 1908.

In a "Note on *Hexanchus griseus*" (Ann. and Mag. Nat. Hist. (7), XVI, 1905) Mr. C. Tate Regan in comparing specimens of this genus from the Atlantic and Japan with a small one from the Pacific Coast of the United States (*Hexanchus corinus* Jordan and Gilbert) concluded them to be all of the same species.

The species *Hexanchus corinus* was based on the following characters in the original description. "This species is closely related to *Hexanchus griseus*, from the Mediterranean and Eastern Atlantic [also from the West Indies]. It differs chiefly in the form of the teeth of the lower jaw, which are serrated on the inner edge, and have on the upper or outer edge only six cusps instead of eight or nine." The largest of the two typical specimens was forty-three inches in length.

Dr. Jordan recently obtained in the market at San Francisco the head of a specimen of this shark. The animal was six or seven feet in length. The jaws were saved. The teeth of this specimen tend to prove the correctness of Mr. Regan's conclusions, as each tooth of the lower jaw has nine well developed cusps.

As to the serrations on the inner edge of the lower teeth Müller and Henle (Syst. Besch. d. Plagiostomen, p. 81) say of Atlantic specimens "Der innere Rand sehr fein gezähnel." "

Since the above was written a female specimen sixty-seven inches in entire length was received from a market in San Francisco. Its description is here included.

Body robust; moderately tapering backwards; the caudal not much bent upwards. Head, measured obliquely across top from tip of snout to first gill opening, 4.16 in length of body to base of caudal, or twice the length of the caudal. Length of eye equal to half the distance from upper lip to tip of snout, which distance is contained 3.66 times in head (obliquely across top). Nostrils near outer edge of snout; a line drawn between posterior edges of nostrils across snout falls medially a little nearer upper lip than tip of snout. Distance

from posterior angle of mouth to first gill opening one diameter of pupil less than distance from upper lip to tip of snout. A deep pocket of membrane is placed at the angle of the lower jaw and covered by the upper jaw when the mouth is closed. Teeth in lower jaw nearly horizontal; eight cusps on each with sometimes a rudimentary ninth; the inner edge of each tooth finely serrated; the symmetrical median tooth with three or four cusps on each side. A group of sharp slender teeth at center of upper jaw; the other teeth longer, directed towards side of jaw, and with one or two cusps on outer base of each. First gill-opening very long, the others becoming progressively shorter backwards; the last, which is contained 3.2 times in head, is three-fifths of the length of the first. When the skin is stretched flat across the throat the distance between the lower ends of the first gill-openings of opposite sides is equal to the length of the fourth gill-opening.

The front of the dorsal is over, or a very little behind, the posterior end of the ventral base, while the posterior end of the dorsal base is a trifle in front of the middle of the anal base. Distance of base of dorsal from caudal base is contained 1.16 times in postorbital part of head. Anterior slope of dorsal equal to its base, or to base of anal, or to anterior slope of ventral. Posterior margin of dorsal very slightly concave; other fins (except caudal) truncate or convex. Anterior slope of pectoral 1.4 in head. When the pectoral is laid close to the body it reaches half-way between the upper part of its base and base of ventrals. Caudal with a very deep notch towards its tip; its lower lobe scarcely developed; anterior slope of lower lobe contained 4.33 times in length of upper lobe, which is contained 2.2 times in rest of body.

Color dark slate, growing lighter below, but not white; under side of snout soiled white; a narrow light lateral stripe along upper part of side to opposite dorsal.

#### Family RAJIDÆ.

#### 2. *Raja rhina* Jordan and Gilbert.

The adults were commonly taken on set-lines and the young were dredged in deeper water. The following descriptions are of specimens from various localities from the Gulf of California to Puget Sound.

Specimens of both sexes measured on median line from between the front of the eyes were from thirty to forty inches in length.

The snout is 3 in length to the inner angle of pectoral; the interorbital space from 3.25 to 3.75 in snout; width of interspiracle 2.33 to 2.66 in snout. A line drawn between the outer angles of the body crosses the median longitudinal line twice the length of the snout from the tip of the snout, or varying to half the diameter of the eye less than this distance. The spiracle from its posterior edge to the posterior edge of the iris is equal to the length of the iris, or to the posterior edge of the eye-ball is contained 2 times in the eye-ball. Holding the outer lobe of the ventral straight back and measuring from the bottom of the notch in the posterior edge of the ventral to its tip the distance is equal to the interorbital width, or a little greater. Holding the edge of the anterior ventral lobe so that it is at a right angle with the posterior lobe a deep rounded notch is left in its posterior edge. The anterior half of the rostral ridges are fused together. The nearest point on the edge of the disk from the anterior edge of the eye-ball is equal to the width of the inter-spiracle or a little less. The general outline of the anterior margin of the disk is deeply concave with a slightly convex median area. The least distance from this median area to a straight line drawn from the tip of the snout to the outer edge of the pectoral is equal to the interorbital width, or to one diameter of the pupil less than this. The outer angle of the pectoral is variable in acuteness, but never quite so round as in *Raja inornata*.

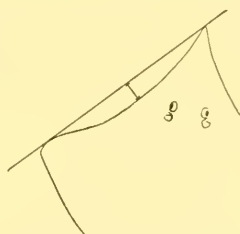


FIG. 1. *Raja rhina*.  
 Female 32 inches long, to  
 show outline of front of  
 disk.

Minute spinules are sparsely scattered over the outer edges of the disk and median line of the back behind the shoulder girdle. Larger stellate spinules are on the anterior edge of the disk, snout, and interorbital space. There are from six to ten enlarged spines around the eye, and sometimes from one to three on the median line between the branchial chambers, but these last are usually absent in large specimens. There are three irregular rows of enlarged spines on the back of the tail, with smaller ones usually scattered between, in the female. In the male the outer row of tail-spines is absent or scattered, there is a patch of very much enlarged spines opposite the eye, and the usual row of sharp spines hooked inward near the angle of the disk. No specimen was observed with more than a single row of these, while large specimens of *Raja binoculata* have two rows and an incomplete third one.

Color dark sienna-brown with irregular black blotches sometimes present. A spot at base of pectoral in the form of an irregular ring always present in the young, and often present in the adult as a ring, or as a diffused blotch, but never larger than the width of the interorbital space. The very young have dark points scattered sparsely over the body.

Specimens from twelve to twenty inches in length differ from these as follows: the interorbital width is contained from 3.5 to 4 in the snout:

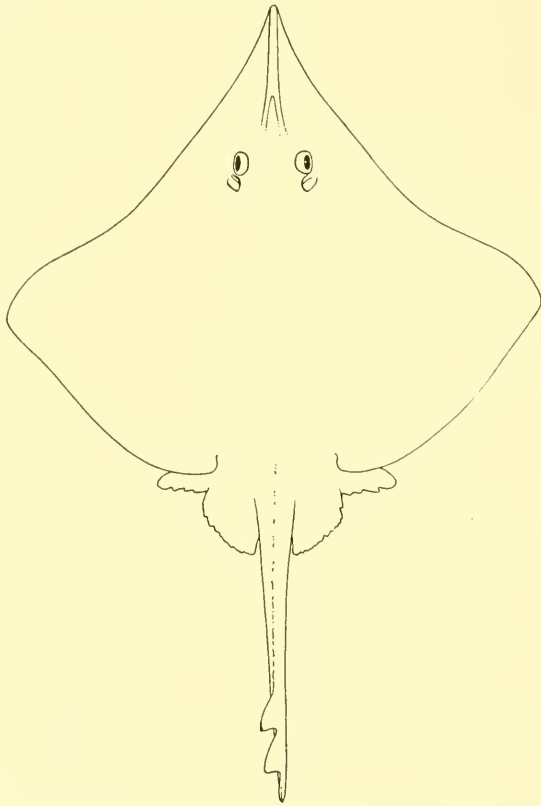


FIG. 2. *Raja rhina*. A female specimen, 32 in. long, from San Francisco.

the interspiracle width from 2.5 to 2.75. The length of the spiracle from its posterior edge to the iris is contained 1.25 in the iris, or to the posterior edge of the eye-ball 2.4 in the eye-ball. The outer ventral lobe from the notch in the posterior edge of the fin is greater than the

interorbital width by from three-fourths to one diameter of the eye. The nearest point from the eye to the edge of the disk is always greater than the interspiracle width. The distance from the median convex area at the side of the front of the disk is not over half of the interorbital space from a straight line drawn from the tip of the snout to the outer pectoral edge. In specimens twenty inches long there are a few spinules on the interorbital, snout, anterior edge of pectoral, and on the median line of the back posteriorly. Specimens twelve inches long and under are, with the exception of the enlarged spines, perfectly smooth.

In the following table measurements are given in hundredths of the length of the disk.

*Raja rhina.*

Locality.	Puget Sound.							San Francisco.				
	Puget Sound.	Gulf of California	Puget Sound.		S. California.	Puget Sound.	S. California.	San Francisco.				
Sex.....	♂	♀	♀	♀	♂	♂	♂	♂	♀	♂	♀	♀
Total length in mm..	250	280	340	422	440	482	525	790	795	810	850	900
Total width in mm..	170	190	234	281	291	337	376	550	552	560	600	620
Length of disk in mm. <sup>1</sup> .....	135	160	197	238	250	280	320	473	465	463	505	535
Width in hundredths of length of disk..	125	116	120	118	117	120	120	119	119	120	120	118
Between angles of pectorals to posterior edge of disk <sup>2</sup>	38	37	41	41	40	40	37	38	37	37	39	37
From between front of eyes to tip of snout.....	32	33	33	32	32	32	34	32	33	30	33	33
Interorbital width..	8	7.5	7.5	8	8	9	8	9	8.5	9	9	9
Long diameter of eyeball.....	7.5	7.5	7	7	7	6	5.5	6	6	6.5	6	6
Eye to nearest point at edge of disk...	16	14	15	15	12	14	12	11	13	11	12	11
Length of outer ventral lobe <sup>3</sup> .....	15	14	15	14	14	15	14	10	12	11	9.5	11
Origin of first dorsal to second dorsal..	12	12	11	13	12	12	11	11	10	11	10	9
Posterior edge of disk to first dorsal....	46	50	44	46	50	45	44	42	47	47	45	46
Width of mouth....	16	16	15	17	15	16	15	17	17	17	16	17
From between jaws to tip of snout....	36	37	36	34	37	36	35	32	35	32	36	36

<sup>1</sup> From tip of snout to a point on median line opposite tips of pectorals.

<sup>2</sup> From a point where a line drawn between angles of pectorals crosses median line of back measured back to posterior edge of disk.

<sup>3</sup> Outer lobe of ventral held straight back and measured from notch in posterior edge of fin.

Specimens just hatched and up to ten inches in length always have only two spines in front of the eye and one behind, a median spine on the back, and a row of spines on the back of the tail. The interorbital space is 2.5 in the snout, and the median portion of the anterior edge of the pectoral touches a straight line from the tip of the snout to the outer edge of the pectoral. The young in these respects does not differ from the adult of *Raja inornata*. (The young specimens are from Puget Sound where *Raja inornata* has never been taken.)

### 3. *Raja binocolata* Girard.

Numerous specimens were taken on set-lines varying in length up to six and one-half feet, and small ones newly hatched and still in the egg-capsule were taken with the dredge. This species reaches a weight of considerably over a hundred pounds.

The snout grows longer with age; the large hooked spines do not grow in proportion with the growth of the body, being smaller in larger individuals, or altogether disappearing; and the body with age grows rougher with spinules.

In the following description the numbers in parenthesis refer to the specimens here listed arranged in reference to size.

Specimen (1) female 77 inches in length, 55.5 inches in width.

Specimen (2) male 60 inches in length, 44 inches in width.

Specimen (3) male 52 inches in length, 38 inches in width.

Specimen (4) female 23 inches in length, 17 inches in width.

Specimen (5) male 16 inches in length, 12 inches in width.

Length of snout from between front of eyes (1) 3.8, (2) 4.33, (3) 4.2, (4) 4.4, (5) 4.6 in width of disk; (1) 2.83, (2 and 3) 3, (4) 3.16, (5) 3.25 in length to inner angle (union with body) of pectoral. Interspiracle width (1, 2, and 4) 1.9, (3 and 5) 1.85 in length of snout. Interorbital width (1) 2.1, (2) 2.5, (3) 2.6, (4 and 5) 3 in length of snout. Length of snout from edge of upper lip (in all) 1.125 in snout from eye. The eye was not measured in (1 and 2). The length of iris is contained (3) 2, (4) 1.5, (5) 1.25 times in distance from its posterior edge to posterior edge of spiracle, or (3) 12, (4) 10, (5) 8.5 times in snout. The length of spiracle (3) 1, (4) 1.33, (5) 1.5 in the length of ball of eye. Transverse width of upper tooth patch (1) 1.9, (2) 1.6, (3) 1.75, (4 and 5) 1.9 in length of snout from upper lip. A line drawn between the outer angles of the pectorals crosses the median line a distance behind the tip of the snout (1, 2, and 4) twice the distance from the tip



of the snout to the middle of the eye or (3 and 5) twice the distance from the tip of the snout to the posterior edge of the eye.

In specimens just hatched, and up to a couple of feet in length, there are two enlarged spines in front of the eye, and one on the orbital margin opposite the posterior edge of the eye. This is very constant; probably three dozen newly hatched young were observed and no variation was found in this respect. These spines are lost in large individuals; no specimen over four feet in length was seen that had them, though in the large ones the spinules of the interorbital space become coarser at the interorbital margins, just as those on the snout become coarser at its tip. But these are not at all like the enlarged hooked orbital spines of the small specimens. In specimens up to two feet in length there is a single row of enlarged spines along the tail, but in large specimens there are three indefinite rows close together. In specimens up to two feet in length there is always a single spine on the median line of the back between the middle of the branchial cavities, which is usually absent in the large ones. The back is everywhere covered with minute prickles in specimens down to sixteen inches in length. Small ones eight to nine inches in length, are smooth, or with prickles only on the median posterior part of the back.

Color dark olive-brown or drab, with a large dusky spot at base of pectoral blending into the body-color. The diameter of the spot is two-thirds of the length of the snout. Light spots as big as the eye are scattered over the body, and form a definite ring around the pectoral spot. Dusky streaks occur on the edge of the pectorals; on the posterior edge following the direction of the rays as short bars, on the anterior edge forming marginal spots, which anteriorly often cross the snout as two bars. Young specimens just hatched have a large, conspicuous, ocellated spot at the base of the pectoral. This has usually a black center encircled by an Indian-red ring, which is in turn encircled by a black ring. Sometimes, however, this spot is solidly coal-black. One egg-capsule was opened, in which there were four young, representing two of each of these color-phases of the spot.

This species is said by Dr. Evermann (Bull. Bur. Fish., XXVI, p. 229) to be specifically identical with *Raja stellulata* and *Raja rhina*. This question is taken up as to *Raja stellulata* under that species. Of the nearly two hundred specimens of the other two species which were caught in Puget Sound no difficulty was experienced in separating them easily and completely, and no important intergrading characters were found.

*Raja binocularata* may be easily separated from all other rays found on the western coast from San Diego to Puget Sound by the comparatively shallow notch in the posterior edge of the ventrals. From seventy-five to one hundred specimens were observed, and this character was not found to vary materially between individuals just hatched and those over six feet in length. When the outer edge of the ventral

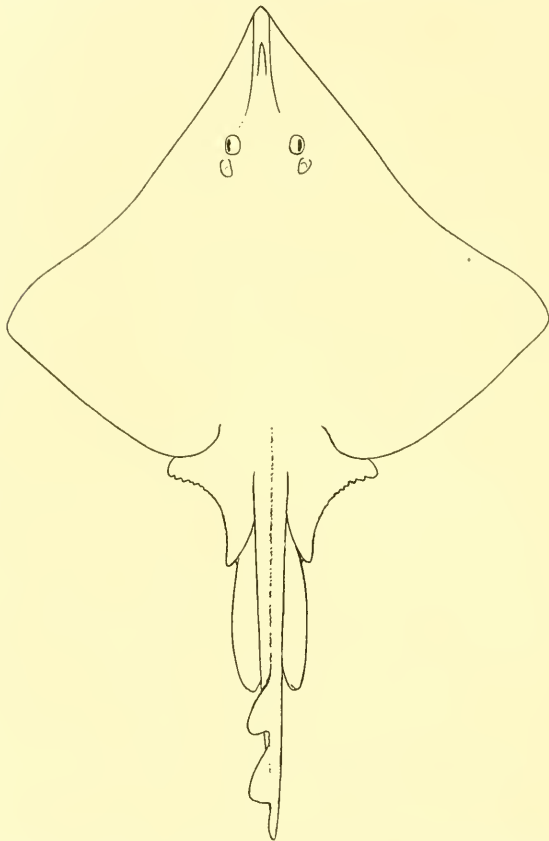


FIG. 3. *Raja binocularata*. Male. 52 in. long. From Puget Sound.

fin is held so that it extends at a right angle with the inner edge, the notch in the posterior edge almost disappears. In treating the ventral of the other species in the same way a deep rounded notch remains.

The rostral cartilages join only at their anterior fourth, while in *Raja*

*rhina* they are joined along their anterior half. This condition may be easily appreciated through the skin. *Raja rhina* never has a large spot at the base of the pectoral. When a spot is present at this place it is in the form of a small ring. It sometimes has light spots scattered over the body, but never very distinct, and never arranged as a conspicuous ring at the base of the pectoral having a diameter nearly as great as the length of the snout (not evident in the young of less than a foot in length). In *Raja binoculata*, especially in the adult, the anterior outline of the disk is less deeply concave, and the snout is shorter and blunter. The eye is smaller; the skin of the adult is without smooth areas; the median spines on the tail are smaller, at least in the adult; the color is more slaty; the flesh is firmer; and the egg-capsules are many times larger. One never has any difficulty in anticipating from the outside of an egg-capsule what species will be found inside, for the young may be even more readily separated than the adults.

4. *Raja inornata* Jordan and Gilbert.

This common species has never been recorded north of California, but for the sake of completeness it is here included, being the only other species in this genus frequenting the coast south of Alaska.

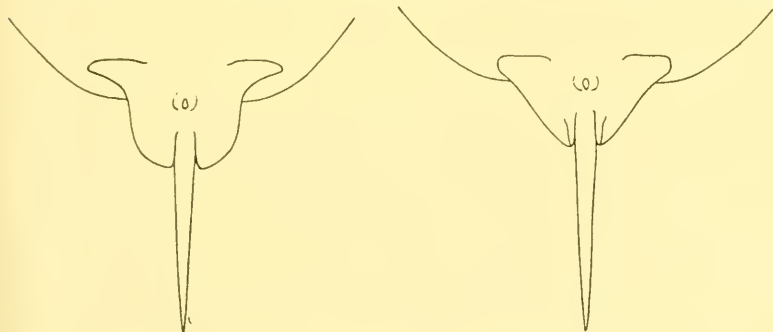


FIG. 4. *Raja inornata*. ♀. 28 in. long. San Francisco.

FIG. 5. *Raja binoculata*. ♂. 27 in. long. To show ventral fins.

The following description is of five female specimens from San Francisco ranging from twenty-five to twenty-eight inches in length.

The snout measured on the median line from between the front of the eyes is contained from 3.5 to 3.6 times in the distance to the inner angle of the pectoral. The interorbital space is from 2.8 to 3

in the snout; the interspiracle width 2 to 2.2. A line drawn between the outer angles of the body crosses the median line of the back twice the length of the snout with the addition of from one to one and a half of the long diameter of the eye from the tip of the snout. The eye, the outer ventral lobe, and the rostral cartilages do not differ materially from those of *Raja rhina* of equal size, as shown by the appended tables. The nearest point of the edge of the disk from the

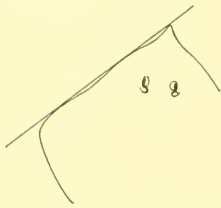


FIG. 6. *Raja inornata*.  
♀ 27½ in. long. To show outline of front of disk.

anterior edge of the eye is from one-half to one diameter of the eye greater than the interspiracle width. The anterior margin of the disk is concave towards the snout and towards the pectoral angle with a convex median portion. The median portion touches, or comes within a diameter of the pupil of touching, a straight line drawn from the snout to the outer anterior pectoral edge. The outer angle of the pectoral is always well rounded.

Small prickles are sparsely scattered over the outer edges of the pectorals, and along the entire median line of the back. Larger ones are on the interorbital space and snout. The enlarged spines around the eye scarcely differ from those of *Raja rhina*. About a dozen large spines are irregularly placed in a patch between the branchial cavities, and the entire back of the tail is covered with about five irregular rows of spines.

A couple of small specimens, fifteen inches in length, a male and female, differ as follows: the width of the interorbital space is from 3 to 3.4 in the snout; the interspiracle width 1.83 to 2.33. The length of the spiracle from its posterior edge to the eye-ball is a third of the eye-ball. There are no prickles, except a few on the interorbital space and snout. About five spines occur on the orbital margin; two or three between the branchial cavities, and about three rows on the back of the tail.

The color of this species is not very different from that of *R. rhina*; it is a clearer, warmer brown, and the pectoral spot is more evident.

This species (except the very young) may be at once known from *Raja rhina*, which it most resembles, by the much less concave anterior outline of the disk, the shorter snout, and the patch of enlarged spines on the back between the branchial cavities. The young are

much more difficult to separate, as the snout in *Raja rhina* is not so long, the edge of the disk not very concave, and the spines undeveloped. The very young of *Raja rhina* differs from that of *Raja inornata* in the greater concavity towards the angle of the pectoral, the less abruptly protruding sharp snout, and the more acute outer

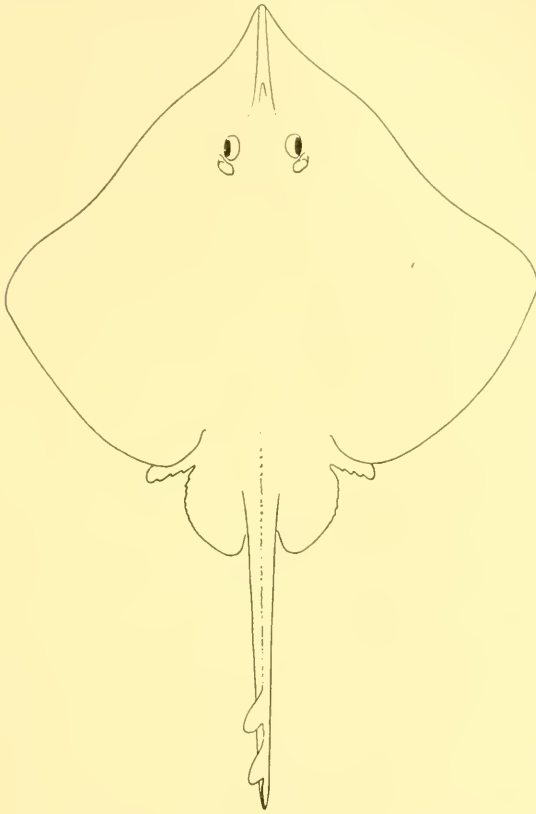


FIG. 7. *Raja inornata*. ♀. 28 in. long. San Francisco.

les of the disk. The outline in *Raja inornata* is scarcely concave anywhere, except at the tip of the snout. The spines and color are the same in the very young of both species.

In the following table the measurements are made as described in the notes under the table for *Raja rhina*. The specimens are all from the coast of California.

*Raja inornata.*

Sex.	♂	♀	♀	♀	♀	♀	♀
Total length in mm. . . . .	370	380	635	650	655	690	710
Total width. . . . .	243	255	460	440	445	485	480
Length of disk. . . . .	201	222	367	360	360	403	400
Width in hundredths of length of disk. . . . .	123	115	124	123	123	121	122
Between angles of pectorals to posterior edge of disk. . . . .	40	40	42	41	39	41	40
From between front of eyes to tip of snout	26	28	27	27	26	27	27
Interorbital width. . . . .	8	8	9	9	9	9	9.5
Long diameter of eye-ball. . . . .	7	6.5	6	6	6	6	6
Eye to nearest point of edge of disk. . . . .	16	16	15	16	16	16	15
Length of outer ventral lobe. . . . .	12	13	10	11	11	10	9.5
Origin of first dorsal to second dorsal. . . . .	12	12	11	11	12	10	11
Posterior edge of disk to first dorsal. . . . .	55	45	48	53	53	48	51
Width of mouth. . . . .	16	15	16	16	16	16	16
From between jaws to tip of snout. . . . .	29	32	30	30	29	30	30

5. *Raja stellulata* Jordan and Gilbert.

A single specimen twenty-one inches in entire length was dredged in thirty fathoms of water. Comparing this with specimens of similar size from the coasts of California, Oregon, and Alaska, the following differences appear: the prickles are sparser and finer; the snout is not nearly so acute; the claspers are slenderer, and very flexible, being quite inflexible in the others; the teeth are not so sharp, and the markings are different. In view of the scanty material at hand, none of the differences are great enough to warrant considering this form a separate species.

Most of the markings remain distinct in alcohol. The color is prevalently dusky light brown with indefinite, very faint slaty spots of varying size scattered over the body, the one at the base of the pectorals being the largest. Small dark spots, some of them arranged around the slaty spots, but not numerous enough to suggest rings, are scattered over the body. The most conspicuous markings are clear naples-yellow spots, ringed with dusky brown, and arranged symmetrically in reference to opposite sides of the upper surface of the disk. The largest is triangular with rounded angles, placed behind the middle of the pectorals, and probably composed of three round spots fused together. A small round spot just inward from this one outward from the eye; one behind the gill-cavity on the shoulder-girdle; one on the middle of the ventral; four or five following the posterior edge of the pectoral; and a few others less definite scattered

at various places, but in the same position on both sides of the body. A yellow cross-bar on caudal. The other specimens from the other localities are plain brown on the body.

In the collection of the University of Washington is a young female skate, four and one-half inches in length, which is referable to this species. The disk is nearly circular, and the snout is represented by a small tubercle in a notch in the front of the disk, but it scarcely extends outward to even with the anterior edge of the disk. The surface of the body is sparsely covered with long fine prickles. There is a very definite row of enlarged spines down the middle of the back and tail. There is a white spot ringed with dusky behind the middle of each pectoral; a pair of very conspicuous white spots on back of tail a little in front of middle of tail nearly meeting medially, and two other pairs much less conspicuous spaced between these and the dorsals.

This specimen agrees very well with the species described by Garman as *Raja kincaidi* (Bull. Mus. Comp. Zoöl., 1908, Vol. LI, No. 9, p. 254). A series of somewhat larger specimens in the Stanford University collection makes it evident that it is the young of *Raja stellulata*.

Dr. Evermann (Bull. Bur. Fish., XXVI, p. 229) concludes that *Raja stellulata*, *Raja binoculata* and *Raja rhina* are all one and the same species. The material at hand certainly does not bear out this supposition. Though *Raja rhina* and *Raja binoculata* are very easily distinct from each other (as here shown under their respective names) *Raja stellulata* stands farther from them than they do from each other.

A specimen of *Raja stellulata* twenty-two inches in length has claspers just a quarter of this length (five and one-half inches), while in a specimen of *Raja rhina* only an inch shorter in length the claspers do not yet reach to the posterior edge of the ventrals, and in *Raja binoculata* of similar size they are still shorter. The pectoral rays of *Raja stellulata* extend anteriorly until they nearly meet near the tip of the snout, being separated by a space not greater than the diameter of the eye. In the other two species the pectoral rays are separated anteriorly by a wide translucent area at least three times the width of the interorbital space. The rostral cartilage of *Raja stellulata* is so delicate that it can scarcely be distinguished without dissection, while in the other two species the cartilage is very strong, being easily felt and seen through the skin. In *Raja stellulata* the body is everywhere covered with prickles in both sexes, and the interorbital space is covered with

coarse spinules which are scarcely enlarged at the orbital rim. The eye is much larger than in the others, and the sides of the disk meet in a more obtuse angle at the snout, forming a sigmoid curve on each

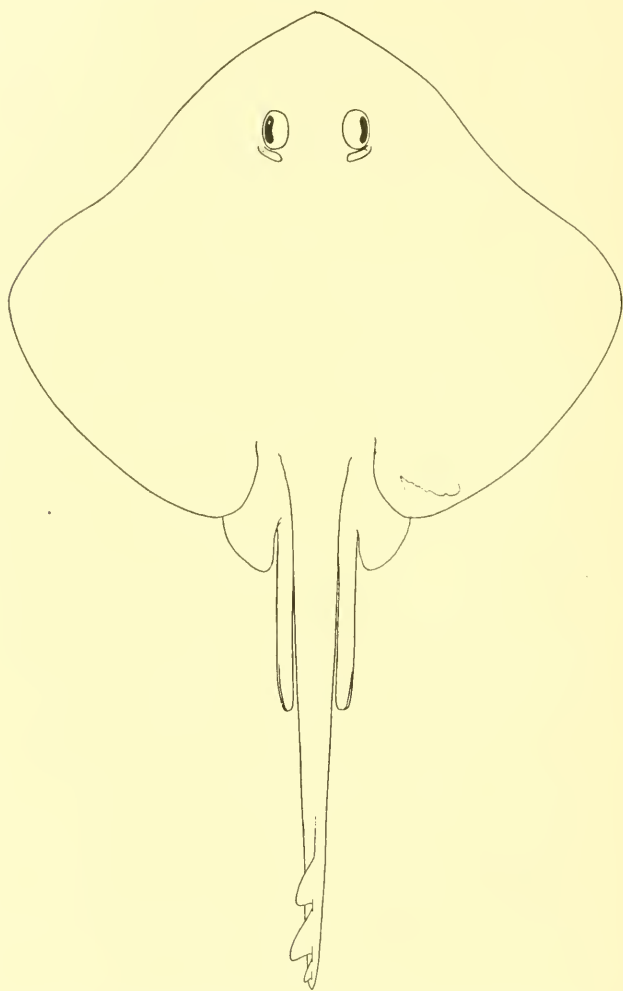


FIG. 8. *Raja stellulata*. ♂. 20 in. long. Puget Sound.

side, convex at the snout, concave towards the pectoral angles. The depth of the notch in the ventral fin is as in *Raja rhina*.



## Family CLUPEIDÆ.

6. *Clupea pallasii* Cuvier and Valenciennes

Great schools of the young of this species were seen, but few of the adults were either seen or taken. The young of a couple of inches in length has a dark lateral band, above which the back is lighter in preserved specimens; but those of three inches in length or longer have the entire upper half of the body dark, the change from the light parts below to the dark parts above being rather abrupt.

## Family ARGENTINIDÆ.

7. *Hypomesus pretiosus* Girard.

Very young specimens an inch and a half in length are almost perfectly transparent when fresh. Preserved they are white and show a double row of black dots along the ventral side. The statement in current descriptions and keys that the ventrals are under or behind the middle of the dorsal is not correct. It is in all sizes under the front, or a little behind the front of the dorsal, but never nearly so far back as the middle.

## Family SYNGNATHIDÆ.

8. *Syngnathus griseolineatus* Ayres.

Not very rare; about a dozen were taken in the seine. The brood-pouches contain eggs and young in all stages of development, and some of the females contain eggs apparently ready to be extruded.

A specimen of this species in the Stanford collections from San Bartolome Bay, Lower California, considerably increases its southern range.

Jordan and Starks in, *Fishes of Puget Sound*, (Proc. Cal. Acad. Sci., Ser. II, Vol. V) ascribe *Syngnathus californiensis* to the Sound. The only ground I can find for such a record are two papers by Jordan and Gilbert (Proc. Nat. Mus., III, pp. 452-458, and IV, pp. 29-70) in which this species is recorded from the Sound, but *Syngnathus griseolineatus* is there treated as a synonym of *Syngnathus californiensis*, hence the species should not be included in that fauna.

## Family EMBIOTOCIDÆ.

9. *Cymatogaster aggregatus* Gibbons.

Many male specimens are jet-black over most of the head and body, with the yellow vertical stripes more or less, sometimes completely,

—obliterated. There is always a light area above the anal, and, less constantly, upon the belly. The lighter longitudinal stripes usually show and the lower fins are scarcely involved. Other males are dusky brown with the yellow bars persisting, and still others are no darker than the females. Though the females vary considerably in depth of color, they never nearly approach the black males in this respect.

Family SCORPÆNIDÆ.

10. *Sebastodes melanops* (Girard).

Two specimens of this species were taken exhibiting two extremes of color variation. One is black on the upper parts, and the fins are black, or dusky black on the ventrals and anal, while the side is unevenly covered with irregular spots. The other specimen is light all over; the upper parts dusky, the spinous dorsal dark, but the other fins only slightly tinged with dusky, the ventrals and pectorals being nearly colorless, and the spots on the side only faintly indicated.

11. *Sebastodes introniger* Gilbert.

A single specimen four inches in length was taken with the dredge. It agrees very well with the original description and with some specimens taken near Unalaska. Coronal spines are present; the head is contained 2.75 times in the length; it has thirty-two scales in the lateral line (pores); the second and third anal spines are subequal, and it has all of the characters alleged by Dr. Gilbert to distinguish the species from *Sebastodes melanostomus*, with which it has been confounded.

The specimen from Puget Sound is yellowish in alcohol (bright red in life) with scattered dark spots representing indefinite cross-bars; a black spot on the opercle; dusky lines radiating from the eye; the ventrals tipped with black; the pectorals colorless; the distal half of the anal, caudal, and soft dorsal rays black; and the spinous dorsal narrowly margined with black.

12. *Sebastodes deani* Starks, sp. nov. (Plate XXIX.)

Head 2.6 in the length to the caudal base; depth 3.25. Eye 3 in head. Dorsal XIII, 14; anal III, 7; forty-five pores in lateral line; the lower jaw projects greatly and enters the profile, and has a large, rather sharp, symphysial knob. The teeth are in very narrow bands, in a single series on the side of the lower jaw, but growing wider

anteriorly, and with a well developed knob in front, which closes entirely in front of the premaxillary teeth, and partly in front of the upper lip. The premaxillary teeth are in very narrow bands, but in more than one series at the side. Anteriorly the band curves inwardly very strongly, and forms a deep notch; the curve is greater and the notch is much deeper than in *Sebastodes saxicola*. The vomer and the front of the palatines have a very few fine teeth, much finer and fewer than in *Sebastodes saxicola*; and their presence is rather difficult to detect. The interorbital space is considerably more deeply concave; it is without ridges, and its width, including the scaly rim that projects over the eye, and measured just behind the preocular spine, is contained 2.1 in the postocular part of the head; the bone is only 2.66 in the same space. The ocular ridges, though rather high, rise very gradually from the interorbital space. The ocular and tympanic spines are sharp, but not at all slender, and are very much larger and higher from their base than in *Sebastodes saxicola*. The preocular spines extend outward over the eye much more; the width of the interorbital (bone only) just behind them is two-thirds of the interorbital width across the tips of the spines. No supraocular spine is present. The occipital ridges are very high and sharp, shorter, higher, much more curved as viewed in profile, and the space between them much deeper than in *Sebastodes saxicola*; the ridges end behind in rather sharp, but low spines. The preorbital plate is armed below with two sharp angles, but these are not hooked backwards as sharp spines as is the case in *Sebastodes saxicola*. The suborbital ring is very narrow, not wider than the first dorsal spine, and narrower even than in *Sebastodes saxicola*. The eye is much larger and the postorbital part of the head shorter; the orbit is much longer than the snout, including the projecting mandible, and equal to the distance from its posterior margin to the tip of the upper opercular spine. The preopercular spines are not so slender, and the gill-rakers are slenderer, and anteriorly longer; the longest is contained 2.5 in the postocular part of the head; they number  $9 + 25$ . The maxillary reaches barely to the middle of the eye.

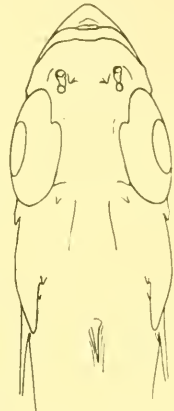


FIG. 9. *Sebastodes deani*. Top of head. To show spines.

The pectoral and ventral reach the same vertical point just behind the vent (in *Sebastodes saxicola* the pectoral reaches well past the ventral); the pectorals are rather narrow and pointed. The second anal spine is stouter and both the second and first are much more strongly curved than in *Sebastodes saxicola*, the second projects well past the much slenderer third, but scarcely reaches to the tips of the soft rays; its length is half that of the head. The spinous dorsal is lower; the fourth and fifth spines are subequal in length, and equal to, or a trifle shorter than, the highest dorsal rays; the lowest spine at the dorsal notch is about half that length. The caudal is very shallowly notched.

The scales are moderately coarsely ctenoid on the body, and with scarcely any accessory scales except on the anterior part of the body and head; ctenoid scales cover the head to the tip of the snout, and cover the opercles and cheek. The preorbital, maxillary, mandible, and breast are closely invested with cycloid scales.

The color is very much darker than in any example of *Sebastodes saxicola* at hand. There is a conspicuous broad dark band on top of the caudal peduncle; another under the soft dorsal extending to below the lateral line and apparently composed of two bars run together; one under the posterior end of the spinous dorsal. Across the anterior part of the body the bars are run together, making the color more or less solid. A very broad dark bar runs back from the eye to the tip of the opercle, and another from the eye to the pectoral base. There is a very inconspicuous narrow bar between the anterior margin of the eyes; another between the posterior margin, and a third between the occipital ridges. The tip of the mandible is dark, and the anterior parts of the maxillary and premaxillary are dusky. The greater part of the dorsals and base of the caudal are dusky. The other fins are colorless, except the pectoral, which is very slightly tinged with dusky. Inside of the mouth and gill-cavities there are dusky blotches, and the peritoneum is black.

The type and only specimen was taken by a shrimp-dredger and secured by the zoölogists of the University of Kansas, to whom I owe the opportunity of describing it. It is 207 mm. in length, and is deposited in the collections of the Carnegie Museum.

I take pleasure in naming this species for Dr. Bashford Dean.

13. *Sebastodes caurinus* (Richardson).

Among the several specimens of this common species is one very dark individual with the fins and most of the body slaty-black; while the lower parts, which in the other specimens are yellow, are broadly washed with reddish-brown.

14. *Sebastodes clavilatus* Starks, sp. nov. (Plate XXX.)

The head is contained 3 times in the length to the caudal base; the depth 3.4 to 3.5 times. The mouth is small, with the lower jaw moderately projecting and slightly entering the dorsal profile; its tip projects a fifth of the diameter of the eye. The symphyseal knob is but little developed, and a very low convex portion of the dental surface fits in a notch at the front of the premaxillaries. Anteriorly the front of the premaxillary is on a level with the middle of the eye, or a little below that point, and the maxillary reaches back to under the middle of the eye; the length of the maxillary is 2.25 to 2.4 in the head. The eye is moderate in size and is equal to the length of the snout or a very little longer in the smaller specimen; it is contained 3.5 to 3.6 in the head. The interorbital space is very slightly, but uniformly, convex, and without median ridges; its width is four-fifths of the diameter of the eye. Ocular ridges are not developed, and their region is scaled over. The occipital ridges are moderately developed, rather sharp, but little curved, diverging slightly backward, scaled over, except at the extreme top, and ending behind in a fine sharp spine. Minute, but sharp, preocular, postocular, and tympanic spines are present. Preopercular spines small, the second the largest, the fifth scarcely developed. The gill-rakers are very slender and in length are equal to a half of the diameter of the eye; there are twenty-six or twenty-seven of them on the anterior limb of the first arch.

The scales are everywhere finely ctenoid, and accessory scales are absent. There are from forty-six to forty-eight pores in the lateral line, and an equal number above, counting the oblique series running upward and forward. Scales cover the snout, preorbitals, and sub-orbitals, maxillary, mandible, and median branchial rays; fine scales are on the bases of all of the fins, and follow the dorsal spines.

The pectoral is rather narrow and pointed; it reaches well past the vent and the tips of the ventrals, but not to the anal. The caudal peduncle is very slender and expands abruptly at the caudal base; its depth is equal to one-fourth of the length of the head. The caudal

is rather deeply notched; the depth of the notch with the outer rays held parallel is equal to half of the diameter of the eye. The second anal spine is a little longer and stouter than the third, but does not reach nearly to the tips of the rays; its length is 2 to 2.1 in the head. There are seven rays in the anal, and fifteen in the dorsal. The dorsal fin is low and rather deeply notched; the lowest spine at the notch is three-fourths of the length of the fourth spine, which is contained 2.66 in the length of the head. The anterior and highest dorsal rays are contained 2.33 in the length of the head. The ventrals reach to the vent.

The life colors of this species were not taken, but the general color was light red. The color pattern resembles that of *Sebastes proriger* and *Sebastes elongatus* in having the lateral line running in a continuous light streak, and a light longitudinal stripe along the side just above the pectoral. There are three dark stripes backward and downward across the cheek, and a conspicuous narrow dark streak along the middle of the maxillary. Dark blotches on the back suggest beginnings of cross-bars; there is one on top of the caudal peduncle, one near each end of the soft dorsal, one under the posterior end of the spinous dorsal, and others under the spinous dorsal more or less obscure and running together. The opercle bears a large dark spot; the tip of the mandible is dark; the outer edge of the membrane between the dorsal spines is dark, and there is a dusky shade across the caudal. The pectoral has a very light dusky tinge above, and the ventrals and anal are colorless. The peritoneum is jet-black.

This species differs from *Sebastes proriger* particularly in the much larger scales. As compared with the description of that species the maxillary is shorter, the eye smaller, the spinous dorsal lower, and the second anal spine shorter.

Here described from two specimens, 14 and 15 cm. in entire length, dredged in deep water near the San Juan Islands, Washington. The larger one is the type and is deposited in the collections of the Carnegie Museum at Pittsburgh. The co-type is in the collections of Stanford University.

15. *Sebastes emphaeus* Starks, sp. nov. (Plate XXXI.)

The head is contained from 3 to 3.1 times in the length to the caudal base; the depth from 3.125 to 3.33. The mouth is small; the lower jaw somewhat projecting; usually not so much as in *Se-*

*bastodes clavilatus*, though between large individuals little difference can be appreciated in this character, as well as in the character of the symphysial knob, or the notch in the front of the premaxillaries. The maxillary reaches back to under the middle of the eye, or in the largest specimens a little past the middle; its length is from 2.25 to 2.33 in the head. The eye is as long as the snout, including the projecting mandible; its diameter is contained from 3.25 to 3.50 in the head. The interorbital width is three-fourths of the diameter of the eye. It is less uniformly convex than in *Sebastes clavilatus* owing to the orbital ridge being a little more prominent, so that there is a slight depression between the raised orbital rim and the convex middle portion of the interorbital space. With this exception, and with the exception that the occipital ridges are a little closer together, the cranial ridges and spines are alike in the two species, as well as the preopercular spines. The slender gill-rakers are half the length of the eye, or a little longer, and number from twenty-six to twenty-eight on the lower limb of the arch.

The scales are a little larger than in *Sebastes clavilatus*, particularly above the lateral line, but are otherwise similar and cover the same areas. They number from forty-one to forty-five in the lateral line or in the oblique series above the line. The pectoral is not so narrow and pointed, and does not reach so far back. The caudal peduncle is wider and not so abruptly expanded at the caudal fin; its depth is contained from 3.4 to 3.6 in the length of the head; the notch in the caudal is not more than half as deep. The second anal spine is considerably longer and stouter than the third, and much stouter than in *Sebastes clavilatus*. It sometimes reaches almost to the tips of the soft rays, but usually is somewhat shorter; its length varies from 1.6 to 1.8 in the head. The anal fin is a little farther forward than in *Sebastes clavilatus*. There are seven anal rays, and fifteen dorsal rays. The lowest spine at the dorsal notch is from one-half to three-fifths of the length of the fourth spine, which is 2.4 to 2.5 in the head or usually equal in length to the anterior dorsal rays, but sometimes a little shorter. In females with the abdomen swollen with eggs the ventrals do not nearly reach to the vent, but they do reach to it in the males.

The color of specimens taken in life is coppery-red with indefinite, broken, greenish-brown cross-bars or blotches. Greenish bands run back from the eye. Spinous dorsal dark green, with bright red towards tips of spines; the outer half of the soft dorsal bright red, the base

of the fin almost black. Pectorals, ventrals, and anal a clear brilliant light red. In alcohol there is a dark blotch on top of the caudal peduncle, a couple of dark bars under the soft dorsal, usually united into one, except at the base of the fin, and continued on the base of the dorsal; three more or less united bands under the spinous dorsal; the bands continuous across line without the interruption of a light streak as in *Sebastodes clavilatus*; the bands under the spinous dorsal are continued on the fin to the edge of the membrane, but usually leave a narrow light edge. With the exception of this narrow light edge the entire membrane of the spinous dorsal is sometimes dusky greenish. Two broad streaks run backward from the eye, the lower one continued to the base of the pectoral; a shorter narrow one just above the maxillary; maxillary sometimes with a narrow band longitudinally. The entire color is much darker than in *Sebastodes clavilatus*.

The chief differences between this species and *Sebastodes clavilatus* may be here repeated. The body is deeper, and with a deeper caudal peduncle, the caudal is less deeply notched; the scales are larger, the anal spine stouter, the color darker, and the lateral line does not run as an uninterrupted streak.

This species was the commonest *Sebastodes* brought up in the dredge from deep water. The longest specimen is 16 cm. in length and the smallest considered in this description is 13 cm., though many smaller ones were saved. The type is one of the largest specimens and is deposited in the Carnegie Museum with some of the cotypes. Other cotypes are preserved and are deposited in the collections of Stanford University and in the American Museum of Natural History in New York.

#### Family HEXAGRAMMIDÆ.

##### 16. *Hexagrammos decagrammus* (Pallas).

The scales on the suborbital stay together with the occipital pair of flaps, which serves to distinguish the adult of this species, can not always be relied upon for the young up to two and one-half inches in length, as in the young the scales on the stay are often difficult to detect, and the occipital flaps are sometimes aborted. The long fourth lateral line serves at once to separate the species from *Hexagrammos stelleri*, and the concave caudal from *Hexagrammos superciliosus*.



17. *Hexagrammos stelleri* Tilesius.

This species was not nearly so commonly taken as *Hexagrammos decagrammus*. The species may at once be known by its short unforked fourth lateral line, which never reaches the tip of the ventral, and usually but little past its base.

18. *Oxylebius pictus* Gill.

This species was frequently seen swimming about the piles of old wharves in Friday Harbor, or sometimes clinging in a peculiar manner with its ventral surface against a pile, its body often straight up or down. Only one specimen was secured.

Family COTTIDÆ.

19. *Jordania zonope* Starks.

Two specimens were collected with a dip-net under an old pier in Friday Harbor; others were seen swimming about the piles apparently finding food among the barnacles.

The typical specimens have XVIII, 16 (not XVII, 15) rays in the dorsal, and twenty-three or twenty-four (not twenty-two) rays in the anal. The specimens from Friday Harbor have the dorsal XVII, 17 and XVIII, 16, and twenty-three rays in the anal.

The colors in life are: body olive-green with reddish spots growing redder towards the tail; lower part of sides with reddish-brown markings; indefinite cross-bars on the back; olive-brown bars on the head margined with clear light green, one downward from the eye, one forward from the eye to the snout, one across the preopercle; a light green band following the edge of the opercle; lips red, caudal clear orange-red with very inconspicuous cross-bars; anal orange-red without markings; ventrals a little more yellow; pectoral greenish, growing red towards tips of rays, and crossed by dark bands; spinous dorsal dark olive-brown with light cross-bars across the spines; soft dorsal with rather fine light and dark cross bars.

20. *Radulinus asprellus* Gilbert.

This species was commonly taken in the dredge. Two mistakes may here be pointed out occurring in the description and key of this species published by Jordan and Evermann (U. S. Nat. Mus. Bull., 47, p. 1919). Instead of "the pectoral reaching to or nearly to the vent," the description should read "to the vent," as in the original

description. The pectoral reaches well past the front of the anal. In the key to the genus the character of the interorbital space for the two species has been transposed. The key should show the interorbital space *scaled over* for *Radulinus boleoides* and *naked* for *Radulinus asprellus*.

21. *Radulinus boleoides* Gilbert.

Two male specimens were taken in the dredge in deep water; the only ones known since the single typical specimen was taken off the Island of Santa Catalina, southern California. They measure respectively 135 and 140 mm. in length. They differ only from the description of the type as specimens twice as long as the type might be expected to, though there is some variation shown in the number of fin-rays and lateral plates.

The head is 3.87 in the length to the caudal base; the depth 7. The eye is 3.75 to 4 in the head; the snout 3; the maxillary 2.75. The dorsal numbers X-21; the anal 22; the pectoral 20. There are forty plates in the lateral series in both specimens. The upper preopercular spine is broad, and not very sharp; the lower one very broad, or in the larger specimen only forming a slight angle; the two rounded processes below are scarcely indicated. The supraorbital rim is slightly raised, so that the interorbital space is concave. The filaments on the eye and occipital region are very minute in one specimen, and difficult to find, but they are present in both. The pectoral reaches to the base of the fourth or fifth anal ray.

The differences between this species and *Radulinus asprellus* may be here repeated with some additions. The head of *Radulinus boleoides* is more completely scaled. Instead of a narrow v-shaped band about one scale wide at the posterior part of the eyes there is a band two or three scales wide. The interorbital space is scaled over, and the scales follow the anterior margin of the eyes. There is a transverse band of scales across the occipital region. The opercles and cheeks are more completely scaled. The lateral series of scales are rounder in outline, not so evidently keeled and angulated behind, and narrower in vertical width. The eye in particular is much smaller; the nasal spines are smaller and slenderer. *Radulinus boleoides* has minute supraorbital and occipital filaments. The dorsal spines are much higher, the tips of the longest spines when depressed reach to the fourth or fifth dorsal ray, while in the male of *Radulinus asprellus* they reach scarcely past the front of the soft dorsal.

22. *Triglops macellus* Bean.

Five specimens of this species were collected from deep water. Three of them have the dorsal XI-29, and the anal 29; the other two have the dorsal XI-28, and the anal 28. All of them have six lower pectoral rays produced (*five* in the type) and nine other pectoral rays, except in one, which has ten as in the type. The lower jaw is included, and the bony interorbital space is a fifth of the diameter of the eye (*a third* in the type). There is a very conspicuous round black spot on each side of the tip of the snout just above the edge of the maxillary. The specimens otherwise agree very well with the original description.

23. *Triglops beani* Gilbert.

Rather abundant in deep water, where several specimens were taken. The largest was 180 mm. in length. The peculiar cross-folds on the breast are usually, but not always, present; and all intermediate conditions are represented among the specimens collected, ranging from five or six folds to none whatever.

24. *Chitonotus pugetensis* (Steindachner).

Apparently rather rare in Puget Sound. A few specimens were taken in the dredge.

In life the colors are slaty-black on the anterior part of the back and the top of the head, while posteriorly the back is greenish. The upper part of the body is crossed by brown bands. The side below the middle of the body is white with irregular spots of clear coppery red. The pectoral is yellow crossed by reddish-brown bands. The ventrals, anal, and under parts of the body are milk-white.

25. *Stelgidonotus latifrons* Gilbert and Thompson.

A second specimen of this recently described species (U. S. Nat. Mus. Proc., XXVIII, 1905, p. 977, Friday Harbor, Washington) was taken. It is not known whether it was seined, dredged, or taken in a tidal pool; neither does it appear in the original description how the type was taken.

It is somewhat longer than the type, being 35 mm. in length, the type was 24 mm. long, and is a male with the anterior anal rays produced and a very minute or scarcely developed anal papilla. It has the dorsal rays IX-18, the anal 14, and the pectoral 14, or one less soft ray in the dorsal and anal and one more in the pectoral than in

the type. There is a well developed, simple, supraorbital tentacle above the posterior part of the eye, one at the occiput, and two equally spaced between these on each side of the head. There are two on the preopercular margin, one on each nasal spine, and a very minute one on the end of the maxillary. It is more completely invested with spinules than was the type; the naked area along the base of the anal is scarcely to be appreciated, the breast is covered, except a small area in front of the ventral base, and just behind the branchiostegal membrane, the head and postaxial area are naked. The lateral plates are even less conspicuous than is shown in the drawing of the type, and each anterior one bears a simple filament. The specimen at hand agrees otherwise with the original description.

26. *Icelinus borealis* Gilbert.

This was the commonest fish brought up in the dredge. The largest specimens are four inches in length, considerably larger than the typical ones. Of the three spines which are usually present in the typical specimens below the forked preopercular spine, the upper one is absent in these specimens, except in the very small ones.

27. *Astrolytes fenestralis* (Jordan and Gilbert).

This common species was taken with the seine in abundance.

The soft rays of the dorsal in fourteen specimens number seventeen, in three specimens sixteen, and in two specimens eighteen. In the anal fourteen specimens have thirteen rays, four specimens have twelve, and one has fourteen. The dorsal band of scales has from thirty-two to thirty-five in the series, and the pores of the lateral line number from thirty-five to thirty-seven. In two or three specimens the lowermost prong of the preopercular spine has failed to develop, or is very small, thus making the spine trifid.

28. *Axyrias harringtoni* Starks.

This species was found to be rather abundant in shallow water where several specimens were taken with the seine in company with *Astrolytes* and *Artedius*. The largest was four inches in length.

The following additions may be made to the original description. The dorsal has seventeen soft rays and the anal thirteen in the type (not sixteen and twelve), in each case the last ray being slenderer than the others. This is the usual number of dorsal rays in the

specimens at hand, varying occasionally to eighteen. One specimen has ten dorsal spines, or one in excess of the usual number. The space between the bases of the first two spines is much less than that between the other spines, and the tips of the spines are very soft and fine-pointed. The dorsal band of scales varies from forty-seven to fifty-four and is nine or ten scales wide anteriorly, counting obliquely. The lateral band is thirty-six or thirty-seven, rarely thirty-eight. The cirri are unevenly distributed along the lateral line, when present being either paired or single, but entirely absent on the majority of scales. As in the type, the preopercular spine is very narrowly forked, and in some cases the lower fork is only slightly developed. The lower jaw is slightly included, especially in the larger examples.

Among these specimens is a male (with the anal papilla enlarged) differing so much from the others that it is here referred to this species with some hesitation. A second male from Nanaimo, B. C., entirely agrees with this specimen. The number of scales and fin-rays, the general color, the shape of the bands of scales and teeth, the position of the cirri, the character of the preopercular spine are all as in the female specimens (the specimens in which the anal papilla is not enlarged). The body however is more robust, especially in the specimens from San Juan Island (the Nanaimo specimen is shrunken in alcohol). In the females the small, simple, pointed cirrus over the front of the eye, which is not longer than the diameter of the pupil, is replaced in the male specimens by a cirrus as long as the diameter of the eye, and with its edges along its distal half broken up into a plume of many subdivisions. A multifid cirrus over the posterior part of the eye does not differ greatly from that of the female except that it is somewhat enlarged and thickened. In the male the membrane between the anal rays is not so deeply incised, and instead of being concave it is convex. The anal and ventrals are white and spotless in the female. In the male they are dusky, and the anal is beautifully marked with fine lines forming a lace-work of small hexagons. Towards the marginal half of the fin a small light spot appears at each angle of the pattern, and soon the lines disappear, leaving only the spots. The lower part of the head is uniformly dusky, whereas in the female it is dusky marked with white spots and lines.

The genus *Axyrius* is most closely related to *Astrolytes*, and should perhaps be considered the same, especially as the lower process of the preopercular spine in some cases fails to develop in the latter genus,

making it bifid as in the former. In *Astrolytes*, however, when the spine is bifid, it is the lower process which has failed to divide, and the upper process is widely forked from the lower, and strongly hooked upward and inward. Other differences are the much finer scales in *Axyrius*; the flat multifid cirrus over the posterior part of the eye, which in *Astrolytes* is smaller and simple; the presence of a cirrus over the anterior part of the eye; and particularly in the ctenoid scales of the lateral line, which are represented by small imbedded plates in *Astrolytes*.

29. **Artedius lateralis** (Girard).

This species is not found nearly so abundantly as *Astrolytes* or *Axyrius* among the San Juan Islands, being probably more southern in its distribution, as it is common in Monterey Bay. These specimens are not so conspicuously marked with a broad light band across the top of the head and body, which forms so striking a marking on the majority of specimens on the California coast. They do not exhibit much variation in the number of rays or scales. The dorsal has sixteen or seventeen rays, the anal twelve or thirteen; there are from twenty-six to twenty-nine series of scales in the dorsal band, and the pores of the lateral line number thirty-four or thirty-five.

30. **Hemilepidotus hemilepidotus** (Tilesius).

Several specimens were taken in shallow water. They all show the spotted under parts which help to distinguish this species from *Hemilepidotus jordani*. Of the eight specimens counted six have the usual number of fin-rays; dorsal III, VIII, 19; anal 15. The other two have twenty dorsal rays, one of them has seven spines in the second division of the dorsal, and sixteen rays in the anal.

Attention may here be called to an evident misprint in the description of *Hemilepidotus jordani* published by Jordan and Evermann (Bull. 47, U. S. Nat. Mus., p. 1934), in which the eye is stated to be three in the head. Specimens of a foot in length have the eye 4.5 in the head, and the original description states it to be four.

31. **Myoxocephalus polyacanthocephalus** Pallas.

Very common in shallow water. There is considerable variation in the width and concavity of the interorbital space apparent among specimens from Puget Sound.

33. *Scorpaenichthys marmoratus* (Ayres).

A larval specimen 15 mm. in length and a couple of very large ones were seined, but the latter were not saved. The small one is compressed and has three well developed preopercular spines; the interorbital space is much wider than in the adult; and the fleshy flaps on the head are very short.

34. *Blennicottus globiceps* (Girard).

A single specimen seven and a half inches in length, the largest ever recorded, was collected by the zoölogists from the University of Kansas at Kanaka Bay, San Juan Island, in a tidal pool. A series of specimens from four to six inches in length from Neah Bay are at hand. The larger ones have a very conspicuous bony ridge running back from each eye. The supraorbital ridge is higher, and the lateral line flaps bear more cirri on their posterior edges than in the small ones. In the small ones the ridges running back from the eyes are only indicated, but there is a perfect gradation in this as well as in the other characters. Specimens from the California coast have not been taken of greater length than about four inches. Specimens from Pigeon Point, California, have the head a little more thickly covered with cirri than in the northern specimens, but no other differences are apparent.

35. *Oxycottus embryum* (Jordan and Starks).

Four specimens were taken in tidal pools and seined. It is apparently rare throughout its known range from Point Lobos, California, to Karluk, Alaska. The species may be easily distinguished from *Oxycottus acuticeps* by the four pairs of tentacles on the top of the head between the eyes and the occiput, the very minute nasal tentacle, and the absence of a tentacle on the eye. On the other species there are only three pairs of tentacles on the head, the nasal tentacle is long, reaching nearly to above the middle of the eye, and the eye-ball just above the pupil bears a simple tentacle. In *Oxycottus embryum* the body is much stouter, especially at the caudal peduncle; the anal papilla smaller; the spinous dorsal rounder, and not so high in front; and the anal rays are fewer. There are multifid flaps on the anterior part of the lateral line in *Oxycottus embryum* each with from two to four points (except in the young where they are simple tentacles), and not developed as far back as the front of the anal, while in *Oxy-*

*cottus acuticeps* the flaps are simple at all ages, or sometimes the first one or two are doubled, and they extend backwards past the front of the anal.

36. **Oligocottus maculosus** (Girard).

Some large specimens of this fish which is very common in tidal pools were taken in the pools at Kanaka Bay, San Juan Island. The species may be readily known from *Oligocottus rubellio* and *Dilarchus snyderi*, which replaces it on the California Coast south of Monterey Bay (its range and that of the latter form overlap from Pigeon Point north to Crescent City) by the absence of cirri at the base of the dorsal fin, or anywhere above the lateral line, and by the absence of a definite dark spot on the front of the spinous dorsal. From *Oligocottus rubellio* it is further known by the smaller head and eye, being in this respect closer to *Dilarchus snyderi*. It has a much blunter snout and lower nasal spines than *Dilarchus snyderi*, from the male of which it is at once distinguished by the generic character of the connected first anal rays.

37. **Dasycottus setiger** Bean.

Taken abundantly in deep water; the largest specimen being eight inches in length. The occipital spines are not so high as in Alaskan specimens, with which these have been compared, and the transverse distance between most of the spines is less.

The life-colors are as follows: grayish flesh ground-color with chocolate-brown cross-bands, spots, and lines; pectoral lead-color, below edge with white; caudal with a light margin.

38. **Nautichthys oculofasciatus** (Girard).

This species apparently adapts itself to various depths, as it was taken from deep water (30 or 40 fathoms) in the dredge, and from shallow water in the seine. It is rather a sluggish fish, and no difficulty was experienced in catching in a dip-net a couple of specimens which were swimming in a foot of water.

The colors in life are orange-brown, the flesh translucent; the pectoral and cheek a little deeper in color than the rest of the head or body; some yellow about the snout and under side of the head; membrane of spinous dorsal light yellow, varying to green; the first spines olive-brown, crossed with light green; soft dorsal light brick-red, crossed with olive-brown; olive-brown spots on pectoral rays; ventrals yellow; anal like soft dorsal, but a little lighter; caudal with a wide



dark bar behind, and a narrow, broken bar at base; an olive-brown bar extending through the eye across the cheek; some inconspicuous light brown cross-bars on the body.

39. *Psychrolutes paradoxus* Günther.

A few specimens were taken in the seine, but it was not found at all abundantly as was the case at Port Ludlow, Washington, in 1896.

40. *Gilbertidia sigalutes* (Jordan and Starks).

A specimen 55 mm. in length was dredged. It is in a much better state of preservation than the type, or the specimen reported upon by Dr. Gilbert (Proc. U. S. Nat. Mus., XXXVIII, p. 981). The specimen at hand differs from Dr. Gilbert's specimen (with which it is directly compared) in being much wider, deeper, and with a wider interorbital space, owing wholly to the fact that the latter specimen is greatly shrunken. The skin is lax as in Liparids, and it is covered closely with small papillæ. The anterior nostril is in a short tube. The dorsal spines are invisible under the loose skin except at their tips, which extend beyond the skin, appearing as soft tubercles. About half of the length of the ventrals is hidden by the skin.

Family RHAMPHOCOTTIDÆ.

41. *Rhamphocottus richardsoni* Günther.

This species was taken rather abundantly by the dredge. It is known among the shrimp dredgers of Puget Sound as the "horse-fish."

Family AGONIDÆ.

42. *Hypsagonus quadricornis* (Cuvier and Valenciennes).

Taken in abundance at thirty or forty fathoms. These and others from off Washington, collected by the "Albatross," have the rostral barbel considerably longer and thicker than in some specimens from Behring Sea, with which they have been compared.

In alcohol there is considerable variation in the markings. Some specimens are slaty-black under the spinous dorsal, the color sometimes extending over the belly. In other specimens this region is almost white, and in these the spinous dorsal is also involved. Behind this broad area are several narrow bands variable in width and thickness, but more constant in position. There is a dark spot at the base of the caudal, and a dark band follows the posterior outline of the caudal,



but the border of the caudal is white. In life the color is senna-brown or dull opaque yellow, with the darker markings brown. One specimen had the spinous dorsal a very bright carmine, the color continued down on the back to the middle of the side. Another had the base of the spinous dorsal and the entire body below it a bright ochre-yellow.

Many of the specimens are thickly covered with a thick growth of hydroids.

43. *Pallasina aix* Starks.

A few specimens were collected. Though this species should possibly stand as *Pallasina barbata* it seems better to consider it as distinct until better evidence to the contrary is presented than I am able to furnish with the material at hand. It has a larger eye than in any of the available specimens from Alaska. This is particularly so in the single large example (five inches long) in which the eye is five-hundredths of the length, while in specimens of equal size from Alaska it is three and one-half hundredths. The length of the mandibular barbel is not variable in Puget Sound examples. As has been pointed out before, specimens with either two or three preventral median plates occur both among the typical *Pallasina barbata* and *Pallasina aix*, but among the latter two is the usual number, and three the exception, while among the others two is the exception. In the cotypes of *Pallasina aix* and the specimens of the present collection from Puget Sound sixty-four have two plates, six have three plates, and two have one plate.

44. *Xeneretmus latifrons* (Gilbert).

Specimens differing in no essential way from the description of the type, or from specimens collected from off Monterey by the "Albatross," were taken rather abundantly in the dredge at a depth of about forty fathoms.

45. *Xeneretmus infraspinus* Gilbert.

A couple of dozen specimens of both sexes of this species were taken by the dredge in deep water in company with *X. alaskanus*, which exceeded it in abundance about three to one. The largest of these is about four and one-half inches in length.

This species is much more robust than *X. pentacanthus*, as was pointed out in the original description (Proc. Cal. Acad. Sci., Ser. III, Vol. III, p. 262). The width of the head is from 5.75 to 6.5 in the entire length to the base of the caudal, while in *X. pentacanthus*

it is from 8 to 9.5.<sup>4</sup> The condition of the preentral plates, which may usually be depended upon to separate these two species, is not absolutely dependable, as occasionally *X. pentacanthus* has only one pair, as in *X. infraspinatus*, instead of two, its normal number.

*X. infraspinatus* resembles *X. alaskanus* much more closely, but may at once be known by the well developed spines on the lower lateral body ridge. These are sharp, stand well away from the body, and do not decrease in size to the base of the caudal fin. In *X. alaskanus* these spines are reduced to very small needle-like points lying close to the body, and on the caudal peduncle are scarcely distinguishable by the naked eye, though they may be readily felt by the finger.

The body of these specimens is scarcely slenderer than that of *X. alaskanus*, nor are the spines and ridges on the side of the head weaker. The postocular spines are usually smaller, and the postocular and nuchal depressions wider and deeper. The anal opening though very often farther back than it ever is in *X. alaskanus*, is, on the other hand, frequently as far forward as in that species. This variation is not sexual.

The small point extending forward on the rostral plate noticed by Dr. Gilbert (Proc. U. S. Nat. Mus., XXVIII, p. 982) is often absent especially in large specimens. In the same paper a *lapsus calami* may be here corrected. In stating the width of the interorbital as being equal to three-fourths of the diameter of the orbit, the intention was to give three-fourths of the diameter of the pupil. In the specimens at hand this dimension varies from three-fourths to the full diameter of the pupil. The variation is that of the pupil rather than that of the interorbital.

#### 46. *Averruncus emmelane* Jordan and Starks.

This was found to be the commonest agonoid fish among the islands. Specimens were taken in abundance in the trawl at from fifteen to forty fathoms.

Of the sixteen specimens examined, ten have nine dorsal spines, and six have eight; twelve have eight dorsal rays, and four have seven; eleven have eleven anal rays, and five have twelve. The pores of

<sup>4</sup>The greater variation in *X. pentacanthus* goes with the greater discrepancy in size of the specimens measured in that species. They were from three and a half to seven inches long, the larger ones the slenderer. In *X. infraspinatus* the specimens were from three to four and one-half inches.

the lateral line number from thirty-eight to forty, the count for the typical specimen being incorrect (thirty-five). The color of the ventrals abruptly coal-black at the base, where they sharply contrast with the white breast, and abruptly white at the tips was found to be a very constant character.

Among these specimens are some small ones, which more or less completely bridge the gap between this species and *Xystes axinophrys*, making it evident that the latter form is the young of this species. The type of *X. axinophrys* is one and three-quarters of an inch long. In addition there are at hand two specimens from Port Ludlow, and one from the San Juan Islands of the same size as the type and agreeing with it in all particulars. A specimen a little under three inches long and several a little larger, from the last locality, show some decided intermediate characters, though more strongly those of *A. emmelane* than of *X. axinophrys*.

In the young (type of *X. axinophrys*) the supraocular spine is very much enlarged, and stands outward over the eye as a high crest. All of the ridges of the head are broken up into spines, and the body spines are larger and sharper than in the adult. The ventral ridges, which are spineless in the adult and lost on the caudal peduncle, are in the young armed with as large spines as the other ridges, and continue as two distinct ridges to the base of the caudal. The dorsal ridges, though not entirely uniting in the adult, are more distinctly separate in the young. In the young the soft dorsal and anal are much higher posteriorly, the rays not decreasing much in length backwards, and are not so broadly adnate to the body. The cirri on the under side of the head are only indicated by well developed fleshy tubercles, but in the exact places and number that they are in the adult. The number of fin-rays, body-spines, and lateral line pores are the same. (The type of *X. axinophrys* has eleven anal rays, not ten.) The color of the young is like that of the adult.

All of these changes are along the lines of those known to occur in other agonoid fishes.

Family LIPARIDÆ.

47. *Liparis callyodon* (Pallas).

Two specimens 2.5 and 3.5 inches in length, and a few small ones a couple of inches in length were collected in the dredge. The species has a much firmer body and tougher skin than *L. dennyi*, as the speci-

mens were preserved perfectly in the same solutions which failed to preserve specimens of the latter species.

As there is some discrepancy between these specimens and the description published by Jordan and Evermann (U. S. Nat. Mus., Bull. 47, p. 2110) the following description is submitted:

The depth of the body under the anterior dorsal lobe is from 4.2 to 4.33 in the length to the caudal base. The length of the head is from 3.50 to 3.66. The maxillary extends to under the anterior margin of the eye; its length is contained three times (or very slightly less) in the head. There are seven or eight series of teeth on each side of the upper jaw counting the series which become parallel with the jaw at the side. Counting the series which run in the opposite direction, or more or less transversely to the jaw, there are fourteen or fifteen. The nostril is in a broad tube; anterior to it is a large pore, and posterior to it over the front margin of the eye is a larger one. The disk is contained 2.8 in the length of the head, or 1.33 of its own distance from the tip of the jaw. The length of the gill-opening is one-fourth of the length of the head; it extends only very slightly in front of the pectoral, not more than to the base of the second ray from the top. The anal opening is the diameter of the disk behind the disk, and an equal distance from the front of the anal. The longest ray in the lower pectoral base is half the length of the head. The longest pectoral rays are equal to the length of the caudal, and are contained 1.66 in the length of the head. The dorsal and anal scarcely join the caudal, or, if at all, only at the extreme base, and there is a decided notch between. The dorsal rays number forty, of which five are of the anterior lobe, the anal thirty-one, and the pectoral thirty-six. An anterior lobe is separated from the rest of the dorsal fin by a deep notch.

This species may be known from all other liparids of the west coast having a large anterior dorsal lobe, with the exception of *L. mucosus*, by the very small gill-opening. *L. mucosus* may be at once recognized by the very large ventral disk; the diameter of which is two-thirds the length of the head.

#### 48. *Liparis cyclopus* Günther.

Three small specimens were dredged. The anterior dorsal rays slightly indicate an anterior dorsal lobe, making this one of the intermediate forms between the genera *Liparis* and *Neoliparis*.

49. *Liparis dennyi* Jordan and Starks.

This species is the most abundant liparid about the San Juan Islands. Many specimens were taken in the dredge. The skin is very thin and tender, and they were more difficult than any other species to preserve in either alcohol or formalin. *L. dennyi* may be known from all others of its genus on our coast except *L. fucensis* by the very wide gill-opening, extending down to about the tenth pectoral ray from the top. From *L. fucensis* it may be distinguished by the broader attachment of the dorsal and anal to the caudal, and by the more robust body.

50. *Liparis pulchellus* Ayres.

A dozen small specimens were taken in the dredge. The dorsal and anal are more broadly joined to the caudal than in any other west coast species. They join the caudal without a notch and together form a continuous fin around the tail. The caudal appears pointed in preserved material, when it is not spread.

## Family BATHYMASTERIDÆ.

51. *Ronquilus jordani* (Gilbert).

This species is not very rare, and a number of specimens were taken in deep water. Among them there is an astonishing variation in color, which, however, does not vary with surroundings as stated by Jordan and Evermann (Bull. 47, U. S. Nat. Mus., p. 2289), as both extremes of variation frequently occurred in the same haul of the dredge. Some specimens have the anal and ventrals, and the lower half of the pectorals jet-black. The gradation from this to entire absence of color on these fins is perfect. The specimens with dark lower fins have the dorsal and anal rays (the other fin-rays do not vary materially) much longer than in those with light lower fins. These would appear to be sexual differences, were it not for the fact that there is nearly as complete a gradation between the long- and short-rayed forms, as there is between those having light and those having dark fins. A slight break will, however, be noticed, above which the dorsal rays run from fourteen to eighteen hundredths of length, and below from ten to twelve. There is no break in color at this place.\* There is considerable variation in the shade of the body-color, but this is apparently not correlated with the other characters, except that there are no very dark-bodied individuals with perfectly colorless lower fins, though light-bodied specimens may have black fins.

The following table is arranged in reference to the depth of color on the lower fins, ranging downward from black to colorless.

Length in mm. to Base of Caudal.	Shade of Lower Fins.	Longest Dorsal Ray in 100ths of Length.	Longest Anal Ray.	Shade of Body.
138	jet black	18	12	dark
95	jet black	15	11	dark
107	jet black	15	11	rather dark
115	dark slate	14	11	dark
135	slate	16	11	very dark
131	slate	15	10	very light
105	slate	15	10	dark
111	light slate	14	9	dark
123	dusky	11	10	light
132	slightly dusky	10	8	dark
100	slightly dusky	12	9	dark
122	very slightly dusky	11	8	light
103	colorless	10	8	rather light
120	colorless	11	8	very light

In life the body is greenish-grey with short reticulated lines of canary-yellow extending longitudinally; a bright yellow line around lower part of eye, and another across cheek; some specimens have the dorsal and pectoral yellow, with the lower rays of the latter abruptly dark slate-color; the ventrals and anal similarly colored, but the latter shading into a clear electric blue toward the base of the rays; in others these lower fins are light yellow. The caudal is always yellow.

#### Family BLENNIIDÆ.

##### 52. *Pholis ornatus* (Girard).

This is the commonest blenny in the region, and was taken in the seine, in tidal pools, and even in the dredge in fifteen or twenty fathoms of water. The number of dorsal spines does not vary greatly. In the eighteen specimens which were carefully examined, ten had seventy-six, six had seventy-seven, and two had seventy-eight spines.

##### 53. *Apodichthys flavidus* Girard.

Taken in abundance in the seine, but not found in tidal pools. The red and bright green forms occur together in exactly the same surroundings, and no specimens were taken which were intermediate in color.

A large male, fourteen inches in length, differs from females of equal size in being slenderer, and in having a longer head and maxillary.

The maxillary is contained 2.33 in the head, while in the females it is almost 3. Of two males a couple of inches smaller, one is intermediate in these characters, and the other does not at all differ from the females. These are possibly characters appearing with age after the limit of size is reached.

54. *Xiphistes chirus* (Jordan and Gilbert).

This species was not at all common about the islands; *Xiphidion mucosum* being much commoner, which in turn was not nearly so common as *Xiphidion rupestre*.

While collecting in 1895 in the southern end of the Sound and at Cape Flattery this species was found abundantly at the former locality, and one specimen (the type of *Xiphistes ulvæ*) was taken at the Cape, while the other two were taken only about the Cape. All three of the species were taken the following year at Port Ludlow, but the relative abundance of each does not appear. Further information on the distribution of these fishes in the sound would be of interest. It is not a deeper water species (at least about the islands) than the others as alleged in the original and in current descriptions, being found wherever *Xiphidion mucosum* occurs.

A re-examination of the type of *Xiphistes ulvæ* proves almost beyond doubt that the species is untenable. The branches of the upper lateral line are not longer than may be found in individuals of *Xiphistes chirus*. It has, however, three anal spines, but as all other characters are identical with those of *Xiphistes chirus* it is doubtless abnormal in this character. Color, the only other alleged difference, is so variable in these fishes that little dependence can be placed upon it.

55. *Lumpenus anguillaris* (Pallas).

Many specimens were seined from shallow water. The young have elliptical spots arranged in longitudinal rows, about equal in color, size, and spacing, over the sides and back. In the adult the spots in the row along the lateral line become more elongated and distinct, while below them the spots disappear, and above them they are more or less broken up into clouded reticulations.

The statement in current descriptions of the genus *Lumpenus* that the lateral line is indistinct, or obsolete, does not adequately state the facts, at least for this species. The lateral line is represented by slightly enlarged scales, not inconspicuous in individuals of mod-



erate sizes especially anteriorly, though less evident in larger ones. There are, however, no pores along the lateral line.

Family ZOARCIDÆ.

56. *Lyconectes aleutensis* Gilbert.

A single specimen, eight inches in length, representing this rare species, was taken in the dredge.

57. *Lycodopsis pacificus* (Collet).

Commonly taken from deep water in the dredge. In current descriptions a faint lateral line is described as running along the side of the body. It is only in exceptional cases that with the aid of a microscope a few very minute pores may be found running back for about a half an inch behind the opercle. In most cases even this much can not be found, so to say that the lateral line is even faintly indicated is misleading.

Usually there is a small black spot on the anterior end of the dorsal at the tips of the rays, and the dorsal is nearly always, but not invariably, margined with dusky or black.

58. *Lycodes brevipis* Bean.

This species was taken in the dredge nearly, but not quite, as commonly as *Lycodopsis pacificus*.

There is considerable variation in the bars on the back. These may end abruptly just above the middle of the side, or they may fade out gradually below, occasionally being faintly indicated posteriorly as far down as the anal base. Usually the bars are conspicuous, but occasionally they may be almost altogether absent. They may, or may not, be immediately surrounded by color darker than the body-color, and their number, which is usually eleven or twelve, may be increased to fourteen. The dorsal may, or may not, be bordered by dusky or black.

59. *Lycodes palearis* Gilbert.

Two small and two large specimens were taken in the dredge; the largest ten inches in length. The species has hitherto been recorded only from Bering Sea.

In small specimens where the cross-bars are evident, the species may be readily distinguished by the fact that the second bar on the back is entirely in front of the dorsal, and by the black spot on the front of

the dorsal. In *Lycodes brevipes* the second bar is well behind the front of the dorsal. In large individuals the color-markings disappear, but specimens of any size may be known from *Lycodes brevipes* by the longer ventrals, which are as long as, or longer than, the vertical diameter of the eye, while in the latter species they are considerably shorter than the eye, and by the more conspicuous mandibular folds. With the original description (in which most of the above differences, as well as others were noted) the small specimens agree, as do also the large ones with exceptions which may be accounted for by size.

In the specimen ten inches in length the head is contained 4.5 times in the entire length; the depth 8.5. The pectoral is 1.8 in the head (it is thus not materially different from *Lycodes digitatus* Gill and Townsend).

In one of the small specimens intermediate and less definite bars occur between the bars across the body and fins, which do not reach to the dorsal outline.

Family GADIDÆ.

60. *Microgadus proximus* (Girard).

Several small specimens were collected on the beaches with the seine, but it was not found in nearly such abundance as *Theragra fucensis*. The following differences between this species and *Microgadus tomcod* of the Atlantic Coast may be published here from notes made by Willis H. Rich, a student at Stanford University. In *Microgadus proximus* the fins, especially the first dorsal, are more falcate, while in *Microgadus tomcod* they are somewhat rounded. The number of rays in the second anal varies from twenty to twenty-three, while in *Microgadus tomcod* they number from sixteen to nineteen. The teeth of the outer row, especially along the side of the lower jaw, are a little larger. The gill-rakers are larger and not so blunt; their total number is from twenty-four to twenty-nine, while in *Microgadus tomcod* they number from sixteen to twenty-two. The color is lighter and not so much broken up into spots. The following tables show the range of variation of gill-rakers and second anal rays.

*Microgadus tomcod.*

Number of gill-rakers . . . . .	16	17	18	19	20	21	22
Number of specimens . . . . .	1	2	8	6	10	3	1
Rays of second anal . . . . .	16	17	18	19			
Number of specimens . . . . .	3	8	15	5			

*Microgadus proximus.*

Number of gill-rakers.....	24	25	26	27	28	29
Number of specimens.....	8	20	15	10	3	3
Rays of second anal.....	20	21	22	23		
Number of specimens.....	8	24	20	7		

61. *Theragra fucensis* (Jordan and Gilbert).

The young of from three to seven inches in length were taken in abundance in shallow water. It is only in the adult that the subopercular bones become swollen and dense, and so distinguish the genus *Theragra* from *Pollachius*.

Family PLEURONECTIDÆ.

62. *Lyopsetta exilis* (Jordan and Gilbert).

A large specimen, nine inches in total length, and a few small ones, about five inches long, were taken in deep water in the dredge. These are with much hesitation referred to this species. Comparing the large one with specimens from Oregon and southern California the body is found to be much deeper, the head smaller, and the fin-rays all a little shorter. These differences do not show, however, in the smaller specimens. In all of them the eye is smaller, the dorsal begins a little nearer to the snout, the distance from the interorbital to the upper profile directly above the middle of the pupil is a little less, the interorbital is lower, and does not extend back in such a high sharp ridge, the mouth is a little smaller, and the ventrals are a little nearer to the tip of the chin.

In the large specimen from Puget Sound the length to the caudal base is 190 mm. The head is 25.5 hundredths of this length; the depth 35; the long diameter of the lower eye 6.5; the distance of the dorsal from the snout 7.5; the interorbital to the profile at middle of pupil 6; the maxillary 9.5; the longest dorsal and anal rays 11.5; and the distance of the ventrals from the tip of the chin 24.

A specimen from Oregon of exactly the same length has the head 28 hundredths of the length; the depth 30; the eye 7.5; the dorsal from the snout 9; the interorbital from the profile 6.5; the maxillary 11; the longest dorsal and anal rays 13; and the ventrals from the chin 26. The pores in the lateral line vary from sixty-one to sixty-nine in all of the specimens.

The following tables show the variation in fin-rays.

## SPECIMENS FROM PUGET SOUND.

Number of dorsal rays.....	77	78	79
Number of specimens.....	1	3	3
Number of anal rays.....	60	61	62
Number of specimens.....	3	3	1

## SPECIMENS FROM CALIFORNIA AND OREGON.

Number of dorsal rays.....	80	81	82
Number of specimens.....	4	2	2
Number of anal rays.....	60	61	62
Number of specimens.....	2	3	3

63. *Citharichthys stigmæus* Jordan and Gilbert.

Four specimens were taken with the dredge, the largest five and one-half inches long. The dorsal rays vary in number from 80 to 87, the anal from 65 to 70, and the scales, counting the series above the lateral line, from 56 to 61. The depth of the body in these specimens is a little greater than in specimens from California and Oregon.

This record advances the range of the species from the southern Californian coast to Puget Sound. Specimens taken by the "Albatross" from off the coast of Oregon ("Albatross," Station 3055), are in the collections of Stanford University.

64. *Isopsetta isolepis* (Lockington).

A few specimens four or five inches in length were taken. The small dark spots are definitely placed. There is one opposite the tip of the pectoral above the lateral line, one at the base of the caudal on the lateral line, and one midway between these on the lateral line. There are four equidistant spots following the base of the anal, and six following the base of the dorsal. A less conspicuous spot is below the lateral line just behind the abdominal cavity.

65. *Parophrys vetulus* Girard.

This was the most abundant flounder of the region. The young was seldom absent from the contents of the seine. The small ones are spotted very much as in *Isopsetta isolepis*.

66. *Lepidopsetta bilineata* (Ayres).

Specimens of this common species, from four or five to thirteen inches in length, were taken in abundance. The species is in need of careful study with more material than is at hand. The sides of

the specimens from Puget Sound are very rough in all the sizes here represented, but in the smaller ones the scales are simply spined on their posterior edges. In specimens six inches long a few scales on the anterior part of the body and head become covered with spinules on their upper surface. As the fish grows larger these spine-covered scales extend over nearly the entire body. In the largest specimen there is only a small space towards the ventral and dorsal edges of the body where the scales are simply ctenoid and not covered with spinules.

Jordan and Goss in their review of the flounders and soles (Rept. U. S. Fish Comm., 1886, p. 286) make the following statement. "Specimens from Puget Sound and northward are rougher than southern specimens and constitute a slight geographical variety, for which the name *Lepidopssetta bilineata umbrosa* may be used."

We have only a single specimen obtained south of Puget Sound, a large example, sixteen inches in length, from San Francisco. This is so very different from northern specimens that it appears scarcely possible to refer it to the same species. However to pass definitely on this question will necessitate the study of a number of individuals. According to the laws which seem to govern the development of the ctenoid scales in the form from Puget Sound, the form from San Francisco Bay should grow rougher with size, but the scales of the body are all perfectly devoid of spinules either on the surface or posterior edge, except a very few (probably not exceeding half a dozen) scattered, slightly ctenoid scales. On the upper part of the head and on the cheek the scales are rough, with spinules on their surface. On the opercle and subopercle most of the scales are cycloid. The color is lighter and more broken up into light spots than in specimens from Puget Sound, and the maxillary of the blind side is longer.

Specimens from the north of Puget Sound likewise require study. Some taken just south of the Alaskan Peninsula ("Albatross," Station 3215) have the eye larger than in any of the others (from the various localities here mentioned). The upper eye is 6.5 hundredths of the length, while in the others it is from 5 to 5.5 hundredths. Specimens from Chignik Bay, Alaska, have the pectorals shorter than in any others. The pectoral of the eyed side is from 11 to 12 hundredths of the length, and on the blind side from 8 to 9 hundredths. In the others it is on the eyed side from 13 to 15 hundredths, and on the blind side from 10 to 11 hundredths. Specimens from Nikalski, Bering Islands, have

the snout more projecting than in others, and the color brown covered with fine light flecks.

All of the specimens from north of Puget Sound have the sub- and interopercles naked, while in the specimens from Puget Sound these bones are covered with smooth round scales.

67. *Microstomus pacificus* (Lockington).

Several specimens were taken in deep water. Specimens six or seven inches in length from off the southern Californian coast, collected by the "Albatross," are slenderer than specimens from Puget Sound of equal size, though this difference does not exist between larger specimens.

The markings vary from clouded indistinct dark brown spots to distinct rings and half-rings of dark brown, or nearly black, scattered over the body, with smaller dark round spots scattered between them and on the fins. Often there is a dark ring on the lateral line near the tip of the pectoral, another at the base of the caudal, and a third slightly nearer to the posterior spot than to the anterior. These are often duplicated above or below the lateral line. A row of less evident rings follows the base of the dorsal and anal.

68. *Glyptocephalus zachirus* Lockington.

This well marked species was found in abundance in deep water. There is much variation in the length of the pectoral of the eyed side between specimens of corresponding size, but it always increases in length with age. In specimens over four inches in length it is always longer, or as long as the head. In specimens smaller than this it may be longer or shorter than the head. In specimens seven or eight inches in length it varies from a quarter of the length of the head longer than the head to nearly twice the length of the head.

LIST OF FISHES KNOWN TO OCCUR IN PUGET SOUND.

Those marked \* are species referred to in the preceding notes, or else seen and examined by the writer, but not otherwise noted.

PETROMYZONIDÆ.

1. *Entosphenus tridentatus* (Gairdner).
2. *Lampetra cibaria* (Girard).

HEXANCHIDÆ.

3. *Notorhynchus maculatus* Ayres.
4. *Hexanchus griseus* (Gmelin).

GALEIDÆ.

5. *Prionace glauca* (Linnaeus).

SCYLLIORHINIDÆ.

6. *Catulus brunneus* Gilbert.

DALATHIDÆ.

7. *Somniosus microcephalus* (Bloch).

SQUALIDÆ.

8. *Squalus sucklii* (Girard).\*

RAJIDÆ.

9. *Raja rhina* Jordan and Gilbert.\*
10. *Raja binocolata* (Girard).\*
11. *Raja stellulata* Jordan and Gilbert.\*

CHIMÆRIDÆ.

12. *Hydrolagus colliæi* (Lay and Bennett).\*

ACIPENSERIDÆ.

13. *Acipenser transmontanus* Richardson.
14. *Acipenser medirostris* Ayres.

NEMICHTHYIDÆ.

15. *Nemichthys avocetta* Jordan and Gilbert.

CLUPEIDÆ.

16. *Clupea pallasii* Cuvier and Valenciennes.\*
17. *Clupanodon caruleus* (Girard).  
[*Alosa sapidissima* (Wilson). Introduced from Atlantic.]

ENGRAULIDÆ.

18. *Engraulis mordax* Girard.

SALMONIDÆ.

19. *Onchorhynchus tshawytscha* (Walbaum).
20. *Oncorhynchus kisutch* (Walbaum).

21. *Oncorhynchus keta* (Walbaum).\*
22. *Oncorhynchus gorbusha* (Walbaum).
23. *Oncorhynchus nerka* (Walbaum).
24. *Salmo mykiss* Walbaum.
25. *Salmo gairdneri* Richardson.\*
26. *Salvelinus malma* (Walbaum).

## ARGENTINIDÆ.

27. *Hypomesus pretiosus* (Girard).\*
28. *Thaleichthys pacificus* (Richardson).
29. *Osmerus thaleichthys* Ayres.

## MYCTOPHIDÆ.

30. *Tarletonbeania crenularia* (Jordan and Gilbert).
31. *Myctophum californiense* Eigenmann and Eigenmann.

## PLAGYODONTIDÆ.

32. *Plagyodus ferox* (Lowe).

## PARALEPIDÆ.

33. *Arctozenus coruscans* (Jordan and Gilbert).

## AMMODYTIDÆ.

34. *Ammodytes personatus* Girard.\*

## AULORHYNCHIDÆ.

35. *Aulorhynchus flavidus* Gill.\*

## GASTEROSTEIDÆ.

36. *Gasterosteus cataphractus* Pallas.\*

## SYNGNATHIDÆ.

37. *Syngnathus griseolineatus* Ayres.\*

## SPHYRNIDÆ.

38. *Sphyræna argentea* Girard.

## STROMATEIDÆ.

39. *Rhombus simillimus* (Ayres).

## SCOMBRIDÆ.

40. *Sarda chilensis* Cuvier and Valenciennes.
41. *Scomber japonicus* Houttuyn.



ZAPRORIDÆ.

42. *Zaprora silenus* Jordan.

BRAMIDÆ.

43. *Brama raii* Bloch.

EMBIOTOCIDÆ.

44. *Damalichthys argyrosomus* (Girard).\*  
 45. *Tæniotoca lateralis* (Agassiz).\*  
 46. *Embiotoca jacksoni* Agassiz.  
 47. *Brachyistius frenatus* Gill.  
 48. *Amphistichus argenteus* Agassiz.  
 49. *Phanerodon furcatus* Girard.\*  
 50. *Cymatogaster aggregatus* Gibbons.\*

SCIÆNIDÆ.

51. *Cynoscion nobilis* (Ayres).

SCORPÆNIDÆ.

52. *Sebastes melanops* (Girard).\*  
 53. *Sebastes mystes* (Jordan and Gilbert).  
 54. *Sebastes pinniger* (Gill).  
 55. *Sebastes ruberrimus* Cramer.  
 56. *Sebastes introniger* Gilbert.\*  
 57. *Sebastes deani* Starks, new species.\*  
 58. *Sebastes caurinus* (Richardson).\*  
 59. *Sebastes clavilatus* Starks, new species.\*  
 60. *Sebastes emphæus* Starks new species.\*  
 61. *Sebastes auriculatus dalli* (Eigenmann and Beeson).  
 62. *Sebastes maliger* (Jordan and Gilbert).  
 63. *Sebastes nebulosus* (Ayres).  
 64. *Sebastes nigrocinctus* (Ayres).

HEXAGRAMMIDÆ.

65. *Hexagrammos decagrammus* (Pallas).\*  
 66. *Hexagrammos superciliosus* (Pallas).  
 67. *Hexagrammos stelleri* (Tilesius).\*  
 68. *Ophiodon elongatus* Girard.\*  
 69. *Oxylebius pictus* Gill.\*  
 70. *Zaniolepis latipinnis* Girard.  
 71. *Anoplopoma fimbria* (Pallas).

## COTTIDÆ.

72. *Jordania zonope* Starks.\*
73. *Radulinus asprellus* Gilbert.\*
74. *Radulinus boleoides* Gilbert.\*
75. *Triglops macellus* Bean.\*
76. *Triglops beani* Gilbert.\*
77. *Chitonotus pugetensis* (Steindachner).\*
78. *Stelgidonotus latifrons* Gilbert and Thompson.\*
79. *Ruscarius meanyi* Jordan and Starks.
80. *Icelinus borealis* Gilbert.\*
81. *Tarandichthys filamentosus* (Gilbert).
82. *Astrolytes fenestralis* (Jordan and Gilbert).\*
83. *Axyrias harringtoni* Starks.\*
84. *Artedius lateralis* Girard.\*
85. *Hemilepidotus hemilepidotus* (Tilesius).\*
86. *Myoxocephalus polyacanthocephalus* (Pallas).\*
87. *Enophrys bison* (Girard).\*
88. *Leptocottus armatus* Girard.\*
89. *Scorpaenichthys marmoratus* (Girard).\*
90. *Blennicottus globiceps* (Girard).\*
91. *Oxycottus embryum* (Jordan and Starks).\*
92. *Oligocottus maculosus* Girard.\*
93. *Dasycottus setiger* Bean.\*
94. *Malacocottus kincaidi* Gilbert.
95. *Nautichthys oculo-fasciatus* (Girard).\*
96. *Blepsias cirrhosus* (Pallas).\*
97. *Ascelichthys rhodorus* Jordan and Gilbert.
98. *Psychrolutes paradoxus* Günther.\*
99. *Gilbertedia sigalutes* (Jordan and Starks).\*

## RHAMPHOCOTTIDÆ.

100. *Rhamphocottus richardsoni* Günther.\*

## AGONIDÆ.

101. *Aspidophoroides inermis* Günther.\*
102. *Bothragonus swani* (Steindachner).
103. *Hypsagonus quadricornis* (Cuvier and Valenciennes).\*
104. *Pallasina aix* Starks.\*
105. *Podothecus acipenserinus* (Pallas).\*

- 106. *Averruncus emmelane* Jordan and Starks.\*
- 107. *Xeneretmus latifrons* (Gilbert).\*
- 108. *Bathyagonus nigripinnis* Gilbert.
- 109. *Xeneretmus triacanthus* (Gilbert).
- 110. *Xeneretmus alaskanus* (Gilbert).\*
- 111. *Xeneretmus infraspinatus* Gilbert.\*
- 112. *Odontopyxis trispinosus* Lockington.\*

CYCLOPTERIDÆ.

- 113. *Lethotremus vinolentus* Jordan and Starks.
- 114. *Eumicrotremus orbis* (Günther).\*

LIPARIDIDÆ.

- 115. *Liparis greeni* Jordan and Starks.
- 116. *Liparis floræ* Jordan and Starks.
- 117. *Liparis callyodon* (Pallas).\*
- 118. *Liparis cyclopus* Günther.\*
- 119. *Liparis dennysi* Jordan and Starks.\*
- 120. *Liparis fucensis* Gilbert.
- 121. *Liparis pulchellus* Ayres.\*

BATHYMASTERIDÆ.

- 122. *Ronquilus jordani* (Gilbert).\*

GOBIIDÆ.

- 123. *Gobius nicholsi* Bean.
- 124. *Lepidogobius lepidus* (Girard).
- 125. *Gillichthys mirabilis* Cooper.
- 126. *Quietula y-cauda* (Jenkins and Evermann).
- 127. *Clevelandia ios* (Jordan and Gilbert).

BATRACHIDÆ.

- 128. *Porichthys notatus* Girard.\*

GOBIESOCIDÆ.

- 129. *Caularchus mæandricus* (Girard).\*

BLENNIIDÆ.

- 130. *Bryostemma decoratum* Jordan and Snyder.
- 131. *Bryostemma nugator* Jordan and Williams.
- 132. *Pholis ornatus* (Girard).\*

133. *Apodichthys flavidus* Girard.\*  
 134. *Xererpes fucorum* (Jordan and Gilbert).  
 135. *Anoplarchus atropurpureus* (Kittlitz).\*  
 136. *Xiphistes chirus* (Jordan and Gilbert).\*  
 137. *Xiphidion rupestre* (Jordan and Gilbert).\*  
 138. *Xiphidion mucosum* Girard.\*  
 139. *Plectobranthus evides* Gilbert.  
 140. *Lumpenus anguillaris* (Pallas).\*  
 141. *Delolepis virgatus* Bean.  
 142. *Lyconectes aleutensis* Gilbert.\*

## ANARRHICHADIDÆ.

143. *Anarrhichthys ocellatus* (Ayres).

## ZOARCIDÆ.

144. *Lycodopsis pacificus* (Collet).\*  
 145. *Lycodes brevipes* Bean.\*  
 146. *Lycodes palearis* Gilbert.\*

## SCYTALINIDÆ.

147. *Scytalina cerdale* Jordan and Gilbert.

## GADIDÆ.

148. *Microgadus proximus* (Girard).\*  
 149. *Gadus macrocephalus* Tilesius.  
 150. *Brosmophycis marginatus* (Ayres).  
 151. *Theragra fucensis* (Jordan and Gilbert).\*

## MERLUCCIDÆ.

152. *Merluccius productus* Ayres.\*

## TRACHYPTERIDÆ.

153. *Trachypterus rex-salmonorum* Jordan and Gilbert.

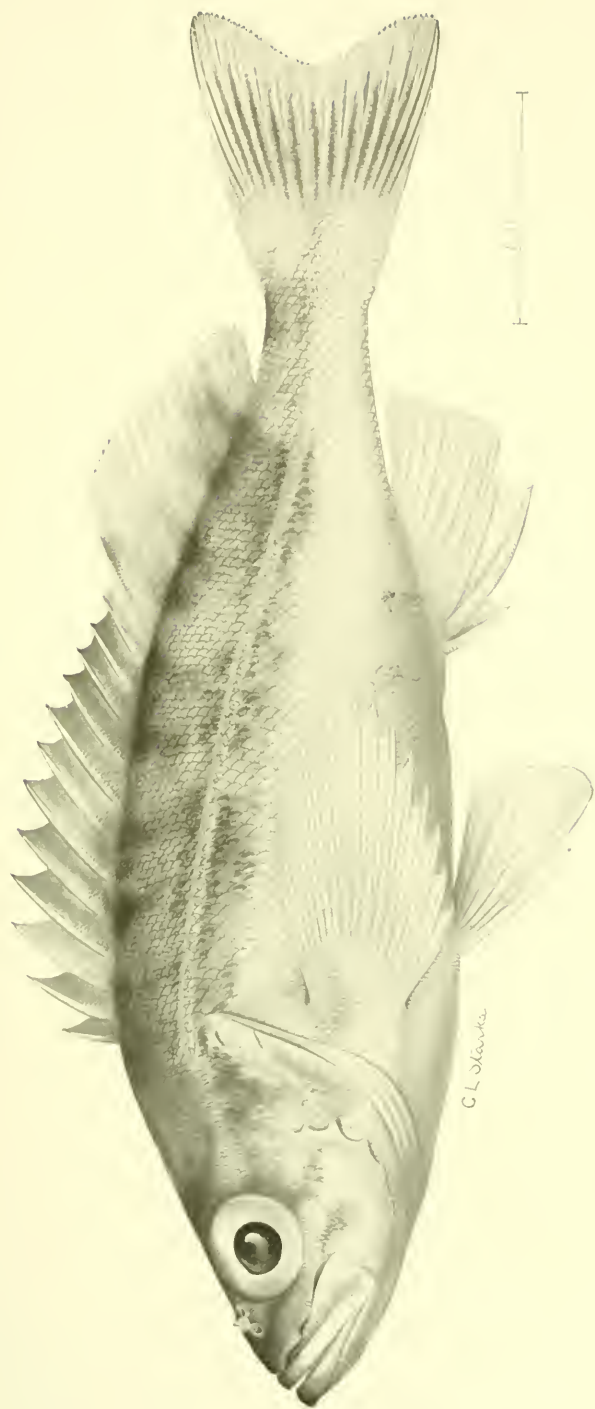
## PLEURONECTIDÆ.

154. *Hippoglossus hippoglossus* (Linnæus).  
 155. *Eopsetta jordani* (Lockington).  
 156. *Hippoglossoides elassodon* Jordan and Gilbert.\*  
 157. *Lyopsetta exilis* (Jordan and Gilbert).\*  
 158. *Psettichthys melanostictus* Girard.\*  
 159. *Citharichthys sordidus* (Girard).



*Sebastes deani* Starks. Type.

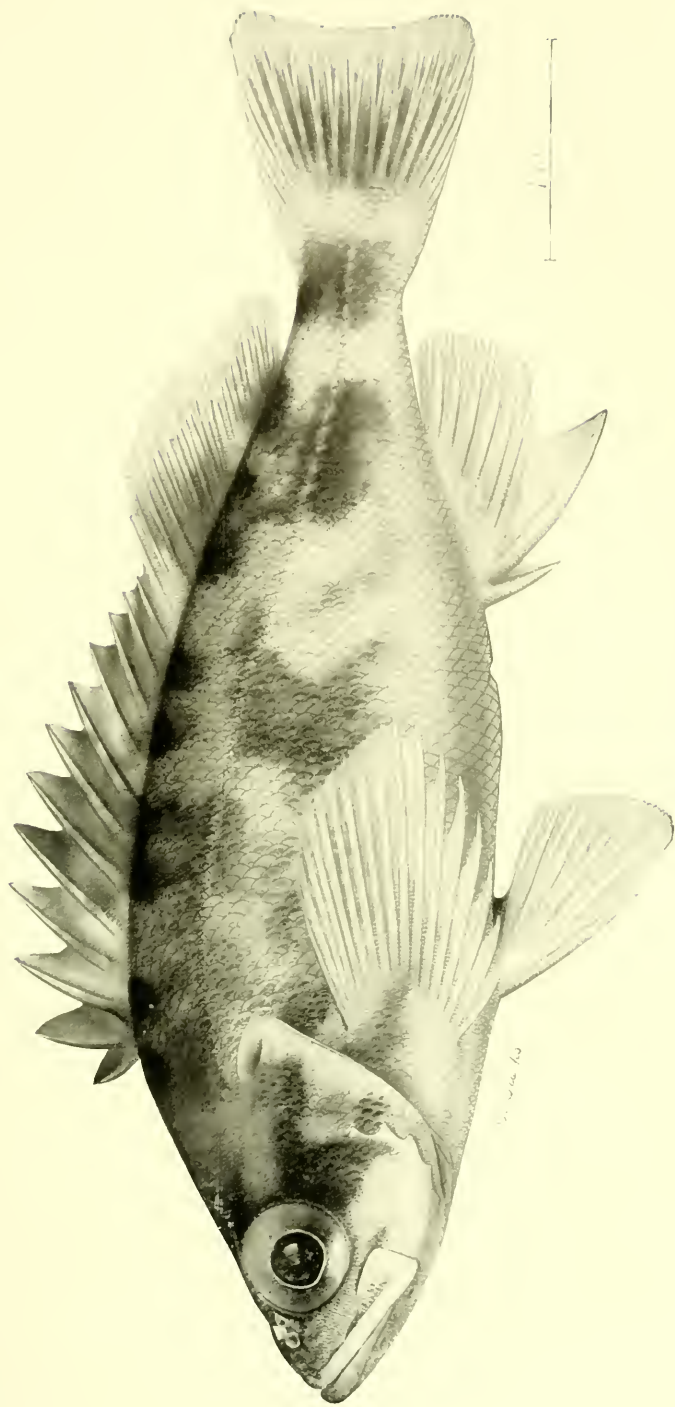




*Sebastodes clarilatus* Starks. Type.







*Sebastodes emphaeus* Starks. Type.



160. *Citharichthys stigmæus* Jordan and Gilbert.\*
161. *Isopsetta isolepis* (Lockington).\*
162. *Inopsetta ischyra* (Jordan and Gilbert).
163. *Parophrys vetulus* Girard.\*
164. *Lepidopsetta bilineata* (Ayres).\*
165. *Platichthys stellatus* (Pallas).\*
166. *Microstomus pacificus* (Lockington).\*
167. *Glyptocephalus zachirus* Lockington.\*
168. *Pleuronichthys nephelus* Starks and Thompson, MS.\*

X. DESCRIPTION OF A NEW SPECIES OF PYGIDIUM.

BY CARL H. EIGENMANN.

**Pygidium barbouri.** (Plate XXXII.)

Type: 37 mm., No. 29313, Museum Comparative Zoölogy.

Cotypes: 32 specimens from 29 to 40 mm. long. M.C.Z., No. 29314.

Cotypes: 2 specimens, C. M. Cat. No. 2465a-b & I. U. Cat. No. 12566.

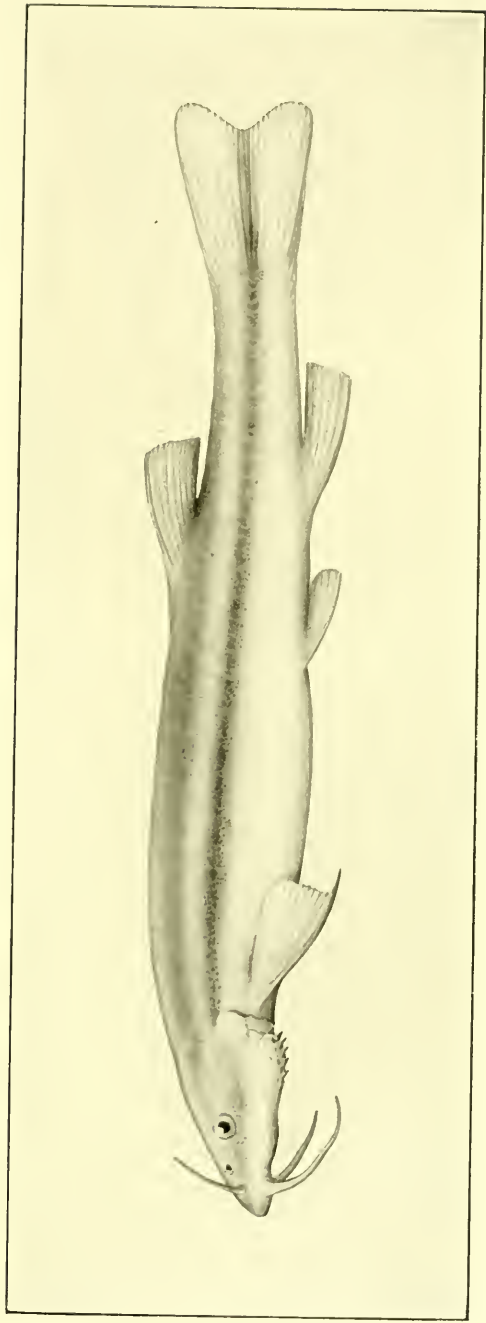
All specimens from the upper reaches of the Beni River, tropical eastern Bolivia.

Head 4.66; depth 7; D. 8; A. 6; eye 3 in snout, 7 in head, 2.5 in space between the eyes.

Width of head equals its length behind the posterior nares, the body tapering to the caudal; nasal barbels reaching to posterior margin of the eye, the longer maxillary barbel scarcely to the gill-opening when laid straight back. Teeth minute, in bands.

First pectoral ray prolonged, not equal to the head in length; dorsal subtruncate, none of its rays prolonged; distance of origin of dorsal from caudal 2.6 in the length; origin of anal from base of middle caudal rays 3.75 in the length; caudal emarginate; accessory rays not evident; ventrals not reaching the short, scarcely rounded anal. A dark median band from the gill-opening to the tip of the middle caudal rays, a light stripe above it; the back chocolate.

The specimens were obtained by Mr. Thomas Barbour at La Paz, Bolivia, from a person who had been prospecting along the Beni River.



*Pygidium barbouri* Eigenmann. (Type.)  $\frac{1}{4}$ .



## XI. THE BRACHIOPODA AND OSTRACODA OF THE CHAZY

BY PERCY E. RAYMOND.

(PLATES XXXIII-XXXVI.)

Brachiopods are more numerous in the Chazy than any other fossils, but the number of species is relatively small. In this paper thirty species are recognized. Only twelve of these are really common and they represent the genera *Camarotachia*, *Zygospira?*, *Leptana*, *Rafinesquina*, *Plectorthis*, *Hebertella*, *Clitambonites*, and *Camarella*. All but two of these belong to the Protremata.

All four orders of the Brachiopoda are represented in the Chazy: the Atremata by the *Lingulidæ* with four species; the Teleotremata by the *Rhynchonellidæ* with five species and the *Atrypidæ* with one; the Neotremata by two rare species; and the Protremata by the *Strophomenidæ* with four species, the *Orthidæ* with ten species, the *Clitambonitidæ* with two species, and the *Porambonitidæ* with two.

Of the thirty species, five are not found in the Champlain Valley, though they are common in the upper part of the Chazy at Montreal and in the valley of the Ottawa. One other species is known only from the type, so there are really only twenty-four species in the region occupied by the typical Chazy.

As a rule the brachiopods are well preserved, but in spite of this there are many details which remain obscure, and several problems which can not be settled until material in just the right state of preservation is found. Thus, in spite of the abundance of *Zygospira? acutirostris*, nothing has so far been learned of the interior, section-cutting and grinding having yielded negative results. The generic position of *Orthidium? lamellosum* is also exceedingly obscure. The finest preservation is among those beautifully weathered-out fossils collected by Professor Hudson from that wonderful little cleft in the rocks at Sloop Bay, Valcour Island. This is the type-locality for Hudson's species *Clitambonites multicostus* and *Schizambon duplicimuratus*. *Petrorania prona*, *Camarotachia pristina*, *Leptana incrassata*, *Hebertella vulgaris*, and *Camarella varians* are abundant there, while a few other brachiopods have been found, but are not common.

The *Orthidæ* have proved to be a most puzzling group, and the

writer has been conservative in naming the species. Further work with larger collections will probably add several more species. At least two more than have been described are indicated by specimens in Professor Hudson's collection.

I wish to express my thanks to Professor George H. Hudson for the loan of many fine specimens, and I must not fail to mention the kindness of the late Dr. J. F. Whiteaves in sending me many of the types preserved in the Museum of the Geological Survey of Canada. Dr. E. O. Hovey was so kind as to loan the types of *Orthis costalis*, and I have consulted freely with Professor Charles Schuchert on many points. The drawings are by Mr. Sydney Prentice, and the photographs, with three exceptions, are by Mr. Louis Coggeshall.

### Sub-Kingdom MOLLUSCOIDEA.

#### Class BRACHIOPODA.

#### ORDER *Atremata* Beecher.

#### Family LINGULIDÆ Gray.

#### Genus GLOSSINA Phillips.

#### 1. *Glossina belli* (Billings).

(Plate XXXIII, figure 1.)

*Lingula Belli* BILLINGS, 1859. Canadian Naturalist and Geologist, Vol. IV, p. 431, figs. 7, 8.

*Lingula Belli* BILLINGS, 1863. Geology Canada, p. 124, fig. 47.

Shell of fair size, roughly triangular, and nearly as broad as long. Both valves rather strongly convex, the greatest convexity a little behind the center. The pedicle valve has a longitudinal ridge or keel which extends from the beak to about the middle of the shell. From this ridge the sides slope rather steeply and are flat or sometimes concave. The front slope is more gradual, and is gently convex. The front is regularly rounded, the sides nearly straight, for about two-thirds their length, and meet at an angle of about  $75^{\circ}$ . The surface of the shell is very smooth, and is marked only by faint and distant concentric lines of growth. There are no radial striæ to be detected even on partially exfoliated shells.

*Locality*.—This is a rare species, so far found only in the Upper Chazy at Valcour Island, New York, and at a higher horizon in the Ottawa valley. The plesiotype is in the Carnegie Museum.



Genus *LINGULA* Bruguière.2. *Lingula brainerdi* Raymond.

(Plate XXXIII, figure 2.)

*Lingula brainerdi* RAYMOND, 1902. Bulletin American Paleontology, Vol. III, p. 302, Pl. 18, figs. 2, 3. April, 1902.

*Lingula limitaris* SEELY (*nomen nudum*), 1902. Report of Vermont State Geologist, new series, Vol. I, p. 145. December, 1902.

*Lingula limitaris* SEELY, 1906. Report of Vermont State Geologist, new series, Vol. V, p. 183, Pl. XLI. Reprint of same, p. 30, Pl. XLI.

This *Lingula* is the commonest and often the only fossil found in the sandstone at the base of the Chazy at Valcour Island, Isle La Motte, South Hero, and Crown Point. The *Lingulæ* are very abundant, but the sandstone is so hard that it is only rarely that good specimens are obtained. At the time the original figures of this species were made, only very fragmentary specimens were at hand, but before the description was drawn up, better specimens were obtained, and a figure of one of them is given here.

## DESCRIPTION.

Shell moderately convex, sub-rectangular, with three flat slopes, one to each of the sides, and to the front. The anterior margin is nearly straight in the middle, but rounded at the angles. The posterior margin is regularly rounded. The surface is marked by numerous concentric lamellæ, and, when partially exfoliated, the shell shows numerous radiating lines on the middle of the valve.

This species differs from *Lingula huronensis* in that the front slope begins in the middle of the valve instead of at the beak; in the more rounded posterior margin, and in the absence of the longitudinal undulations. It is, however, a related species. From *Lingula lyelli* it differs in being much broader in proportion to the length, and more rounded at the apex.

An average specimen is 16 mm. long, and 11.5 mm. wide. A small one is 8.5 mm. long and 6 mm. wide.

*Locality*.—This species is common in the sandstone at the base of the Chazy at Valcour Island and Crown Point, New York, and at South Hero and Isle La Motte, Vermont. The cotypes are in the collections at Cornell University.

3. *Lingula columba* Raymond.

(Plate XXXIII, figures 3, 4.)

*Lingula columba* RAYMOND, 1905. American Journal of Science, Series 4, Vol. XX, p. 368.

Shell small, oval in outline, gently and uniformly convex. The front is semicircular in outline, the posterior end somewhat triangular, the beak pointed. The surface is covered with very numerous and prominent concentric striae, no radiating lines showing, except when the shell is partially exfoliated.

One specimen is 10 mm. long and 7 mm. wide. Another is 7 mm. long and 5 mm. wide. This species is not so abundant in any place as *Lingula brainerdi*, but it is more often met with, as it ranges through a much greater thickness of rock, and has about the same geographic distribution.

*Locality*.—This species is fairly common in the Chazy limestone at Valcour Island, and Chazy, New York, and at Isle La Motte, Vermont.

4. *Lingula lyelli* Billings.

(Plate XXXIII, figures 5, 6.)

*Lingula Lyelli* BILLINGS, 1859. Canadian Naturalist and Geologist, Vol. IV, p. 348, figs. 1a-1d; p. 431.*Lingula Lyelli* BILLINGS, 1863. Geology of Canada, p. 124, fig. 49.

*Lingula lyelli* occurs in great abundance in the soft clayey shales of the Aylmer formation in the Ottawa Valley and exhibits a considerable variation in form. Young specimens correspond almost exactly to Billings' descriptions and figures, but some of the adults depart so far from the sub-rectangular form that they more nearly resemble *Glossina belli* than the normal form of *Lingula lyelli*. The straight sides and the long slope of the anterior margin are, however, always present.

## DESCRIPTION.

Outline somewhat oval, pointed posteriorly, and broadest in front. Dorsal valve shorter than the opposite one, the posterior margin rounded instead of triangular. Each valve shows three flat slopes, one on each side, and one extending from near the beak to the anterior margin. The sides of young specimens are straight and nearly parallel. The adult shells are widest toward the front and the sides converge backward. A few specimens show three faint longitudinal folds on the frontal slope of the pedicle valve. The surface is usually

marked by numerous concentric lines of growth. A partially exfoliated specimen shows numerous radiating lines extending to both the front and to the sides. A single cast of a dorsal valve shows two of the central muscle scars.

This species may be distinguished from *Lingula huronensis* by the backward convergence of the sides and the longer and narrower form. From *Lingula brainerdi* it differs in the same particulars and also in the length of the frontal slope.

An average specimen is 17 mm. long and 14 mm. wide. A dorsal valve is 14.5 mm. long and 13.5 mm. wide. A young specimen with parallel sides is 8.5 mm. long and 6 mm. wide.

*Locality*.—This species was originally described from specimens found on Allumette Island. It occurs also at Aylmer and at the Hog Back, near Ottawa, Canada, in the shales of the Aylmer formation.

#### 5. *Lingula huronensis* Billings.

*Lingula Huronensis* BILLINGS, 1859. Canadian Naturalist and Geologist, Vol. IV, p. 433, figs. 9a-9d.

*Lingula Huronensis* BILLINGS, 1863. Geology of Canada, p. 124, fig. 48.

This species was described from specimens found in the Black River limestone at Lake Huron, and, according to Billings, similar specimens were found at L'Original in the Chazy. There are no specimens of this type in our collections, but Dr. Ami has listed it from the Chazy in the region about Ottawa.

### ORDER *Telotremata* Beecher.

#### Family RHYNCHONELLIDÆ Gray.

#### Genus CAMAROTÆCHIA Hall and Clarke.

The Palæozoic Rhynchonellidæ have been divided into a number of genera, but the diagnoses of the genera are based on so limited an amount of material that it is often difficult to understand what are the real characteristics. *Rhynchonella plena* was referred by Hall and Clarke to the genus *Camarotæchia*, but recently there has been a tendency to refer it to *Rhynchotrema*. An examination of the original descriptions of the two genera does not make exactly clear what the differences are which separate them.

*Rhynchotrema* was proposed by Hall in the 13th Annual Report of the New York State Cabinet of Natural History, pp. 66-68, 1860.

In that paper no real generic characters were brought out, the name being proposed because of the unusual appearance of certain specimens from Iron Ridge, Wisconsin, in which the deltidial plates were preserved. In part 2 of Volume VIII of the "New York State Paleontology," 1895, Hall and Clarke further elucidate the characters of the genus. They mention the absence of dental lamellæ, the presence of a thin linear cardinal process, and state that the crura arise from the cardinal portion of a comparatively broad hinge-plate, instead of from the margins of the dental sockets. The type is *Rhynchotrema capax* (Conrad).

The distinctive characters of *Camarotæchia* are stated by the authors of the genus in the following words:

"The median septum of the brachial valve is divided posteriorly in such a manner as to form an elongate cavity, which does not extend to the bottom of the valve. Each branch of the septum supports one of the lateral divisions of the hinge-plate, to which are attached the curved crural processes. There is no cardinal process. In the pedicle valve slender vertical lamellæ support the rather small teeth and extend well into the cavity of the valve, enclosing a deep and narrow pedicle scar." (Paleontology New York, Vol. VIII, pt. 2, p. 190.) The type of the genus is *Rhynchonella congregata* Conrad, which usually occurs as internal casts in sandy shale.

Winchell and Schuchert, who wrote at about the same time as Hall and Clarke, employ the name *Rhynchotrema* for all the "early rhynchonelloid species having a prominent cardinal process." (Paleontology of Minnesota, Vol. III, pt. 1, p. 458.)

The writer has before him some very good internal casts of *Rhynchotrema capax*, and some silicified shells of *R. inæquivalve*. In all of them the teeth of the pedicle valve are supported by thin lamellæ. In all the brachial valves there is a low median septum which divides under the beak, producing a small spondylium as in *Camarotæchia*. One of the silicified specimens shows a very thin cardinal process, and the casts of *R. capax* show the former presence of this process by a distinct groove. The presence or absence of the cardinal process seems, then, to be the only way of separating the two genera.

In the sandstone at Aylmer, Quebec, internal casts of *Rhynchonella orientalis* Billings are very abundant and often well preserved. These casts show distinctly the dental lamellæ of the pedicle valve. In the groove which is the impression left by the median septum on the

east of the brachial valve, there is a narrow ridge as there is in similar casts of *Camarotoechia congregata*. This ridge indicates that the septum divided at the posterior end. In *Rhynchotrema capax* this ridge is divided by a deep and narrow cleft, indicating the cardinal process, but in the casts of *Rhynchonella orientalis* there is no sign of such a cleft, and the ridge is smooth, as in *Camarotoechia congregata*. In Professor Hudson's collection there are casts of the interior of *Camarotoechia pristina* Raymond which show this same condition, and in the Carnegie Museum there are two internal casts of *Rhynchonella plena* Hall which show the undivided ridge at the posterior end of the furrow made by the dorsal septum. If then, the separation of these genera depends upon the presence or absence of the cardinal process, as it seems to do, all three of the common rhynchonelloids of the Chazy must be referred to *Camarotoechia*. The interior of *Camarotoechia major* is not known.

#### 6. *Camarotoechia plena* Hall.

(Plate XXXIII, figures 7-18.)

- Atrypa plena* HALL, 1847. Paleontology of New York, Vol. I, p. 21, Pl. 4 bis, figs. 7a-7c.  
*Atrypa plicifera* HALL, 1847. *Ibidem*, p. 22, Pl. 4 bis, figs. 8a-8d.  
*Atrypa altilis* HALL, 1847. *Ibidem*, p. 23, Pl. 4 bis, figs. 9a-9d.  
*Atrypa plena* BILLINGS, 1856. Canadian Naturalist and Geologist, Vol. I, p. 208, figs. 17, 18, ?19.  
*Atrypa plena* ROGERS, 1858. Geology of Pennsylvania, Vol. II, pt. 2, p. 817, fig. 592.  
*Rhynchonella plena, plicifera, altilis* HALL, 1859. 12th Annual Report New York State Cabinet Natural History, pp. 65, 66.  
*Rhynchonella plena* BILLINGS, 1859. Canadian Naturalist and Geologist, Vol. IV, p. 444, fig. 22.  
*Rhynchonella plena* BILLINGS, 1863. Geology of Canada, p. 126, fig. 50.  
*Camarotoechia plena* and *altilis* HALL and CLARKE, 1893. Paleontology of New York, Vol. VIII, pt. 2, p. 190.

*Camarotoechia plena* is the most abundant and probably the most variable of the fossils of the Chazy. With a large quantity of material at hand, it becomes a difficult matter to determine whether or not some of the extreme variations should receive specific names.

A study of the shells in all stages of growth shows that the three species described by Hall must be combined as one species. *Atrypa plena* and *Atrypa plicifera* represent the normal adult, and *Atrypa altilis* the extreme stage to which development in the number of plications can be carried.

## ONTOGENY.

The nepionic shell is bi-convex, smooth, without fold or sinus. It usually reaches a length of about 1 mm. The first change is the introduction of a sharp median sinus in the dorsal valve, and a small fold on the pedicle valve. Thus the fold and sinus at this stage have a position just the reverse of that in the adult. Sharp plications are now introduced on both valves, and new ones added at the sides so rapidly, that, at a length of about 2 mm. the maximum number of plications is attained. At this stage the great variation in the number of plications can be observed. Some of these small shells have as many as thirty plications on each valve, while others have only half that number. In later stages of growth no new plications are added, except in the very rare instances where one or more of the plications bifurcate. The dorsal sinus persists, though becoming shallower and wider until the shell has reached a length of about 4 mm. When it reaches a length of 7 or 8 mm. the ventral sinus and dorsal fold are formed. The permanent ventral sinus occupies about half the front of the shell, and takes in a variable number of plications—from four to seven—according to the multiply or pauciplicate character of the shell at this stage.

## DESCRIPTION OF THE ADULT.

The adult shells are sub-triangular to sub-circular in outline, with a wide, shallow ventral sinus and a somewhat elevated dorsal fold. Surface marked by from seventeen to twenty-four strong plications, four to seven of which are in the sinus and five to eight on the fold. The plications are crossed by zig-zag lines of growth, which are sometimes stronger and sometimes weaker on partially exfoliated specimens than on specimens with perfect shells. The dorsal beak is strongly incurved, and the umbo bears a slight median depression. The beak of the pedicle valve is only slightly incurved, and does not rest against the brachial valve. The delthyrium is open throughout life. None of the specimens in the collection show the deltidial plates.

Casts of the interior of the brachial valve show a low septum which extends about one-third the length of the shell. This septum divides at its posterior end as in the typical species of *Camarotachia*, but there is no cardinal process as in *Rhynchotrema*.

In the section at Valcour Island, *Camarotachia* first appears in

Zone 33 (see ANNALS CARNEGIE MUSEUM, Vol. III, p. 517), 718 feet above the base of the formation. In this zone, the specimens are rare, and all are without fold and sinus, but correspond in all respects to the shell of *Camarotæchia plena* in the neanic stage. In the next zone, 729 feet above the base, the species suddenly becomes abundant, but all the specimens are small, with numerous plications. Specimens are fairly common in the succeeding forty feet of strata, and the species becomes constantly more variable in the size and number of plications, until in the layers around Cystid Point (Zones 37-39, at 767-789 feet above the base of the formation) we find the acme of variation. At this locality may be found all the varieties of *Camarotæchia plena* that are found in any of the strata higher or lower, and, while the species is more abundant in some of the later beds, its characters become more fixed, and there is not so great a variety of forms.

*Locality.*—This species is very common in the upper part of the Chazy at Valcour Island, Chazy, and other localities in northern New York, at South Hero and elsewhere in Vermont, and in the Aylmer formation in the Ottawa Valley. The specimens here figured are in the Carnegie Museum.

#### 7. *Camarotæchia orientalis* (Billings).

(Plate XXXIII, figures 19-22, 24-33.)

*Rhynchonella orientalis* BILLINGS, 1859. Canadian Naturalist and Geologist, Vol. IV, p. 443, fig. 21.

*Rhynchonella orientalis* BILLINGS, 1863. Geology of Canada, p. 126, fig. 57.

It was suggested by Sir William Logan (Geology of Canada, 1863) that *Camarotæchia orientalis* was probably only a variety of *Camarotæchia plena*. Considering the variability of the latter species it is possible that *Camarotæchia orientalis* arose from it by the checking of the plications at an early stage, while the fold and sinus continued to maturity. In this connection it should be noted that the two species do not seem to occur together. At the Mingan Islands and at St. Martin Junction near Montreal, where *Camarotæchia orientalis* is abundant, *Camarotæchia plena* does not occur. On the other hand, *Camarotæchia plena* is very abundant at Valcour Island, Chazy, and South Hero, but no specimens of *Camarotæchia orientalis* have been found in that region. In all these localities *Camarotæchia* is accompanied by an abundance of *Iiebertellas*. At St. Martin Junction,

*Camarotæchia orientalis* and *Hebertella borealis* are found with a profusion of cystids of the type of *Malocystites murchisoni*. In the corresponding fauna at Valcour Island, *Camarotæchia plena* and *Hebertella vulgaris* occur with other cystids, the most common of which is *Malocystites emmonsii*. *Malocystites murchisoni* does not occur in the same layers, but is quite common some hundreds of feet lower in the strata, below the range of *Camarotæchia plena*.

In the Aylmer formation at Aylmer, *Camarotæchia orientalis* occurs in the sandstone at the base of the section, accompanied by *Hebertella imperator*. The specimens of *Camarotæchia orientalis* in the sandstone are casts, and the divided septum in the dorsal valve and the absence of a cardinal process show that the shells are *Camarotæchias*.

#### ONTOGENY.

For comparison with *Camarotæchia plena* a short sketch of the life history of this species is introduced.

1. Nonplicate nepionic stage of short duration. Shell biconvex, smooth.

2. First (reversed) neanic stage. With the introduction of the first plication on the pedicle valve, a sinus is formed on the brachial valve, and this state, in which the normal form of the adult is reversed continues until the shell reaches a length of from 3 to 5 mm. When the shell reaches this size all the plications of the adult, nine to fourteen, can be detected on the anterior margin. The pedicle valve is then deeper than the brachial, the ventral beak is a little incurved, and the delthyrium is open.

3. Equivalve neanic stage. After the shell reaches a length of from 3 to 5 mm., the dorsal sinus becomes gradually shallower and finally disappears, and the ventral fold merges into the uniform roundness of the front of the shell. When the shell reaches a length of from 7 to 8 mm. the two valves are about equally convex and the fold and sinus have disappeared.

4. Normal adult stage. The next change is the formation of a dorsal fold and a ventral sinus. This change takes place gradually and the shell does not show the adult condition until it has attained a length of 10 or 12 mm., although it acquired all its plications when only 3 or 4 mm. long. In the adult state there are four plications on the fold and three in the sinus.



## DESCRIPTION.

Shell transversely oval in outline, nearly straight in front, and rounded at the sides and at the beaks. There are ten to fifteen strong, simple plications, three of which are in the sinus and four on the fold. The sinus is deep and angular, occupying about one-third the width of the front of the shell. The ventral beak is acute, not far extended, a little incurved. The deltidial plates cover a part of the delthyrium in a few specimens, but usually they are not preserved. Ordinarily the valves show only slight traces of surface markings, but well preserved shells show strong zigzag lines of surface.

*Locality.*—This shell is common at the Mingan Islands, St. Martin Junction, near Montreal, and at Aylmer, Canada.

8. *Camarotœchia pristina* Raymond.

(Plate XXXIV, figures 1-10.)

*Camarotœchia pristina* RAYMOND, 1905. American Journal of Science, series 4, Vol. XX, p. 368.

## DESCRIPTION.

Shell small, transversely oval to sub-circular in outline. Both valves moderately and regularly convex. The dorsal valve has a low fold and the ventral valve a shallow sinus, which is noticeable only toward the front of the shell. There are ten to fourteen strong rounded plications, four of which are on the fold and three in the sinus. The two plications in the middle of the fold are smaller than the two outside ones, and the median plication in the sinus is the weakest one on the ventral valve.

The life-history of this species is not very different from that of the species just described, but it should be noted that the middle plications of the dorsal valve, instead of originating at the same time as the others, are intercalated considerably later. This explains why they are weaker than the two just outside them.

A specimen collected by Prof. Hudson shows the cast of the interior of a dorsal valve. There is a low median septum which extends half-way to the front of the shell. At its posterior end it divides, forming a low spondylium as is usual in this genus. There is no cardinal process.

*Locality.*—This species is common in the upper part of the Lower Chazy at McCollough's sugar-bush, at Chazy, New York, and is also found at Valcour Island. The cotypes are in the Carnegie Museum.

9. *Camarotæchia major* Raymond.

(Plate XXXIV, figures 11-14.)

*Camarotæchia major* RAYMOND, 1905. American Journal of Science, 4th series, Vol. XX, p. 369.

Outline somewhat oval, widest a little in front of the middle. Brachial valve with ten to fourteen strong plications. The ventral valve has from nine to thirteen. The fold and sinus are hardly defined except by a gentle arch to be seen in viewing the shell from the front. The fold bears five plications, the median one being stronger than the others, while the sinus has four plications, the two strongest in the middle. The ventral beak is incurved, but does touch the dorsal valve. The interior has not been seen.

Length of the figured specimen, 23 mm.; width, 21 mm.

*Locality*.—This species is very rare, and has been found only at Cystid Point, Valcour Island, New York, in the Upper Chazy. The holotype is in the Carnegie Museum.

## KEY TO THE PRECEDING SPECIES.

*Camarotæchia plena*.—Plications uniformly strong.

*Camarotæchia orientalis*.—Median plication of sinus and central ones on fold stronger than the others.

*Camarotæchia pristina*.—Median plication of sinus and central ones on fold weaker than the others.

*Camarotæchia major*.—Middle plication of fold strongest. Fold and sinus very weak.

## Genus PROTORHYNCHA Hall and Clarke.

10. *Protorhyncha dubia* Hall.

*Atrypa dubia* HALL, 1847. Paleontology of New York, Vol. I, p. 21, Pl. 4 bis, fig. 5.

*Rhynchonella dubia* HALL, 1859. Twelfth Annual Report New York State Cabinet Natural History, p. 66.

*Protorhyncha dubia* HALL and CLARKE, 1893. Paleontology of New York, Vol. VIII, pt. 2, p. 180.

*Atrypa dubia* was described by Hall from a small exfoliated specimen obtained from the upper part of the Chazy at Chazy, New York. The location of the type is not now known, and the description given by Hall is not sufficient to identify more material. The original specimen may have been a young *Camarotæchia plena*, a young *Camarotæchia pristina*, or a broken and exfoliated *Iiebertella*. The name should be dropped as the species was not so defined as to be recognizable.

The genus *Protorhyncha* was proposed by Hall and Clarke to include primitive Rhynchonelloids, and *Atrypa dubia* was designated as the type. In a foot-note appended to their description, the authors of the genus remark that the details of the generic description have been drawn from specimens identified as *Atrypa dubia*, but collected in the gorge of the Kentucky River at High Bridge, Kentucky. The specimens referred to are in the private collection of Prof. Charles Schuchert, and an examination of them shows that they are different from anything the writer has seen in the Chazy. Hall and Clarke did not figure any specimens of *Protorhyncha* from the Chazy, nor did they figure the specimens from High Bridge which they referred to that species. As an example of *Protorhyncha* they figure *Atrypa equiradiata* Hall from the Clinton, but Schuchert, in his "Synopsis of American Fossil Brachiopoda" (Bulletin U. S. G. S., No. 87), has referred this species to the genus *Camarotæchia*. The only other species mentioned by Hall and Clarke is *Porambonites ottawaënsis* Billings, from the Black River, but this species appears to be a *Rhynchotrema*. *Camarella antiquata* Billings was referred to *Protorhyncha* in Schuchert's "Synopsis," but that species has recently been made the type of the genus *Swantonina* by Walcott. (Proceedings U. S. National Museum, Vol. XXVIII, p. 296, 1905.) *Camarella(?) minor* Billings is also doubtfully referred to *Protorhyncha* in the "Synopsis," but with the comment that it may be the type of a new genus. Dr. Walcott evidently thinks it a *Swantonina* (*loc. cit.*).

It seems then that the name *Protorhyncha* must be reserved for the shells from the Stones River formation at High Bridge, Kentucky, from which Hall and Clarke drew their generic diagnosis. This is the species identified by Ulrich as *Protorhyncha ridleyana* (Safford). (Geologic Atlas of the United States, Columbia Folio.)

Super-family SPIRIFERACEA Waagen.

Family ATRYPIDÆ Gill.

Genus ZYGOSPIRA Hall.

11. *Zygospira* (?) *acutirostris* Hall.

(Plate XXXIV, figures 15-22.)

*Atrypa acutirostra* HALL, 1847. Paleontology of New York, Vol. I, p. 21, Pl. 4 bis, fig. 6.

*Rhynchonella acutirostris* HALL, 1859. Twelfth Annual Report Cabinet Natural History, p. 65.

This little brachiopod is very common at a number of localities in the Champlain Valley. For a generic diagnosis it is necessary to depend upon the external characters, as no specimens have as yet been obtained which show the brachidia. Several specimens have been examined for spirals by the transparency method, but without success. However, the shape of the shell, with its deep dorsal sinus and ventral fold remove it at once from the *Rhynchonellidæ*, and suggest the *Zygospirinaæ*, as Whitfield has already pointed out. While it seems probable that this shell is a *Zygospira*, its exact generic reference must await more favorably preserved material. From the stratigraphic position of the formation in which it is found, it may be expected to show a somewhat simpler brachidium than *Zygospira modesta*, perhaps approaching the form found in *Hallina*.

#### DESCRIPTION.

Shell elongate, oval, widest near the front, pointed at the apex. Pedicle valve convex, with a low fold on which are three plications. Brachial valve shorter than the opposite one, more nearly oval in outline, with a deep narrow sinus which extends almost to the beak. Surface marked by from thirteen to fifteen sharp plications on each valve. Pedicle beak extended, sharp, not incurved.

The young of *Camarotæchia* are very similar in appearance to these specimens, but are somewhat broader and less deeply lobed. *Z.?* *acutirostris* has one large, very sharp plication in the center of the pedicle valve.

*Locality*.—Common in the Lower and Middle Chazy at Valcour Island, Valcour, Chazy, and Crown Point, New York, and Isle La Motte, Vermont.

#### ORDER *Neotremata* Beecher.

##### Family SIPHONOTRETIDÆ Kutorga.

##### Genus SCHIZAMBON Walcott.

#### 12. *Schizambon duplicimuratus* Hudson.

(Plate XXXIV, figures 23-25.)

*Schizambon duplicimuratus* HUDSON, 1905. Report New York State Paleontologist for 1903, p. 284, Pl. 5, figs. 6, 7.

Shell nearly circular in outline, slightly unsymmetrical. Both valves are moderately convex, the surface lamellose and covered with small

slender spines. On the dorsal valve is a narrow depression, which is most distinct at the beak, and becomes obsolete on the anterior third of the shell. The ventral valve shows an oval pedicle opening a short distance in front of the beak, and a narrow depression which extends from the beak to the opening.

*Locality.*—This species is rare, and has been found only at Valcour Island and Chazy, New York. The figured specimens are in the Yale University Museum.

Family CRANIDÆ King.

Genus PETROCRANIA nomen nov.

(*Craniella* Ehlert, preoccupied.<sup>1</sup>)

13. **Petrocrania prona** Raymond.

(Plate XXXIV, figures 26-31.)

*Crania prona* RAYMOND, 1906. *Annals Carnegie Museum*, Vol. III, p. 574.

Ventral valve flat or slightly convex, attached by a part of its surface for at least a portion of its life. Dorsal valve depressed conical, sub-rectangular in outline, usually wider than long. Apex near the posterior margin not prominent. Surface marked by strong concentric lamellæ, which on some specimens turn upward, so that the surface is very rough, while on others they are worn down so as to be indistinguishable.

The muscle-scars are well shown in the brachial valves. Near the posterior margin and somewhat widely separated are two narrow scars, the posterior adductors. Half-way between the posterior margin and the center of the shell are two prominent, elevated scars. These are the anterior adductors. On the anterior outer margins of these scars on some specimens fainter scar-like depressions may be observed. These may be scars of brachial muscles, or they may be connected with the vascular sinuses. Just in front of the center of the shell of one specimen are two approximate scar-like impressions, the origin of which is not evident. The vascular sinuses originate outside the anterior adductors, extend to the front of the shell, and then turn backward, following the margin nearly to the outer ends of the posterior adductors.

<sup>1</sup>Mr. Lambe has called my attention to the fact that *Craniella* was used for a genus of sponges by O. Schmidt in 1870 (*Spong. Atlant. Gebiet.*, 66) and therefore was not available when Ehlert used it for a brachiopod in 1888 (*Bull. Soc. Études Scientif. d'Angers*, 37). I therefore propose to substitute the name *Petrocrania*, with the same meaning as *Craniella*, Ehlert.

This species differs from *Petrocrania ulrichi* (Hall and Clarke) in having the apex nearly marginal instead of sub-central, in having the anterior adductors further back and nearer together, and in the shape of the vascular markings.

*Locality*.—This species is common at a single locality on the east side of Valcour Island, and rare at Sloop Island, and at Chazy, New York.

ORDER **Protremata** Beecher.

Family STROPHOMENIDÆ King.

Genus LEPTÆNA Dalman.

14. **Leptæna incrassata** Hall.

(Plate XXXIV, figures 32-37.)

*Leptæna incrassata* HALL, 1847. Paleontology New York, Vol. I, p. 19, Pl. 4 bis, figs. 2a-2c.

*Leptæna fasciata* HALL, 1847. *Ibidem*, figs. 3a, 3b. Non 3c.

*Leptæna incrassata* ROGERS, 1858. Geology Pennsylvania, pt. 2, p. 817, fig. 519.

*Strophomena fasciata* HALL, 1858. Twelfth Annual Report New York State Cabinet Natural History, p. 70.

*Strophomena incrassata* BILLINGS, 1859. Canadian Naturalist and Geologist, Vol. IV, p. 443.

*Rafinesquina fasciata* HALL and CLARKE, 1892. Paleontology New York, Vol. VIII, pt. 1, p. 283.

*Leptæna incrassata* WINCHELL and SCHUCHERT, 1893. Paleontology Minnesota, Vol. III, pt. 1, p. 410.

After comparison of a full series of specimens with the figures of *Leptæna incrassata* and *L. fasciata* in Volume I of the "Paleontology of New York" it becomes evident that both of Hall's species are founded on the same type of shell. The figure 3c in the original illustrations of *Leptæna fasciata* was made from a specimen collected at Galway, Saratoga County, New York. This shell is very different from the ones shown in the other figures, and as the Chazy formation does not occur at Galway, it is very probable that this shell did not come from that formation.

This shell is rather common in the upper part of the Chazy on Valcour Island, and is easily recognized by its transverse outline and the abrupt deflection of the front. In young shells the outline is nearly circular, the brachial valve is nearly flat, and the front is not deflected. Hall probably had one of these young shells in hand when describing *Leptæna fasciata*. *Leptæna incrassata* is much like *L. charlottæ* Win-

chell and Schuchert, and is probably congeneric with it. The striae are alternating in size as in *Rafinesquina*, but the transverse form and the geniculation are like *Leptæna*. Some of the larger specimens show fine concentric wrinkles on the ears of the pedicle valve.

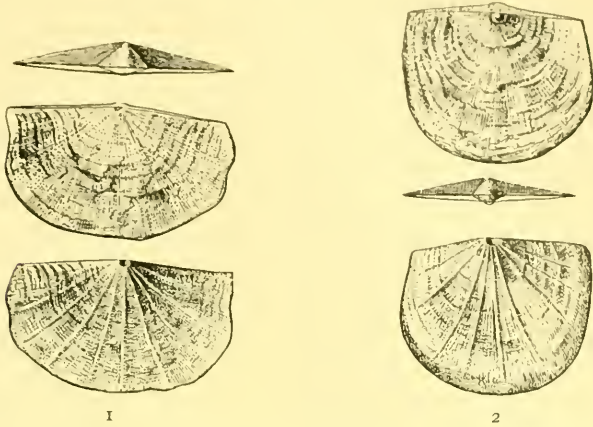


FIG. 1. *Leptæna incrassata* Hall. Cardinal, dorsal, and ventral view of a small specimen to show deltidium, pedicle opening, and surface markings.  $\times 2$ .  
 FIG. 2. Similar views of another specimen of the same species.  $\times 2$

DESCRIPTION.

Shell transverse, concavo-convex, abruptly deflected in front. In young stages the shell is plano-convex, not deflected in front, and the outline is sub-circular. In the adult the shell is wider than long and regularly rounded in front. The width at the hinge is not quite equal to the greatest width. The surface is marked by from twenty to thirty strong striae, between which are very fine striae. On partially exfoliated shells all the striae seem to be of equal size. These striae are crossed by fine concentric lines which are about the same size as the striae and thus give to the surface a pitted appearance. On the ears of mature shells there are fine concentric wrinkles. The delthyrium, which is wide, is covered by a convex deltidium, but there is a large pedicle opening at the apex. This passage remained open throughout the life of the animal, and usually encroached upon the beak.

The interior of the brachial valve shows a large, deeply bifurcated cardinal process, the groove between the elements of which is so deep that the two parts seem entirely separated. This groove extends

across the area to the apex, and is probably the path of the anal tube. On either side of the cardinal process is a narrow dental socket, bounded by two low plates. The four adductor scars lie directly in front of the cardinal process. By the sides of the anterior pair are high divergent ridges somewhat like those in *Stropheodonta inaequistriata* of the Hamilton. Dividing the anterior pair of adductor scars is a very low and thin median septum. Outside the area involved in the muscular attachment the interior of the valve is thickly covered with sharp spinules, which are directed forward. These spinules are arranged in radiating rows, and do not extend beyond the line at which the valve is deflected. Along the crest of the fold in the shell are radial grooves, seemingly indicating that the mantle of the animal was thrown into

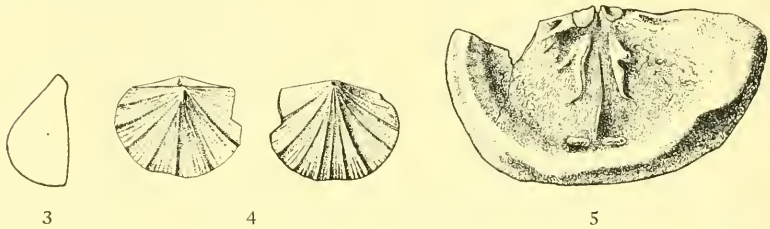


FIG. 3. Outline of the specimen shown in fig. 32, Plate XXXIV, to show curvature of the shell.

FIG. 4. *Leptæna incrassata* Hall. Both valves of a very young specimen.  $\times 2$ .

FIG. 5. The same species. Drawing of the specimen shown in fig. 34, Plate XXXIV.  $\times 2$ .

a series of radial folds in order to accomplish the deflection. Such abrupt turns in brachiopod shells have been explained by saying that one valve grew faster than the other, but this in turn requires an explanation of the cause of the acceleration of growth. In the present case there might be an explanation in the fact that as the shell increased in size and weight, there would come a time when the small pedicle could no longer support the shell in an upright position, and the shell would fall back upon the heavier (pedicle) valve. Then, in order to keep the opening of the valve free, there would be a constant upward turning of the edge of the mantle, and consequently a change in the direction of the new shell deposited after the change of position.

*Locality.*—This shell is very common at Sloop Island, Valcour Island, and Chazy, New York. A few specimens have been found at Crown Point and Cooperville, New York.



Genus RAFINESQUINA Hall and Clarke.

15. *Rafinesquina champlainensis* Raymond.

*Rafinesquina champlainensis* RAYMOND, 1902. Bulletin American Paleontology, Vol. III, p. 373. Pl. 18, figs. 5, 6.

This large *Rafinesquina* is very abundant in the middle layers of the Chazy, and occupies the same place in the fauna of the Chazy that *R. alternata* does in the Trenton. In general form it resembles *R. alternata*, but is much more nearly hemispheric.

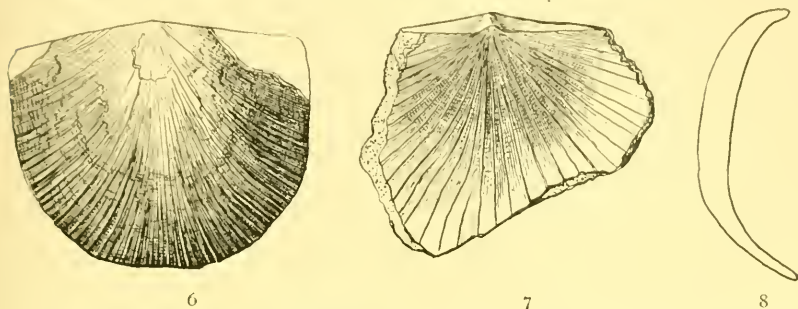


FIG. 6. *Rafinesquina champlainensis* Raymond. A pedicle valve. Natural size.

FIG. 7. The same species. A specimen showing the brachial valve, the cardina area, and the deltidium. Natural size.

FIG. 8. The same species. Outline profile of a specimen cut along the median line, showing the curvature of both valves.

DESCRIPTION.

Shell large, ventricose, almost hemispheric. Length and width nearly equal. Hinge line usually a little longer than the width below, and the cardinal extremities are produced into broad rounded ears. The pedicle valve is strongly and evenly convex, the highest point being about the middle of the valve. The brachial valve is flat on the umbo and concave in front, following the curvature of the opposite valve. Cardinal area on the pedicle valve rather wide. Deltidium covered by a broad convex deltidium. Area of brachial valve linear. The surface is marked by very numerous fine radiating striae, every

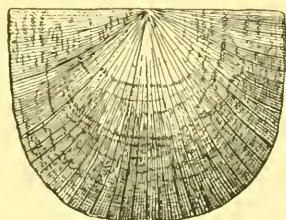


FIG. 9. *Rafinesquina champlainensis* Raymond. The impression of a brachial valve. Natural size.

third or fourth one of which is stronger than the ones between. The striæ increase by implantation. In the partially exfoliated state in which the specimens are usually found, the striæ appear nearly equal and the shell structure fibrous.

*Locality*.—The range of this shell seems to be the same as that of *Maclurites magnus*. It is very abundant at Maclurea Point, Crown Point, Valcour Island, Bluff Point, and Chazy, New York, and Isle la Motte and South Hero, Vermont.

16. **Rafinesquina distans** Raymond.

(Plate XXXV, figure 1.)

*Rafinesquina distans* RAYMOND, 1906. Annals Carnegie Museum, Vol. III, p. 575.

This is a small, fairly common shell, usually found in the upper part of the Chazy, associated with *Camarotæchia plena*. It is also found in the dolomitic limestone of the reefs.

DESCRIPTION.

Shell small, nearly flat, about three-fourths as long as wide. The greatest width is at the hinge. The sides and front are regularly rounded. The surface is marked by eight to twelve prominent striæ, between which are groups of from ten to fifteen very fine striæ. There is no other species in the Chazy on which the principal striæ are so widely separated, and it can be easily distinguished by this character.

*Locality*.—Rare in the middle of the Chazy at Crown Point, and common in the Upper Chazy at Valcour Island.

Genus STROPHOMENA Blainville.

17. **Strophomena prisca** Raymond.

(Plate XXXV, figures 2, 3.)

*Strophomena prisca* RAYMOND, 1905. American Journal of Science, Vol. XX, series 4, p. 369.

The genus *Strophomena*, which has not previously been known in American faunas older than that of the Black River, is represented in the Chazy by a rare form, of which only a few specimens have been found.

DESCRIPTION.

Shell of medium size, resupinate, nearly as long as wide. Pedicle valve convex at the umbo, flat in front to about the middle of the

shell, and then concave. Brachial valve flat on the umbo and convex in front. Cardinal area narrow, the wide delthyrium mostly covered by the deltidium, with a small opening for the pedicle at the beak. Muscle area in the pedicle valve small, confined to the space under the umbo. Surface marked by fine alternating striæ, the prominent striæ being very numerous and increasing by implantation. Between each pair of the strong striæ are two or three finer ones, and the whole surface is crenulated by very fine concentric striæ. The brachial valve sometimes shows some fine concentric wrinkles.

One specimen is 15.5 mm. long and 20 mm. wide. Another is 16 mm. long and 19.5 mm. wide.

*Locality*.—All the specimens are from the lower layers on Valcour Island, and are in the Carnegie Museum.

#### Family ORTHIDÆ Woodward.

##### Genus ORTHIS Dalman.

##### 18. *Orthis costalis* Hall.

(Plate XXXV, figure 4.)

*Orthis costalis* HALL, 1847. Paleontology of New York, Vol. I, p. 20, Pl. 4 bis, fig. 4a. Non 4b, 4b, 4c.

*Orthis costalis* HALL, 1883. Second Annual Report New York State Geologist, Pl. 34, fig. 35.

*Orthis costalis* HALL and CLARKE, 1892. Paleontology New York, Vol. VIII, pt. 1, Pl. 5, figs. 16, 17.

This species is generally listed as one of the commonest and most characteristic brachiopods of the Chazy, but the writer has only seen one specimen which he was sure belonged to the species, and that the specimen represented in figure 4a on the plate accompanying Hall's original description. Through the kindness of Dr. Hovey I have been able to study the types of this species, preserved in the collection at the American Museum of Natural History. The original of figure 4a is undoubtedly an *Orthis*. It is a pedicle valve with about thirty-two simple plications. The hinge is nearly equal to the greatest width, and the shell is nearly as long as wide (11 × 13 mm.).

The original of Hall's figure 4c—the smaller of the specimens marked 4b on the plate—is an exfoliated pedicle valve of a *Plectorthis*. This specimen is on a small fragment of limestone with numerous other brachial and pedicle valves, all of which belong to *Plectorthis exfoliata*,

a species which is exceedingly abundant in the lower part of the Chazy at Chazy, New York.

A third specimen sent by Dr. Hovey, and presumably labeled by Hall, proves to be a large exfoliated brachial valve of *Hebertella vulgaris*.

To return to the first specimen, which must be taken as the holotype of *Orthis costalis*. This specimen is on a chip of dark limestone which contains no other fossil except a fragment of a *Strophomena*. The lithological character of the fragment is entirely different from that of the other two fragments sent by Dr. Hovey, and is a pure dark limestone such as is found at Chazy only in the Middle Chazy or the Black River. The strata of the Lower Chazy at Chazy are all yellowish in tone. The specimen is imperfect, but it agrees in proportions and number of plications with *Orthis tricenaria*, and it is possible that it is a specimen of that species. The writer has described two species of *Orthis* from the Chazy, but both are quite different from this type of *Orthis costalis*. *Orthis acutiplicata* comes from the lower layers of the Chazy at Valcour Island, but it has only about half as many plications as *O. costalis*. *Orthis ignicula* is more like *O. costalis*, but the width at the hinge equals, or is greater than, the width below, and the shell is nearly one-third wider than long (10×14 mm. in one specimen, 4×6 mm. in another, and 9.5×14 in a third). *Orthis costalis* and *O. tricenaria* are long and have the width at the hinge less than the greatest width, while *Orthis disparalis* and *O. ignicula* are short and wide, and the greatest width is at the hinge.

#### 19. *Orthis ignicula* Raymond.

(Plate XXXV, figures 5-7.)

*Orthis disparalis* BILLINGS, 1859. Canadian Naturalist and Geologist, Vol. IV, p. 440, figs. 20a, b (non Conrad).

*Orthis ignicula* RAYMOND, 1905. American Journal of Science, series 4, Vol. XX, p. 369.

#### DESCRIPTION.

Shell transversely oval in outline, wider than long. Greatest width at the hinge. Pedicle valve strongly convex, the cardinal area high and a little incurved. Brachial valve nearly flat, with a broad depression toward the front. Cardinal area of this valve also wide. Cardinal process small. Delthyrium narrow, the deltidium not preserved in any of the specimens at hand. Surface marked by from

sixteen to twenty-five simple, rounded plications, which increase by implantation.

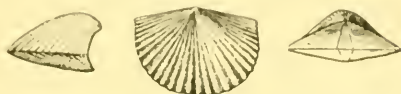


FIG. 10. *Orthis ignicula* Raymond. Side, dorsal, and cardinal views of a small specimen. One-half larger than natural size.

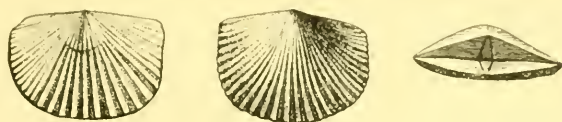


FIG. 11. The same species. Dorsal, ventral, and cardinal views of a larger specimen. Same magnification.

*Locality.* A rare species, found so far only on Valcour Island, where it is most commonly associated with *Camaratæchia plena* at Cystid Point.

#### 20. *Orthis acutiplicata* Raymond.

(Plate XXXV, figures 8-10.)

*Orthis acutiplicata* RAYMOND, 1905. American Journal of Science, series 4, Vol. XX, p. 370.

In the sandy and dolomitic layers near the base of the Chazy at Valcour Island there is an *Orthis* which differs from both *Orthis ignicula* and *O. costalis* in having the brachial valve more convex, and in having fewer plications on the surface. It seems to have only a limited vertical range, and has been found at only one locality, where, however, it is quite abundant.

#### DESCRIPTION.

Shell small, almost circular in outline. Width at the hinge not quite equal to the greatest width below. Cardinal area of pedicle valve high, nearly flat. Delthyrium narrow, deltidium not preserved. Brachial valve convex on the umbo, flattened in front. Surface marked by from twelve to fifteen simple plications which are separated by spaces wider than themselves.

*Locality.*—Near base of the Chazy at the southern end of Valcour Island, New York.

21. *Plectorthis exfoliata* Raymond.

(Plate XXXV, figures 11, 12.)

*Hebertella exfoliata* RAYMOND, 1905. American Journal of Science, series 4, Vol. XX, p. 370.

It is not easy to determine whether this species should be referred to *Hebertella* or *Plectorthis*. The valves are nearly equally convex, and the surface is marked by fine plications or coarse striæ. The statement in the original description that the sinus of the brachial valve of this species is deeper than in *Hebertella vulgaris*<sup>2</sup> is incorrect, two species being mixed up in the original types. *Plectorthis exfoliata* is very abundant in the lower part of the Chazy at Chazy and Valcour, but nearly all the specimens are exfoliated single valves. It is the species usually identified as *Orthis costalis*. (See Hall, Paleontology New York, Vol. I, Pl. 4 bis, figs. 4b, 4b, 4c; and Hall and Clarke, *ibidem*, Vol. VIII, Pl. 5, fig. 15.)

## DESCRIPTION.

Valves nearly equally convex, the pedicle valve a little the deeper. Outline variable, but usually somewhat transversely oval, the shells being slightly wider than long. Hinge line nearly equal to the greatest width. Cardinal area of pedicle valve moderately high, scarcely incurved. A single specimen shows a remnant of a deltidium. Pedicle valve evenly convex, with a suggestion of a low median fold. Brachial valve evenly convex or with a slight median sinus. Surface marked by thirty to forty fine simple plications, two or three of which on each valve seem to bifurcate. Specimens of this species are somewhat similar to those specimens of *Hebertella vulgaris* which lack the sinus in the pedicle valve, but the striæ are much coarser.

*Locality*.—This species is very common in the lower Chazy at Chazy, Valcour, and Valcour Island, New York, and a few specimens have been found at other horizons on Valcour Island.

Genus PLÆSIOMYS Hall and Clarke.

22. *Plæsiomys platys* (Billings).

(Plate XXXV, figures 13, 14.)

*Orthis platys* BILLINGS, 1859. Canadian Naturalist and Geologist, Vol. IV, p. 438, fig. 15.

<sup>2</sup>The *Hebertella costalis* of my papers in the American Journal of Science, Vol. XX, and ANNALS CARNEGIE MUSEUM, Vol. III, no. 4, should be read *Hebertella vulgaris*. This mistake arose from a failure to restrict the *Orthis costalis* of Hall to the specimen first figured by him. Some of the other types were *Hebertellas*.

*Orthis platys* BILLINGS, 1863. Geology of Canada, p. 129, fig. 54.

*Orthis platys* HALL and CLARKE, 1892. Paleontology of New York, Vol. VIII, pt. 1, p. 218.

*Orthis platys* WINCHELL and SCHUCHERT, 1893. Paleontology Minnesota, Vol. III, pt. 1, p. 424.

*Dinorthis platys* SCHUCHERT, 1897. Bulletin United States Geological Survey, No. 87.

In the first part of Volume VIII of the "Paleontology of New York," Hall and Clarke proposed to divide the reversed impunctate Orthids into three groups: first, that of *Orthis pectinella*, for which the name *Dinorthis* was proposed, second, the group of *Orthis subquadrata*, with the name *Plæsiomys*, and third, the group of *Orthis sinuata*, called by them *Hebertella*. Winchell and Schuchert, in the Paleontology of Minnesota, rejected the name *Plæsiomys*, and show that there were species and varieties with all gradations in the striæ from the very finely striated forms like *Orthis deflecta* to the coarsely plicated shells like *O. pectinella*. While this is doubtless true, it seems best to retain the name *Plæsiomys* for the present, and apply it to such forms as *Orthis subquadrata* and *O. platys*, in which the surface is not coarsely plicated, but is covered with striations which increase by bifurcation and implantation.

#### DESCRIPTION.

Pedicle valve fairly high and convex on the umbo, flat or only slightly convex in front. Brachial valve nearly flat, usually showing a shallow sinus on the umbo. Surface marked by fairly coarse striæ, which increase by implantation. There are usually three or four in the space of two millimeters on the front of the shell. The interior of the pedicle valve shows a small muscle area under the beak, composed of two strong diductor scars, and between them two very narrow adductor scars. Deltidium narrow. No specimen has been seen which was so preserved as to retain the deltidium. In the brachial valve there is a low median septum. Other details could not be made out.

*Locality.*—This species is rather common at Crown Point, and less common at Valcour Island, Chazy, and Montreal. It usually occurs in a partially exfoliated condition.

#### Subgenus VALCOUREA nov.

This subgenus is proposed for impunctate orthids with reversed valves, strophomenoid habit, well developed deltidium, simple cardinal

process, and finely striated surface. Type, *Plasiomys strophomenoides* Raymond. *Strophomena deflecta* Conrad, *S. recta* Conrad, and *Orthis loricula* Hall and Clarke also belong here. This subgenus differs from *Plasiomys* Hall and Clarke in having the surface much more finely striate, and in retaining the deltidium throughout life.

23. **Valcourea strophomenoides** Raymond.

(Plate XXXV, figures 15-19; plate XXXVI, figure 1.)

*Plasiomys strophomenoides* RAYMOND, 1905. American Journal of Science, series 4. Vol. XX, p. 370.

DESCRIPTION.

Shell small, pedicle valve convex at the umbo, concave in front. Brachial valve convex, with a narrow sinus on the umbo. Surface marked by numerous fine striæ which increase by bifurcation and implanation. There are usually seven or eight in a space of two millimeters on the front of the shell.

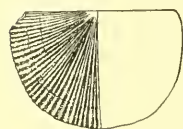


FIG. 12. *Valcourea strophomenoides* Raymond. A small specimen, to show surface markings.  $\times 2$ .

The cardinal area of both valves is low. On the pedicle valve there is a convex deltidium, which is perforated at the apex for the passage of the pedicle. The interior of the pedicle valve shows a small but strongly impressed muscle scar under the umbo. The scar is roughly quadrate, and contains a pair of strong diductor scars, between which are the scars of the adductor muscles. Behind the latter is a deep pedicle scar. The lateral edges of the diductor scars are bounded by strong plates which run back to support the teeth. The interior of the brachial valve shows

a robust, simple cardinal process and small dental sockets, bordered by strong plates which do not diverge greatly. In front of the cardinal process is a low median septum, on either side of which are the four scars of the adductors, not, however, deeply impressed.

This species can be distinguished from *Plasiomys platys* by its much finer striæ and the much more convex brachial valve. It is commoner than the former species, and is usually found in the middle of the Chazy.

*Locality*.—Crown Point, Valcour Island, and Plattsburgh, New York. The cotypes are from near the Fair Grounds at Plattsburgh, and are in the Carnegie Museum.



Genus *HEBERTELLA* Hall and Clarke.

24. *Hebertella borealis* (Billings).

*Orthis borealis* BILLINGS, 1859. Canadian Naturalist and Geologist, Vol. IV, p. 436, fig. 14.

*Orthis borealis* BILLINGS, 1863. Geology of Canada, p. 129, fig. 56.

DESCRIPTION.

Shell transversely oval, width at hinge considerably less than the width below. Sides rounded, front straight or slightly rounded. There is a low, broad depression in both valves. The pedicle valve is the more convex of the two in young specimens, but in mature shells the brachial valve is slightly the larger. The cardinal area of



FIG. 13. *Hebertella borealis* (Billings). A specimen from St. Martin Junction. Natural size.



FIG. 14. *Hebertella borealis* (Billings). A specimen with a very short hinge-line. St. Martin Junction. Natural size.

the pedicle valve is high and incurved, with a narrow delthyrium. The surface is marked by from twenty to thirty broad, simple plications, separated by very narrow grooves.

This species is commonly reported from the Trenton of Canada, Kentucky, Tennessee, and Minnesota, but the shells so identified have a deeper sinus in the pedicle valve and do not have a sinus in the brachial valve. Professor Foerste has recently given the name *Hebertella frankfortensis* to the form which occurs in the Trenton. (Bulletin Denison University, 1909, p. 318, Pl. VII, figs. 11A, B.)

*Locality*.—The writer has reported this species from Valcour Island, but he is now doubtful whether it occurs there. It is common at St. Martin Junction, near Montreal, at Caughnawaga and elsewhere in Canada.

25. *Hebertella vulgaris* sp. nov.

(Plate XXXVI, figures 2-5.)

*Orthis perveta* BILLINGS, 1859. Canadian Naturalist and Geologist, Vol. IV, p. 434 (non Conrad).

*Orthis subæquata* BILLINGS, 1859. *Ibidem*, p. 434 (non Conrad).

*Orthis gibbosa* BILLINGS, 1859. *Ibidem*, p. 434 (non Billings, 1856).

*Hebertella vulgaris* RAYMOND, 1906. Annals Carnegie Museum, Vol. III, p. 501, *et seq.* Not described.

*Hebertella vulgaris* is very closely allied to *H. borealis*, but has a wider shell and very much finer striæ. Young shells have a marked sinus in the brachial valve, and it was such specimens that Billings identified as *Orthis perveta* and *Orthis gibbosa*. The shells so identified by Billings are now before me. The shell does not show a punctate structure, and therefore can not belong to *Dalmanella*, as *Orthis subæquata*, *O. perveta* and *O. gibbosa* do.

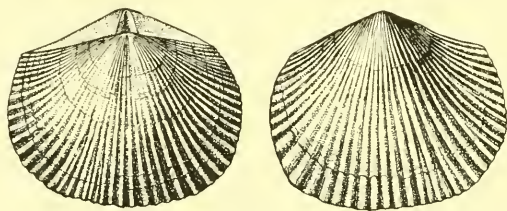


FIG. 15. *Hebertella vulgaris* Raymond. A large specimen, showing some bifurcating striae.  $\times 2$ .



FIG. 16. The same species. A small specimen with direct striae. One-half larger than natural size.

DESCRIPTION.

Valves nearly equally convex, outline transversely oval, hinge of variable length, but always less than the greatest width. Sides and front rounded. Some specimens have a broad shallow sinus in the

pedicle valve, while others have that valve evenly convex, or merely flattened toward the front. The brachial valve usually shows a narrow but not deep sinus, which extends from the beak nearly or quite to the front. The line in which the two valves meet is usually straight, but in those specimens which have a sinus in the pedicle valve and none in the brachial, the front is sinuate. Mature specimens usually have from sixty to ninety fine striæ on each valve. The striæ increase both by bifurcation and implantation.

The cardinal area of the pedicle valve is high and slightly incurved, the delthyrium apparently open. The teeth are supported by thin lamelle, between which are the scars of the muscles. In the brachial



FIG. 17. *Hebertella vulgaris* Raymond. Two brachial valves. One-half larger than natural size.

FIG. 18. The same species. The interior of two pedicle valves. Same magnification.

valve there is a low median septum which expands at the posterior end, forming a platform, in the middle of which is the small linear cardinal process. In front of this platform are two pairs of deep adductor scars. The dental sockets are narrow and deep.

*Locality.*—This species is common at Chazy and Valcour Island, New York, and occurs at many different horizons, but is commonest in the upper division.

## 26. *Hebertella imperator* (Billings).

(Plate XXXVI, figures 6, 7.)

*Orthis imperator* BILLINGS, 1859. Canadian Naturalist and Geologist, Vol. IV, p. 435, figs. 11-13.

*Orthis imperator* BILLINGS, 1863. Geology of Canada, p. 129, fig. 55.

*Hebertella imperator* HALL and CLARKE, 1892. Paleontology of New York, Vol. VIII, pt. 1, p. 222.

This species, the individuals of which attain a larger size than any of the other *Orthidæ* of the Chazy, does not appear to occur in the typical Chazy deposits, but is very abundant in the Ottawa Valley. It

usually occurs as internal casts in sandstone, and as the present collection does not contain any specimens showing the exterior, Billings' original description is here repeated.

#### DESCRIPTION.

"Subquadrate, large, very gibbous, hinge line less than the greatest width of the shell; front margin gently convex, straight, or slightly concave; front angles rounded; a portion of the sides, equal to about one third the length along the middle, usually straight, but sometimes a little convex; above the sides curve inward to the cardinal angles.

"The ventral valve is moderately and somewhat irregularly convex, the beak small, pointed, and much elevated. In most of the specimens a broad, low mesial ridge or depressed fold extends from the beak to the front margin; sometimes the fold is barely perceptible or obsolete, and in such cases the whole of the valve, except a small space at the cardinal angles is flat, and slopes with scarcely any curvature from the beak to the front; at each of the cardinal angles a portion of the shell is depressed toward the dorsal valve. Area large, triangular, a little arched. Foramen not large, extending nearly to the apex of the beak.

"Dorsal valve very convex, most elevated in the upper half, and sloping abruptly to the sides, front and cardinal angles, the latter strongly reflected, as is also in some specimens a narrow border along the upper third of the sides; the beak and area strongly incurved over the hinge line. Along the middle of this valve a broad, shallow mesial furrow extends from the beak to the front. The foramen is occupied by a sharp cardinal process.

"The surface is covered with moderately coarse, radiating ridges, about four or five in the width of two lines, at the margin. They appear to be two or three times subdivided between the beak and the front."

The interior of the brachial valve shows small dental sockets, bounded by lamellæ which are supported by branches of the median septum. The delthyrium is wide and open, the cardinal process small and linear. The muscle scars are not deeply impressed, but on some specimens two pairs of adductor scars can be made out.

In the pedicle valve the muscle area is very strongly marked, somewhat triangular in outline, and widest at the front. At the sides it is bounded by strong lamellæ which support the teeth. At the front of the scar a sort of platform is formed by the thickening of the shell.

The scar has three elements; the large pedicle scar at the apex, a pair of diductors at the sides, and a pair of narrow adductors on a slight ridge in the middle.

The specimens show considerable variation in the size of the striæ. Some have a comparatively few coarse, direct plications, while others have large striæ which increase by bifurcation and implantation.

It is very probable that this species is only a local variation of *Hebertella borealis*, as it differs from that species in rather minor particulars. The most persistent difference is that the pedicle valve is always convex, while in *H. borealis* there is usually a sinus in this valve.

*Locality*.—Common at Hawkesbury, Cornwall, and Aylmer, Canada.

27. *Hebertella bellarugosa* (Conrad).

(Plate XXXVI, figures 8, 9.)

*Orthis bellarugosa* CONRAD, 1843. Proceedings Academy Natural Sciences, Philadelphia, Vol. I, p. 333.

*Orthis bellarugosa* HALL, 1847. Paleontology New York, Vol. I, p. 118, Pl. 32, fig. 3.

*Hebertella bellarugosa* HALL and CLARKE, 1892. Paleontology New York, Vol. VIII, p. 222.

*Orthis (Hebertella?) bellarugosa* WINCHELL and SCHUCHERT, 1893. Paleontology of Minnesota, Vol. III, pt. I, p. 434, Pl. 33, figs. 1-4.

This species is common in the upper part of the lower division of the Chazy at the southern end of Valcour Island, and in the lower part of the upper division on the eastern side. The specimens are of about the same size and have the same characteristics as those found in the Trenton of Minnesota, Wisconsin, and Tennessee.

DESCRIPTION.

Shell usually nearly circular in outline, valves about equally convex. Surface marked by from thirty to forty coarse striæ which increase by implantation and bifurcation. The radial striæ are crossed by sharp concentric lamellæ, producing the rugose appearance which suggested the specific name. From ten to fifteen of the radial striæ are stronger than the others, and between each pair of strong striæ is a single weaker one, except in the sinus of the brachial valve, where there are two. The pedicle valve is evenly convex, somewhat flattened toward the front, but without a sinus. Hinge line less than the greatest width. Cardinal area not high, nor much incurved. The brachial valve has a narrow median sinus.

The shells vary in outline; some are wider than long, while in others the width and length are about equal. The sides are rounded, and the front is nearly straight in some specimens and rounded in others.

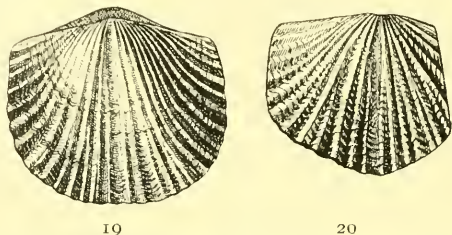


FIG. 19. *Hebertella bellarugosa* (Conrad). A brachial valve.  $\times 2$ .

FIG. 20. The same species. An imperfect brachial valve, to show the strong concentric lamellæ.  $\times 2$ .

*Locality*.—A rather common shell in two localities on Valcour Island, New York.

### 28. *Orthis acuminata* Billings.

*Orthis acuminata* BILLINGS, 1859. Canadian Naturalist and Geologist, Vol. IV, p. 44, fig. 19.

*Orthis acuminata* BILLINGS, 1863. Geology of Canada, p. 130, fig. 59.

This species, which is characterized by its *Spirifer*-like outline, was founded by Billings on a single specimen from Caughnawaga, Canada. The type is now before the writer, and it proves to be an imperfect

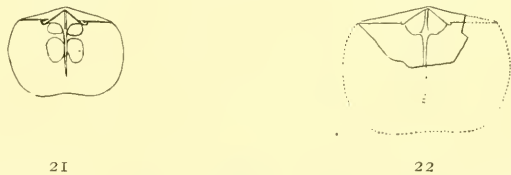


FIG. 21. The type of *Orthis acuminata* Billings. Outline drawing to show the portion of the shell now preserved, and its probable shape when complete. One-half larger than natural size.

FIG. 22. Interior of a brachial valve of *Hebertella vulgaris*, to compare with the preceding.

brachial valve of some species of *Hebertella*, perhaps *H. vulgaris*. The acuminate character of the cardinal extremities is due to a transverse fracture of the shell and the flaking off of some of the inner layer. The shell is broken very evenly along the front, but that it is broken

is shown not only by the condition of the edge, but by other evidence. In the first place, the median septum extends to the anterior margin, a very unusual condition in the *Orthis*s; secondly, the cardinal process is about half as long as the shell, which is certainly not a normal feature; and thirdly, only the posterior pair of adductor scars are retained on this fragment. The accompanying text figure shows the present condition of the shell, and the probable outline when complete. This name had better be dropped, as it will be impossible to identify any more material with this type.

29. *Orthis piger* Billings.

*Orthis piger* BILLINGS, 1859. Canadian Naturalist and Geologist, Vol. IV, p. 442.

This species was never figured, and it appears that the type is not to be found, so that it is not now possible to place the species in its proper genus.

Family CLITAMBONITIDÆ Winchell and Schuchert.

Genus CLITAMBONITES Pander.

30. *Clitambonites multicostus* (Hudson).

(Plate XXXVI, figures 10-14.)

*Syntrophia multicosta* HUDSON, 1905. Report of the New York State Paleontologist for 1903, p. 285, Pl. 5, figs. 8-15.

DESCRIPTION.

Shell similar in form to a typical *Orthis*, the brachial valve flat or only slightly convex, the pedicle valve pyramidal, with a high, flat cardinal area, which may be at right angles to the plane of the brachial



FIG. 23. *Clitambonites multicostus* Hudson. Exterior and interior of a large specimen, showing spondylium. The deltidium is entirely removed. One-half larger than natural size.

valve, or tilted a little backward. The surface is marked by very numerous fine striae which increase by bifurcation.

In the pedicle valve there is a wide, deeply concave spondylium, supported by a strong median septum. This spondylium was the place of attachment of the adductor and diductor muscles, but the scars left by them are very faint. Beneath the spondylium and extending nearly to the front of the shell are the radial markings of the vascular system. The delthyrium is very wide, and was covered by a convex deltidium, traces of which are seldom preserved in the specimens so far collected.

The area of the brachial valve is crossed obliquely by two grooves bounded by small lamellæ, forming shallow dental sockets. At the middle line is a narrow, sharp cardinal process, in front of which is the low median septum. On either side of the septum are two large, deeply impressed scars, and at its anterior end, two small scars. The large adductor muscles must have been necessary in order to hold the valves together, as the teeth and sockets are rudimentary.

*Locality.*—This species is abundant on the eastern side of Valcour Island, and less common at Bluff Point, and Chazy. It is probably one of the species which has been identified as *Orthis costalis*.

### 31. *Clitambonites porcia* (Billings).

(Plate XXXVI, figures 15, 16.)

*Orthis porcia* BILLINGS, 1859. Canadian Naturalist and Geologist, Vol. IV, p. 439, figs. 16-18.

*Orthis porcia* BILLINGS, 1863. Geology of Canada, p. 130, fig. 58.

An examination of the type of this species, which was made possible by the kindness of the late Dr. Whiteaves, shows that the specimen described by Billings was the pedicle valve of a *Clitambonites*. At the apex and along the edges of the delthyrium there still remain portions of the deltidium, and it required only a slight amount of development to reveal the presence of a spondylium. The specimen differs from a pedicle valve of *Clitambonites multicosus* in having a narrower deltidium and spondylium, and in having much coarser striæ. The specimen is 6.25 mm. long, 8 mm. wide, and 3 mm. high at the apex.

*Locality.*—Two miles south of Montreal, Canada.

### Genus ORTHIDIUM Hall and Clarke.

### 32. *Orthidium ? lamellosum* Raymond.

(Plate XXXVI, figures 17, 18.)

*Orthidium lamellosum* RAYMOND, 1905. American Journal of Science, Series 4, Vol. XX, p. 371.



## DESCRIPTION.

Pedicle valve strongly convex, area high. The outline of the shell is subquadrate, the greatest width at the hinge, and the cardinal extremities slightly alate. There is a narrow but deep median sinus, in which there is one plication.

Brachial valve with a shallow median sinus containing two plications. The valve is slightly convex and has about twenty sharp plications which are crossed by strong concentric lamellæ. An average specimen is 3 mm. long, and 5.5 mm. wide. The specimens are all separated valves and the figured pedicle valve is to be taken as the holotype. The interior of the shell is unknown, and therefore its reference to the genus *Orthidium* is based on external characters only.



FIG. 24. *Orthidium lamellosum* Raymond. A well preserved brachial valve supposed to belong to this species.  $\times 3$ .

*Locality*.—Rather common at Valcour Island, and less so at Chazy and at Crown Point, New York. The holotype is from Sloop Island.

## Family PORAMBONITIDÆ Davidson.

## Genus CAMARELLA Billings.

33. *Camarella longirostris* Billings.

(Plate XXXVI, figures 29, 30.)

*Camarella longirostra* BILLINGS, 1859. Canadian Naturalist and Geologist, Vol. IV, p. 302, p. 445, fig. 23.

*Camarella longirostra* BILLINGS. Geology of Canada, p. 127, fig. 63.

*Triplecia gracilis* RAYMOND, 1902. Bulletin American Paleontology, Vol. III, p. 303, fig. 1, Pl. 18.

*Triplecia gracilis* Raymond was based on a large and well preserved brachial valve and a mutilated pedicle valve of *Camarella longirostris*. *Camarella longirostris* and *C. parva* differ widely from the *Camarella volborthi* of the Black River. Specimens of the latter, which is the type of the genus, have the ventral beak short and incurved, while the beak of the pedicle valve of *Camarella longirostris* is extended, and straight.

## DESCRIPTION.

Outline triangular, longer than wide, the beak of the pedicle valve attenuate and projecting some distance beyond the beak of the opposite valve. The brachial valve has a short, prominent fold, and the

opposite valve an equally abrupt sinus. The surface is usually smooth but perfect valves show numerous fine wavy striæ, crossed by still finer concentric lines of growth. No interiors have been seen, but in transmitted light pedicle valves preserved in calcite show the spondylium. A perfect specimen has the following dimension: length of pedicle valve, 7 mm., width, 5 mm.; length of brachial valve, 5.5 mm. A larger brachial valve is 7 mm. in length and width, and a still larger pedicle valve is 10 mm. long and 7.5 mm. wide.

*Locality.*—This species is common in the middle of the Chazy at Crown Point, Valcour Island, and Chazy; in the lower portion at Valcour, and in the upper part at Valcour Island.

### 34. *Camarella varians* Billings.

(Plate XXXVI, figures 19-27, 33-36.)

*Camarella varians* BILLINGS, 1859. Canadian Naturalist and Geologist, Vol. IV, p. 445, fig. 24.

*Camarella varians* BILLINGS, 1863. Geology of Canada, p. 127, fig. 52.

*Camarella varians* BILLINGS, 1865. Paleozoic Fossils of Canada, Vol. I, p. 220.

No name could be more appropriate for this exceedingly variable species than the one proposed by Billings. Fortunately, a sufficient amount of material has come to hand to enable us to trace the changes which take place during the growth of this shell, and it will be shown that the various varieties represent stages in the life history of the individual. It is interesting to note that while at one stage in the ontogeny the shell has a simple fold and sinus, without plications, yet this shell does not correspond to *Camarella longirostris*, as the pedicle beak does not project beyond that of the brachial valve.

#### ONTOGENY.

The material which illustrates the ontogeny of this species consists of a great number of perfect calcified specimens from the gray, coarsely crystalline layers in the reefs at Smugglers Bay and Sloop Island, Valcour Island, New York. The horizon is at the base of the Upper Chazy. The specimens are not preserved in such a way as to throw any light on the development of the internal structures, but the series of stages in the growth of the external shell is complete from specimens 1 mm. in length up to those 13 mm. long.

In the nepionic stage the shell is elongate-oval in outline, the hinge line shorter than the greatest width, both valves slightly and evenly

convex, with beaks elevated above the hinge line, and the delthyrium open. No fold, sinus, or plications are developed.

When the shell is about 1 mm. long it assumes a subtriangular shape, the greatest width being toward the front of the shell. The brachial beak becomes closely appressed to the hinge, and the pedicle beak extends slightly behind it, the pedicle passage remaining open. This form is retained until a length of from 1.5 mm. to 2 mm. is attained, when a fold is developed on the front of the brachial valve, and a sinus in the pedicle valve. This will be referred to as stage 1. A little later, when about 3 to 3.5 mm. long, a plication is introduced in the middle of the sinus, thus dividing the fold into two parts or plications. This is stage 2. The next step, at 4 to 4.5 mm. is the introduction of a fold in the sinus between the two plications just formed on the brachial valve. This makes three plications on the brachial valve, two in the sinus of the pedicle valve, and one on each side of the sinus, a total of four on the pedicle valve. This is stage 3. Next, two plications are introduced on the sides of the brachial valve outside the fold, and a corresponding pair on the pedicle valve. This is stage 4. In the fifth and last stage illustrated by these specimens, another plication is introduced in the sinus of the pedicle valve, making three plications in the sinus, four on the fold, one on each side of the fold, and two on each side of the sinus.

The origin of the many varieties, which at first sight might appear to be different species, is that development has been arrested in certain individuals at each of the stages mentioned above, and the shell has grown to adult size without going through the succeeding stages, or else has skipped certain stages. Thus there is a specimen from Cystid Point, Valcour Island, 7.5 mm. long and 6.5 mm. wide, which has only the fold and sinus, without plications (Plate XXXVI, fig. 28). The general form of this specimen is somewhat like that of *Camarella longirostris*, but the beak of the pedicle valve is incurved, not extended, and the brachial valve is subtriangular instead of subcircular. This specimen is an adult the development of which was arrested at stage 1. Another specimen, 8.5 mm. long and 8 mm. wide, has one plication in the sinus and two on the fold. The development of this individual was arrested at stage 2. The specimen is from the quarry at Kings Bay, Cooperville, New York (Plate XXXVI, fig. 24). A majority of the individuals have their development arrested at stage 3, when there are three plications on the fold and two in the sinus. Numer-

ous specimens from various localities on Valcour Island, Valcour, Plattsburgh, Chazy, and Crown Point show this stage of development, and this might be styled the normal form of the species. Specimens of this sort are from 6.5 to 9.5 mm. in length (Plate XXXVI, fig. 21). Other specimens of about the same size, from Sloop Island, show an adult condition in which there are three plications on the fold, and two in the sinus, but there is also a plication on each side of the fold and sinus (Plate XXXVI, figs. 25, 26). The adults which have passed through all stages of development are found in abundance on Sloop Island. Specimens are from 10 to 14 mm. in length, have three plications in the sinus, four on the fold, and one or two pairs on each valve outside the fold and sinus (Plate XXXVI, figs. 33-36).

Billings mentions specimens from the Mingan Islands with five plications on the fold and four in the sinus, but such specimens have not yet been found in the Champlain Valley.

A variety which can not be correlated exactly with any of the above stages occurs on Sloop Island. The best specimen is 10.2 mm. long and 7.3 mm. wide, which is rather a narrow form for this species. The sinus of the pedicle valve contains one plication, and the dorsal fold two, as is usual in stage 2, but in addition there is a plication on each side of the fold and sinus. In this case the formation of plications in the fold and sinus was arrested at an early stage, but the development at the sides continued. This is of especial interest in connection with *Camarella volborthi* of the Black River, which has three plications on the fold, two in the sinus, and two or three pairs of plications at the sides. This species may have been derived from a variety of *Camarella varians* in which the development of plications in the fold and sinus was arrested at stage 3, while the development of plications at the sides went on beyond any stage noted in *C. varians*.

#### DESCRIPTION.

Shell subtriangular in outline, the greatest width toward the front. Both valves convex, the ventral beak extended a little beyond that of the opposite valve; both beaks incurved. The sinus in the pedicle valve has from one to three plications, and the fold from two to four. Most individuals do not have any plications outside the fold and sinus, but a few have one or two pairs on each valve. The majority of the specimens have three plications on the fold and two in the sinus; a

few have four on the fold, three in the sinus, and two on the sides; an occasional specimen has two on the fold and one in the sinus; and one individual shows a simple fold and sinus as in *Camarella longirostris*.

*Locality*.—This species is common at Crown Point, Valcour Island, Plattsburgh, Valcour, Chazy, and Cooperville, New York, and the Mingan Islands.

#### THE OSTRACODA.

In a previous paper the writer described two new species of ostracods from the Chazy, but did not figure them. The present brief note is presented principally to give figures of three of the more common species. The ostracod fauna of the Chazy is not a very large one, and the specimens are not well preserved. Beside the four species enumerated in this paper, the collection contains representatives of a small form with a long horn in the center of the ventral margin, and single valves of three or four species of small, smooth shells.

#### Genus *LEPERDITIA* Rouault.

##### 1. *Leperditia limatula* Raymond.

*Leperditia limatula* RAYMOND, 1905. American Journal of Science, Series 4, Vol. XX, p. 380.

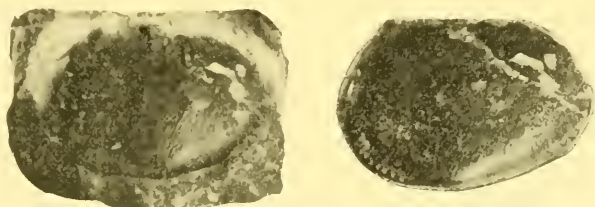


FIG. 25. *Leperditia limatula* Raymond. Two photographs of the holotype, both larger than natural size. The second photograph and the one of *Eurychilina* below, are by Prof. George H. Hudson of Plattsburgh, N. Y.

#### DESCRIPTION.

"Shell of medium size, a little smaller than *Leperditia fabulites*, oblong in outline, higher behind than in front. Hinge short, straight. Anterior end regularly rounded. The posterior end slopes back almost straight for a short distance, but is broadly rounded on the lower posterior margin. The eye tubercle is small, on some specimens sharp,

on others obscure. It is situated in the anterior angle, above and a little in front of the 'muscle spot.' The latter is large, circular, and very finely reticulated. Back of the muscle spot is a region of the shell which is covered with fine raised lines radiating from the side of the spot. These lines frequently anastomose, making a very pretty reticulate surface. The muscle spot is raised above the general surface of the carapace on the lower posterior side, where these lines originate, but the upper and anterior sides are level with the main part of the shell.

"The right valve overlaps the left valve considerably, especially along the ventral edge, which is abruptly deflected and usually shows a low short ridge right at the keel. The lower margins of the anterior and posterior ends are flanged. The border is very narrow and is marked by small pits, which increase in size ventrally. On one finely preserved specimen the anterior flange shows eight pits, of which the seventh, counted from the front, is largest, and the eighth is very small. On the posterior flange of the same specimen there are ten pits, the eighth from the posterior end being the largest, the ninth a little smaller, and the tenth minute. The left valve is not so high in proportion to the length as the right valve, but it is also abruptly deflected ventrally. It shows neither anterior nor posterior flanges and there is a small projection close to the hinge line and parallel to it. Below this is a slight depression."

Dimensions of several specimens:

Length 10.5 mm.; height 7.5 mm.

Length 9 mm.; height 6 mm.

Length 9.5 mm.; height 6.25 mm.

Length 9.5 mm.; height 7.5 mm.

*Locality*.—Common on Valcour Island in certain localities. Rare at Valcour and Chazy, New York.

## 2. *Leperditia nana* Jones.

*Leperditia canadensis* JONES, 1858. Annals and Magazine Natural History, series 3, Vol. 1, p. 244, Pl. 9, figs. 11-15.

*Leperditia canadensis* var. *nana* JONES, 1858. Canadian Organic Remains, Decade III, p. 92, Pl. II, figs. 6, 7, 9, 10.

*Leperditia canadensis* JONES, 1884. Annals and Magazine Natural History, series 5, Vol. 14, p. 240.

*Leperditia canadensis* JONES, 1891. Contributions to Canadian Micro-Palontology, p. 97.

This species, which was originally described from the Ottawa Valley, is very abundant in the Chazy at various points along Lake Champlain. The carapace has no very strongly marked characteristics, and the shell is distinguished chiefly by its uniformly small size and regular convexity.

#### DESCRIPTION.

Shell small and kidney-shaped. Hinge line nearly straight and less than the greatest length. Both valves strongly convex, thickest a little back of the middle. The height of the shell is only slightly greater at the back than at the front. Both eye-spot and muscle-spot are very small and frequently indistinguishable. Both ends are regularly rounded, and the ventral margin is only slightly convex.

*Locality*.—Common in the Chazy at Chazy, Valcour, Valcour Island, and Crown Point, New York, and in the Lowville throughout the Ottawa Valley.

#### Genus EURYCHILINA Ulrich.

#### 3. *Eurychilina latimarginata* Raymond.

*Primitia latimarginata* RAYMOND, 1905. American Journal of Science, series 4, Vol. XX, p. 380.

#### DESCRIPTION.

"Carapace small and depressed. Front and posterior margins meet the dorsal margin at angles of little more than  $90^{\circ}$ . Both ends are broadly rounded, the ventral margin is gently curved. The shell is a little higher at the posterior end than in front. There is a deep sulcus just in front of the middle, which starts from the dorsal margin and extends half-way down the valve, turning a little forward at the lower end. On well-preserved specimens, in front of this sulcus there is a prominent eye-spot, which is sometimes translucent. Often there is another slight depression or sulcus in front of the eye-spot. The border is wide, concave, and of nearly uniform width all around from the anterior angle of the dorsal margin to the posterior one. The test is frequently punctate."

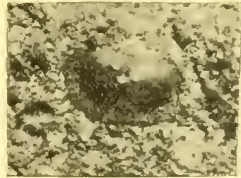


FIG. 26. *Eurychilina latimarginata* Raymond. A photograph of the holotype. Larger than natural size.

*Locality*.—Common all through the Chazy limestone at Chazy, Valcour Island, Crown Point, and elsewhere in the Champlain Valley."

## Genus SCHMIDTELLA Ulrich.

4. *Schmidtella crassimarginata* Ulrich.

*Schmidtella crassimarginata* ULRICH, 1890. American Geologist, Vol. X, p. 269, Pl. LX, figs. 27-30.

Several right valves which appear to belong to this species have been found in the Chazy. They also resemble *Schmidtella crassimarginata ventrilabiata* Ruedemann in general form, but lack the lip-shaped projection on the ventral border. They are longer than either Ulrich's or Ruedemann's specimens, the length being 2.5 mm. and the height 1.5 mm.



FIG. 27.  
*Schmidtella crassimarginata* Ulrich. Photograph of a specimen from Valcour Island, N. Y.

## DESCRIPTION.

Carapace small, strongly convex, with a depressed border, which is widest at the middle of the valve. The hinge-line is straight, and nearly equals the length of the shell. The greatest convexity is at about the middle of the valve. The slope to the dorsal margin is flattened, while the other slopes are convex. The border is wide, smooth, and slopes away from the main body of the shell, from which it is separated by a narrow, sharp groove. The surface of the shell shows a few large scattered depressions.

*Locality.*—This shell is commonest in the "trilobite layers" at Sloop Bay, Valcour Island, New York.

## EXPLANATION OF PLATES.

## PLATE XXXIII.

1. *Glossina belli* (Billings). A pedicle valve from the base of the Upper Chazy, Valcour Island.  $\times 2$ . Carnegie Museum.

2. *Lingula brainerdi* Raymond. A partially exfoliated valve from the sandstone at the base of the Chazy on Valcour Island.  $\times 2$ . Carnegie Museum.

3, 4. *Lingula columba* Raymond. Two valves from the base of the Upper Chazy at Valcour Island.  $\times 2$ . 3 is in the Yale University Museum, and 4 in Professor Hudson's collection.

5, 6. *Lingula lyelli* Billings. Valves representing the two forms referred to this species. The specimens are from the sandstone of the Aylmer formation at Allumette Island, Quebec, and are in the Museum of the Geological Survey of Canada.

7-17. Dorsal and ventral views of a number of specimens of *Camaratachia plena* Hall, to show variation in outline and in the number and strength of the plications. All natural size, and the specimens are in the Carnegie Museum. All are from the same layer at Cystid Point, Valcour Island.



18. *Camarotæchia plena* Hall. An internal cast showing the dental lamellæ and the undivided cast of the spondylium of the brachial valve.  $\times 2$ . Specimen from Valcour Island, now in Carnegie Museum.

19-21. *Camarotæchia orientalis* (Billings). Three specimens from St. Martin Junction, Quebec, Canada. Natural size.

22. The same species. An internal cast from the Aylmer sandstone at Aylmer, Quebec. Compare with 18 and 23.  $\times 2$ . Carnegie Museum.

23. *Camarotæchia congregata* (Conrad). An internal cast from the Hamilton at Worcester, Otsego Co., New York. Compare with 18 and 22.  $\times 2$ . Carnegie Museum.

24-31. *Camarotæchia orientalis* (Billings). Various views of four specimens from St. Martin Junction. Natural size.

32, 33. The same species. A specimen from the Mingan Islands. Collected by W. H. Twenhofel and donated by Professor Schuchert.  $\times 2$ . Carnegie Museum.

#### PLATE XXXIV.

1, 2. *Camarotæchia pristina* Raymond. Photograph of two very small specimens in Professor Hudson's collection.  $\times$  about 4.

3-6. The same species. Small specimens,  $\times 2$ .

7, 8. Internal casts of the same species. Compare 8 with 18, 22, and 23 of the preceding plate.

9, 10. Photographs of two more specimens in Professor Hudson's collection.  $\times$  about 2.

11-14. *Camarotæchia major* Raymond. Three views of the holotype.

14 is a photograph of the pedicle valve by Professor Hudson. 11-13, natural size. Specimen in the Carnegie Museum.

15-22. *Zygospira? acutirostris* (Hall). Photographs and drawings of small specimens in the Carnegie Museum. 19-22,  $\times 4$ .

23, 24. *Schizambon duplicimuratus* Hudson. A drawing of the brachial valve and a photograph of the pedicle valve of a specimen in Professor Hudson's collection.  $\times 2$ .

25. A small specimen from Valcour which may be the same species as the last.  $\times 2$ . Carnegie Museum.

26-31. *Petrocrania prona* Raymond. Exterior and interior of several brachial valves, showing the muscular and vascular scars.  $\times 2$ . 29 and 30 are the same specimen.

32. *Leptæna incrassata* Hall. A large specimen from Sloop Island, showing the alate cardinal extremities and the concentric wrinkles.  $\times 2$ . Carnegie Museum.

33-27. The same species. 33-35, interiors of brachial valves; 36, 37, pedicle valves of small specimens, enlarged.

#### PLATE XXXV.

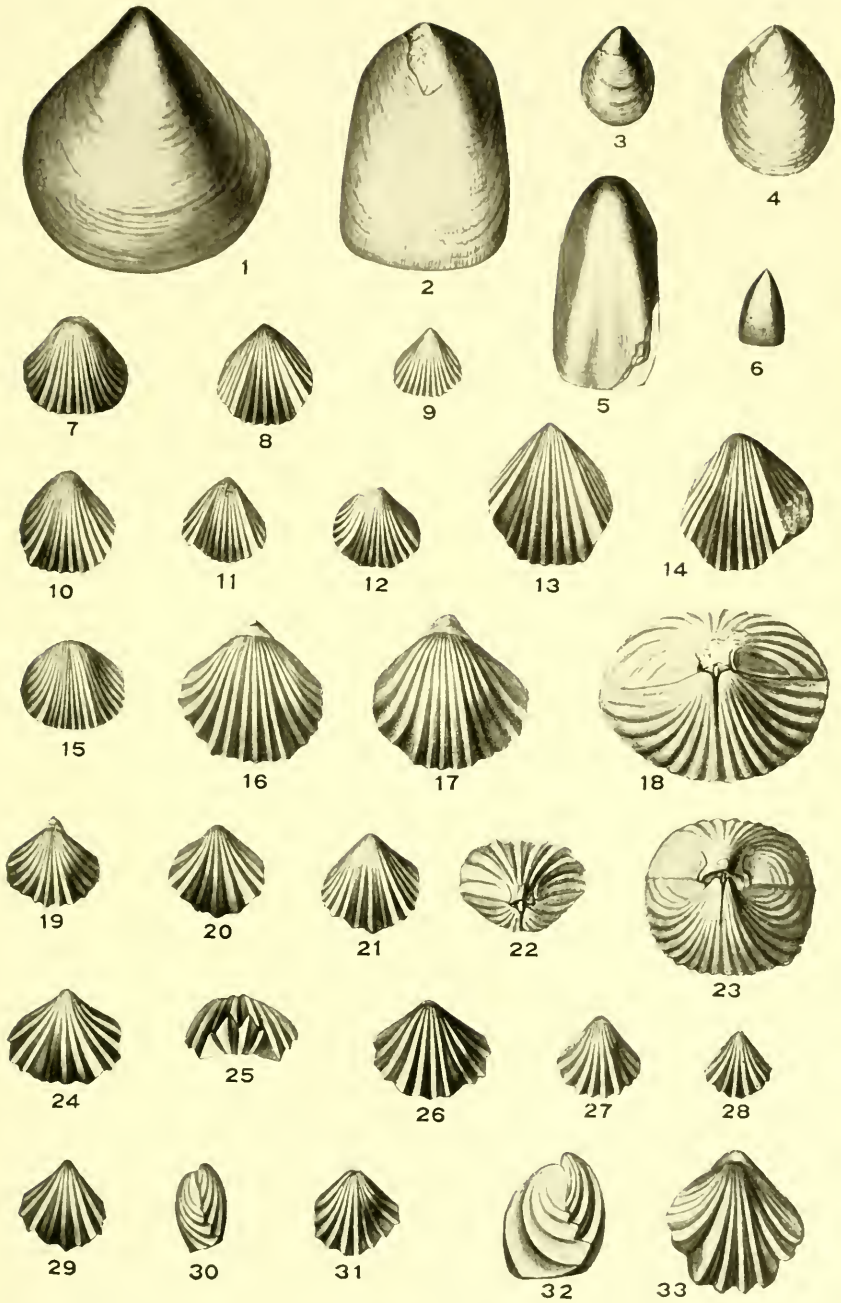
1. *Rafinesquina distans* Raymond. Holotype.  $\times 2$ . Carnegie Museum.

2. *Strophomena prisca* Raymond. Interior of pedicle valve. Natural size. Carnegie Museum.

3. The same species. Exterior of pedicle valve.  $\times 2$ . Carnegie Museum.
4. *Orthis costalis* Hall. Photograph of holotype. American Museum Natural History.
5. *Orthis ignicula* Raymond. A small specimen in Professor Hudson's collection.
- 6, 7. The same species. Brachial and pedicle valve of the holotype. More than twice natural size. Carnegie Museum.
- 8-10. *Orthis acutiplicata* Raymond. Three specimens from the lower part of the Chazy at Valcour Island.  $\times 2$ . Carnegie Museum.
11. *Plectorthis exfoliata* Raymond. A pedicle valve. This was one of Hall's types of *Orthis costalis*. American Museum Natural History.
12. The same species. The brachial valve of a small specimen in Professor Hudson's collection.
- 13, 14. *Plasiomys platys* (Billings). Photographs of a brachial and pedicle valve from the Middle Chazy at Sloop Bay, Valcour Island, New York. Natural size. Carnegie Museum.
15. *Valcourea strophomenoides* Raymond. Interior of a pedicle valve from the Middle Chazy at Plattsburgh, New York,  $\times 2$ . Carnegie Museum.
- 16, 18. The same species. Drawing and photograph of the interior of a brachial valve. The drawing is  $\times 2$ . Same locality as the last.
- 17, 19. The same species. Drawing and photograph of the interior of a pedicle valve. Drawing  $\times 2$ . On the same block with 18 and 19 may be seen the exteriors of other specimens of this same species.

## PLATE XXXVI.

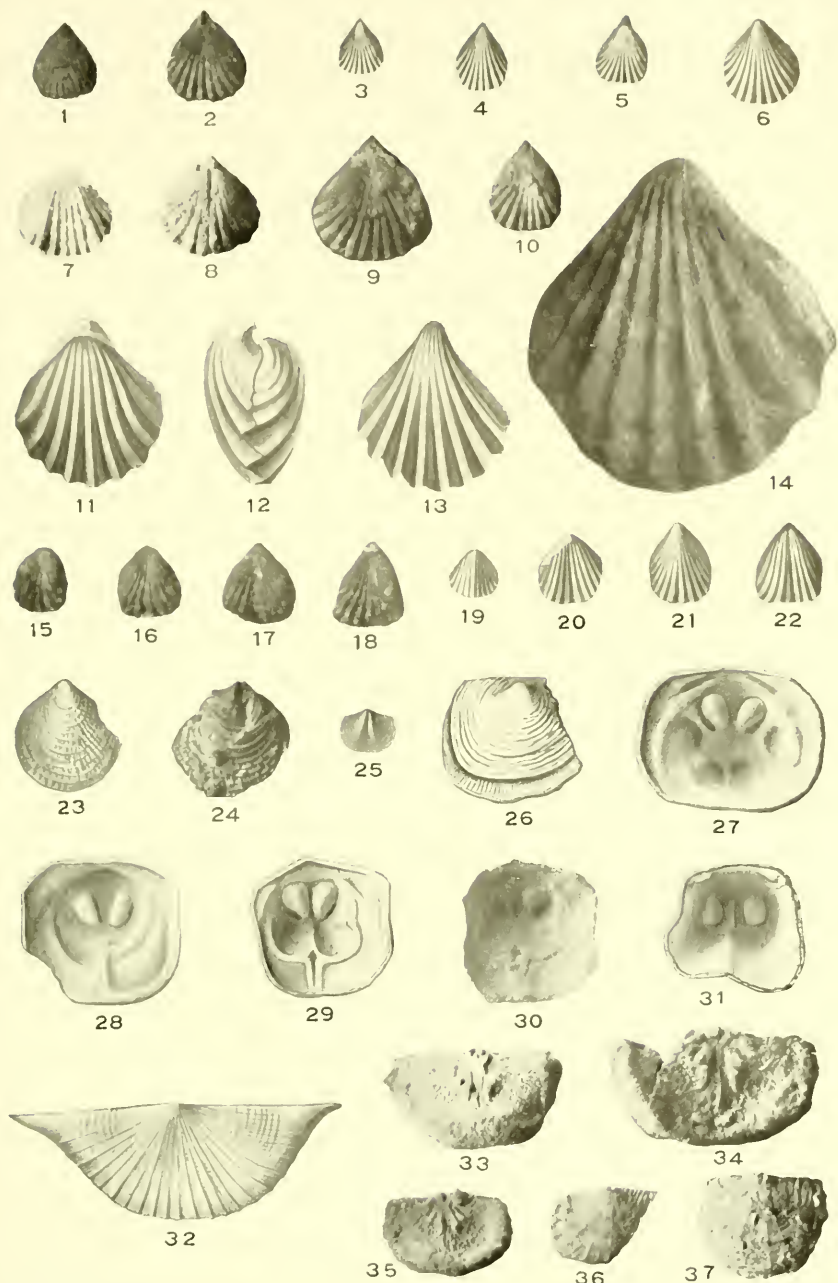
1. *Valcourea strophomenoides* Raymond. Dorsal view of an entire specimen from Plattsburgh, New York.  $\times 2$ . Carnegie Museum.
- 2, 3. *Hebertella vulgaris* Raymond. Dorsal view of one specimen, and pedicle valve of another. 2 is from the Upper Chazy and is in Professor Hudson's collection, and 3 is from the Lower Chazy, and is in the Carnegie Museum.
4. The same species. Interior of a brachial valve.  $\times 2$ . Professor Hudson's collection.
5. Cast of the interior of the pedicle valve of the same species. Such specimens as this are often identified as *Orthis costalis*. Professor Hudson's collection.
- 6, 7. *Hebertella imperator* (Billings). Casts of the interior of a brachial and a pedicle valve from the Aylmer sandstone at Aylmer, Quebec. Natural size.
- 8, 9. *Hebertella bellarugosa* (Conrad). Dorsal and cardinal views of a specimen from the Upper Chazy at Valcour Island, New York. Photograph by Professor Hudson of a specimen in his collection.
- 10, 11. *Clitambonites multicoustus* (Hudson). An entire specimen from Professor Hudson's collection.  $\times 2$ .
- 12-14. The same species. Photographs of two interiors and one exterior of brachial valves. All in Professor Hudson's collection.
- 15, 16. *Clitambonites porcia* (Billings). Pedicle valve of the holotype.  $\times 2$ . Museum of the Geological Survey of Canada.
17. *Orthidium? lamellosum* Raymond. A pedicle valve from the base of the Upper Chazy at Sloop Island. Holotype.  $\times 2$ . Yale University Museum.



S. Prentice, del.

Chazy Brachiopods.

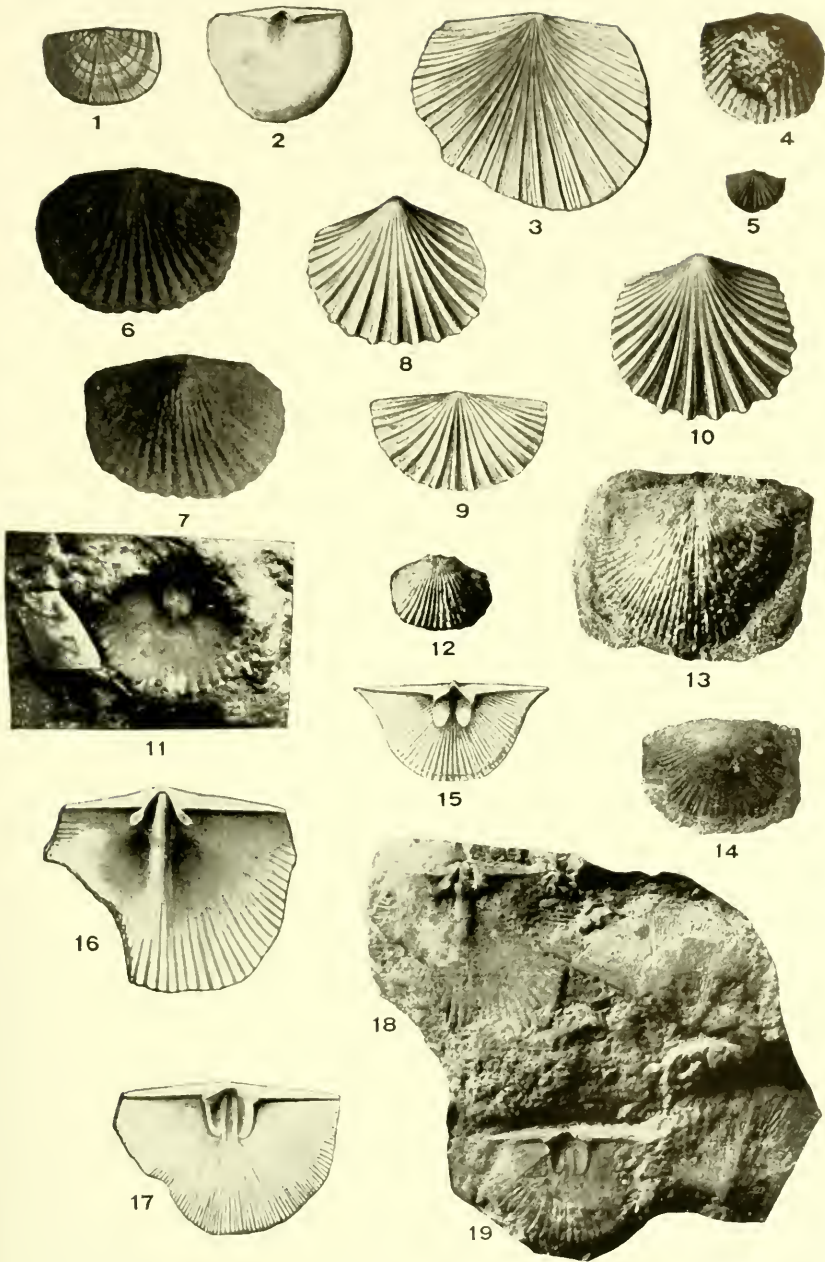




S. Prentice, del.

Chazy Brachiopods.



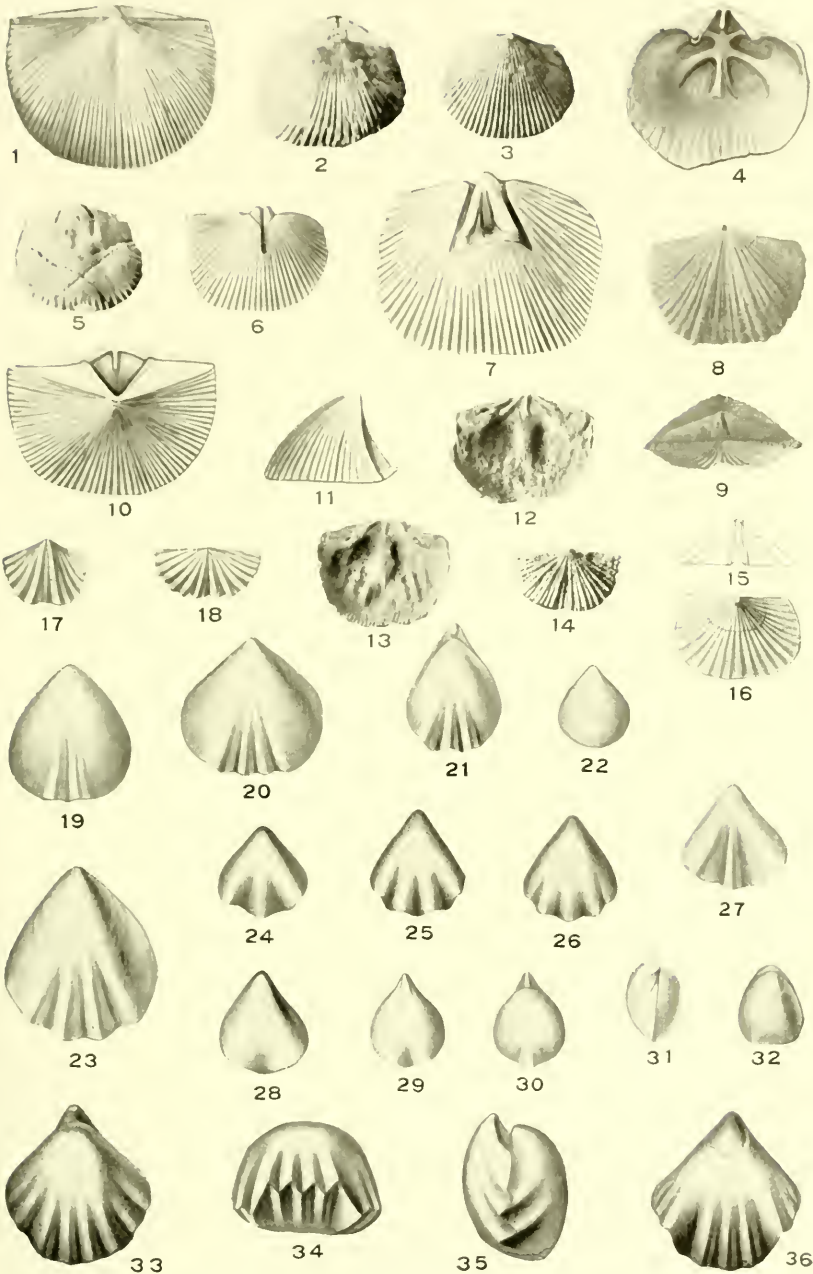


S. Prentice, del.

Chazy Brachiopods.







S. Prentice, del.

Chazy Brachiopods.



18. A brachial valve which is supposed to belong to the preceding species.  $\times 2$ .
19. *Camarella varians* Billings. A brachial valve of an immature specimen. Stage 2.  $\times 4$ . Carnegie Museum.
20. The same species. A pedicle valve of an immature specimen.  $\times 4$ . Carnegie Museum.
21. The same species. A rather elongated adult, arrested at stage 3.
22. The same species. An immature specimen, before the development of the fold and sinus.  $\times 2$ . Carnegie Museum.
23. The same species. An immature specimen. Stage 3.  $\times 4$ .
24. The same species. An adult, arrested at stage 2.  $\times 2$ . Yale University Museum.
- 25, 26. The same species, one of the specimens referred to in the text.  $\times 2$ .
27. The same species. An adult in which there are faint plications on each side of the first plication in the sinus.  $\times 2$ .
28. The same species. An adult, arrested at stage 1.  $\times 2$ .
- 29, 30. *Camarella longirostris* Billings. A specimen showing the elongate beak, but lacking the wavy striæ of the surface.  $\times 2$ .
- 31, 32. *Camarella panderi* Billings. A specimen from Pauquette Rapids, to compare with *C. longirostris*. Natural size. Carnegie Museum.
- 33-36. *Camarella varians* Billings. Four views of a large specimen from Sloop Island.  $\times 2$ .

## XII. A NEW CAMEL FROM THE MIOCENE OF WESTERN NEBRASKA.

BY O. A. PETERSON.

(PLATES XXXVII-XL.)

During the season of 1909, while engaged in collecting fossil bones for the Carnegie Museum in the Miocene formation (Upper Harrison beds) in Sioux County, Nebraska, the writer discovered the remains of a new species of the genus *Oxydactylus*. While the anatomical differences of the latter genus have, to date, necessitated the erection of five species in that genus, none is more remarkable in its differentiation than the present form.

The skull and neck of the type were found in position, with the lower jaws and atlas articulating perfectly in their respective places. If the latter conditions were not true I would not associate the cervical region with the skull on account of the proportionate measurements when compared with the type of the genus.

### *Oxydactylus longirostris* sp. nov.

Type: Skull, lower jaws, greater portion of the neck, fragments of humerus, and ulno-radius. Carnegie Museum Cat. Vert. Foss., No. 2498.

Horizon: Miocene (Upper Harrison beds).

Locality: Whistle Creek, Sioux County, Nebraska.

*Specific Characters.*—*Skull proportionately heavy and elongated when compared with that of other species of the genus, premaxillaries longer, a further reduction of the size of the first and second pairs of incisors, longer diastemata, and cervical vertebrae relatively short.*

### COMPARATIVE DESCRIPTION OF THE TYPE.

*Skull.*—Pls. XXXVII-XXXIX. The principal and most important specific character ascertained for this species is the proportionally large and elongated skull, which is unusual and quite surprising, when compared with other species of the genus. The premaxillaries furnish a good share of the general elongation of the skull, as they are more produced in front of the canines than is usually the case, resulting

in extremely long anterior palatine foramina (see Pl. XXXVII). The diastemata of the alveolar border on the premaxillary and maxillary are quite large and it is evident that the antero-posterior diameter of the molar-premolar series of teeth is rather short in proportion to that of the premaxillary and maxillary, the diameter from P<sup>2</sup> to the tip of the premaxillary being 9 mm. longer than the continuous molar-premolar series, while the same measurement of *O. longipes* shows the diameter in front of P<sup>2</sup> to be 20 mm. shorter.

The skull is considerably crushed to one side, but the general features are well shown and appear to be but very little different from those of *O. longipes* or *O. brachydontus*. The external auditory meatus is proportionally smaller than in the latter species. The characteristic fissure of the frontal, which is situated over the orbit, is closed up before it reaches the orbit so that the border of the latter is complete as in *Procamelus elrodi* Douglass, while in *Oxydactylus longipes* and other Miocene camels as well as in *Poebrotherium* of the Oligocene this fissure is generally open. In recent camels this fissure is also quite generally open.

*Lower Jaw.*—Pls. XXXVII and XXXIX. The inferior borders on the posterior half of both rami are unfortunately missing, but enough is preserved to show that the jaw is very long, quite slender, provided with a long well-coössified symphysis, and a strong angle, while the coronoid process is somewhat lighter than is the case in *O. longipes* and *O. brachydontus*.

MEASUREMENTS OF SKULL AND LOWER JAWS. Mm.

Length of skull from premaxillary to top of occiput.....	422
Length of skull from premaxillary to and including M <sup>3</sup> .....	238
Length of skull from M <sup>3</sup> to and including the occipital condyle....	158
Breadth of skull across the zygomatic arches in front of the glenoid cavity, approximately.....	150
Breadth of skull at M <sup>3</sup> .....	85
Greatest breadth of muzzle opposite P <sup>1</sup> , approximately.....	45
Breadth of skull at postorbital processes of frontal, approximately	150
Breadth of occipital condyles.....	56
Greatest length of lower jaw, including incisors.....	358
Length of lower jaw, from incisors to and including M <sup>3</sup> .....	240
Length of lower jaw, from M <sup>2</sup> to and including the angle.....	120
Depth of lower jaw, from top of coronoid process to inferior border of angle, approximately.....	175
Depth of lower jaw at diastema between P <sub>1</sub> and P <sub>2</sub> .....	28



*Teeth.*—Pls. XXXVII-XXXIX. The first and second incisors of the upper dentition are reduced when compared with *O. longipes*.  $I^2$  is also slightly reduced, while the canine is a little enlarged.  $P^1$  is less trenchant than in *O. longipes* and is more like that tooth in *O. brachydontus* including the fangs coalesced into a single root.  $P^2$  has a heavy cingulum throughout the internal base of its crown, but is otherwise quite similar to that in *O. longipes*. The internal cingulum of  $P^3$  is also quite heavy, but otherwise the differences from  $P^3$  of *O. longipes* are very slight and not worthy of mention, which is also true of  $P^4$ , while the transverse diameter of the molars are somewhat greater in proportion.

The position of the lower incisors is quite procumbent; their crowns are fan-shaped and in every respect similar to those of *O. longipes*. The lower canine is quite heavy in correspondence with the one above, while back of this tooth there is little or no difference in the dentition from that of other species.

## MEASUREMENTS OF DENTITION.

	Mm.
Antero-posterior diameter of the upper dentition . . . . .	232
Antero-posterior diameter of the upper incisor series . . . . .	30
$I^2$ antero-posterior diameter at base of crown . . . . .	5
$I^3$ antero-posterior diameter at base of crown . . . . .	9
Canine antero-posterior diameter at base of crown . . . . .	13
$P^1$ antero-posterior diameter at base of crown . . . . .	7.5
$P^1$ transverse diameter at base of crown . . . . .	5
Antero-posterior diameter of continuous molar-premolar series . . . . .	130
$P^2$ antero-posterior diameter . . . . .	14
$P^2$ transverse diameter . . . . .	6
$P^3$ antero-posterior diameter . . . . .	17
$P^3$ transverse diameter . . . . .	10
$P^4$ antero-posterior diameter . . . . .	17
$P^4$ transverse diameter . . . . .	16
$M^1$ antero-posterior diameter . . . . .	20
$M^1$ transverse diameter . . . . .	20
$M^2$ antero-posterior diameter . . . . .	23
$M^2$ transverse diameter . . . . .	21
$M^3$ antero-posterior diameter . . . . .	27
$M^3$ transverse diameter . . . . .	23
Antero-posterior diameter of lower dentition . . . . .	240
Antero-posterior diameter of lower incisor series . . . . .	37
Lower canine, antero-posterior diameter at base . . . . .	14
Lower canine, transverse diameter at base . . . . .	9
$P_I$ antero-posterior diameter at base . . . . .	8

P <sub>1</sub> transverse diameter at base . . . . .	5
Antero-posterior diameter of continuous molar-premolar series . . . . .	124
P <sub>2</sub> antero-posterior diameter . . . . .	12
P <sub>2</sub> transverse diameter . . . . .	5
P <sub>3</sub> antero-posterior diameter . . . . .	16
P <sub>3</sub> transverse diameter . . . . .	6.5
P <sub>4</sub> antero-posterior diameter . . . . .	19
P <sub>4</sub> transverse diameter . . . . .	10
M <sub>1</sub> antero-posterior diameter . . . . .	20
M <sub>1</sub> transverse diameter . . . . .	13
M <sub>2</sub> antero-posterior diameter . . . . .	24
M <sub>2</sub> transverse diameter . . . . .	17
M <sub>3</sub> antero-posterior diameter . . . . .	39
M <sub>3</sub> transverse diameter . . . . .	16

VERTEBRAL COLUMN.

(PLATE XL.)

The vertebral column is represented by the greater portion of the cervical region, which was found in a consecutive series from the occipital condyle to the fifth cervical. Of these vertebræ the atlas, the third, and fourth cervicals are complete; the axis is somewhat damaged by erosion; while the fifth cervical is represented only by the anterior portion.

*Atlas*.—Pl. XL, Fig. 6. The size of the atlas compared with that of *O. longipes* is more nearly normal than is the case in the vertebræ succeeding it. Excepting a deeper notching on the lateral borders of the articulation for the condyles in *longirostris* the detailed structure of the bone in the two species does not differ. The bone is of considerable length antero-posteriorly; the alæ being moderately expanded transversely, but extending well back of the articular faces for the axis, and terminating in rather heavy protuberances. The neural canal is of large size and the neural spine is only very slightly indicated.

*Axis*.—Pl. XL, Fig. 5. The axis is actually, as well as proportionally, shorter than that bone in *O. longipes*. The articulation for the atlas, however, is of considerably greater diameter, and the neural spine is heavier, while the postzygapophyses, in their uncrushed state, are very slightly broader than in the latter species. From the posterior half of the axis the neck, throughout its length, does in fact show the curious small proportionate diameter. The shorter neck in the present species would seem to be, at least to some extent, offset by the abnormal length of the head.

*Third Cervical Vertebra.*—Pl. XL, Figs. 2, 4. Besides the much smaller proportionate size of the third cervical vertebra, when compared with *O. longipes*, there are other noticeable differences. The anterior and posterior divisions of the transverse process are not connected in a continuous ridge as in *Oxydactylus longipes*, *Procamelus elrodi* Douglass, and also apparently in *Alticamelus altus*, but fade away on the side of the centrum, indicating faint parallel ridges, with the posterior division superior in position to the anterior division. On the external faces of the prezygapophyses are prominent eminences in the type under description, which are entirely absent or poorly indicated in *O. longipes*. The neural spine is not so high as in the latter species, but it is heavier and the median antero-posterior area has a transversely broad and rugous area for muscular attachment (see Fig. 4, Pl. XL).

*Fourth Cervical Vertebra.*—Pl. XL, Figs. 1, 3. The fourth cervical has the centrum very nearly as long as the one preceding it, but the pre- and postzygapophyses are less overhanging. The anterior and posterior divisions of the transverse processes are less separated as parallel ridges, on the sides of the centrum, and the bone as a whole is heavier; otherwise there is very little difference in the detailed structure of the two bones. In *O. longipes* the centrum of the fourth cervical vertebra is about 30 mm. longer than in the present species.

*Fifth Cervical Vertebra.*—The fifth cervical vertebra is represented only by the anterior portion. The zygapophyses are quite heavy, but the anterior face of the centrum is no larger, nor is the anterior division of the transverse process any heavier than in the corresponding bone of *O. longipes*.

## MEASUREMENTS.

	Mm.
Atlas, greatest length.....	92
Atlas, length of neural arch, superiorly.....	47
Atlas, length of neural arch, inferiorly.....	47
Atlas, transverse diameter of articulation for condyles.....	62
Atlas, vertical diameter of articulation for condyles.....	37
Atlas, vertical diameter of articulation for axis, including the neural arch.....	48
Atlas, transverse diameter of articulation for axis.....	61
Axis, greatest length.....	163
Axis, length of centrum, including odontoid process.....	146
Axis, transverse diameter of articulation for atlas, approximately..	78
Axis, transverse diameter of postzygapophyses.....	40



Third Cervical, greatest length.....	187
Third Cervical, greatest length of centrum.....	154
Third Cervical, transverse diameter of prezygapophyses.....	44
Third Cervical, transverse diameter of postzygapophyses.....	46
Third Cervical, vertical diameter, prezygapophyses to ventral border of centrum.....	52
Third Cervical, vertical diameter, postzygapophyses to ventral border of centrum.....	63
Fourth Cervical, greatest length.....	170
Fourth Cervical, greatest length of centrum.....	147
Fourth Cervical, transverse diameter of prezygapophyses.....	60
Fourth Cervical, transverse diameter of postzygapophyses.....	48
Fourth Cervical, vertical diameter from prezygapophyses to vertical border of centrum.....	50

FORE LIMB.

(PLATE XL.)

The distal end of the humerus and the proximal end of the ulno-radius were found articulated in situ, and in close proximity to the type. These fragments are only provisionally referred to the type, pending the discovery of more complete material of this species.

The fragment of the humerus as well as the ulno-radius are only slightly larger than the corresponding parts of *O. longipes* and display no noteworthy differences from those of the latter species, described in the ANNALS of the Carnegie Museum, Vol. II, p. 454, 1904.

A first phalanx, Pl. XL, Figs, 8, 9, which was found in the talus, below where the above described specimen was found, may or may not belong with the type. The bone is less robust than the corresponding bone in *Oxydactylus longipes*.

MEASUREMENTS.

Mm.

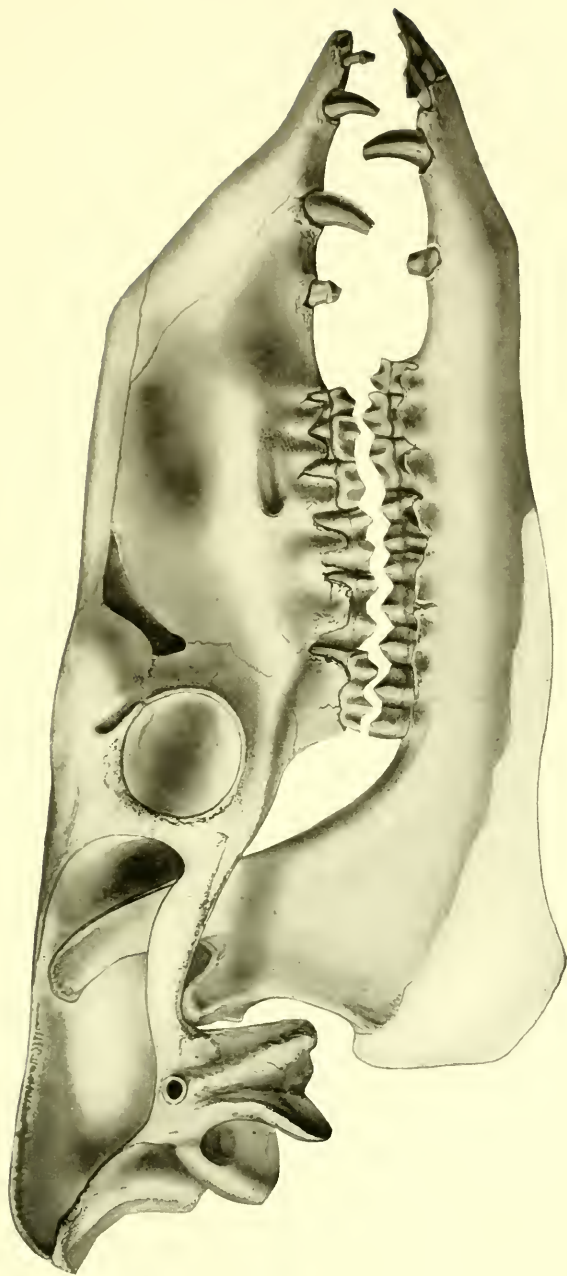
Humerus, antero-posterior diameter of distal end, internally.....	51
Humerus, transverse diameter of trochlea distal end.....	48
Ulno-radius, transverse diameter of articulation for humerus at head of radius.....	48
Ulna, length of olecranon process, approximately.....	68

CONCLUSION.

The remains described above furnish additional proof of the structural variations which these animals developed before the closing epoch of their existence; and incidentally also speak quite eloquently of the various changes, which sometimes undoubtedly took place in a

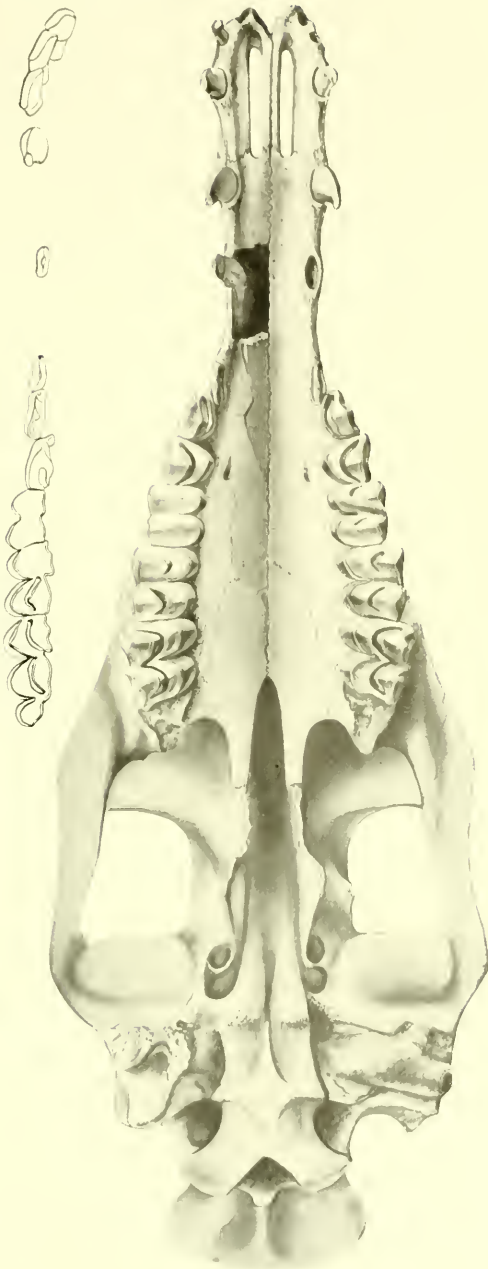
comparatively short geologic time in a given locality. From the study of the changed lithological features, of the strata, together with the changes of the faunæ of different horizons, in certain localities, one is able to form a mental picture, of possible causes for the varied changes in structure. It is possible to imagine a locality so altered that a certain portion of its inhabitants which were capable of modifications, did modify in order to fit themselves to the requirements of their rapidly changing environment; others migrated, or perished; their places being filled by different forms from other places. In turn the introduced forms would become greatly multiplied on account of conditions which had become especially favorable to them. Or, on the other hand, the immigrants found the new habitat less desirable and only lingered awhile until they reached extinction.

After a careful comparison of the above described type with other Miocene camels, I find that it most nearly agrees with *Oxydactylus*, though it is with some reluctance that it has been referred to that genus on account of its long head and short neck, which are certainly deep-seated characters pointing to an earlier origin than the comparatively brief time of the deposition of the Lower and Upper Harrison beds. I assume, therefore, that the line was perhaps already established in the late Oligocene and that the different forms paralleled each other. The discovery of complete limbs in connection with the skull and vertebræ of this species would be a most welcome help to completely determine its phylogenetic position.



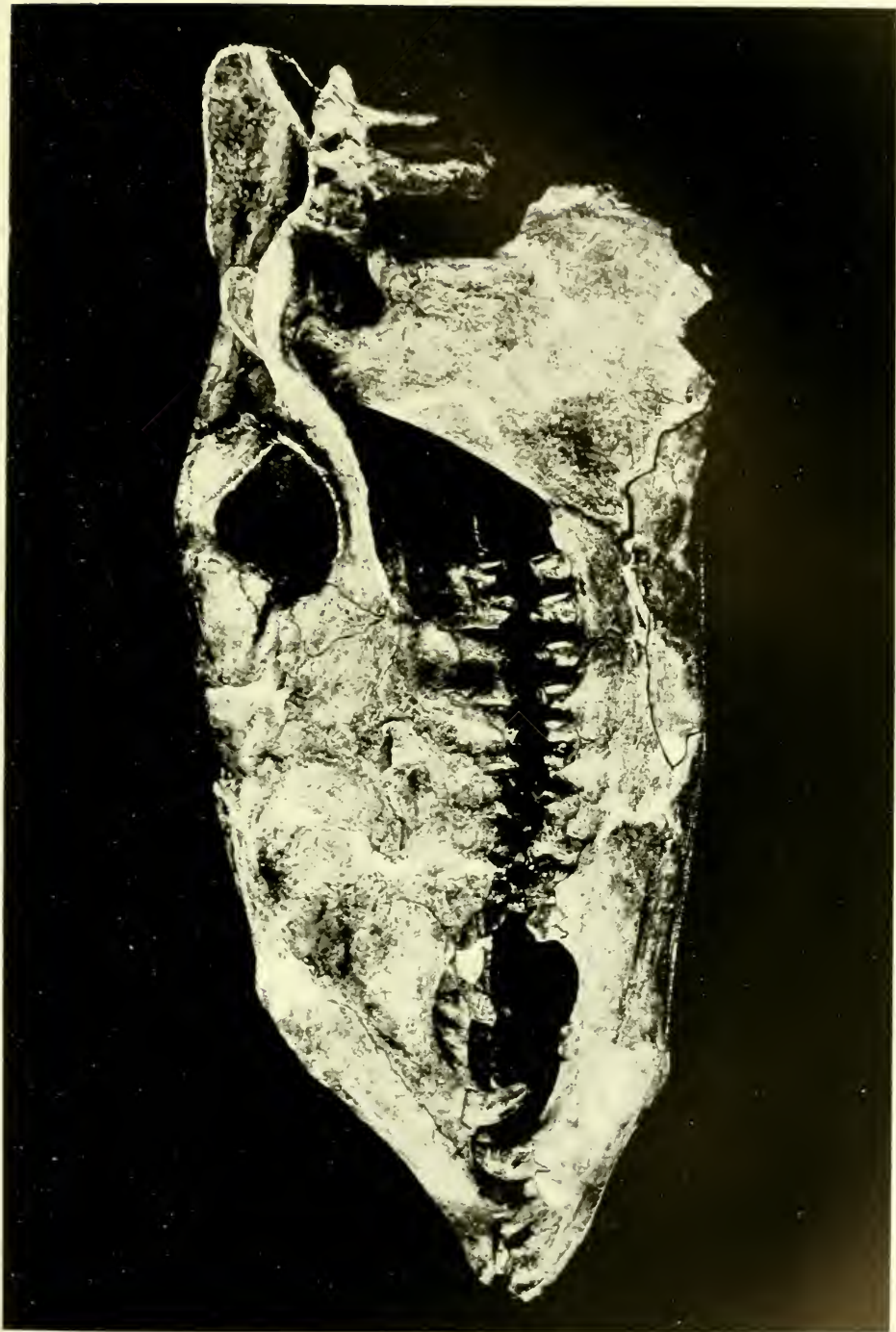
Side View of Skull of *Oxydactylus longirostris*,  $\frac{2}{3}$  nat. size. (Crushed portions slightly restored.)





Palatal View of Skull and Crown View of Lower Dentition of *Oxydactylus longirostris*,  $\frac{2}{3}$  nat. size. (Skull slightly restored.)

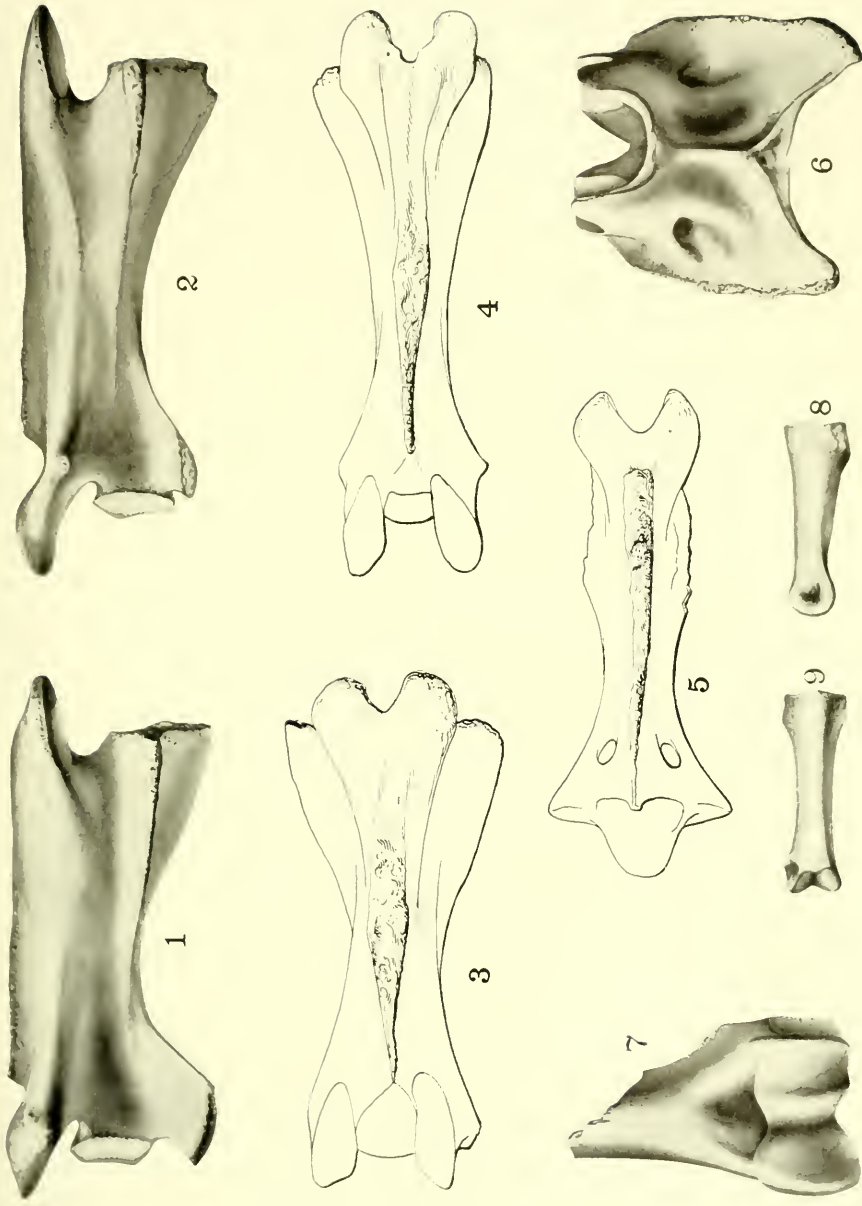




Photographic Reproduction of Skull and Lower Jaws of *Oxydactylus longirostris*. About  $\frac{2}{3}$  nat. size.







Vertebrae and Limb Bones of *Oxydactylus longirostris*,  $\frac{2}{3}$  nat. size. 1 and 3, side and dorsal views of third cervical; 2 and 4, side and dorsal views of fourth cervical; 5, dorsal view of axis; 6, ventral view of atlas; 7, anterior view of humerus; 8 and 9, lateral and dorsal views of phalanx.



XIII. A MOUNTED SKELETON OF STENOMYLUS HITCHCOCKI, THE STENOMYLUS QUARRY, AND REMARKS UPON THE AFFINITIES OF THE GENUS.

BY O. A. PETERSON.

In the history of mammalian paleontology it is seldom that the complete knowledge of the osteology of a genus has been acquired so rapidly after its discovery as that of the small aberrant camel, *Stenomylus*. Since the first remains discovered in the Miocene strata (Lower Harrison beds) a few years ago and described by the present writer, there have been found more complete remains of this genus than of any other Miocene mammal discovered. This is mainly due to the fortunate discovery by Dr. F. B. Loomis of a deposit of the remains of these animals in a hill of closely packed and finely-grained sand having a vertical thickness of about 60 feet overlaid by a more or less heavily bedded sandstone in the Niobrara River Valley, Sioux County, Nebraska.

The accompanying sketch-map (Pl. XLI) represents a portion of the quarry in which the greater number of skeletons were found, and conveys a general idea of the manner in which the remains of these delicate camels occurred. A special feature of the illustration is the approximate location of the type of *Stenomylus hitchcocki* Loomis<sup>1</sup> with relation to the main mass of material in the quarry (see skeleton to the extreme right on the map). When Dr. F. B. Loomis opened this quarry in 1908 the writer, who was then working in the Agate Spring Fossil Quarries in the same general locality, asked and was granted the privilege to continue the excavation for the Carnegie Museum when Loomis and Dr. R. S. Lull of Yale University were through that season. An area about 75 X 20 feet was accordingly uncovered and the accompanying illustration is a horizontal plan of a portion of the quarry. Each square on the plan represents one square foot and the shaded outlines are those of the bones found in the upper bone-layer,<sup>2</sup> about eighteen inches above the main layer.

<sup>1</sup> *Amer. Jour. Sci.*, Vol. XXIX, pp. 297-323, 1910.

<sup>2</sup> This layer is not mentioned by Dr. Loomis, but he referred to one below the main layer, which was not worked by the party from the Carnegie Museum.

Through the publications by Dr. Loomis (*l. c.*) and Peterson<sup>3</sup> this cameloid is now well known, and the abundance of its remains, which have recently been collected in this quarry by Amherst, Yale, the American, and the Carnegie Museums is quite out of the ordinary, especially on account of their wonderfully perfect preservation, the hyoids and the cartilaginous ribs in many instances being present.<sup>4</sup> A survey of this plan results in further confirming Dr. Loomis' statement of the possible origin of interment of this material, *i. e.*, the herd of animals meeting with a catastrophe up the stream, their carcasses floated down and found lodgment in the backwater of some large cove in which sands were accumulating behind a barrier of considerable elevation. (See Plates XLII and XLIII.) The fact that the section of packed sand in which the *Stenomylus* quarry is located is in the neighborhood of 60 to 80 feet (about 22 to 32 meters) in depth, appears to the writer to necessitate the idea of an uneven topography of the locality in which the stream was located. Although it is nearly always difficult to detect evidences of the former topography of an extended area of sediment, it is known that in the Agate Spring Fossil Quarries there are evidences of an uneven surface.<sup>5</sup> The Carnegie Museum Quarries, Nos. 1 and 2, as well as the University of Nebraska Quarry, are on one level with a slight dip to the north, while quarry A of the Carnegie Museum some distance to the north from those first mentioned, is considerably lower, but contains practically the same fauna as the former. As stated by Dr. Loomis, and observed by referring to the accompanying field sketch, *Stenomylus* is almost exclusively the only material so far found in this quarry. Hence the name. These skeletons indicate that the carcasses perhaps floated down stream some distance before they found a lodgment, which, in a measure adds weight to the contention of Loomis that *Stenomylus* was perhaps an upland form.

*The Mounted Skeleton.*—(Plate XLIV.) As usual the conception of the animal is most perfect when the skeleton is set up in full relief. There have been a number of half-relief skeletons prepared in this museum and one of them sent abroad. From these together with the

<sup>3</sup> ANN. CAR. MUS., Vol. IV, pp. 41-44, 1906; pp. 286-300, 1908.

<sup>4</sup> Besides the fine material collected by Yale, Amherst, and the American Museums, there were perhaps thirty or forty individuals collected by the Carnegie Museum, of which 16 are practically complete.

<sup>5</sup> MEMOIRS OF THE CARNEGIE MUSEUM, Vol. IV, 1910, p. 205, Fig. 1.

type specimen of this species figured and described by Dr. Loomis (*l. c.*, p. 299) we get a very fair idea of proportions, but in a full relief, there is always something added, or more prominently brought out, which is more or less obscure even in a half-relief. In a properly articulated skeleton there is conveyed a more accurate conception of the form of the thoracic cavity, the position, and relative angles of the vertebral column and the different limb-bones, which is not to be derived from a half-relief mounted in the position in which it was found in the field.

The present restoration, prepared by Mr. Serafino Agostini, is composed of six individuals,<sup>6</sup> of which the skull, jaws, atlas, eleventh, and twelfth dorsals, the seven lumbar, and the pelvis belong to one individual, No. 2779; the last cervical, the dorsal and caudal regions, the limbs, and the feet to a second individual, No. 2780; the fourth, fifth and sixth cervicals and the sacrum to a third individual, No. 2782; while the axis and the sternum pertain to Nos. 2782 and 2783 respectively.

In comparing the skeleton with that of the recent South American lama it may be said that the head is proportionally smaller, the neck is somewhat longer and slenderer, but ascends from the vertebræ of the trunk in a similar manner, *i. e.*, the seventh and sixth cervicals when articulated properly are directed forward and upward, not forward and downward as in *Camelus bactrianus*. The thoracic cavity is somewhat larger than in the lama, but the number of ribs are the same (twelve) and also flattened in the same general manner. The sternum is composed of six segments which are quite heavy, the manubrium and xiphisternum being proportionally larger than in the lama, but the sternum as a whole has not the successive increase in vertical thickness of each sternebra from before backward, as in the latter. The lumbar vertebræ (seven in number) are very similar to those in the recent form; they are, however, longer, with the centra somewhat more compressed laterally, and the neural spines directed forward at a greater angle. The sacrum is composed of four well-coössified centra. The sacrum as a whole is not so broad as in the lama and the neural spines are heavier, while the sacral foramina back of the first pair are quite inconspicuous when compared with the large ones in the recent form. The tail is short and light; there are usually sixteen

<sup>6</sup> The disarticulated skeletons in this quarry always have the bones less crushed and make more perfect free mounts than those found articulated.

vertebræ in the caudal region of the recent form while in the fossil there are fourteen.

The scapula is remarkably similar to that bone in the lama, the spine being located a little further from the coracoid border and the glenoid border being more prominently everted than in the latter. The humerus is considerably shorter than the radius and ulna, while in the lama they are of more nearly equal length. The carpus is higher and narrower; the trapezium is present and has an articulation with the distal palmar angle of the scaphoid as well as with the palmar face of the trapezoid. In the lama the trapezium is absent. The proportionate length of the metacarpals (canon bone) to the radius and ulna is about the same as in recent forms, but the humerus is considerably longer in the latter. The length of the phalanges is different in proportion from those in the lama, *i. e.*, the proximal is shorter, while the median and terminal are longer. There is little or no evidence of support for a tylopodous cushion; the tubercles on the plantar face of the phalanges are, however, less prominent than they are in other Miocene camels (*Oxydactylus*) and it is possible that there was a tendency to develop these characteristic pads, especially on the second phalanx of the feet of this animal.

The pelvis is somewhat longer and narrower than in the lama. The expansion of the ilium is, however, very abrupt as in the latter. The point of the ilium and the tuberosity of the ischium is longer and sharper in the fossil form. As is the case with the humerus of the fore limb we find the femur proportionally shorter than in the lama while the tibia is somewhat longer. The tarsus is distinctly higher and narrower while the metatarsals are fused into a canon-bone and are of much similarity in the two forms. The phalanges of the hind foot are similar to those of the fore foot, *i. e.*, the proximal shorter, the median and terminal longer than in *Lama*.

The proportion of the head to the body is not unlike that in *Oxydactylus longipes*, while the thoracic cavity is somewhat greater. The structure and proportions of the limbs more nearly agree with those in *Oxydactylus longipes* than in the genus *Lama*, the femur of *Oxydactylus*, however, being longer in proportion to that in *Stenomylus*. As a whole the skeleton of the latter indicates structures of greater endurance than in *Lama* and even perhaps greater than in the contemporaneous long-limbed form *Oxydactylus*. Thus it is seen that the femur is shorter than in the latter, while the humerus is pretty

much in the same proportion but shorter than in the recent form. This indicates that the heavy muscles of the shoulder and thigh in *Stenomylus* did not extend as low down from the body, thus giving the limbs less resistance and consequently much freer action when in motion.

MEASUREMENTS.	Cm.
Length of skeleton, skull to end of ischium along curves of vertebral column.....	114
Length of skull.....	20
Length of cervical region.....	34
Length of dorsal region.....	25
Length of lumbar region.....	18
Length of sacrum.....	7
Height of skeleton at sixth dorsal.....	70
Height of skeleton at anterior part of pelvis.....	66

The writer is pleased to see that his original views in placing *Stenomylus* in a separate phylum of the *Camelida* is accepted. I do not, however, think that it is necessarily a direct derivative of *Poëbrotherium* as Loomis thinks. On the other hand it is more probably an offshoot of an earlier Tertiary form—a heterochthonic rather than an autochthonic type. Thus the peculiar structure of the palate at the sphenoid bones, the backward sloped coronoid process of the lower jaw, caused by the higher position of the orbit, and also the development and position of the dentition of *Stenomylus* are such deep-seated characters and so different from those in *Poëbrotherium* that one must hesitate before seriously regarding the former genus as directly derived from the latter. It requires no stretch of the imagination to regard some Eocene form such as *Protylopus*, or one cotemporaneous with it, as a possible progenitor. The transition from *Poëbrotherium* to other Miocene forms and to the recent *Tylopoda* is within a reasonable probability, while such rapid modification, as would be required from the middle Oligocene to the superimposed beds of this locality regarded as lower Miocene, in order to transform *Poëbrotherium* into a form like *Stenomylus* seems, to say the least, to be most anomalous.

In confining our attention to the region of the palatines, the vomer, the pterygoids, and the presphenoid of the cranium, it is obvious that the variation in form between the two genera in question is quite out of the ordinary. In *Stenomylus* the posterior palatine processes, the posterior portion of the vomer, and the presphenoid unite to form a

solid and heavy ridge, which posteriorly completely borders the posterior nares and more or less interrupts the backward extension of the median pterygoid fossa, on account of the heavy descending processes, while in *Poëbrotherium* the palatine processes unite with the pterygoids in a normal way and form the median pterygoid fossa usually observed in later Miocene camels and in most mammals—*i. e.*, unobstructed posteriorly. While the contention of Dr. Loomis "that the compression of the muzzle by the preorbital and subnasal pits" in *Stenomylus* may possibly be a partial cause of the forward position of the post-narial opening, it is also true that these pits on the muzzle of other Miocene camels are similarly located and are deep without having affected either the size or position of the posterior nares; nor is the peculiar consolidation of the vomer, the palatines, the pterygoids, and the presphenoid of *Stenomylus*, described above, affected in these. The characters above enumerated and discussed are of much importance and, I would say, of quite early origin. Although I believe in a comparatively rapid acquirement of new characters under changed conditions, I do not think that the anatomical features in *Stenomylus* as a whole can be disposed of altogether under the plea of especially rapid modifications. I would rather regard the genus a migrant sufficiently modified in order to more successfully live in the same general neighborhood with forms more indigenous to the locality.

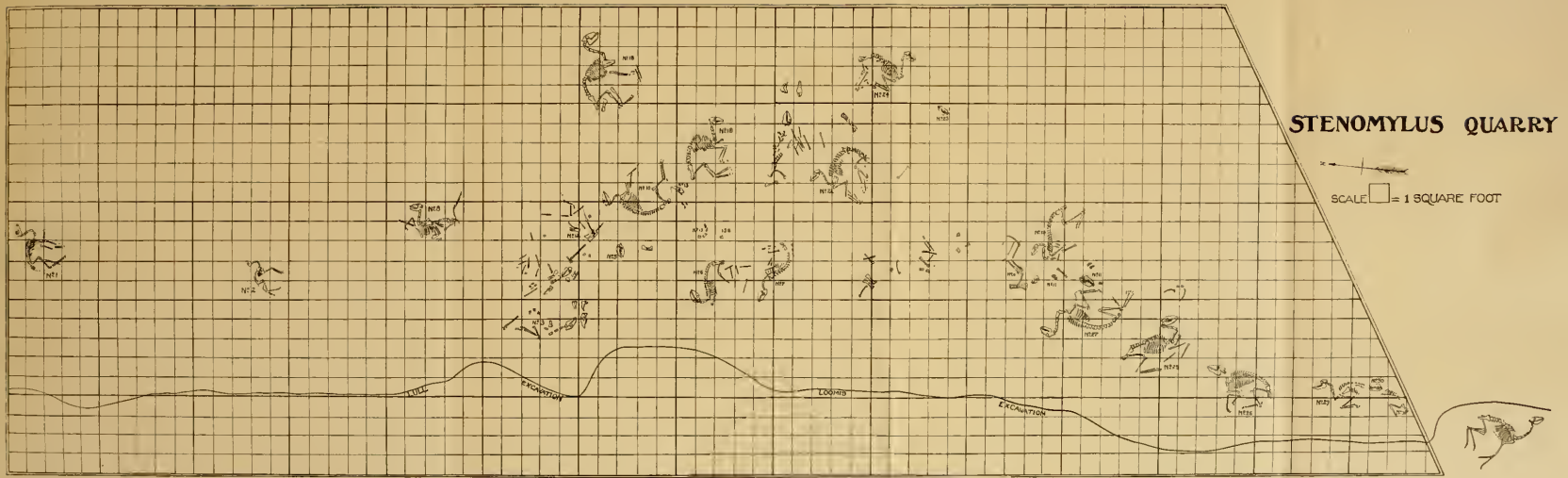
In my earlier papers upon the genus *Stenomylus* I used *Oxydactylus* for comparison, first, on account of the complete preservation of the type of the latter, and secondly, in order to more graphically express the tylopodan characters in other Miocene forms of which so many are common to *Stenomylus*. I plainly stated (p. 300, *l. c.*) that the genus "should be regarded as the type of a new sub-family," which sub-family Dr. Matthew accepted,<sup>7</sup> employiug the name *Stenomylina* to designate it. In reviewing my first papers describing *Stenomylus* I am unable to find any statement which could lead Dr. Loomis to say that I placed *Stenomylus* "near the long-limbed type *Oxydactylus*" (*l. c.*, p. 322) except in the sense above stated.

NOTE ON THE GROOVE FOR THE EXTENSOR TENDON ON THE OLECRANON PROCESS OF THE ULNA OF *Stenomylus gracilis* PETERSON.

In reading the recent paper by Dr. Loomis upon *Stenomylus* (*Amer. Jour. Sci.*, Vol. XXIX, pp. 297-323, 1910) I became interested in the


<sup>7</sup> Bull. Amer. Museum of Natural History, Vol. XXVIII, 1910, p. 42.



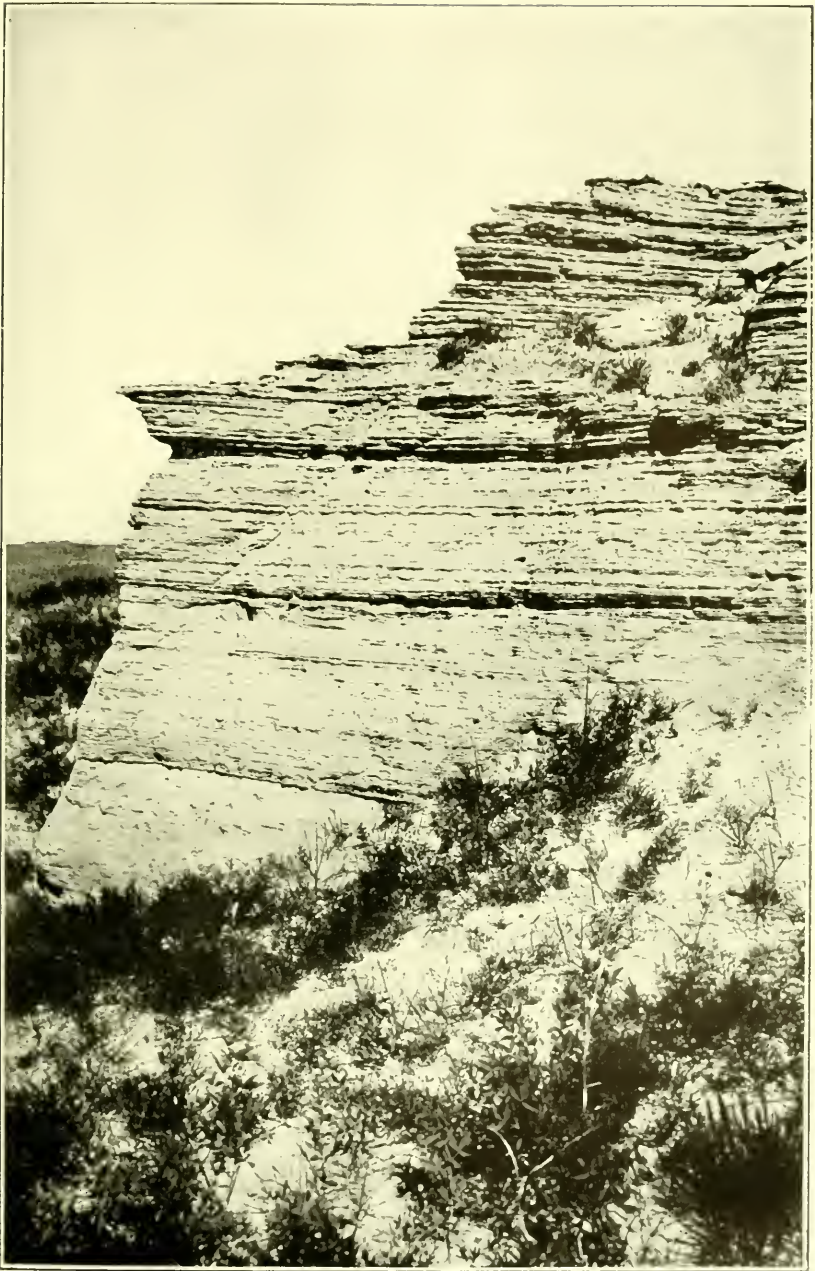


# STENOMYLUS QUARRY



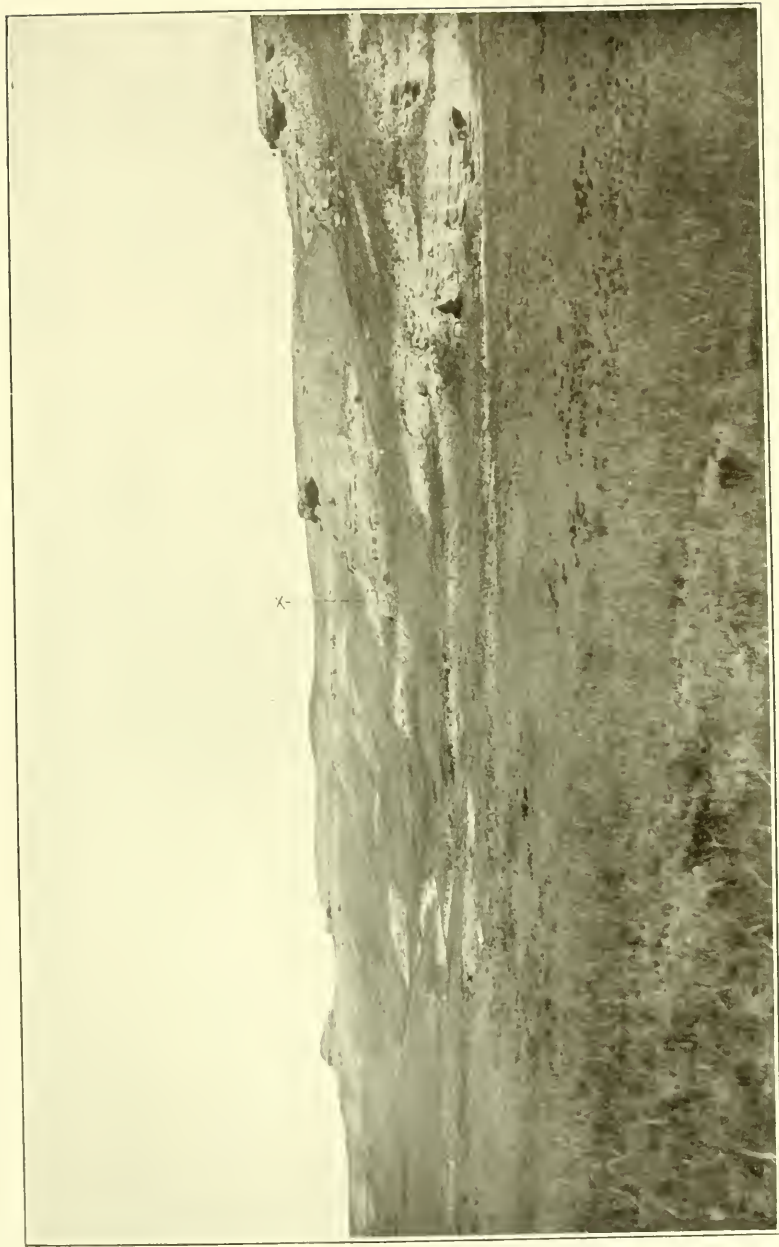
SCALE  = 1 SQUARE FOOT





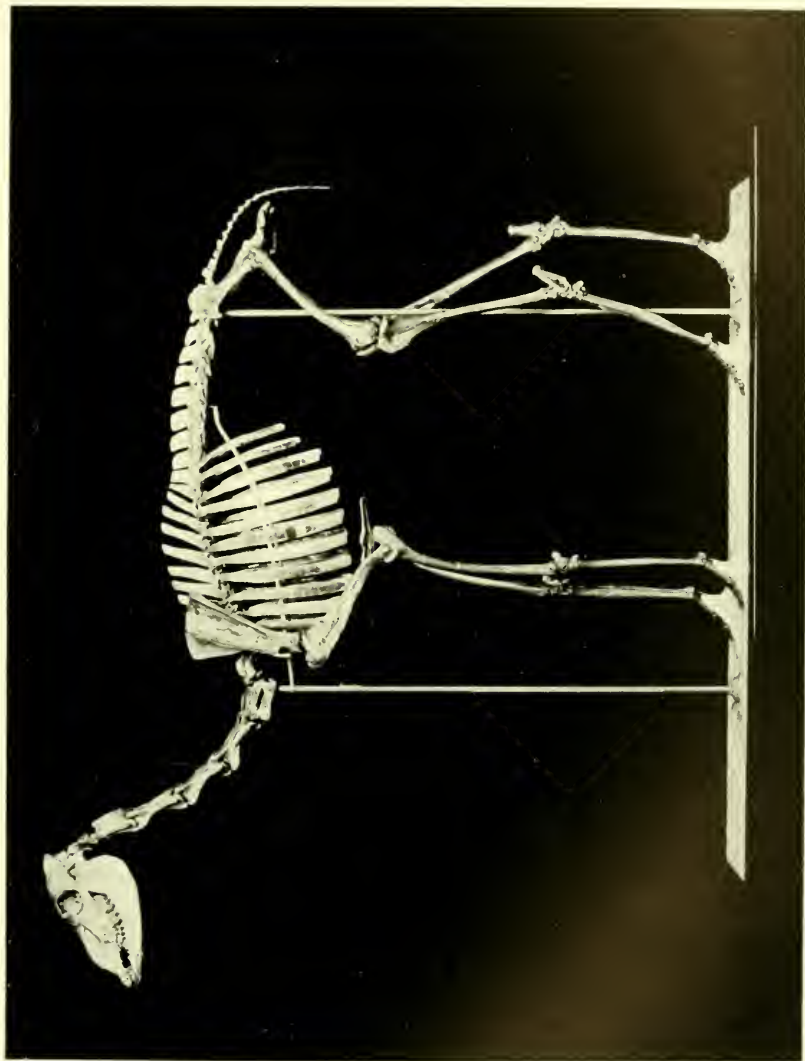
View of an Exposure of the Sediment at the *Stenomylus* Quarry.





View of the exposures on the Niobrara River in which *Stenomytus* occurs. The site of the quarry is indicated by the mark X.





Mounted Skeleton of *Stenonyx hitchcocki* Loomis. (In Carnegie Museum.)





question of absence or presence of the groove for the extensor tendon on the upper anterior border of the olecranon process of *Stenomylus gracilis*. In describing the ulno-radius (ANN. CAR. MUS., Vol. IV, p. 229, 1910) I stated that the above mentioned groove is absent, which may be erroneous, since I find that upon very careful scrutiny and by a slow and tedious process of removing a closely adhering silicious spot of matrix on the radial face of the process it becomes apparent that this spot is in reality an eroded cavity which was slowly filled by this silicious matrix. It is thus clear that the absence or presence of the tendinal groove on the olecranon process of the ulna in *S. gracilis* cannot be determined from the type specimen.

It should also be stated that the trapezium has an articulating surface for the scaphoid instead of one for the scale-like mc. II as stated (*l. c.*, p. 293).

February 6, 1911.

#### XIV. A MOUNTED SKELETON OF DICERATHERIUM COOKI PETERSON.

BY O. A. PETERSON.

(*Science*, Vol. XXIV, pp. 281-282, 1906; ANN. CAR. MUS., Vol. IV, pp. 47-48, text-figures 12, 13, plate XIV, 1907)

Some recent publications by Professors Frederic B. Loomis<sup>1</sup> and Erwin H. Barbour<sup>2</sup> on *Diceratherium* remains from the now well-known Agate Spring Fossil Quarries in Sioux County, Nebraska, have appeared, but no detailed description of the osteology, outside of an illustration of a half-relief mount by the latter author, has hitherto been published. The present paper is only intended to briefly treat of the articulated skeleton recently placed on exhibition in the Hall of Mammalian Paleontology of the Carnegie Museum, reserving for a later publication more detailed work on the extensive collection of material representing this genus in this museum.

No. 2499, the basis of the articulated skeleton, consists of the skull with the lower jaws, the complete cervical series, seven dorsals, a number of ribs, portions of both fore limbs and fragments of hind limbs and feet. This material establishes a good basis for the determination of the different parts of the bony structure in this species and the composite skeleton is thought to accurately represent *D. cooki*.

From the large number of individuals already cleared from the matrix we are still unable to state definitely whether there were eighteen or nineteen dorsals in the presacral series. On the other hand the number of the lumbar as well as the cervicals and sacral are well established from our material, while the caudal series is approximately correct.

##### SKULL.

The skull used in this restoration (No. 2499) is typical of *Diceratherium cooki* described in previous publications. The teeth are somewhat more worn down than those of the type No. 1572, showing that the crotchet on M<sup>2</sup> is completely united with the already broad-

<sup>1</sup>*Amer. Jour. Sci.*, Vol. XXVI, pp. 51-64, 1908.

<sup>2</sup>Nebraska Geological Survey, Vol. III, Plate 1, 1909.

ened ectoloph, while on  $M^3$  both crotchet and crista are quite plain. The diameters of the teeth of the present skull are only very slightly greater than those in the type, in fact there is practically no difference in all the measurements of the two skulls here compared when an allowance is given for the slightly larger size and crushing of No. 2499. A curious feature of some individuals is seen in the presence of the upper canine. This feature is, however, not to be regarded as of any great morphological importance and may be regarded as a case of atavism, pointing back to the Oligocene forms (*Leptacetherium* and *Aceratherium*<sup>3</sup>) which have the superior canines much more strongly developed. The premaxillaries are restored from other individuals.

The lower jaws are quite heavy, the transverse diameter of the horizontal ramus being thick and the diastema between the large incisor and  $P_{\frac{3}{3}}$  rather short. The inferior border of the ramus terminates posteriorly in a heavy and excessively everted process, which is a characteristic feature of the angle of the lower jaw of old individuals (especially males) of this species. The glenoid condyle is very broad transversely and the coronoid process has rather an excessive forward direction. The median incisors are not present, but are plainly indicated by alveoli. The lateral, or cutting, incisors are much worn, as is also the case with the molar pre-molar series.

The deciduous dentition in all the different stages is well represented in the material of *Diceratherium* from this fossil quarry. In this connection it may be interesting to say a few words in regard to the deciduous lower incisors and canines. From the material in the Carnegie Museum there have been selected three individuals of a slight difference in ages in order to illustrate my point. In each case the lower canines or their alveoli are present and in two of the three pairs the full series of incisors are represented; the third pair being farther advanced in maturity.

In the valuable monograph on the "Extinct Rhinoceroses" by Professor Henry F. Osborn he has distinguished the Rhinocerotidæ as follows: "Manus functionally tridactyl. Upper canines atrophied. Median upper incisors and lower canines opposed and irregularly developed" (*l. c.*, p. 80). In later publications Lucas and Hatcher<sup>4</sup>

<sup>3</sup>Osborn, H. F., "The Extinct Rhinoceroses," *Mem. Amer. Mus. Nat. Hist.* Vol. I, pp. 132, 146, 1898.

<sup>4</sup>*Proc. National Museum*, Vol. XXIII, No. 1207, pp. 221-223; *ANN. CARN. MUS.*, Vol. I, 1901, pp. 135-144.

maintain that the second inferior incisor of *Trigonias osborni* from the lower Oligocene has already become hypertrophied into a large procumbent cutting tooth while immediately behind it is placed the canine. Quite recently there has appeared a paper on *Diceratherium* by Loomis in which this large procumbent tooth is again referred to as the lower canine (*l. c.*, p. 52). From the material now at hand it is possible not only to substantiate the contention of Lucas and Hatcher but entirely to establish as a fact that *the upper incisor of the Rhinocerotidæ does not oppose the lower canines but opposes the lower incisor two or three*. The deciduous incisor dentition as well as the canine of the lower jaw in *Diceratherium* is complete. The second or third permanent incisor has entirely taken up the space of  $I_{\frac{1}{2}}$  and  $\frac{2}{3}$ , while at some distance behind the canine occurs. In adult forms all evidence of the canine is entirely obliterated. When the earlier Tertiary ancestors of the Rhinocerotidæ are found the lower canine will undoubtedly be found to be much more reduced in size than the upper, while  $I_{\frac{1}{2}}$  or  $I_{\frac{2}{3}}$  will be found to oppose the enlarged upper incisor.

#### VERTEBRAL COLUMN.

*Cervicals, 7; Dorsals, 19(?); Lumbar, 5; Sacral, 4-5; Caudals, 26(?)*.

The cervical vertebræ are comparatively short and heavy. The axis has a strong overhanging neural spine, the third cervical lacks the spine, while the fourth has it only faintly indicated. On the succeeding three cervicals the increase in length of the neural spines is more rapid, the seventh being of considerable height. Nineteen dorsals are inserted in this skeleton which is thought to be approximately correct inasmuch as certain species in the ancestral line from the upper Oligocene (*Aceratherium tridactylum*<sup>5</sup>) have this number. The anterior dorsals have short, broad, and depressed centra, and high and heavy neural spines. Further back the centra are higher, narrower, and terminate ventrally in more defined keels, while the neural spines are lighter and lower; the five or six last dorsals already assuming the lumbar-like neural spines. There are five lumbar vertebræ in *A. tridactylum* which is also true of the present form. The sacrum on the other hand is composed of from four to five coössified vertebræ, while in the Oligocene form there are three (Osborn, *l. c.*, p. 85). A series of caudals, seventeen in number, are of one individual (No. 1843) found in consecutive order from the first to the seventeenth.

<sup>5</sup>Osborn, H. F., *Bull. Am. Mus. Nat. Hist.*, Vol. V, p. 85. 1893.

Nine caudals have been added to the end of this series, twenty-six in all, which is approximately the correct number of vertebrae in the tail.

The ribs are rather long which gives the animal a large thoracic cavity similar to that in *A. tridactylum*. In their shape they are also quite similar to those of the latter species. The manubrium is an elongated, laterally compressed, and vertically deep plate of bone. Anterior to the contact for the first pair of ribs there is a long heavy process, extending directly forward, constituting the greater half of the antero-posterior diameter of the presternum. Posteriorly the bone is slightly expanded transversely and has a rough surface for the attachment of the succeeding segment of the mesosternum. The first two segments of the mesosternum are of considerably greater vertical diameter than the transverse; the posterior end of the fourth sternebra is nearly cubical in outline, while the fifth is broader than deep. The lumbar region is rather short, the sacrum has four to five coössified centra, and the caudal region is of moderate length.

#### LIMBS.

The scapula is rather long and narrow; the spine is heavy and greatly overhangs the postscapular fossa; the coracoid is prominent; the glenoid border is much concave supero-inferiorly, while the coracoid border, some distance above the glenoid cavity, is greatly convex in the same direction. The humerus may be regarded as short and heavy, with a powerfully developed deltoid crest, a prominent supinator ridge, a deep anconeal fossa, and the intercondylar ridge shifted well towards the ulnar border of the trochlea. Proximally and distally the radius and ulna are well interlocked by rough attachments, and in adult or old individuals the shafts come in contact with one another by prominent and rugose ridges, which supported a heavy cartilaginous band. The olecranon process of the ulna is large and truncated and the shaft is comparatively heavy.

The manus is functionally tridactyl. The fifth metacarpal is, however, present in a rudimentary condition, while that of *Acera-therium tridactylum* is said to be strictly tridactyl.

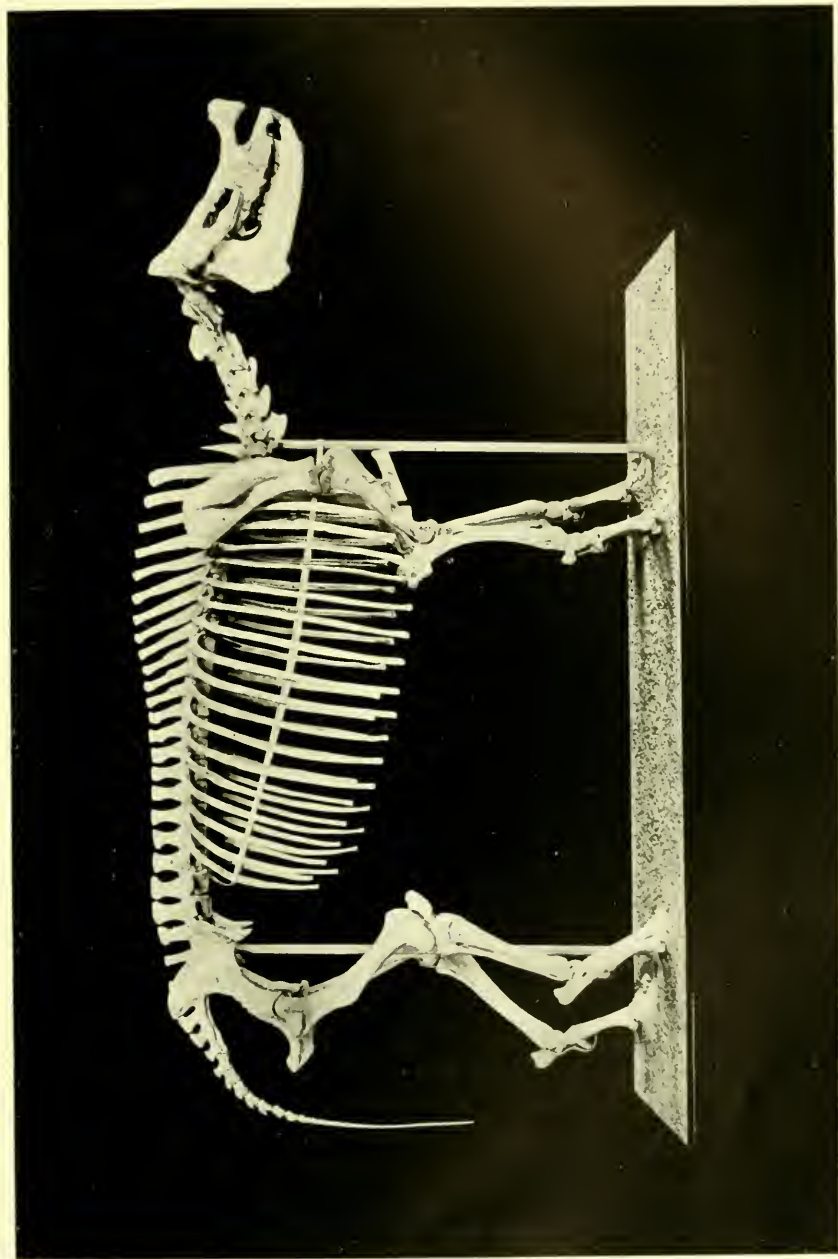
The presence of mc. V in *D. cooki* led to a closer study of Professor Osborn's memoir on "The Extinct Rhinoceroses" previously cited. The illustration of *A. tridactylum* on page 84 of this work appears to

have mc. V present and does not agree with the statement on page 159 of the same work; viz., "There are only three digits in the manus, hence the name *tridactylum*, there being no trace of the fifth digit. . . ." I infer, however, from his statement on pages 130 and 131 that mc. V might be present in a rudimentary form in *A. tridactylum*. This would seem perfectly natural in the light of present facts, since we should otherwise be forced to accept a rather involved variation of considerable morphologic importance. That is we should expect the various species in the Oligocene, leading up to the *Diceratheres* to be differentiated in a very marked degree so far as the absence and presence of mc. V is concerned, and also that these differences held good until the close of the lower Miocene.

In all the material of *Diceratherium* from the Agate Spring Fossil Quarries which I have seen, mc. V is present in a rudimentary form; nor is this surprising considering the fact that this digit is yet of considerable size in some of the earlier forms (*Aceratherium tetradactylum* Lartet and *Trigonias osborni* Lucas). The late Eocene and early Oligocene ancestors of *Diceratherium* had undoubtedly the manus more or less tetradactyl, the fifth digit, however, was rapidly reduced in later forms but was still present in a rudimentary condition, possibly in all the species of that genus, at the close of the lower Miocene.

The carpus is of equal height and breadth, the three functional metacarpals are of medium length with their shafts placed rather close together and displaying but slight divergency at the distal ends. The second phalanx of the median digit is raised very slightly from the ground while the lateral toes appear to be more elevated.

The pelvis is short and broad, the ilium being broadly expanded with a large area for the gluteal muscle, while the supra-iliac border is strongly emarginated as in older forms (*A. tridactylum*), but the ischium and pubis are apparently shorter. The femur is quite long, but comparatively slender, the different trochanters are, however, well developed, indicating a heavy thigh, and the antero-posterior diameter of the distal end is great in proportion, due chiefly to the very large internal border of the rotular trochlea. One of the more characteristic features of the tibia and fibula is the tendency of the proximal and distal ends to become coössified in fully adult and old individuals. The pes is strictly tridactyl. It is high and narrow with a broad, rather low astragalus, a very heavy tuber of the calcaneum, and quite elongated metatarsals. The unguinal phalanges, especially the median pair,



Mounted Skeleton of *Diceratherium Cooki* Peterson. (In Carnegie Museum.)





are shorter than in the manus. The articulated skeleton represent an animal with a well proportioned head, a short neck, a long and rather heavy body supported by legs comparatively short and heavy. The dentition, together with other anatomical features of the skeleton, strongly suggest an animal whose habitat was among shrubs and vegetation along streams and other bodies of water.

MEASUREMENTS.	Cm.
Length of skeleton from anterior point of nasals to ischial tuberosity	180
Length of skull.....	40
Length of neck.....	35
Length of dorsal region.....	75
Length of lumbar region.....	21
Length of sacrum.....	18
Length of tail.....	50
Greatest transverse diameter of thorax.....	43
Greatest transverse diameter at point of ilia.....	33
Height of skeleton at fourth dorsal vertebra.....	100
Height of skeleton at fifth lumbar vertebra.....	93
Height from base to acetabulum of pelvis.....	70



ANNALS  
OF THE  
CARNEGIE MUSEUM

VOLUME VII. NOS. 3-4.

EDITORIAL NOTES.

THE celebration of Founder's Day, which took place on April the 27th, was a memorable occasion. The principal speakers were Dr. A. Lawrence Lowell, President of Harvard University; Governor Augustus Everett Willson of Kentucky; and Mr. Andrew Carnegie, the Founder. The latter, accompanied by Mrs. Carnegie, arrived in Pittsburgh on the day before the celebration, and remained until the morning of the 29th. The visit of Mr. and Mrs. Carnegie will always be remembered with profound pleasure, and it is hoped that it may be followed by many other visits. The great enterprises which Mr. Carnegie has established, and which are massed under the common name of the Carnegie Institute, will certainly be profited should the Founder be able to devote to them a small portion of his time, giving to those in charge of them the benefit of his counsel and helpful criticism.

THE work in the Carnegie quarry on Dinosaur Peak, Utah, has been resumed under the direction of Mr. Earl Douglass, who returned to the quarry early in April. He reports continued success in the recovery of the remains of the great animals which last summer had been partially uncovered, and he reports also that he has found an impression of the skin of a Stegosaurus, the skull of a large carnivorous dinosaur, an early Jurassic mammal, and many other things of importance.

DR. F. X. SCHAFFER of the K. K. Hofmuseum in Vienna spent the months of March and April at the Museum, studying the Tertiary

invertebrates contained in the Bayet collection. He left for the West at the end of April, and, after visiting Chicago and Denver, spent some time with Mr. Earl Douglass in his camp at the dinosaur quarries in Utah. He is extending his journey to the Pacific coast, and will probably not return to Pittsburgh before the late summer or early fall.

Dr. J. Perner of the Bohemian National Museum of Prag, and Baron F. v. Huene of the University of Tübingen, both widely known among the rising paleontologists of Europe, visited the Museum during the month of May. Like Dr. Schaffer, they are intending to spend the summer months in making reconnoissances in the fossil fields of the Rocky Mountain region.

A number of visitors from different cities of the United States and from abroad have spent considerable time in the Museum, with a view to studying the building and the methods of administration which prevail here. Among those who have quite recently visited us was Mr. Cecil C. Brewer of London, England, who is charged with the work of preparing the plans for the new National Museum of Wales, which is to be erected at Cardiff. We are constantly being requested to furnish plans relating to the building, and the cases which we use, to museums throughout the United States and foreign countries, and it is always a pleasure to be able to meet requests for information.

It may be said that many of our visitors have expressed pleasure at the results obtained in the Museum by side-lighting. Cross-lighting unfortunately leads to perplexing reflections and shadows, and while it is impossible by any system of side-lighting to secure as much illumination as is secured by cross-lighting, nevertheless the general effect, provided the windows are made large enough, is far more pleasing and restful to the eye. This is well illustrated in our galleries of vertebrate paleontology, which are lighted from the side, but in which we have succeeded in securing ample illumination, with the elimination of the puzzling reflections which would exist were the room lighted from both sides.

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PROFESSOR CHARLES R. EASTMAN is completing his work of cataloging and reporting upon the fossil fishes contained in the Bayet collection. His paper upon the Eocene Fishes of Monte Bolca constitutes the last part of Vol. IV of the Memoirs. His report upon the Fishes from Solenhofen is ready for the printer, and will very shortly be followed by a report upon the Fishes from Cerin and elsewhere.

## XV. THE CARNEGIE MUSEUM EXPEDITION TO CENTRAL SOUTH AMERICA, 1907-1910.

BY W. J. HOLLAND, *Director.*<sup>1</sup>

As early as the year 1904 the question of sending field-parties to different parts of the South American continent for the purpose of making thorough biological surveys, more particularly of the ichthyic faunas of the various river-systems, came up for discussion between the writer and Dean C. H. Eigenmann of Indiana University, the present Curator of Fishes in the Carnegie Museum. Certain regions were pointed out by Dr. Eigenmann as being of strategic importance in ichthyic chorology; others as being of interest, because we hitherto have possessed only a partial knowledge of the faunas inhabiting the streams by which they are traversed. In the spring of 1904 a small sum was set aside for the purpose of carrying on a systematic exploration of one of these regions, the northern border of Patagonia, but for reasons, which it is not necessary here to state, actual work was postponed.

Explorations in the streams between Rio de Janeiro and Buenos Aires seemed especially desirable, inasmuch as work in this area had been more or less desultory. In the fall of 1906 Prof. J. C. Branner invited Dean Eigenmann to join him in an expedition to Brazil on which he was about to embark. Dr. Eigenmann was unable to accept the kind invitation, but the opportunity to make use of the experience of Professor Branner, gained by long sojourn in Brazil, appeared too good to lose. Mr. John D. Haseman, a student of Indiana University, desired to get the experience which such a trip would give him. After conference between the writer and Dr. Eigenmann it was decided on behalf of the Carnegie Museum to give Mr. Haseman a commission to join Dr. Branner at Bahia. He was provided with the necessary equipment and on October 5, 1907, set sail from New York, and reached Bahia on the 19th of the same month. He arrived, to his great disappointment, just as Dr. Branner was about to leave. Never-

<sup>1</sup> This is the first of a series of articles relating to the Expedition to Central South America.

theless he was able to obtain from Dr. Branner, before the departure of the latter, a great deal of information and many useful suggestions as to modes of travel, and was put into communication with a number of gentlemen, who subsequently generously gave him valuable assistance. Lingered only a short time in Bahia, he plunged into the interior of the State, accompanied only by native guides to help him.

As the work progressed, and reports and collections were from time to time received from Mr. Haseman, showing that he was making excellent progress, he was instructed as to the further steps which he should take. He was urged to collect in all the streams which can be reached from Rio de Janeiro and São Paulo by railroad, and then to make his way southward to Buenos Aires. After having collected about Buenos Aires, he was instructed to ascend the Paraguay, so as to reach its headwaters during the dry season, and, if he deemed it possible, to cross over to the Amazonian watershed and descend the Guaporé Madeira. The plans of the expedition were from time to time enlarged, and, as the evidence of Mr. Haseman's success reached the Museum, advice was freely asked by him and received. The work of carrying out the details of the broader plans laid before Mr. Haseman was entirely entrusted to him. He not only covered the route mapped out for him, but in some cases exceeded the fondest hopes of those who had commissioned him.

During the last one hundred years five notable expeditions have collected fishes in various parts of South America. In the early part of 1817 Spix and Martius and Natterer went to Brazil with the bridal party of Dom Pedro d'Alcantara, Crown-prince of Portugal, and the Archduchess Karolina Josepha Leopoldina of Austria. Spix and Martius traveled in Brazil in the years 1817-1820 as representatives of the King of Bavaria. John Natterer, the representative of Austria, remained for eighteen years, going from Rio de Janeiro to Cuyaba, Matto Grosso, Manaos, and ascending the Rio Negro and the Rio Branco. Castelnau visited South America in 1843, followed the same general route as far as Matto Grosso, but continued westward to Titicaca and Lima. He returned by way of the Ucayale and Amazons. In 1865 the Thayer Expedition, under the leadership of Louis Agassiz, accompanied by numerous assistants, went to Brazil and remained there for more than a year. The sole survivor of the party at the present day is Dr. J. A. Allen. This expedition was divided into smaller parties, who explored various parts of southeastern Brazil, and

the Amazons as far as Peru. Guiana and northern Brazil were explored in part by Richard and Robert Schomburgk.

Mr. Haseman, traveling only with native guides, exceeded the mileage of any of these large expeditions. Only one other collection of importance has been made upon the Guaporé, which Mr. Haseman descended in 1909, that of Natterer, obtained during the years from 1825-1830, and which is preserved in the K. K. Hofmuseum in Vienna. No specimens from this mighty stream exist in any North American Museum except our own.

The result of the labors of Mr. Haseman, so far as the collection of fishes is concerned, is the addition to the Museum of many thousands of specimens, representing, it is believed, almost all of the species hitherto reported from the regions in which he traveled, and many species which up to the present time have been unknown to science.

Especial recognition is accorded by the writer in his official capacity to Professor J. C. Branner for his kindness in advising Mr. Haseman as to the manner of making his arrangements for travel in the interior, and to Dr. O. A. Derby, the Director of the Geological Survey of Brazil, whose interest in the Expedition was enlisted by Dr. Branner, and who in ways innumerable assisted Mr. Haseman, entering into his plans with the greatest sympathy and enthusiasm. Without the self-denying coöperation of Dr. Derby it is doubtful whether so great success could have been achieved by Mr. Haseman.

In the first paper from the pen of Mr. Haseman, which follows this introductory note, he gives a general outline of his itinerary and an account of the methods employed by him in collecting. To this Dr. C. H. Eigenmann has appended a carefully prepared list of localities. This paper will be followed by several others prepared by Mr. Haseman since his return to the Museum, embodying some observations and conclusions made by him. In justice to Mr. Haseman it should be stated that his conclusions were for the most part reached upon the field, without access to the writings of others, who have studied the ichthyology of South America, and it should not be counted too severely against him, if a detailed and critical study of the material brought home by him should not in all respects sustain some of the opinions he advances.

The great assemblage of specimens made by Mr. Haseman has since his return been accessed and classified in a preliminary manner by himself working under the direction of Dr. Eigenmann, the Curator of

Fishes, and, as rapidly as it can be done, the whole vast collection will be cataloged and reported upon, the new species being described and figured:

The writer cannot conclude these lines without expressing his admiration for the patience and physical and moral courage shown by his young friend in his lonely and often perilous wanderings through regions where dangers lurked on all sides.



XVI. A BRIEF REPORT UPON THE EXPEDITION OF THE  
CARNEGIE MUSEUM TO CENTRAL<sup>1</sup> SOUTH AMERICA.

BY JOHN D. HASEMAN,<sup>1</sup>

TOGETHER WITH A LIST OF LOCALITIES AT  
WHICH MR. HASEMAN COLLECTED.

BY C. H. EIGENMANN.

I sailed, October 5, 1907, from New York to Bahia to collect fishes for the Carnegie Museum. I arrived in Bahia on the 19th of the same month. I went with the expectation of remaining about a year in southeastern Brazil. In fact I did not return to the Museum until February, 1910, when I had far exceeded the original plans. During my stay in South America I made what may be considered numerous separate journeys, of which I propose to give a brief outline, to be followed by an account of the methods I employed in collecting.

I am very grateful to Dr. W. J. Holland, the Director of the Carnegie Museum, whose untiring assistance and sympathy never waned. I am also very grateful to Dr. Miguel Calmon, the Brazilian Minister of Industries, for his kind assistance. Dr. O. A. Derby, the Director of the Brazilian Geological Survey, deserves a great deal of credit for the success of the expedition, because many things would have been impossible without his kind coöperation. I am also very thankful to Dr. J. C. Branner, Dr. Carlos Moreira, and many other persons in various South American countries, as well as to some of my former professors, especially Professor Eigenmann, who assisted me in various ways. I desire particularly to express my grateful appreciation of the services of all of my native guides, who made it possible for me to penetrate and return from the far interior of Brazil.

ITINERARY.

*Journey No. 1. The Basin of the Rio São Francisco and the Waters to the East and West of it. From November, 1907, to March, 1908.*

After a few days' delay at Bahia, where I collected in the markets

<sup>1</sup> This is the second of the series of papers which are to be published upon the Expedition to Central South America.

and in the bay, I began collecting in the headwaters of the Rio Itapicuru along the eastern base of the Serra da Jacobina. I crossed this range at the village of Jacobina and rode down the arid basin of the Rio Salitre to Baixa Grande, where I explored a large cave. In pools of the Rio Salitre I found two species of cichlid fishes, already known to science, which had not been previously reported from the basin of the Rio São Francisco, and were in fact the first specimens of *Cichlida* recorded from that system of streams. From Baixa Grande I recrossed the Serra da Jacobina and returned to Bom Fim, or Villa Nova da Rainha. After collecting for some days at and near Bom Fim, I went to Joazeira, a small town on the banks of the Rio São Francisco. From Joazeira I went seven hundred and fifty miles up the Rio São Francisco to the point where navigation terminates on account of the rapids of Pirapora. This trip was taken in a small steamer. Dr. Cleto Japi Assu, the Director of the Steamship Company plying on the river, gave me a pass on all of the boats of the line, which was a great favor, because at that time I did not know very much of the language. From Pirapora I returned to Cidade da Barra, where I collected about two weeks in the rivers, smaller streams, swamps, and adjacent lagoons and lakes. I then went up the Rio Grande to Barreiras and back to Boqueirão, which is located at the fork of the Rios Grande and Preto. I went up the Rio Preto to Santa Rita and rode over the Serra de Piauí to Lagoa de Paranagua in the state of Piauí. I returned to Santa Rita and rode along the Rio Preto to its junction with the Rio Sapon. I continued up the Rio Sapon to its headwaters. Here I found the basin of an old drained mountain lake having a good connection with the Rios Sapon and Nova, thus uniting the São Francisco and the Amazon basins. I continued down the Rio Nova to the waterfall known under the name of Cachoeira da Velha, about twenty miles above Porto Franco on the Rio do Sonno. The horrors of the hunger and rain I endured on my retreat upon the back of a worn-out mule as I made my way over the chapada between Jalapão and Prazeres will remain untold. I finally arrived again in Bahia early in March. The chief results of this trip were:

1. The discovery that cichlid fishes occur in the São Francisco basin.
2. The confirmation of the rumor that there is a connection between the Rio Tocantins and the Rio São Francisco.

3. An increase in the number of fishes reported from the São Francisco River.

4. The determination that the fishes of the Itapicurú are nearly all found in the São Francisco River.

*Journey No. 2. Along the Coast North of Bahia. The latter part of March and the first two weeks of April, 1908.*

From Bahia I sailed up the coast to the mouth of the Rio São Francisco, in order to collect fishes below the large Paulo Affonso Falls. I went up to them and found that during heavy floods fishes might pass the Bahian branch of the falls. I returned to the mouth of the river and went up the coast to Pernambuco. However, the long dry season made work in this section of Brazil almost futile. Therefore I returned to Bahia, collecting as I traveled. The most important result of this trip was the discovery that it is possible for fishes to pass the Falls of Paulo Affonso.

*Journey No. 3. To the Waters about Rio de Janeiro and São Paulo. From April 19 to first week of November, 1908.*

I left Bahia for Rio de Janeiro on April 19, and, after six days of necessary delay in Rio, went to the headwaters of the Rios São Francisco, Doce, and Grande of the Parana basin. On the return I collected in the lower courses of the Rio Parahyba, Lagoa Feia, and Rio Itapemirim. The chief result of this trip was the discovery that the *Gymnotidæ* are represented in the coastal streams of eastern Brazil. I returned to the Parahyba and went across the divide to the headwaters of the Rio Grande. Then I proceeded up the Parahyba River and crossed over the divide to the Tieté basin and down the same to São Paulo. From São Paulo I went to various places near Santos. After returning to São Paulo I proceeded to the Parahyba River near Araguary and back to Bebedouro, Piracicaba, and down the Rio Tieté to the upper Rio Parana. I returned to Bauru and went over to Salto Grande de Paranaponema. These trips were undertaken with a view to ascertaining the relation of the distribution of the aquatic life to the various waterfalls in the upper Rio Parana and its affluents. I returned to Rio de Janeiro in November. The chief results of these excursions were:

1. The addition of many species, heretofore known and described, to the faunal list of the region.

2. The knowledge that fishes can pass practically all of the waterfalls during big floods.

## 3. The abundance of molluscs in certain regions.

*Journey No. 4. To the Rio Ribeira da Iguape. November to December 19, 1908.*

From Rio de Janeiro I went down the coast to Iguape. I then ascended the Rio Ribeira da Iguape in boats and canoes as far as Iporanga and walked over some of the outliers of the Serra do Mar to Agua Quente, near which point I explored a cave called Caverna das Areas. In this cave I collected several specimens of a blind catfish, which previously had been taken by Ricardo Krone of Iguape. I also caught six specimens of *Aglea intermedia*, a crab with reduced eyes. The chief results of this trip were:

1. The collection of the two interesting species found in the Caverna das Areas.
2. The securing of a large number of species not previously reported from the Ribeira basin.
3. The observation of the excessive development of mailed catfishes in the Ribeira.
4. The determination of the great similarity of the fishes of the Ribeira to those of the upper Rio Parana.

*Journey No. 5. To the Rio Iguassú. From December 20, 1908, to the middle of January, 1909.*

From Iguape I went to Paranagua and over the Serra do Mar to the Iguassú basin. The chief results of this trip were:

1. The observation of the paucity of fishes and other forms of life in the Rio Iguassú.
2. Nearly all of the fishes are new species.
3. Fishes cannot ascend the large falls of the Iguassú.
4. I infer that the Iguassú basin is far older than any of the aquatic forms which inhabit the Parana basin.

*Journey No. 6. Rio Grande do Sul to Montevideo. From the middle of January to February 17, 1909.*

I sailed down the coast to Porto Alegre and worked my way over to the Uruguay River and thence to Montevideo. The chief results of this trip were:

1. The large number of species of fishes, molluscs, and crustacea, which I obtained from this part of South America.
2. The determination of the absence of any connection which will allow an easy intermingling of the forms of the Rio Grande do Sul with those of the La Plata basin.

*Journeys Nos. 7 and 8. To San Juan and the Rio Colorado. From February 18 to March 15, 1909.*

From Buenos Ayres I made two trips, one to San Juan, and the other to the Rio Colorado. Both of these trips revealed the paucity as well as the similarity of the life of the two regions.

*Journey No. 9. Paraguay basin to São Luiz de Cáceres, and thence to Manaos. From March 15 to November 10, 1909.*

I took a boat from Buenos Ayres for Asuncion, Paraguay, and went to the creeks near Sapucay and to Villa Hays. I went up the Paraguay River to Corumba, near which point I collected in the Urucum Mts., and in eastern Bolivia at Puerto Suarez. I went on up the Paraguay River to São Luiz de Cáceres, whence I started on a trip by ox-cart *via* San Matias, Bolivia, along the trail to San Ignacio as far as Las Encruziajas, where I turned to the north in order to reach a farm called Bastos, situated on the banks of the Rio Alegre. Then I went down the Guaporé River as far as the fort at Principe da Beira, where there are some dangerous rapids during the dry season. On account of the rapids and reputedly bad Indians I went up the Rio Machupo to San Joaquin, and took an ox-cart over to the Marmore, where I fished some time at a farm called Berlin. I went down the Marmoré River to Guaja Mirim and then to Villa Bella, which is situated at the fork of the Rios Marmoré and Beni. I then went over the various Madeira falls to São Antonio de Rio Madeira, where I boarded a small steamer for Manaos. The chief results of this long trip were:

1. A large collection of aquatic forms from a little known region.
2. The conviction on my part that there is no connection between the Paraguay and Amazon basin through which a wholesale exchange of fishes has taken place.
3. The majority of the species of fishes have been able to pass all of the Madeira falls.
4. Certain swamp-loving species of fishes are found in the headwaters of nearly all of the Brazilian rivers.
5. The belief on my part that no species of *large* fishes have ever passed from the headwaters of any river basin into that of another.

*Journey No. 10. The Lower Amazon basin. From November 10, 1909, to January 25, 1910.*

From Manaos I went to Santerem, where large collections were



made. I went down the Amazon to Belem, Para, and made two excursions from the latter point, one to Bragança, the other to Alcobaca at the first rapid in the Rio Tocantins. These trips added many new forms to the collection, more particularly parasitic catfishes, cœcilians, reptiles, lepidosirens, turtles, and one fine specimen of *Pipa americana* with eggs in its back.

I sailed from Belem, Para, for New York on January 25, 1910.

Much of the time of the entire trip was consumed in traveling. This is especially true for the regions where primitive modes of transportation were often necessary. The task was not an easy one for one person. The necessary physical exertion detracts from the collecting ability of anyone. However, I feel confident that from this trip the Museum now has the largest collection of fishes from the region between the Amazon and Patagonia. I also collected a great many batrachia, molluscs, crustaceans, and aquatic insects found in the region traversed by me. I also collected about thirty species of snakes and several thousands of lepidoptera and coleoptera, with other material of minor importance.

I believe that the most important result of the expedition will probably be the modification in some respects of the theories which have been hitherto advanced in regard to the distribution of South American fishes.

#### IMPLEMENTS AND METHODS OF COLLECTING.

In order to obtain all species thorough explorations must be made in a great variety of localities. Search must be instituted in swamps, in lakes, along the margins of rivers, especially under the plants which usually grow along the sides of all slowly flowing streams, in rapidly flowing waters, in stagnant pools, in whirlpools, in deep water, in clear and in muddy water, in rapids and in waterfalls, under rocks and logs, in sand and mud, in hollow logs, in holes in rocky ledges and the banks of rivers, in holes in dried up lagoons, in mountain rills, in coastal swamps, in shady streams, and in the campos. Each of these proved to be the habitat of some species not found anywhere else, and methods of collecting must be selected which are suitable both to the species and to its environment. The following is an account of the appliances and methods which I employed, or of which I heard.

1. *Seines with Different Sizes of Meshes and a Central Sack.*—A seine about seventy-five feet long (the so-called "Baird Col-

lecting Seine"), having a mesh of one-quarter of an inch, is the most valuable of all implements. With this it is possible to collect along the margins of rivers both in the daytime and at night. This seine is also useful in lagoons and creeks, and on sand-bars, but it cannot be advantageously drawn in muddy places. Shorter seines are needed for small and rapid streams, especially when there are large quantities of brush and boulders in them. I had better success by placing the seine without a canoe when the water was not deep. During the day I always had far better success by placing the nets around large sections of the plant-grown margins of the lakes and rivers and fastening both ends of the net to the banks. Then the encircled plants were quietly removed and the nets pulled ashore. In this way I sometimes obtained a canoe-load of fishes at one haul, the catch containing at times as many as fifty species. Great care must be taken in employing this method because of alligators, snakes, and sting-rays. Seining, as well as other methods of collecting, should be employed during all stages of the rise and fall of the rivers, because there is a wonderful migration of fishes during this time. The Guarani Indians call this migration *Piracema*, and at times they cannot catch more than small characins and cichlids. The migration is associated with spawning, and nearly all of the large species of fishes go up the rivers when the flood season begins. At this time the Indians go to the waterfalls to catch the masses of fish which are waiting for a rise of the river sufficient to enable them to get above the falls.

In swift water seines having a fine mesh are not good. For large fishes and fast-swimming species a longer seine with coarse meshes must be used. As a rule *Lepidosiren* can be captured during the dry season in swamps by cutting a circle in the grass and placing the seine in it. Then remove all of the grass and roll up the net.

2. *Gill-nets and Set-nets*.—Gill-nets can be used when there are no Piranhas (*Serrisalmoninæ*), but wherever Piranhas exist seining and netting have to be done skilfully and quickly, because the Piranhas can cut a net into pieces in an instant. Set-nets are very useful in rocky places, especially for mailed catfishes, which hide under rocks during the day.

3. *Dip-nets*.—In mountain rills, in grassy places, and under rocks in rapidly flowing water a dip-net is often needed, and with the aid of the feet many small mailed catfishes, *Pygidiida*, and small characins

can be driven into it. Small specimens buried in the sand may also be taken in a dip-net.

4. *Tarafa, or Casting-net.*—A tarafa or casting-net is very useful, especially at night and in muddy water. These conical nets can be thrown into the pot-holes of waterfalls, where no other kind of net can be used. They also can be cast between logs, in rapids, in muddy and grassy places, and do not necessarily require the entrance of the operator into the water, which is frequently dangerous. A small fine-meshed casting-net is needed for small species, while a net with large coarse meshes is necessary for large fishes.

5. *Diverting Stream into Net.*—In some of the mountain rills a net having a fine mesh can be put into the stream and then a portion of the stream above the net may be deflected into another channel. Everything may thus be taken. This is an especially good method of collecting *Pygidiidæ*.

6. *Rod and Line, Throwing Lines.*—A rod and line are good for small fishes, but wire leaders are needed, because several species are capable of cutting other kinds of leaders. For large catfishes, like *Jahu* and *Pirahyba*, a strong throwing line with a large hook is required. It is safer to tie the line to something, especially when fishing from the rocky ledges of waterfalls, where during the dry season one may easily hook a fish which one person cannot handle unaided.

7. *Trot- or Set-lines.*—Catfishes may readily be taken upon properly baited set-lines, but Piranhas and Candirus soon devour the fishes after they have been hooked. The destruction of specimens caused by these carnivorous fishes is not so great in extremely deep as in shallow water.

8. *Fish-traps.*—Fish-traps are useful along the banks of rivers and in deep water. Traps of different sizes and shapes may easily be made from vines and bamboos. Different kinds of bait must be used for different kinds of fishes. Below rapids and falls the Indians put in bamboo platforms when the streams are beginning to fall, and the fish pile up on them when they start over the falls. Along the lower Amazon where tidal effects are great, the natives put in long plaited wings leading up to a central pen which has an easily flexible entrance like any fish-trap, but no exit. When the tide falls the fish are left high and dry.

9. *Snares.*—Snares made of wire, thread, and fiber of bark can be used successfully for species which will not take a hook, and are hard to catch in a seine.



10. *Harpoons*.—The harpoon is useful in taking very large fishes, and it is nearly impossible to obtain very large specimens of the Pirarucu (*Arapaima gigas*) except by resorting to this method.

11. *Bow and Arrows*.—In places access to which is difficult because of brushwood, and plants, or because of rocks and rapids, or because of the swampy character of the banks, an Indian with his bow and arrows is sure to secure some prized specimens.

12. *Dynamite*.—In muddy places and deep water dynamite is not good, because so many fishes do not float when killed in this way. If the fish are feeding in water not too deep, over a solid bottom, and in brushy places, a charge of dynamite with a short fuse will kill most of the scaled species, but it is very hard to get the stunned catfishes. In deeper places I usually attach a float to the charge of dynamite. The carnivorous fishes will soon devour the stunned specimens, if they are not immediately gathered. Fishes killed with dynamite are always hard to preserve, for decomposition sets in much more rapidly than in the case of fishes taken in other ways, and the finer tissues and minuter organs are often filled with lesions destroying the usefulness of specimens for purposes of exact histological investigation.

13. *Native Poisons*.—There are several kinds of poisonous plants, the leaves, fruit, and bark of which will kill fish, but such poison is only good in lagoons and small streams which do not flow rapidly. *Timbo* is the best. It can be eaten by man, but when pounded and placed in a small lagoon it appears to interfere with the respiration of the fishes either by taking up the free oxygen in solution in the water, or by the prevention of the passage of oxygen through the gill membranes into the blood. As a rule the water turns black and it takes about ten hours to kill all of the fish, and even then *Hoplias* and *Erythrinus* are seldom killed, because they bury themselves in the mud, and the poison does not appear to affect them there.

14. *Processo da Mandioca*.—The mandioca process excels all others as a display of native ingenuity. A flexible pole is passed through a large mandioca root and is then secured in the sand or earth near a whirlpool or rapid. The upper end of the pole has a short string furnished with a hook which is pulled down and imbedded in the tip of the mandioca. When a fish like *Prochilodus* sucks and gnaws away the peeled tip of the mandioca, and liberates the hook,

the bent pole straightens out, flips up, and often catches the fish under its head.

15. *Angle-worms and Open Umbrella for Eels.*—The natives of Aregua, Paraguay, catch *Symbranchus* with a bunch of worms tied to a string and an opened umbrella. When the eels seize the worms they are jerked up with the upturned umbrella before they let go of the food.

16. *Dead Animals and Imprisoned Fishes.*—A freshly killed animal or an imprisoned large fish left in the rivers over night are sometimes full of *Cetopsis* and parasitic *Pygidiidæ* on the following morning.

17. *Hollow Logs and Submerged Canoes.*—Hollow logs and sunken canoes frequently yield prized specimens, if quietly and quickly removed from the water. In the case of such logs it sometimes is possible to stop or plug the open end and then roll them out upon the bank.

18. *Holes in Banks, Rocks, Stumps, and in Logs.*—Rare specimens were often taken by me in holes and crannies by the use of my naked hands.

19. *Soft-wood Canoes.*—I was told that the native caught a species of *Tachysurus* during the spawning season with soft-wood canoes. They are split and sunk quickly by means of weights. The erected dorsal spines of the mass of assembled fishes penetrate the soft wood and the fishes are held captives. This is possible from what I know of this fish, but I did not see this mode of fishing practiced.

#### PRESERVING AND TRANSPORTING SPECIMENS.

It is quite as difficult to save as to make collections while traveling in Brazil. In the remoter districts formalin is the best preservative on account of its small bulk. All medium-sized to large specimens should be injected the same day on which they are taken with 95 per cent. alcohol or a little strong formalin. The native rum or *cachaca* suffices to preserve specimens for only a few days. If kept longer in this fluid they soften. In tropical climates it is best to kill fishes by the use of strong alcohol, avoiding, however, a degree of strength sufficient to cause distortion after death. As a rule 70 per cent. alcohol is best, but there is no absolutely fixed formula for different species. It is almost impossible to transport fishes on mule-back and in ox-carts, because they are shaken to pieces sooner or later.

## THE ELEMENTS OF PERSONAL RISK IN COLLECTING IN THE TROPICS.

Fishing in South America is by far the most dangerous of all forms of scientific exploration. In addition to the dangers besetting the collector on land the fisherman is in danger of drowning, stepping on a sting-ray, getting into contact with an electric eel, getting bitten by Piranhas, *Palometes*, and Candirus, or being carried off by either a large anaconda, or caiman. Besides all of these dangers one has to pass his time in regions which are, as a rule, infested with all kinds of biting gnats, mosquitoes, flies, ants, and ticks. One must paddle about in rivers the margins of which are always laden with all kinds of tropical diseases.

In order to maintain good health in the tropics my advice would be to eat anything you can get, whenever you can get it, and as much as you crave, especially fruits, vegetables, and lean meat, avoiding fats. Keep hard at work. Eternal vigilance is the price of a good collection. Always sleep under a mosquito-bar, and go to bed early, thereby getting a good rest and taking few chances of being bitten by mosquitoes. Black coffee is a much better beverage than alcoholic drinks. I learned to smoke and think I was the better for it, because tobacco soothes the mind and drives away many of the annoying insects. I advise against taking quinine daily, but rather recommend the injection of liquid quinine when the fever comes. I took frequent baths and did not shave. Wounds heal up more quickly in the tropics than in temperate regions if the sunlight has access to them. It is best to keep the stomach slightly acid and a calomel purge should be used as soon as there are any signs of indigestion. If the stomach can be kept normal there is no danger of sickness. It is not absolutely necessary to boil or filter drinking water. I am thoroughly convinced that the temperament of the individual has a great deal to do with health in the tropics. Ever-changing activities and a variety of interests tend to produce a frame of mind which is hostile to disease. Calmness in the face of grave danger is indispensable. Worry and fretfulness should be banished. Great faith should be put in one's own arms, legs, and head. I am well aware that few are able to endure the hardships encountered in long journeys away from the beaten path in any climate, but my only trouble at any time while traveling in Brazil arose from the occasional difficulty of getting something to eat. I feel sure that most of the deaths of travelers in the tropics result either from inexcusable ignorance or from unnecessary fear.

## LOCALITIES FOR FUTURE WORK.

The Plano Alto, or central plateau of Brazil, supports an extremely meager fauna and flora. An occasional deer, beetles, and a few woodpeckers are the animals most commonly seen. But along the base of this dissected plateau are numerous large forests and jungles which are teeming with life and are as a rule free from the dreaded tropical diseases. The regions along the border of Bahia and Goyaz, between the Rio Grande and Rio Preto, teem with insects, birds, plants, and large mammals, especially during the dry season (April to November). This region is on the outskirts of civilization, and therefore a good place for collecting. Besides this area is quite accessible, another point to be considered by the collector. It is possible to go by rail from Bahia to Joazeiro and then by small steamers up the Rio São Francisco and Rio Grande to Barreiras, and also from Rio Grande up the Rio Preto to its junction with the Rio Sapon. In the eastern part of the São Francisco basin west of the Serra de Jacobina in the Rio Salitre valley, during extremely prolonged droughts, the denizens of forest and field are pushed out of their usual abodes to seek water. They consequently congregate around the salty lagoons of the Salitre basin. I have seen at one time more than one hundred species of birds, together with many of the larger mammals, more or less peacefully partaking of the scanty saline water.

The country of the Rio Ribeira da Iguape is the cheapest region of Brazil for an explorer, and it is quite accessible and has a good climate except during the heavy rains, which usually fall between December and April. From this part of Brazil one may easily get to Paraguay either by land or by water. The climate of eastern Paraguay is superb. Living in Paraguay is cheaper than elsewhere in South America. If the collector settles down in the interior and wins the confidence of the Indian children, great quantities of natural history specimens may be obtained by offering to them small sums.

The headwaters of the Rio Paraguay can be easily reached by steamer from the capital of Paraguay. The chapada of Matto Grosso and the Bolivian highlands draining into the Paraguay river are accessible, healthful, and a very rich field for natural history specimens.

With some difficulty the explorer can cross over into either the Guaporé or the Araguay basin. In the great Guaporé valley there is scarcely a break in the gigantic forests, which are choked by vines,

smothered by epiphytes, and filled in between by bamboos and scrubby plants. In the midst of this floral confusion roams the whistling tapir, howling, babbling, and squealing monkeys from the size of a mouse to that of a dog. Countless gorgeously colored birds and butterflies flit around, huge alligators bellow in the lagoons, and the fish never stop leaping after foolish insects. After the noises of the day the hush which comes at night-fall causes even the hardened traveler at times to shudder. No man over fifty years of age should attempt to enter this region. A hard heart and cold blood are useful to him who invades it.

### THE LOCALITIES AT WHICH MR. JOHN D. HASEMAN MADE COLLECTIONS.

BY C. H. EIGENMANN.

The following list of localities has been compiled from Mr. Haseman's notes, his manuscript map, and from the labels of the specimens so far examined. The localities are given in the order in which they were reached. Where a locality was visited more than once, it usually occurs only in the place given it by the first visit. With this list and the foregoing general account by Mr. Haseman students ought to have no difficulty in placing the localities. In some instances the dates in Mr. Haseman's notes do not agree with the dates on the labels accompanying the specimens. Since, however, the dates are always within a few days of each other, no great confusion can arise.

The collector's numbers attached to specimens are given in many cases.

The localities are numbered *seriatim*, and at the close of the paper is given an alphabetical list with reference to these numbers.

1. Rio Coite, into the Rio Salitre, into Rio São Francisco.  
Coll. Nos. 2, 14, 19. Nov. 6, 1907.
2. Rio Aqua Branca, into headwaters of Itapicurú.  
Coll. Nos. 40 and 41. Swift rocky stream from Serra de Jacobina. Nov. 6, 1907.
3. Rio Ipema, into headwaters of Itapicurú.  
Coll. No. 39. Small stream from Serra de Jacobina.  
Nov. 7, 1907.
4. Rio Lamas, small creek into headwaters of Itapicurú.  
Coll. No. 5. Nov. 7, 1907.

5. Rio Zinga, small creek into headwaters of Itapicurú.  
Coll. Nos. 6, 25 to 29. Nov. 7, 1907.
6. Rio Itapicurú Grande, headwater of Rio Itapicurú.  
Coll. No. 38. Swift and rocky mountain stream near Jacobina.  
Nov. 8, 1907.
7. Rio Pajaia, into headwaters of Itapicurú.  
Coll. Nos. 20-24. Small, rocky, rapid stream from Serra Jacobina between Bom Fim and Jacobina. Nov. 8, 1907.
8. Rio de Jacobina, into Rio Itapicurú.  
Coll. Nos. 33-37. Quiet, muddy stream, with plant-grown, swampy margins, some boulders; within sight of the mountains.  
Nov. 8, 1907.
9. Lagoa Salgado, Rio Salitre, into Rio São Francisco.  
Coll. Nos. 30-32. Saline lake with muddy margin in upper course of Rio Salitre. Nov. 10, 1907.
10. Bom Fim, Rio Amaratú, into Rio Itapicurú. Nov. 11, 1907.
11. Saõ Thome, Rio Salitre, into Rio São Francisco.  
Coll. Nos. 3, 4. Nov. 12, 1907.
12. Rio Salitre, into Rio São Francisco.  
Coll. Nos. 9, 10, 12, 13. Ten miles south of Baixa Grande in a stagnant water hole. Nov. 14, 1907.
13. Baixa Grande, Rio Paqui, into Rio Salitre, into Rio São Francisco.  
Coll. No. 1. Nov. 14, 1907.
14. Rio Paqui, into Salitre near Baixa Grande.  
Coll. Nos. 7, 8, 11. Small creek in semi-arid region; muddy and grass-grown, with some pebbles. Nov. 14, 1907.
15. Finca Amaratú, Rio Itapicurú.  
Creek on farm emptying into Itapicurú Mirim. Nov. 21, 1907.
16. Joazeiro, Rio São Francisco.  
Coll. Nos. 185-208. Sandy island in front of Joazeiro.  
Nov. 27, 1907.  
Coll. Nos. 42-124. Temporary backwater lagoon, deep and muddy; six miles east of town. Nov. 28, 1907.  
Coll. Nos. 125-184. Two miles below Petrolina, opposite Joazeiro. Rocky, weedy shore of the Rio São Francisco.
17. Barra, Fork of Rio São Francisco and Rio Grande.  
Coll. Nos. 125-154 (duplicated). Muddy water and muddy banks. Dec. 6, 1907.

18. Januaria, Rio São Francisco.  
Coll. Nos. 249-273. On sandy shores of an island in front of town. Dec. 12, 1907.  
Coll. No. 399. Dec. 18, 1907.
19. Cachoeira de Pirapora, Rio São Francisco.  
Coll. Nos. 155-249. In the river at and below the fall, a creek which enters the fall, a lagoon one and one-half miles below the fall. Dec. 15, 1907.
20. Lagoa de João Pereira, Barra, Rio São Francisco.  
Coll. Nos. 274-360. One of a series of five lakes, at times connected with the Rio São Francisco, at times dry. Dec. 23, 1907.
21. Lagoa de Porto, near Barra, Rio São Francisco.  
Coll. Nos. 362-398. One of a series of five lakes. Dec. 24, 1907.
22. Lagoa Barreiras, Rio São Francisco.  
Coll. Nos. 400-440. A weed-grown, muddy pond, with swampy margins, near the village Barreiras. Jan. 4, 1908.
23. Boqueirão, Rio Grande of Rio São Francisco basin.  
No numbers. Rio Grande and swampy grass-grown ponds; water clear. Jan. 6-9, 1908.
24. Lagoa Parnagua or Paranagua, Paranahyba basin.  
Coll. Nos. 441-450. West side, in plant-grown, muddy, swampy, sandy, and pebbly shores. Jan. 16, 1908.
25. Santa Rita de Rio Preto, into Rio Grande, into Rio São Francisco.  
Coll. Nos. 451-484. In the Rio Preto and tributaries. Jan. 24, 1908.
26. Rio Preto, ten miles below fork of Rio Sapão. Jan. 27, 1908.
27. Cachoeira da Velha, Rio Novo, into Rio Somno, into Tocantins.  
No numbers. Above and below fall. Swift current, clear water, rocky or sandy; in places grass-grown. Feb. 4, 1908.
28. Stromé, Rio Somno. Headwaters.  
No numbers. Headwaters, creeks, swampy "brejos." Feb. 6, 1908.
29. Rio Sapão, into Rio Preto, into Rio São Francisco. Near Prazeres.  
No numbers. Feb. 11, 1908.
30. Rio Preto, into Rio Grande, into Rio São Francisco.  
Coll. No. 486. Formosa. Feb. 15, 1908.

- No numbers. From the river, from a grass-grown lagoon, and from along the margin of the river seven miles below Formosa.  
Feb. 15, 1908.
31. Barra, on Rio São Francisco.  
Coll. Nos. 484-485. Rio São Francisco. Feb. 23, 1908.  
Coll. Nos. 487-488. Rio São Francisco. Feb. 24, 1908.
32. Queimadas, Rio Itapicurú.  
Coll. Nos. 489-494. In rapids of Rio Itapicurú.  
March 2, 1908.  
Coll. Nos. 495-532. Under railroad bridge. March 2, 1908.
33. Alagoinhas, Rio Catu.  
Coll. Nos. 538-550. Small, narrow stream, sticks, stones, grass-grown. March 4, 1908.
34. Rio Itapicurú.  
Coll. Nos. 532-537. Twelve miles from Timbo.  
March 5, 1908.
35. Bahia.  
Coll. Nos. 557-640. Various places about Bahia.  
March 11, 1908.  
Coll. Nos. 866-929. Bay of San Salvador. April 13, 1908.
36. Penedo, mouth of Rio São Francisco.  
Coll. Nos. 700-793. In and along Rio São Francisco. Both sides of river. March 22, 1908.  
Coll. Nos. 794-809. Clear pond one mile from river but connected with it at high water. March 22, 1908.  
Coll. Nos. 810-815. April 2, 1908.
37. Propria, Rio São Francisco.  
Coll. Nos. 816-824. Muddy places. March 30, 1908.
38. Maceio, on coast.  
Coll. Nos. 825-864. Various places in sea and fresh water.  
April 6, 1908.
39. Barra de Penedo, mouth of Rio São Francisco.  
Coll. Nos. 931-936. Mostly from clear pools used for drinking water.  
Coll. Nos. 937-938. Mouth of Rio São Francisco.  
April 7, 1908.
40. Aracaju, sea and brackish water.  
No Coll. Nos. April 10 1908.



41. Cachoeira, Rio Paraguassu.  
Coll. Nos. 939-972. River high, water rather dark, dirty.  
April 14, 1908.
42. Sete Lagoas, into Rio das Velhas, into Rio São Francisco.  
Coll. Nos. 973-976. In lake near town. May 4, 1908.  
Coll. Nos. 977-985. Creek, half mile south of town, rapid,  
rocky, cool. May 4, 1908.
43. Rio das Velhas, into Rio São Francisco.  
Coll. Nos. 986-988. Creek about three miles from town.  
May 10, 1908.  
Coll. Nos. 989-1004. Ponds about four miles from town.  
May 11, 1908.  
Coll. Nos. 1005-1036. In a mountain rill and small ponds.  
May 13, 1908.
44. Miguel Burnier.  
Coll. No. 1037. Headwaters of Rio das Velhas. Only 1  
species. May 14, 1908.  
Coll. Nos. 1038-1044. A rapid stream south of Miguel  
Burnier, tributary of Rio Paraopeba. Only two species.  
May 14, 1908.
45. São João del Rey, Rio das Mortes, into Rio Grande, into Parana.  
Coll. Nos. 1045-1073. Ponds, and rapid, mostly clear streams.  
May 19, 1908.  
Coll. Nos. 1074-1081. Seven miles from town in Rio das  
Mortes. May 19, 1908.
46. Sitio, Rio das Mortes, into Rio Grande, into the Parana.  
Coll. Nos. 1083-1088. Cool, clear, rapid stream, full of  
brush. May 21, 1908.
47. Serraria, Rio Parahybuna, into Rio Parahyba.  
Coll. No. 1082. Rapids of Rio Parahybuna. May 22, 1908.
48. Rio Doce.  
Coll. Nos. 1089-1109. In Rio Doce and creek near village of  
Rio Doce. May 24, 1908.  
Coll. Nos. 1110-1121. Rocky mill race at Rio Doce.  
May 25, 1908.  
Coll. Nos. 1122-1134. Creeks, pools and river. May 26, 1908.  
Coll. Nos. 1135-1136. Rio Doce. May 27, 1908.  
Coll. Nos. 1137-1158. Fumaca, whirlpool two miles below  
village of Rio Doce.  
Coll. No. 1159. Creek near town. May 28, 1908.

49. Entre Rios, Rio Parahyba.  
 Coll. Nos. 1160-1180. Shallow, grass-grown, cool, clear creek. June 1, 1908.  
 Coll. Nos. 1181-1201. Cool, clear, shallow creek two miles below town. June 2, 1908.  
 Coll. Nos. 1202-1203. Rio Parahyba. June 3, 1908.  
 Coll. Coll. Nos. 1204-1210. Rocky rapids. June 3, 1908.
50. Campos, Rio Parahyba.  
 Coll. Nos. 1265-1308. Two rather small lagoons one mile north of the Parahyba. Shallow, many grasses and aquatic plants. June 13, 14, 1908.  
 Coll. Nos. 1309-1310. Rio Parahyba. June 14, 1908.  
 Coll. Nos. 1311-1361. Sandy and muddy margins and lagoons two miles below Campos. June 15, 1908.  
 Coll. No. 1497. Lagoon near Campos along the Parahyba. June 26, 1908.
51. Lagoa Feia, near seacoast south of mouth of Parahyba.  
 Coll. Nos. 1362-1367. Shores, swampy, mucky with abundance of plants; 9 feet above sea level. June 16, 1908.  
 Coll. Nos. 1498-1499. Market at Campos. June 26, 1908.  
 Coll. Nos. 1500-1512. Tocos, swamp on sugar-farm. June 27, 1908.
52. Munez Freire or Cachoeira, Rio Itapemerim.  
 Coll. Nos. 1367-1399. Rio Itapemerim, sandy or rocky, clear and swift, and creek one mile below town. June 18, 1908.  
 Coll. Nos. 1400-1422. A plant-grown swamp through which passes a mountain stream. Cold water. Bed with logs, brush, and much mud. June 19, 1908.
53. São Joao da Barra, Parahyba.  
 Coll. Nos. 1423-1461. One mile below town and four miles from the sea, from river and lagoons.  
 Coll. Nos. 1462. In salt-water five miles below town. June 23, 1908.  
 Coll. Nos. 1463-1476. In fresh-water, also found in ocean. June 23, 1908.  
 Coll. Nos. 1477-1481. Mouth of Parahyba, along sand bar separating salt- and fresh-water. No fresh-water fishes. June 23, 1908.  
 Coll. Nos. 1482-1496. In running fresh-water along plant-grown margins of river. June 24, 1908.

54. Barra da Pirahy.  
Coll. No. 1513. Swampy rills. July 5, 1908.
55. Bom Jardim, Rio Grande, into Rio Paraná.  
Coll. Nos. 1514-1520. In lagoons above waterfall three miles above Bom Jardim. Cool, plant-grown, sand and mud. High altitude; few (6?) species. July 7, 1908.  
Coll. Nos. 1521-1523. Whirlpool below falls. July 8, 1908.
56. Santa Rita de Jacutinga, Rio Preto, into Parahyba.  
Coll. No. 1524. Lagoon above waterfalls near town. July 9, 1908.  
Coll. Nos. 1525-1528. Rio Preto below falls. Rocky and sandy; cool, rapid water. July 10, 1908.
57. Barra de Pirahy, Parahyba.  
Coll. Nos. 1529-1541. Rio Parahyba. July 12, 13, 1908.
58. Jacarehy, Rio Parahyba.  
Coll. No. 1542-1547. Creeks, ponds, swamps, one mile north of town. July 14, 1908.  
Coll. Nos. 1548-1561. Rio Parahyba and nearby lagoons. July 15, 1908.
59. Mogy das Cruzes, Rio Tieté, into Rio Paraná.  
Coll. Nos. 1562-1571. Rio Tieté, flat and swampy in places; sandy margins of river. July 17, 18, 1908.  
Coll. Nos. 1572-1590, Rio Tieté, one kilometer from town; clear, blackish, cool water. July 19, 1908.  
Coll. Nos. 1591-1592. Rio Tieté. July 20, 1908.
60. Piracicaba, Rio Tieté, into Rio Paraná.  
Coll. Nos. 1594-1598. July 23, 1908.  
See also No. 75.
61. Sapina, Rio Tieté, into Paraná.  
Coll. Nos. 1599-1616. Four miles from city. July 23, 1908.
62. Santos, coast of São Paulo. July 23, 1908.
63. Raiz de Serra, Rio Mogy, into Santos Bay.  
Coll. Nos. 1617-1632. Creek at base of mountains, ten miles from Santos. July 26, 1908.  
Coll. Nos. 1636-1654. Rio Mogy, clear, shallow, big granite boulders. July 27, 1908.
64. Alto da Serra, Rio Tieté, into Rio Paraná.  
Coll. Nos. 1633-1635. Small rills with an abundance of algæ and reeds. July 25, 1908.

65. Piassaguera, near Santos.  
Coll. Nos. 1655-1656. In fresh water near a bay of ocean.  
July 29, 1908.
66. Santos.  
Coll. Nos. 1657-1685. Marine fishes. July 29, 1908.
67. Rio Pilao, near Santos.  
Coll. Nos. 1712-1713. From torrent 100 feet broad, one foot deep, fifteen miles southwest of Santos, near water-works.  
July 31, 1908.
68. Cubatão, Rio Cubatão.  
Coll. Nos. 1714-1729. Clear, swift, and rocky creeks, seven miles west of Santos. July 31, 1908.
69. Mogy Mirim, into Rio Mogy Guassu, into Rio Grande, into Rio Parana.  
No numbers. River, creeks, lagoons about Mogy Mirim.  
Aug. 7, 1908.
70. Corrego de João de Deus. Twelve miles from Mogy Mirim.  
No numbers. Aug. 7, 1908.
71. Rio Paranahyba, into Rio Paraná.  
No numbers. Bridge twenty-one miles above Araguay.  
Aug. 14, 1908.
72. Jaguará, Rio Grande, into Rio Paraná.  
Coll. Nos. 1740-1770. Creeks and lagoons of the Rio Grande.  
Aug. 18, 19, 1908.
73. Mogy Guassu, Rio Mogy Guassu, into Rio Grande, into Paraná.  
Coll. Nos. 1771-1787. River, creeks, etc., about Mogy Guassu.  
Aug. 25, 26, 1908.
74. Bebedouro, near Rio Grande, and Rio Paraná.  
Coll. Nos. 1788-1805. Creek and swampy ponds.  
Sept. 1, 1908.
75. Piracicaba, Rio Tieté, into Rio Paraná.  
Coll. Nos. 1812-1822. Below big falls of the Rio Piracicaba.  
Sept. 5, 8, 9, 1908.  
Coll. Nos. 1806-1810. Rio Piracicaba-Mirim, above big falls.  
Sept. 7, 1908.  
Coll. Nos. 1811. Below falls of Rio Piracicaba-Mirim, under stones. Above falls of Rio Piracicaba. Sept. 7, 1908.
76. Salto de Avandava, Rio Tieté.  
Coll. Nos. 1834-1853. In mill race—above the falls, rocky, clear.  
Sept. 14, 1908.

- Coll. Nos. 1854-1864. In and below the falls.  
Sept. 15-17, 1908.
77. Salto das Cruces, Rio Tieté.  
Coll. Nos. 2004-2008. Above falls.  
Coll. Nos. 2010-2015. Muddy hole near entrance of and above rapids. Sept. 22, 1908.  
No numbers. Twenty miles from Salto das Cruces at railroad camp.
78. Salto das Cruces, Rio Tieté.  
Coll. Nos. 2001-2002. Mud-hole along margin of river.  
Sept. 22, 1908.
79. Itapura, Rio Tieté.  
Coll. No. 2003. A canal around big falls. Sept. 27, 1908.
80. Miguel Calmon.  
No numbers. Twenty miles east of Avanhandava in lake and swampy creek. Oct. 11, 1908.
81. Bauhru, Rio Tieté. No numbers.
82. Salto Grande de Paranapanema, into Rio Parana.
83. Aqua Quente, into Rio Ribeira da Iguape.  
Coll. Nos. 2020-2046. Eight miles from Iporanga in small mountain creeks near caves. Nov. 27, 1908.
84. Cavernas das Areas.  
Coll. Nos. 2047-2060. Sixteen miles southwest of Iporanga in Serra do Mar. Nov. 28, 1908.
85. Iporanga, Rio Ribeira da Iguape.  
Coll. Nos. 2061-2092. In Rio Ribeira and tributaries.  
Dec. 1, 1908.
86. Xiririca, Rio Ribeira da Iguape.  
Coll. Nos. 2093-2100, 2125-2130. Dec. 5, 8, 1908.
87. Iguape, Rio Ribeira da Iguape.  
Coll. Nos. 2100-2124. From Ricardo Krone. Dec. 13, 1908.  
Coll. Nos. 2135-2140. Near sea, but in swampy, mucky, freshwater. Dec. 15, 1908.  
Coll. Nos. 2141-2147. Small mountain rills back of city.  
Dec. 16, 1908.
88. Serrinha Paraná, Rio Iguassú, into Paraná.  
Coll. Nos. 2148-2156. Rio Iguassú. Dec. 22, 1908.  
Coll. Nos. 2157-2165. Creek near the river. Dec. 22, 1908.

89. Rio das Mortes, into Rio Iguassú.  
Coll. Nos. 2170-2176. Creek six miles west of Serrinha, with numerous falls.
90. Porto União da Victoria, Rio Iguassú.  
Coll. Nos. 2177-2196. High floods, in muddy places.  
Dec. 27, 1908.  
Coll. Nos. 2197-2203. Rio Iguassú and flooded margins, swamps and lagoons.  
Dec. 28, 1908.  
Coll. Nos. 2204-2210. Four miles below town. Dec. 29, 1908.
91. Morretes, on Marunby, into Rio Nhundiaquara, into ocean at Paranagua.  
Coll. Nos. 2212-2236. Rapids and swampy margins.  
Jan. 2, 3, 1909.  
Coll. Nos. 2237-2257. Rocky, rapid course of one of many creeks.  
Jan. 4, 1909.
92. Porto Alegre, Rio Grande do Sul.  
Coll. Nos. 2252-2263, 2276-2277, 2280-2297, 2321-2332. Rio Guahyba in front of town.  
Jan. 17, 18, 20, 21, 22, 24, 1909.
93. Cachoeira, Rio Jacuhy, into Lago dos Patos at Rio Grande do Sul.  
Coll. Nos. 2333-2352. Creeks of Rio Jacuhy near town.  
Jan. 26, 27, 1909.
94. Santa Maria, Rio Vaccacahy-Mirim, into Rio Guahyba, into Jacuhy.  
Coll. Nos. 2342-2345. Small, rocky, clear mountain-stream, two miles east of town; few fish.
95. Cacequy, Rio Ibicuhy, into Uruguay.  
Coll. Nos. 2346-2360. Creeks near railroad station.  
Jan. 31, 1909.  
Coll. Nos. 2361-2382. Eight kilometers west of town, Rio Ibicuhy.  
Feb. 1, 1909.  
Coll. Nos. 2383-2389. Rio Cacequy one mile from railroad station.  
Feb. 1, 1909.
96. Uruguayana, Rio Uruguay  
Coll. Nos. 2390-2453. Rio Uruguay, deep, muddy water.  
Feb. 5, 1909.
97. Rio Negro, Urúguay, or Paso de los Torros, into Rio Uruguay.  
No numbers.
98. Arroyo Miguelete, Montevideo.  
No numbers.  
Feb. 17, 1909.

99. San Juan, Argentina.  
Coll. Nos. 2500-2512. Rio San Juan and irrigating canals.  
Feb. 25, 27, 1909.
100. Rio Colorado, Argentina.  
Coll. Nos. 2529-2530. Choel-choel, tributary of Rio Negro.  
March 4, 1909.  
Coll. Nos. 2513-2528. Rio Colorado. March 5, 1909.  
Coll. Nos. 2531-2532. Muddy ponds twenty miles east of  
town of Colorado. March 6, 1909.
101. Buenos Aires, Rio de Prata.  
Coll. Nos. 2533-2536. March 11, 1909.
102. Asuncion, Paraguay.  
Coll. Nos. 2540-2542. Rio Paraguay. March 23, 1909.  
Coll. Nos. 2543-2544. Cerro de Lambaré, five miles below  
Asuncion in saline swamp.  
Coll. Nos. 2546-2553. Bays in front of and near Asuncion.  
March 30, 31, 1909.  
Coll. Nos. 2554-2556. Rio Paraguay.
103. Sapucay, Paraguay.  
Coll. Nos. 2557-2576. Mountain rills near town.  
April 2, 1909.  
Coll. Nos. 2577-2585. Arroyo Poná. April 5, 1909.
104. Arequa, Paraguay.  
Coll. Nos. 2586-2591. Laguna Ipacary. April 7, 8, 1909.
105. Villa Hays, mouth of Rio Confusso, into Rio Paraguay.  
Coll. No. 2593. April 11, 1909.  
Coll. Nos. 2594-2599. April 13, 14, 1909.
106. Corumba, on Rio Paraguay, Matto Grosso.  
Coll. Nos. 2650-2661. Lagoons and rivers near town.  
April 28, 1909.  
Coll. Nos. 2662-2666. Rio Paraguay. April 2(-), 1909.  
Coll. Nos. 2695-2702. Rio Paraguay. May 9, 1909.
107. Urucum Mountains, 25 miles back of Corumba, Matto Grosso.  
No numbers. April 27, May 2, 1909.
108. Puerto Suarez, 15 kilometers across bay from Corumba, Bolivia.  
Coll. Nos. 2667-2690. One mile from village. May 6, 1909.  
No numbers and 2691-2694. May 7, 1909.
109. São Luiz de Caceres, Matto Grosso.  
Coll. Nos. 2703-2708. Rio Paraguay. May 23, 1909.

- Coll. No. 2709. Creek six miles back of São Luiz.  
May 23, 1909.
- Coll. Nos. 2710-2730. Old cut-off of Rio Paraguay.  
May 24, 1909.
- Coll. Nos. 2731-2750. Rio Paraguay. May 20, 1909.
- Coll. Nos. 2751-2758. Rio Paraguay. May 27, 1909.
110. Campos Alegre, Rio Jauru, into Rio Paraguay.  
Coll. Nos. 2759-2770. Twenty-eight miles above mouth of  
Rio Jauru and about thirty southwest of São Luiz de Cáceres.  
Rich fauna. June 2, 1909.  
Coll. Nos. 2771-2773. June 3, 1909.
111. San Matias, Bolivia, into Rio Paraguay.  
No numbers. Lagoon near village. June, 1909.  
No numbers. Cave twelve miles from San Matias, on frontier  
of Brazil and Bolivia. June, 1909.  
No numbers. Carricha from the cave. June, 1909.
112. Rio São Francisco, into Rio Paraguay, Matto Grosso.  
Coll. Nos. 2771-2775. Sixteen miles west of San Matias.  
June 10, 1909.
113. Rio Santa Rita, into Rio Paraguay, Matto Grosso.  
Coll. Nos. 2776-2779. Near frontier of Bolivia. June 12, 1909.
114. Petas, Bolivia, into Rio Paraguay.  
Coll. No. 2780. June 13, 1909.
115. Rio Boa Ventura, into Rio Guaporé of Amazon basin.  
Coll. Nos. 2781-2786. South of Villa de Matto Grosso.  
June 16, 1909.
116. Posada, into Guaporé.  
Coll. No. 2787. About forty miles south of Villa de Matto  
Grosso. June 21, 27, 1909.
117. Bastos, Rio Alegre, into Rio Guaporé.  
Coll. Nos. 2788-2800. Eight miles south of Villa de Matto  
Grosso. June 26, 28, 1909.
118. Rio Guaporé.  
No numbers. Below mouth of Rio Paragan. July 8, 1909.  
No numbers. Sixty miles above San Antonio de Guaporé.  
July 23, 1909.  
Coll. Nos. 2833-2843. San Antonio de Guaporé.  
July 29, 1909



- Coll. Nos. 2844-2846. Swamp four miles from Rio Guaporé.  
July 30, 31, Aug. 3, 1909.
- Coll. Nos. 2847-2913. San Antonio de Guaporé in Rio  
Guaporé. Aug. 3, 9, 10, 11, 13, 1909.
119. Rio Machupo, Bolivia, into Rio Guaporé.  
Coll. Nos. 2922-2924. Twenty miles below San Joaquin.  
Aug. 28, 1909.
120. San Joaquin, Bolivia.  
Coll. Nos. 2925-2927. Rio Machupo.  
Coll. Nos. 2928-2945. Lake one mile west of town.  
Sept. 4, 1909.  
Coll. Nos. 2946-2980. Rio Machupo. Sept. 5, 6, 1909.  
Coll. No. 2981. Mud-hole near town. Sept. 7, 1909.
121. Berlin, Rio Mamoré.  
Coll. No. 2982. Rio Mamoré, three miles south of Berlin.  
Sept. 14, 1909.  
Coll. Nos. 2983-2989. Rio Mamoré. Sept. 15, 1909.
122. Rio Mamoré.  
Coll. Nos. 2990-2997. Below mouth of Rio Guaporé.  
Sept. 19, 1909.
123. Guaja-ussu, Rio Madeira.  
No numbers. Sept. 28, 1909.
124. Palo Grande, Mamoré.  
Coll. No. 2998. Waterfall in Mamoré, in rapids under stones.  
Sept. 30, 1909.
125. Villa Bella, Bolivia, Rio Beni, into Rio Madeira.  
Coll. Nos. 2999-3010. Rising river; hard to collect.  
Oct. 5, 1909.  
No numbers. Swamp back of Villa Bella.
126. Cachoele de Ribeirão, Rio Madeira.  
Coll. Nos. 3011-3012. Oct. 17, 1909.
127. Cachoele de Theotone, Rio Madeira.  
Coll. Nos. 3015-3020. In whirlpool. Oct. 13, 1909.
128. Cachoele de Girão, Rio Madeira.  
Coll. Nos. 3020-3025. Whirlpools. Oct. 26, 1909.
129. São Antonio de Rio Madeira.  
Coll. Nos. 3013-3014. Nov. 2, 1909.  
Coll. Nos. 3026-3035. Rio Madeira near São Antonio.  
Nov. 3, 1909.

130. Manaos, mouth of Rio Negro.  
 Coll. Nos. 3036-3155. About Manaos. Nov. 15-19, 25, 27-29, 1909.  
 Coll. Nos. 3156-3158. Igarapé de Cachoeira Grande, two miles out of Manaos. Nov. 30, 1909.  
 Coll. Nos. 3159-3166. Manaos. Dec. 2, 1909.  
 Coll. Nos. 3167-3168. Ten miles above Manaos on Rio Negro. Dec. 4, 1909.
131. Santarem.  
 Coll. Nos. 3169-3185. Rio Tapajos. Dec. 6, 1909.  
 Coll. Nos. 3816-3202. Swampy pools of Amazon and Tapajos opposite Santarem. Dec. 7, 1909.  
 Coll. Nos. 3203-3218. Rio Tapajos. Dec. 8, 1909.  
 Coll. Nos. 3219-3241. Upper end of island; Amazon, four miles above Santarem. Dec. 9, 1909.  
 Coll. No. 3242. Tapajos: in hollow logs in Amazon, one mile above Santarem. Dec. 10, 1909.  
 Coll. Nos. 3256-3271, 3307-3308. Igarapé de Jaura, entering Rio Tapajos, two miles above Santarem. Dec. 11, 19, 1909.  
 Coll. Nos. 3243-3355. Igarapé de Maica, four miles below Santarem. Dec. 12, 1909.  
 Coll. No. 3272. Tapajos in front of Santarem. Dec. 14, 1909.  
 Coll. Nos. 3273-3306. Island in Amazon, three miles above Santarem. Dec. 15, 1909.  
 Coll. Nos. 3324-3325. Rio Tapajos at Santarem. Dec. 20, 1909.
132. Amazon.  
 Coll. Nos. 3309-3310. Half-way between Santarem and Para. Dec. 21, 1909.  
 Coll. Nos. 3311-3323. Para market. Dec. 24, 1909.  
 Coll. Nos. 3326-3351. From Gran Para, between Belem and Salinas. Dec. 27, 1909.  
 Coll. Nos. 3402-3403. Jan. 4, 1910.  
 Coll. Nos. 3412-3443, 3451-3499. Market. Jan. 15-22, 1910.
133. Bragança, Rio Caete, 16 kilometers from ocean, 162 from Para.  
 Coll. Nos. 3352-3365. Igarapé in Bragança. Dec. 29, 1909.  
 Coll. Nos. 3366-3400. Salt water, mouth of Rio Caete. Jan. 1, 1910.

134. Alcobaca, Tocantins.

Coll. Nos. 3344-3450. Below first falls.

Jan. 10, 1910.

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XVII. DESCRIPTIONS OF SOME NEW SPECIES OF FISHES  
AND MISCELLANEOUS NOTES ON OTHERS OBTAINED  
DURING THE EXPEDITION OF THE CARNEGIE  
MUSEUM TO CENTRAL SOUTH AMERICA.

BY JOHN D. HASEMAN.<sup>1</sup>

Some of the species of the *Pygidiidæ* called "Candiru" are said to live as parasites in the branchial cavities of the larger siluroids. In fact they attach themselves to any kind of fish or animal, including man. By means of suction, for which their mouths are adapted, they fasten themselves to their victim, and then painlessly cut the skin, and gorge themselves upon its blood. The fishes brought into the market at Manaus often show many wounds inflicted by the Candirus. Below the first fall in the Madeira River it is difficult to take a catfish which has not been bitten several times by the Candirus. In a creek called Igarape Irura, near Santarem, I collected four hundred specimens of Candirus (*Stegophilus*) buried in the sand. They are minute and could be seen by the millions in this locality, where the water was too shallow to permit the presence of large fishes of any kind. The fishes belonging to the genus *Vandellia*, as well as to other genera of the *Pygidiidæ*, lie buried in sand-bars, and I have often seen them when disturbed rise like a flash and bury themselves again in an instant, leaving a small round hole where they re-entered the sand.

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*Geophagus brasiliensis* and *surinamensis* have been found in brackish water. I saw one individual of *G. brasiliensis* taken from the sea near Santos. Near Iguapé I put specimens of *Acestrorhynchus hepsetus*, *Geophagus brasiliensis*, *Astyanax rutilus*, *Hoplias malabaricus*, and *Pæcilia vivipara* into sea-water. Naturally the pæcilids were not affected. They normally live in both salt and fresh water. *Acestrorhynchus* and *Hoplias* died in a short time. *Astyanax rutilus* lived for about an hour. *G. brasiliensis* was at first somewhat restless and

<sup>1</sup>This is the third paper relating to the Expedition of the Carnegie Museum to Central South America.

puffed up, but later on it did not appear to suffer from the sudden change from fresh to salt water. It lived several hours in a bucket of sea-water.

**Electrophorus electricus** (Purakee).

I have often seen electric eels along the rocky ledges of the Guaporé, Marmoré, and upper Madeira Rivers, coming to the surface and emitting air. This was observed in the morning and evening. They rise almost vertically and begin making large air-bubbles before their snouts protrude from the water. They delay only an instant before descending again.

An Indian shot a specimen five feet long with an arrow, and I swam in after it. I pulled it to the sandy margin of the river and while it was still covered with water I passed my hand three times over the entire body of the dying eel. The shock I felt was acute, but far from being a stunning blow. While I was removing it from the water and putting it into a dip-net made of copper wire it wriggled against the wire, and I received all of its voltage and fell helpless on the moist sand. A series of terrible shocks continued so long as the eel remained on my bare legs and I could not let go of the dip-net. The Indian relieved me by pulling the eel away by means of the arrow, which still remained in its head. I never saw a fish killed by an electric eel, and I do not believe that they are capable of doing this in a river. The shock appears to be only a protection.

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*Pimelodella transitoria* (Mir. Rib.) is a synonym of *Pimelodella lateristriga*.

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**Lophiosilurus alexandri** Steindachner.

- No. 2881. One specimen, 6.5 cm. long. Cidade da Barra, Bahia, Rio São Francisco, Dec. 6, 1907.  
" 2878. One specimen, 20.5 cm. long. Joazeiro, Bahia, Rio São Francisco, Nov. 28, 1907.  
" 2879. One specimen, 28.5 cm. long. Penedo, Alagoas, Rio São Francisco, below Paulo Affonso Falls, March 20, 1908.

This species, well represented by the three specimens cataloged above, is peculiar to the basin of the Rio São Francisco.

## CEPHALOSILURUS, gen. nov.

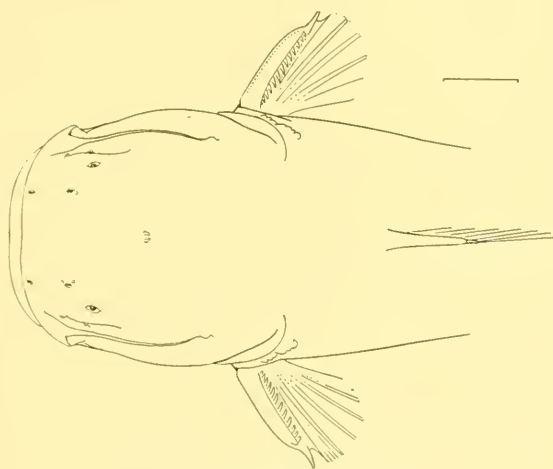
Head large, not as flattened as in *Lophiosilurus*; lower jaw slightly protruding; dorsal and adipose fins well developed and high; occipital crest not exposed as a triangular shield, with a narrow bony stay to the base of the dorsal; otherwise like *Lophiosilurus*.

**Cephalosilurus fowleri** sp. nov.

(Plate XLVI.)

*Type* (unique).—No. 2880. 310 mm.<sup>2</sup> Cidade da Barra, Bahia, Rio São Francisco, Feb. 25, 1907.

Locally known as Pocoma. Larger, more slender, and less compressed than *Lophiosilurus alexandri* Steindachner. The lower jaw does not protrude so much and the barbels are twice as long. The dorsal

FIG. 1. *Cephalosilurus fowleri*.

and adipose fins are twice as high and without triangular bony ridges on the head, as in *Lophiosilurus alexandri*. D. I. 6; A. 8; P. I. 6; head 3.16 in the length of the body, longer than broad; depth at the origin of the dorsal 5.5 in the length; longest dorsal rays one-half as long as the head; pectoral spine two-thirds the length of the head, both margins with teeth; eyes small without distinctly free margins; mouth

<sup>2</sup> The measurements of length given in the text are to base of caudal. On plates the full length is generally given.

large; a broad band of teeth in each jaw; postmental barbels about one-half as long as the maxillary barbels, which extend to the gill-cleft; gill-membranes separate, and joined only to the front edge of the isthmus, as in *Lophiosilurus*; head covered with skin, without exposed bony ridges; occipital process extending to the dorsal plate; lateral-line organs well developed, as in *Lophiosilurus*; the anterior portion of the body depressed and the caudal portion compressed; the caudal round; the skin on the dorsal and lateral sides covered with papillæ and short hair-like projections; the color above and below brown; many black spots on the sides, back, and fins.

I take pleasure in dedicating this species to Mr. H. W. Fowler.

***Imparfinis mirini*, sp. nov.**

(Plate XLVII.)

*Type*.—No. 2981. 8.3 cm. long. Near Piracicaba above the falls of the Rio Piracicaba-mirini, September 7, 1908.

*Cotypes*.—Nos. 2982 *a-d*; 5-7 cm. long. From same place, taken at same date.

*Cotypes*.—Nos. 2983 *a-c*; 5.5-7 cm. long. Same place and date, but from below the falls, which are twenty feet high.

A. 10; D. I. 6; head about 5; depth 6; eye 2.5 in snout, 2 in the interorbital space, 5 to 6 in the head; caudal portion of body compressed; head conical, being almost as deep as wide, and two-thirds as wide as long. No free orbital margin; weak dorsal and pectoral spines with soft tips; mental barbels extending almost to base, and postmentals slightly past base, of pectorals; maxillary barbels to, or beyond, the tip of pectorals; ventrals inserted below the middle of dorsal; practically no dorsal plate and very minute occipital process; the adipose is longer than the anal and equals the distance between the dorsal and adipose; caudal forked; color almost uniform light brown, with some dark edges on fins. Two specimens have bases of caudal black and some indistinct blotches on the back. This species is easily distinguished from *Imparfinis piperatus* by its conical instead of depressed head.

This species lives under stones in rapids.

*Imparfinis transfasciatus* (Ribeiro) and *Rhamdiaglanis frenatus* (R. Von Ihering) are synonyms of *Imparfinis piperatus*.

I have examined the types of all of these species.



**Bunocephalus depressus**, sp. nov.

(Plate XLVIII, fig. 1; Plate XLIX.)

*Type* (unique).—No. 2984. 5.5 cm. Rio Machupo, near San Joaquin, Bolivia, September 6, 1909.

D. 5; A. 11; P. 1. 4; C. 9; distance from tip of snout to base of dorsal goes 2.8 in length of body; maxillary barbels extending slightly past base of pectorals, and postmentals extending to the gill-opening; pectoral spine with hooks on both margins about as long as the width of the spine; spine equal to the distance from the tip of snout to the base of the pectorals; head gently depressed, with no prominent knobs; eyes small and about one-third of the interorbital space, which is equal to the length of the snout; mouth small, upper jaw longer than the lower, snout rather pointed; width at base of pectorals greater than the length of the head and one-fourth of the length of the body, greatest depth one-eleventh the length of the body; coracoid process shorter than the humeral process, neither of which is very long; no warts or papillæ on the skin; uniform light brown in color, about six minute dark spots or pores along the sides.

This species is easily recognized by its greatly depressed body, the eleven anal rays, and by the long post-dorsal portion of the body.

**ACESTRIDIUM**, gen. nov.

Tip of snout expanded, disc-like, and provided with long spines; D. 7; all of scutes provided with many series of delicate spiny ridges and depressions. Otherwise like *Farlowella*.

**Acestridium discus**, sp. nov.

(Plate L, fig. 1; Plate LI.)

*Type*.—No. 2985. 7.2 cm. over all. Igarapé de Cachoeira Grande, near Manaus, Brazil, Nov. 30, 1909.

*Cotypes*.—No. 2986, a-b, 6 and 5 cm. Same place and date as type.

Tail posteriorly depressed, with a single series of plates on the sides; dorsal fin inserted over the anal; no adipose; abdomen without a median series of plates; upper angle of gill-opening slightly nearer the origin of dorsal than the tip of the snout; length of the produced snout about 4 in the distance from its tip to the anus; tip of snout with an expanded spiny disc; eye 4 in interorbital; head 3.5 in body; breadth of head 3.5 in its length; all scutes with many delicate keels; D. 7;



A. .5; twenty-five to twenty-seven lateral scutes; five scutes between the supra-occipital and the dorsal plate, color light brown, with a few indistinct spots on the fins and a faint band back of the eyes.

This species is easily recognized by the expanded snout and many delicate keel-like ridges on the scutes.

All the specimens were collected in a grassy, cool, shady, swampy creek known as Igarapé de Cachoeira Grande, near Manaus, November 30, 1909.

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PLATYSILURUS, gen. nov.

Teeth all alike, and those on the vomer in two patches; upper jaw slightly longer, head more or less conical, not greatly depressed; fontanel continued behind the eyes as a deep groove, which is continued into the dorsal plate, which is firmly joined to the occipital process; snout rather long and somewhat pointed; head almost twice as long as broad; caudal deeply forked, the lower lobe broader and longer; a bony process back of upper angle of gill-opening ending in a few roughened plates on the anterior part of the lateral line.

The single species of this genus resembles *Platystomatichthys sturio* in nearly all details, excepting the stronger dorsal and pectoral spines, the much shorter and less pointed snout, and the larger eyes.

**Platysilurus barbatus**, sp. nov.

*Type*.—No. 2987. 17.5 cm. São Antonio de Rio Madeira, Nov. 3, 1909.

*Cotypes*.—Nos. 2988 *a-c*. 9.5–12.5 cm. Rio Machupó, near San Joaquin, Bolivia, September 6, 1909.

D. .6; A. 11; P. .9; head 3.33; depth at origin of dorsal 6; first rays of anal three times as long as the last; adipose of greater extent than the anal, and about equal to the distance between it and the last dorsal ray, two and a half times as long as high; caudal peduncle short and almost round; pectoral spine longer than the dorsal, three-fourths as long as the head and denticulated on both margins; dorsal spine denticulated on the posterior margin; eye 6 in head, about 3 in the snout, 1.25 in the interorbital space; humeral process rather short and spine-like; maxillary barbel three times as long as the body, its proximal part wire-like; post-mentals extend to middle of pectoral; lower caudal lobe fully one-third as long as the body; head broader than deep; snout tapered and sub-conical; top of head bony and

striated; upper part of sides dusky, with a large dark median lateral spot below the dorsal, and five or six smaller round black spots about the size of the eye along either side of the adipose and the upper caudal lobe; ventral side white; lower caudal lobe black.

The cotypes are less highly colored and have shorter maxillary barbels.

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*Kronichthys subteres* (Ribeira) is a synonym of *Hemipsilichthys gobio* (Lütken).

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*Dysichthys australe* Eigenmann is a synonym of *Bunocephalus rugosus*. They have three pairs of barbels and are identical in all other details. *Dysichthys australe*, as well as Cope's *Dysichthys coracoideus*, are based on small specimens in which the mental barbels are very small and were overlooked. As the specimens grow the mental barbels increase considerably. I have examined the type of *Dysichthys coracoideus* (Cope). It has three pairs of barbels, and I consider it the same as *Bunocephalus bicolor*.

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I was unable to find any differences between the fishes known by the natives as "Jahu" found in the upper affluents of the Rio de la Plata and those found in the various falls of the Rio Madeira. Specimens less than two feet in length are, as a rule, more or less spotted, and have a velvety yellowish color, while the large adults are almost black in color and are nearly always found in and below waterfalls. Medium-sized and young specimens are oftener found in deep water some distance below waterfalls. Hence *Platystoma lütkeni* Steindachner and *Paulacea jahu* Von Ihering should stand as *Paulacea lütkeni* (Steindachner).

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There are some individual and local variations in the genus *Salminus*, and the young are somewhat different from the adults; but I am unable to draw any distinction between the various species described from the São Francisco, Rio Grande do Sul, and the La Plata basins. Hence I consider all of the species to be *Salminus hilarii*. The genus is not found in the Amazon basin and I doubt if *Salminus affinis* (Steindachner) belongs to this genus.

I have not seen any specimens of *Phreatobius cisternarum* (Gœldi), but from the description and the habitat assigned I am inclined to believe that it is a very small *Pygidium amazonicum* (Steindachner).

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#### THE BREEDING HABITS OF THE GEOPHAGINÆ.

The *Geophaginæ* have a lobe on the upper branch of the first gill-arch, which is supposed to be associated with the retention of the eggs during the period of incubation. The lobe exists, but it is not used to secure the eggs. I found the eggs of *Geophagus brasiliensis* in the Rio Itapicurú. They were placed in nests similar to those of the North American sun-fishes. The eggs of all the species of this genus are small and numerous, in great contrast to those of species which carry their eggs in the mouth. I took eggs out of the mouth of *Tachysurus barbatus*, but these eggs were one-fourth to one-half of an inch in diameter, and were contained loosely in the mouth. Besides, I did not see more than about twelve eggs in any one mouth; however, I was told that as many as two dozen are found in large individuals. *Osteoglossum bicirrhosum* also retains its eggs loosely in a pouch-like depression formed by the elastic skin which connects the bones of the lower jaw. But its eggs are few (less than two dozen) and about one-fourth of an inch in diameter.

I found one specimen of *Geophagus brasiliensis* which had a peculiarly tuberculated first gill-arch. It appeared to have eggs imbedded between the gill-rakers, but the egg-like structures were abnormal growths. Many species of *Geophagus* protect their young in their mouths. In the Rio Jacuhy I saw many young *Geophagus gymno-genys* swimming about a medium-sized female along a sand-bar. When I attempted to catch them, they nearly all disappeared in the mouth of the mother. When I retreated I saw the young swimming about the mother again. I could not have been deceived, because there were no stones and grass in which they could hide and they do not bury in hard sand. After observing them for some time, I netted the mother, and found her mouth entirely full of young fishes of the same size as those seen swimming about. She began to eject the young as soon as she was out of the water. I have found eggs in the mouths of various families of fishes, but these eggs either came from ripe ovaries placed in the killing-bucket or were being eaten or were sucked in during the respiratory process a short time before

the specimens were killed, I saw no specimens of *Geophagina* in which the mouth-cavity was used to incubate the eggs, and I observed a very large number of specimens.<sup>3</sup>

**Typhobagrus kronei** (Ribeiro).

In every character these blind cat-fishes agree with *Pimelodella lateristriga*, except that their eyes appear to have been gouged out, the sockets having been retained.

D. I. 6; A. 12; depth about half the length of the head, which is not quite one-fourth the length of the body; pectoral spine with ten teeth, which are about one-half the width of the spine; snout not pro-

<sup>3</sup>In view of what Mr. Haseman says the following quotations concerning the breeding-habits of American *Geophagina* will be of interest:

Castelnau says of *Retroculus lapidifera*, "Au lieu de l'abandonner au sien des eaux, ce qui est le cas presque universel des poissons, celui-ci porte une à une dans sa bouche et à une assez grande distance sur le rivage de petites pierres dont il forme un lit dans lequel il dépose des œufs."

Hensel writes as follows (*Wiegmann's Archiv für Naturgeschichte*, 1868, 669): "Die Gattung *Geophagus* ist durch höchst merkwürdige Eigenthümlichkeiten in ihrer Brutpflege bekannt, und zwar scheint es das männliche Geschlecht zu sein, welches sich durch eine besondere Aufmerksamkeit für die Brut auszeichnet. Ich habe Gelegenheit gehabt, ähnliches auch bei *G. scymnophilus* zu beobachten. Leider war der Sommer schon zu weit vorgerückt (December), um das Laichen selbst zu sehen. Ich muss es daher unentschieden lassen, ob der Fisch ein besonderes Nest baut, oder ob er die Eier in der Mundhöhle ausbrütet. Dagegen gelang es mir sehr häufig, die Sorgfalt zu beobachten, mit welcher das Thier, wahrscheinlich das Männchen, die Jungen beschützt und leitet. Zu der Zeit, in welcher diese noch sehr klein sind, hält sich der alte Fisch in den seichten Gebirgsbächen auf, wo das Wasser hell und rein über die Geschiebe dahin fließt, und wo er auch wahrscheinlich laicht. Hier nun findet man ihn an besonders flachen Stellen in der Nähe des Ufers, wo das Wasser durch locale Hindernisse aufgehalten, ganz ruhig erscheint, wo die Steine mit grünen Algen überzogen sind, und der Boden reichlich mit Schlamm bedeckt ist. Hier schwimmt die Heerde der Jungen vielleicht aus 20-30 Stück bestehend sorglos umher, während der Alte in einer Entfernung vorsichtig Wache hält. Zeigt sich nun irgend eine Gefahr z. B. ein plötzlich herantretender Mensch, so erscheint der Alte schnell unter der Heerde und giebt ihr wahrscheinlich ein Zeichen. Alle Jungen versammeln sich wie auf Commando an dem Maule des Alten, das sie wie ein Bart umgeben, blitzschnell verschwinden sie alle zusammen in ihm, und ehe man es hindern kann, hat sich der Alte weit mit ihnen entfernt. Behält man ihn im Auge, so sieht man wie er bald eine Stelle, ähnlich der verlassenen aufsucht und hier seine Jungen aus ihrem Gewahrsam wieder entlässt.

"Hat man den Fisch von weitem beobachtet, was bei der Klarheit des Wassers

duced; teeth in two bands of about equal width in each jaw; maxillary barbels not extending to the adipose; post-mental barbels extending beyond base of pectoral, and mental barbels not reaching the base of pectorals; dorsal spine slightly nearer to the tip of the snout than to the origin of the anal; dorsal spine about half the length of the head,

leicht ist, so gelingt es nicht selten durch Vorsicht so nahe heran zu kommen, dass man durch schnelles Zufahren, mit einem Netz z. B., zwischen den Alten und seine Jungen gelangt, und diese in der Bucht isolirt. Sie schwimmen dann in einen Haufen zusammengedrängt in dem kleinen, ihnen übrig gebliebenen Raume hin und her und harren der Hilfe des Alten, während dieser ausserhalb unruhig auf eine Lücke lauert, durch die er seine Jungen entführen kann. Er vollführt das so schnell und vorsichtig, dass es mir trotz aller Mühe niemals gelungen ist, ihn mit den Jungen im Maule durch das Netz zu fangen. Erst dadurch, dass auf seiner Flucht dicht neben ihn ein starker Schuss in's Wasser abgefeuert und er auf diese Weise getödtet oder betäubt wurde, gelang es mir ein Exemplar mit der Brut in der Mundhöhle zu erhalten. Die Jungen liegen darin dicht gedrängt, mit den Köpfen nach den Kiemen hin gerichtet."

Von Ihering (*Die Süßwasser-fische von Rio Grande do Sul*, 1893, 61) adds: "Ein grosses Exemplar des *Geophagus brasiliensis* beobachtete ich bei Pedras Brancas, wie es über seinem als eine flache Grube in ca. 1½ Meter tiefem Wasser in dem Boden gearbeiteten Neste Wache hielt, ohne sich vertreiben zu lassen. Doch gelang es nicht ihn zu fangen, und bleibt es zu untersuchen, ob es das Weibchen ist, welches die Brut pflegt. Beim Bagre sind es beide Geschlechter."

Mrs. Agassiz says (*A Journey in Brazil*, 1893, 241) of some species of this sub-family: "These specimens furnished a complete embryological series, some of them having their eggs at the back of the gills, between the upper pharyngeals and the branchial arches, others their young in the mouth in different stages of development, up to those a quarter of an inch long and able to swim about, full of life and activity, when removed from the gills and placed in water. The most advanced were always found outside of the gills, within the cavity formed by the gill-covers and the wide branchiostegal membrane. In examining these fishes Mr. Agassiz has found that a special lobe of the brain, similar to those of the *Triglas*, sends large nerves to that part of the gills which protects the young, thus connecting the care of the offspring with the organ of intelligence. The specimens of this morning seem to invalidate the statement of the fishermen, that the young, though often found in the mouth of the parent, are not actually developed there, but laid and hatched in the sand. The series, in these specimens, was too complete to leave any doubt that in this species at least the whole process of development is begun and completed in the gill-cavity."

I am told, though I have not been able to verify the statement, that the habit of entering and leaving the mouth on the part of some American *Geophaginae* has been observed and photographed in some of the European aquaria. Attention may be called to the often recorded observation that eggs are carried in the mouths of African Cichlids. Such an incident is figured by Pellegrin in the work used by Mr. Haseman while preparing this paper.—CARL H. EIGENMANN.

with teeth on the front edge of its tip; caudal deeply lobed, the upper lobe the longer, about one-fourth the length of the body; the depth of the caudal peduncle not quite one-third the length of the head; usually a dark band along the sides; tips of the dorsal fin sometimes dark. In some specimens the head is more depressed than in others, and the band of teeth in the lower jaw is relatively wider. Nearly all specimens have pits under the head. The sense of touch is acute, and they swim away rapidly when disturbed.

The exit of the cave in which they were found is stopped up, and the water spurts up through the sand and rocks like a fountain. The cave has a break in its roof quite like that at the Twin Cave, Mitchell, Indiana, differing in that there are high mountains on all sides. The mouth or exit of this cavern appears to have been stopped up for a long time. The overhanging roof and cliff have caved in. This blind cat-fish has been known for a long time to the inhabitants of Iporanga under the name of "Ceguinho." They eat them. *Pimelodella lateristriga* is called "Mandy-tinga." The blind cat-fish is said to occur in only one of the forty or more caves of this region.

The erection of a new genus for the reception of this fish, which is indistinguishable from *Pimelodella lateristriga* except by the loss of the power of vision, does not appear to me to be proper. In my judgment it should be designated as *Pimelodella lateristriga* var. *kronoi*.

#### A BLIND *Aglea intermedia* AND ITS ORIGIN.

On December 27, 1908, I collected specimens of *Aglea intermedia* in a cave called Caverna das Areas. It is near Agua Quente on the Atlantic slope of the Serra do Mar, in the upper course of the Rio Ribeira da Iguapé. The specimens were taken near the origin of the left branch of the cave, about two miles above the break in its roof, and almost seven miles from the exit of the cave which is known as Bombas. There are several sink-holes entering this cave, but they are all high up in the mountains.

I have refrained from describing these crabs as new, even though they can easily be distinguished from the parent form, which lives outside of the cavern. They have almost lost the natural bluish tinge, have more hair and longer antennæ, fewer spines on the carapace, and the black part of the lens is reduced to about one-fourth of its original size. In life they showed no sign of being able to see.

I took six specimens. I took one small specimen, but my guide let it escape before I had an opportunity to narrowly examine it. They were rare, and were seen in only one place. They had never been observed by the natives in any of the caves.

The parent crab of the cave form is apparently no better adapted to and does not avoid the sunlight any more than any other fresh-water Brazilian crab. I caught this species of crab along with two others and three species of fishes in the entrance of another cave, but they were not beyond the reach of direct sunlight.

I cannot explain the origin of *Typhlobagrus kronei* and of these blind crabs in any other way than through accident. The ancestors of both these forms are known, and are living on the outside of the caves.

I have entered many caves in Cuba, the United States, and in Brazil, and I think that Lankester's view of cave-life has more to support it in nature than the view expressed by Dr. Eigenmann in his book on cave vertebrates. On page 12 Eigenmann states that in view of the fact that six or seven of the eight known *Amblyopsidæ* are cave-dwellers and only one other species of the numerous North American fishes lives in caves, the Lankester accident theory is absurd.<sup>4</sup>

<sup>4</sup>I do not comprehend Mr. Haseman's mental attitude. He certainly did not read with any care what I published. Concerning Lankester's accident theory of the origin of cave animals, I say (*Cave Vertebrates of America*, 1909, 12):

"While this is a possible mode of origin of cave-animals, and even of blind ones, it is highly improbable that many, or even any, animals depending, as he supposes, on their eyes, have come to first colonize the cave. Fishes are annually swept into caves, but these are not able to permanently establish themselves in them. To do this the fish must have peculiar habits, special methods of feeding and mating, before an accidental colonization can become successful, and if they are so adapted for a cave existence, they would probably voluntarily colonize the caves, without waiting for an accident. The *Amblyopsidæ* are a small family of fishes, eight species being known. They form a very small part of the large fish-fauna about the North American caves. But since six, possibly seven, of the species of this family are cave-dwellers, and only one of the numerous other fishes is permanently at home in the caves, we must suppose, if the theory under consideration is the correct one, that the accident of being carried into the caves happened to six or seven out of the *Amblyopsidæ*, and to only one of all the other fishes about the caves. The absurdity of this supposition is self-evident." Again, on p. 15: "It must also be evident that a fish depending on its sight to procure its food can never become a cave form. Sun-fishes, which are annually carried into the present fully developed caves, belong to this class of fishes. They are always poor when found in the caves, and will never be able to establish themselves in them. On the other hand, there is no reason why fishes detecting the prey either by smell (or taste) or touch



But Eigenmann's view is more absurd and faulty in explaining the absence of blind fishes in the numerous caves of eastern Greene County, Indiana, which are drained by the west fork of White River. At any rate the blind cat-fish and the crab with reduced eyes found in Brazil must either have been stopped up in the entrance of the cave when the overhanging roof fell, or have been washed in accidentally through some sink-hole and have been unable to get out. I do not doubt that other forms have likewise been either washed in or stopped up in the same cave, but they have either found their way out, or have been exterminated. If the cat-fish voluntarily entered the cave it is surprising that it has not also entered the caves of Sete Lagoas, Minas, Santa Abreu, Bahia, and the numerous other caves of the Iporanga district. In the upper course of the Paraguay I caught *Rhamdia quelen* and *Characidium fasciatum* in the entrance of a cave; but where there is and always has been an easy exit, they find their way out and no blind forms are found.

The condition of the blind crab and blind fish leads one to infer that they have not been relatively long dwellers in that cave. The age of this part of Brazil leads one to infer that these caves are very old, but until erosion had played its part they would not have been accessible to aquatic forms.

The idea that cave forms originally lived under rocks, or avoided light and were thus prepared for cave-life does not find any support in the Brazilian blind fish. The majority of mailed cat-fishes and *Pygidiidæ* are found under cover during the day, while the parent of the blind cat-fish lives as much in the open as any cat-fish, and seems to prefer the grassy margin of the streams. It has very sharp pectoral spines, which inflict painful wounds, and does not need to hide.

It appears to be nothing more than a rapid specific adaptation that has enabled the *Aglea intermedia* with reduced eyes and *Typhlobagrus kronei* to be able to exist in the cave, while the other forms, which might have entered the cave at the same time by accident, have been exterminated.

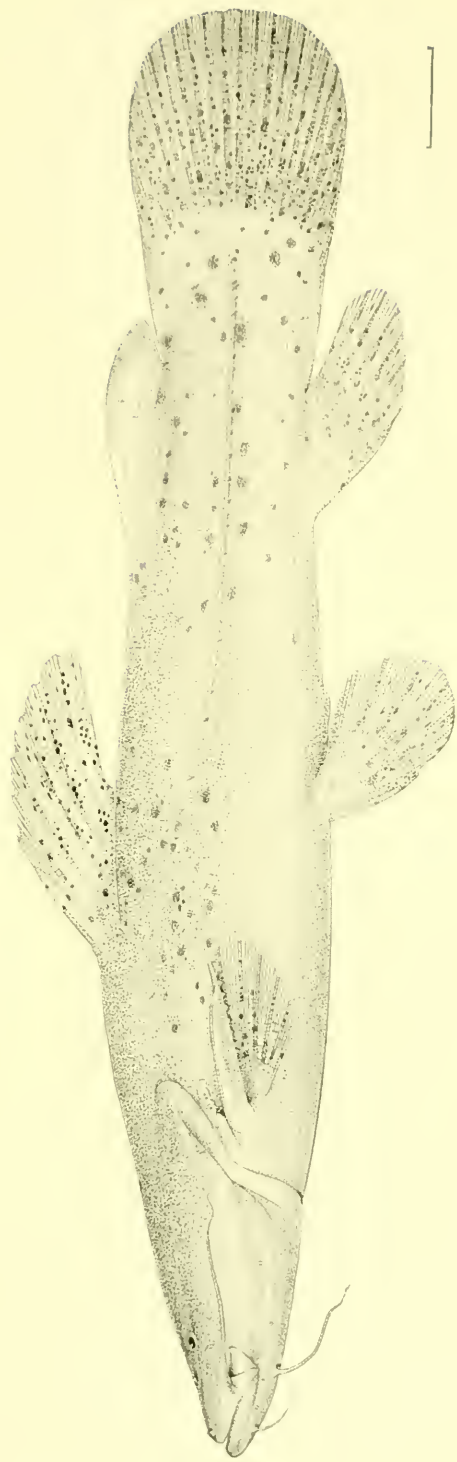
should not be capable of colonizing caves. The cat-fishes and *Amblyopsidæ* belong to the latter class. *It is surprising that more cat-fishes have not established themselves in caves.*"

It must be evident from the above that it is no surprise to me that this cat-fish is found in the caves. Whether it was carried in by accident or not is of no consequence. Its long barbels and the peculiar taste organs of cat-fishes put it among the possible candidates for cave-existence.—C. H. EIGENMANN.

It is generally accepted that Cuba once had surface streams which later became subterranean. The Twin Caves at Mitchell, Indiana, are formed by a cave-in of a part of the roof which formerly covered a continuous underground stream. A similar cave-in has taken place in the case of the Caverna dos Areas, near Iporanga, Brazil, which in addition has its exit stopped up by large rocks and other débris. In fact all of the caves in which blind fishes have been found show abundance of evidence that radical transformations have taken place in their channels during bygone days; while caves like those of Santo Abreu Bahía, of São Luiz de Cáceres and Coimbra, Matto Grosso, San Matias, Bolivia, Cavernas do Lagoa Santa, etc., of Minas Geraes, Gruta de Alambary, Gruto do Monjolinho, Gruta da Arataca, etc., of Iporanga, Brazil, and the numerous caves of eastern Greene County, Indiana, appear to have sufficient food and other favorable conditions for blind fishes, but none of these caves exhibit any signs of radical changes in their channels. Hence it appears that all caves which have had unobstructed channels and mouths with ready exits and entrances have no blind fishes.

In view of these facts it appears that the "accident theory" is the most probable explanation of the origin of blind fishes in the caves.

I think that the Iporanga cave region would be the most fruitful place in the world for experimental and cave exploration work, because of the favorable climatic conditions, the extensive caves almost unknown, and the present state of its existing life.



*Cephalostilurus fowleri* Haseman. Type. 495 mm. C. M. Cat. No. 2880.





*Imbarfuis mirini* Haseman. Type, 100 mm. C. M. Cat. No. 2981.





1. *Bunocephalus depressus* Haseman. Type, 65 mm. C. M. Cat. No. 2984.  
2. *Imparfinis hollandi* Haseman. Type, 230 mm. to base caudal. C. M. Cat. No. 2864.

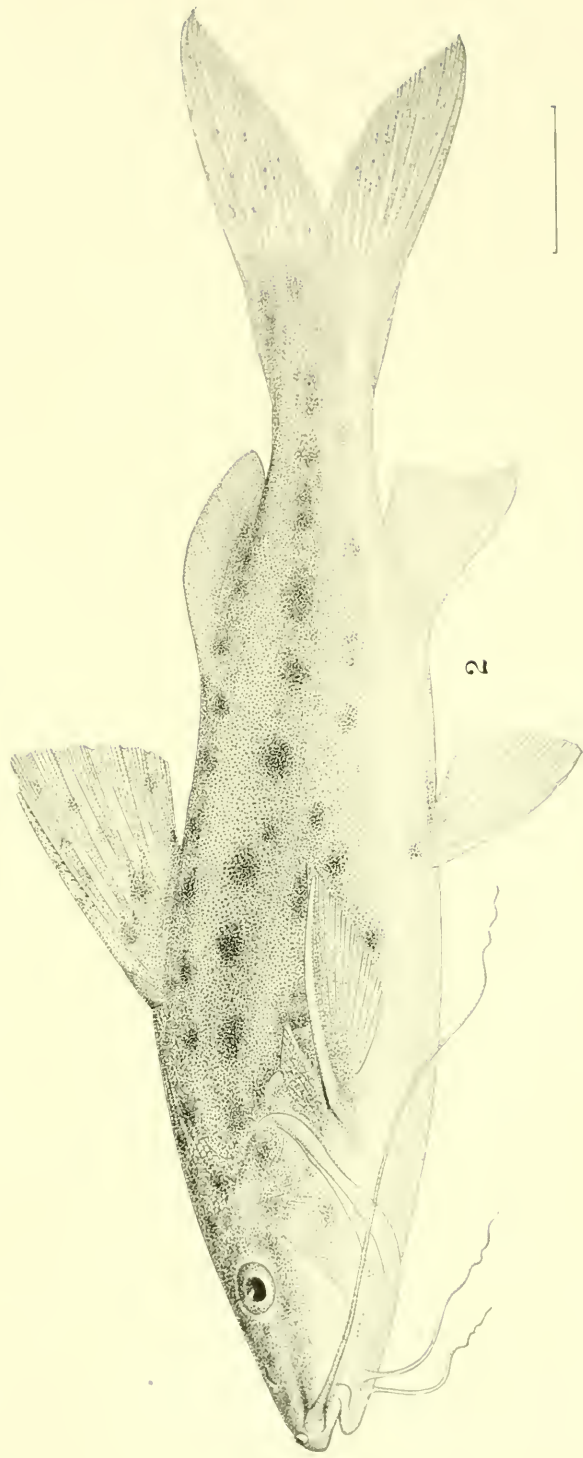






*Bunococephalus depressus* Haseman. Entire length 43 mm. C. M. Cat. No. 2084.





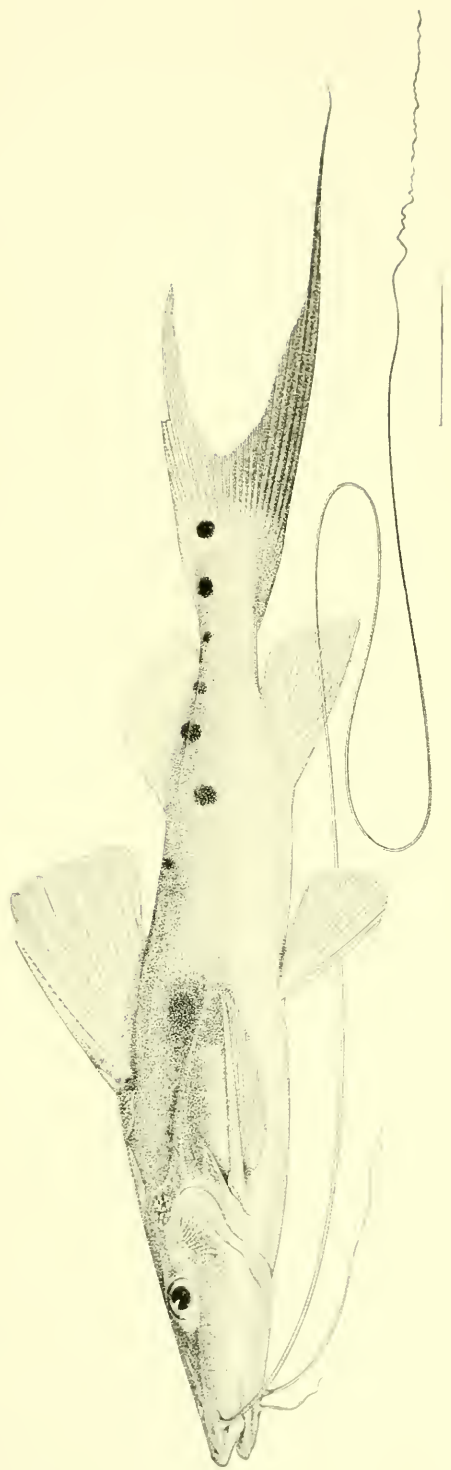
1. *Acestridium discus* Haseman. Type. 72 mm. C. M. No. 2985.  
2. *Pimelodus ortmanni* Haseman. Type. 163 mm. C. M. No. 2857.





Dorsal and ventral views of head of *Acetridium discus* Haseman.





*Platytilurus barbatus* Haseman. Type. 231 mm. C. M. Cat. No. 2987.





XVIII. AN ANNOTATED CATALOG OF THE CICHLID  
FISHES COLLECTED BY THE EXPEDITION OF THE  
CARNEGIE MUSEUM TO CENTRAL SOUTH  
AMERICA, 1907-10.

By JOHN D. HASEMAN,<sup>1</sup>

During the last three years I had opportunity to examine most of the cichlids herein recorded from the basin of the Amazon, and from the principal rivers south and east of that basin. Owing in part to the lack of sufficient material, many species in the past have been founded on trivial characters. After studying such carefully both in the field and in the laboratory, I have relegated several of them to synonymy. Seventy-nine species are here recognized, of which I myself collected sixty-six. Both Pellegrin<sup>2</sup> and Regan<sup>3</sup> have dealt in detail with the American *Cichlidæ*. I have accepted the conclusions of Regan, unless otherwise stated in the text.

My thanks are due to Dr. C. H. Eigenmann, the Curator of Ichthyology at the Carnegie Museum, for the use of the literature, which he placed at my command, and for many valuable suggestions; to Mr. Witmer Stone and Mr. R. W. Fowler for enabling me to examine some of the types of the *Cichlidæ* named by Cope and preserved in the Academy of Natural Sciences of Philadelphia; and to Dr. W. J. Holland, for the opportunity to prepare this paper and for his editorial revision of the manuscript.

The following list contains the description of eleven new species and four new varieties.<sup>4</sup>

<sup>1</sup>This is the fourth paper relating to the Expedition to Central South America published in these ANNALS.

<sup>2</sup>Contribution à l'Étude Anatomique, Biologique, et Taxonomique des Poissons de la Famille des Cichlides, *Memoires Société Zoologique France*, XVI, 1904, 41-402.

<sup>3</sup>*Annals and Magazine of Natural History* (7), XV, 1905, 329-347; XVI, 1905, 60-77, 225-243, 316-340; XVII, 1906, 49-66. *Proceedings of the Zoological Society of London*, 1905, i, 152-168.

<sup>4</sup>Mr. Haseman presents in the following pages a list of the specimens taken at each place, with their lengths, the date of collection, and notes setting forth the character of the specimens of each locality, when they differ from the generalized

## Family CICHLIDÆ.

## Genus CHÆTOBRANCHUS Heckel.

1. *C. flavescens* Heckel.

*Geophagus badiipinnis* Cope.

No specimens were taken on the expedition.

2. *C. semifasciatus* Steindachner.

No specimens were taken by me on my journeys.

## Genus CHÆTOBRANCHOPSIS Steindachner.

3. *C. orbicularis* Steindachner.

No. 2499,<sup>5</sup> 12 cm., Santarem, Dec. 8, 1909.

No. 2500, 10 cm., Belem, Pará, Jan. 22, 1910.

These specimens do not have spots on their sides. They are scarcely distinguishable from the following.

4. *C. australis* Eigenmann and Ward.

No. 2497*a-b*, 6 and 6.5 cm., Campos Alegre, Rio Jauru, June 4, 1909.

No. 2498, 2 cm., Puerto Suarez, Bolivia, May 6, 1909.

The latter specimen has no spots on the cheeks and the vertical fins are spotted.

## Genus CICHLA Bloch and Schneider.

5. *C. ocellaris* Bloch and Schneider.

No. 2502*a-b*, 12 and 16 cm., São Antonio de Guaporé, Rio Guaporé, July 23 and 26, 1909.

No. 2503, 14.5 cm., Santarem, Dec. 12, 1909.

This specimen has D. XVI, 17, and three typical bars.

No. 2504, 25 cm., Manaus, Nov. 17, 1909.

Has D. XVI, 16. No cross-bars, and only two dark spots representing obsolescent cross-bars near the anterior and posterior base of the dorsal fin. Some of the scales in the pectoral region have brown spots.

No. 2505, 19 cm., Manaus, Nov. 17, 1909.

Has spots on the sides.

No. 2506, 5 cm., Villa Bella, Rio Beni, Bolivia, Oct. 5, 1909.

type of each species. It is quite probable that a more critical study of this large amount of material may lead to conclusions at variance with some of those here expressed.—C. H. EIGENMANN, Curator of Fishes.

<sup>5</sup>The numbers preceding the record of length are the numbers given in the Catalog of Fishes of the Carnegie Museum.

*Cichla argus* Valenciennes is a synonym of *C. ocellaris* Bloch and Schneider. *Cichla neiderleini* and *C. chacoënsis* Holmberg (1891) are synonyms of some species of *Crenicichla*. The genus *Cichla* is not found in the basin of the Rio de la Plata.

6. **C. temensis** Humboldt.

No. 2507*a-b*: *a*, 19.5 cm.; *b*, 16 cm.; Manaos, Nov. 15 and 17, 1909.

The specimen numbered 2507*b* has A. II, 10; D. XV, 16, and no distinct bars on the sides.

Genus UARU Heckel.

7. **U. amphiacanthoides** Heckel.

No. 2507, 12 cm., Manaos, Nov. 16, 1909.

8. **U. imperialis** (Steindachner).

*Habitat*.—Amazon near Rio Negro.

No specimens were taken by the expedition of the Carnegie Museum.

Genus ACAROPSIS Steindachner.

9. **A. nassa** (Heckel).

Nos. 2508*a-e*, 2.5–10 cm., Bastos, Rio Alegre, June 26, 1909.

Nos. 2509*a-b*, 5 cm., São Antonio de Guaporé, Rio Guaporé, July 28 and Aug. 3, 1909.

Nos. 2510*a-b*, 10 cm., Santarem, Dec. 11, 1909.

Nos. 2511*a-b*, 12.5 cm., Manaos, Nov. 27 and 29, 1909.

Genus ASTRONOTUS Swainson.

10. **A. ocellatus** (Agassiz).

*A. hypostictus* Cope.

Nos. 2512*a-c*, 12–17.3 cm., São Antonio de Guaporé, July 23–Aug. 11, 1909.

Nos. 2513*a-b*, 13 and 19 cm., Campos Alegre, Rio Jauru, June 4, 1909.

Nos. 2514*a-b*, 12 and 13.5 cm., Manaos, Nov. 15, 1909.

One of these specimens has nineteen dorsal and fourteen anal rays, six rows of scales on the cheeks, and thirty-one scales in a row below the lateral line.

The native name applied by the Guarani to this species is "Carauusu."

11. **A. ocellatus zebra** Pellegrin.

*Habitat*.—Santarem. No specimens were obtained.

12. **A. orbiculatus**, sp. nov. (Plate LIII.)

No. 2515, *type*, 14 cm., Santarem, Dec. 7, 1909.

No. 2516, *cotype*, 13 cm., same place and date.

D. XII, 22; A. III, 16; eye 4.16 in head, less than the length of the snout and one-half of interorbital space; depth 1.75 to 1.8 in length; six rows of scales on the cheeks; nares nearer the eyes than tip of snout; head 2.8 in length of body; dorsal spines subequal from the fifth, which is slightly more than one-third the length of the head; scales 7-33-16; pores  $\frac{20-21}{13-15}$ ; caudal peduncle one-half as long as deep. Both the specimens on the posterior edge of the operculum have a fringe, which is orange in life and white in spirits, and the fringe has two rows of dark spots in it; there is a similar but smaller blotch above the base of the pectoral; four irregular black bands on the sides, one of which in one of the specimens is broken and forms a large black blotch in the region of the reiflexed tip of the pectoral fin; both have dark spots under the pectoral fin near the origin of the same, and there are large ocellated caudal spots. The lateral bands are broader and fewer and hence there is less orange pigment between the bands than in *A. ocellatus*. The depth of *A. ocellatus* is two or more (more in all of my specimens), while in this species it is not more than 1.8.

Genus *ÆQUIDENS* Eigenmann and Bray.

13. *A. tetramerus* (Heckel).

Nos. 2517*a-c*, 5-6 cm., San Antonio de Guaporé, Rio Guaporé, July 31 and Aug. 3, 1909.

No. 2518, 4 cm., Bastos, Rio Alegre de Guaporé, June 26, 1909.

Of these four specimens, two most closely resemble typical *A. tetramerus*, one in some details resembles *A. guaporensis*, and No. 2518, which comes from the headwaters of the Guaporé, is very much like *A. paraguayensis*, and perhaps should be associated with that species, even though the caudal peduncle is slightly longer. As a rule, *A. tetramerus* grows to be larger than *A. paraguayensis*. No. 2519, 10 cm., Bragança, Pará, in a creek near salt water, Dec. 29, 1909.

No. 2520, 13.5 cm., Santarem, Dec. 11, 1909.

No. 2521, 14 cm., Manaos, Nov. 27, 1909.

No. 2522*a-b*, 4.8 and 9 cm., Corrego de Boa Ventura, headwaters of Rio Alegre, June 16, 1909.

No. 2523, 8.5 cm., San Joaquin, Bolivia, Sept. 4, 1909.

Nos. 2521-2523 do not have two entire rows of scales between the lateral line and the base of the first dorsal rays.

No. 2524, 12.3 cm., Manaus, Nov. 15, 1909.

D. XV, 9; A. III, 8; 3.5-27-8; depth 2.33; head 2.8; eye 3.5; four rows of scales on the checks; folds of the lower lips interrupted; six gill-rakers on lower anterior arch; interorbital space 2.75 in head; preorbital width equal to the diameter of the eye; dorsal and anal fins scaleless; dorsal spines subequal from the fourth, the last one of which is not quite one-half the length of the head; the pectoral fin as long as the head; snout a little longer than the postorbital portion of the head; no distinct bands, bars, or spots, excepting a few spots in the soft dorsal. There is a remarkable difference between specimens from different localities, but intermediate stages exist in the same rivers. There are so many intermediate forms that it appears to a collector that each genus consists of but one variable species. This species was not found in the La Plata basin.

14. **A. centralis** (Holmberg). Reported from Santiago de Estero.

No specimens were obtained by the Expedition of the Carnegie Museum.

15. **A. portalegrensis** (Hensel).

? *Iheros centralis* Holmberg.

No. 2545*a-i*, 8-9 cm., Puerto Suarez, Bolivia, May 6-7, 1909.

One specimen has twelve dorsal rays.

No. 2546*a-b*, 3-8 cm., Arequa, Paraguay, Lake Ipacary, April 8, 1909.

No cross-bars; brown lines composed of spots along the rows of scales below the lateral line.

No. 2547, 9 cm., Sapucay, Paraguay, April 2, 1909.

No. 2548, 4.5 cm., Uruguayana, Rio Uruguay, Feb. 7, 1909.

No. 2549*a-b*, 5 and 7 cm., Sapucay, Paraguay, April 5, 1909.

No. 2550, 9.6 cm., Corrego de Boa Ventura of Rio Barbados, June 16, 1909.

Depth 1.75; the maxillaries not quite extending to the eyes.

No. 993, 6 cm., Puerto Suarez, Bolivia. (Steinbach Coll.)

No. 2552*a-e*, 1.7 to 7.3 cm., Cacequy, Rio Grande do Sul, Jan. 31 and Feb. 1, 1909.

The smaller specimens have only one row of scales on the soft dorsal, and the depth is contained 2.16 times in the length.

No. 2553*a-b*, 1.5-3 cm., Villa Hays, Paraguay, April 11-13, 1909.

No. 2554, 4.5 cm., Campos Alegre, Rio Jauru, June 3, 1909.

Depth is 1.84 of length.

No. 2555a-b, 6.5 and 7.1 cm., São Francisco, Bolivia, Paraguay basin, June 10, 1905.

Depth is respectively 1.84 and 2.16 in the length.

No. 2556a-b, 5.8 and 6.2 cm., Porto Alegre, Rio Grande do Sul, Jan. 19, 1909.

These specimens are identical with the specimens having three anal spines taken in the Rio São Francisco, which I identify as *Cichlasoma bimaculatum*. They were rare and were taken along with the common forms having four anal spines. *Cichlasoma bimaculatum* is the northern form, and as a rule has four anal spines, while *Æquidens portalegrensis* is the southern form and as a rule has three anal spines. I collected only one specimen with four anal spines in the La Plata basin, and I feel sure that it is an aberrant individual of the three-spined form. The only known specimen of *Acara guianensis* (Regan) similarly has but three anal spines. It should be associated with *C. bimaculatum*. Unless I am mistaken in these observations there would seem to be no line of demarcation between the genera *Cichlasoma* and *Æquidens*.

No. 2557a-f, São Luiz de Cáceres, Alto Rio Paraguay, May 24, 1909.

All of these specimens have depths less than 2 in the length.

One has four anal spines, but inasmuch as they were all of the same size and taken at one haul of the net, I feel sure that the four-spined specimen is simply an aberrant form.

No. 2558a-c, 5.5 to 6.5 cm., Salto das Cruzes, Rio Tieté, Sept. 22, 1908.

Two of these specimens have no caudal spots.

No. 2559, 8 cm., San Joaquín, Bolivia (Marmoré basin), Sept. 4, 1909.

No. 2560a-e, 1.6 to 6 cm., Corumba, Rio Paraguay, April 27, 1909.

No. 2561, 2 cm., Urucum Mts., near Corumba, May 2, 1909.

No. 2562, 3 cm., Uruguayana, Rio Uruguay.

This specimen, as well as some others, has the soft dorsal very faintly scaled. This fact, together with some erroneous cases of classification (for instance, the *Æquidens tetramerus* of Eigenmann [*Annals Carnegie Museum*, IV, 1907, 144] has scaled vertical fins, and is thus *Æquidens portalegrensis*), has extended the range of *A. vittata* and *A. tetramerus*, neither of which has been taken in the La Plata basin.

No. 2563, 2.5 cm., Puerto Suarez, Bolivia, May 7, 1909.

The basal halves of soft dorsal and anal, and the entire spinous

dorsal and anal black; only a few spots in the tip of the soft dorsal; head 2.5; depth 1.84; no white line from eye to snout; less than twenty-four scales in median lateral series.

I am inclined to think that *Heros centralis* Holmberg is a synonym of this species.

16. **A. vittatus** (Heckel).

*A. sypsilus* Cope.

No. 2525a-b, 1.6 cm., Manaos, Nov. 30, 1909.

This species was not found in either the Guaporé or Paraguay basins.

I have examined the type of *Acara sypsilus* (Cope). It is a synonym of *A. vittatus*.

17. **A. guaporensis**, sp. nov. (Plate LIV.)

No. 2575, type, 5.4 cm., São Antonio de Guaporé, July 9, 1909.

Length to base of caudal 5.4 cm., greatest depth 2.8 cm.; length of head 2 cm.; preorbital width .45 cm.; diameter of eye 8 cm.; length of snout .8 cm.; interorbital space .8; A. III, 7; D. XV, 9; scales 3.5-25-9; pores  $\frac{11-14}{9}$ ; six or seven gill-rakers on the lower anterior arch;

maxillaries extending to front margins of eyes; fold of the lower lip continuous; cheeks with three rows of scales; preoperculum scaleless; 1.5 scales between the lateral line and first dorsal rays; dorsal spines subequal from the fourth, which is one-half as long as the head; dorsal and anal rays extending to middle of caudal; pectoral fin 1.2 times the length of the head; ventral fins extending beyond the origin of anal; caudal fin round; caudal peduncle two-thirds as long as deep; fins all scaleless excepting the base of caudal; greatly arched from head to origin of dorsal; the dorsal posterior half of body much compressed; seven cross-bands, the third of which has a black spot between the eighth to twelfth pore of the lateral line; a small dark spot on the upper edge of base of caudal; fins spotless, but the edges of dorsal and anal very black; no spot or bar beneath the eyes.

This species appears to be intermediate between *A. tetramerus* and *A. paraguayensis* both in structure and habitat. *A. paraguayensis* is the southern form and is not found as far north as the Madeira basin. *A. tetramerus* ranges to the north and is not found in the Paraguay river.

18. **A. awani**, sp. nov. (Plate LV.)

No. 2576, type, 14.5 cm., São Antonio de Guaporé, Rio Guaporé, July 31, 1909.

No. 2577, *cotype*, 13 cm., São Antonio de Guaporé, Rio Guaporé, July 23, 1909.

D. XV, 10; A. III, 8;  $\frac{16-17}{8-9}$ ; scales 3.5-24 to 26-9; depth almost 2; maxillaries not extending to the anterior margins of the eyes; diameter of eye 3.5 in head, almost 2 in the interorbital space, and equal to the preorbital width; snout one-half as long as the head, and distinctly longer than the postorbital portion of the head; preoperculum scaleless; four rows of scales on the cheeks; caudal peduncle two-thirds as long as deep; one and a half scales between the lateral line and the first dorsal rays; six gill-rakers on the lower anterior arch; pectoral fin one and a third times the length of the head; caudal scaled almost to its tip, but other fins scaleless; dorsal spines increasing until the last, which is more than one-half the length of the head; caudal round; a faint lateral band and seven cross-bars with a large dark spot on the third one; a dark spot on the upper edge of the base of caudal; fins dusky but spotless; no spot or bar beneath the eyes; fold of the lower lip not continuous. This species has a broader interorbital, longer dorsal spines, longer pectoral fins, thicker body, fewer scales between the lateral line and first dorsal rays, different coloration, and a greater depth than the same-sized *A. tetramerus*, its nearest ally.

I have dedicated this species to Awan, a Pawumwa Indian, who made his first acquaintance with a white man when aiding me with a seine in the Guaporé river. His name is the name of the vine from which they make the poison for their arrows.

19. **A. dorsigera** (Heckel).

*A. frenifera* Cope, *A. flavilabrus* Cope, *A. thayeri* (Steindachner).  
No. 2564a-b, 2 and 3.5 cm., Corumba, Rio Paraguay, April 27, 1909.  
No. 2565a-f, 2.5 to 3.3 cm., Puerto Suarez, Bolivia, May 7, 1909.  
No. 2566a-c, 2.4 cm., São Luiz de Cáceres, Rio Paraguay, May 24, 1909.

No. 2567, 2.5 cm., San Joaquin, Bolivia, Sept. 4, 1909.

No. 2568, 2.5 cm., Rio Alegre, Aug. 3, 1909.

A. III, 7.

No. 2569, 3.5 cm., São Antonio de Guaporé, Rio Guaporé, Aug. 3, 1909.

Eye 3 in the head; a spot on the sides of the body below the sixth to tenth scale of the lateral line; twenty-two scales in a series below the lateral line; D. XV, 8; A. III, 8.



No. 2570, 3 cm., São Antonio de Guaporé, Aug. 11, 1909.

No dorsal spot.

No. 2571, 2 cm., Posada, Campos de Matto Grosso, June 21, 1909.

No dorsal spot.

No. 2572a-d, 2.7 to 3.5 cm., San Joaquín, Bolivia, Sept. 4, 1909.

Scales 2.5 to 3-23-8 or 9; gill-rakers five or six; depth 2; D. XV to XIV, 7; A. III, 7. These specimens are slightly deeper and have no spot on the dorsal spine, but in these characters there are complete series of intergradations between the extremes or end variations. Some have slightly scaly soft dorsals, and this varies with size. Cope's figure and description of *A. flavilabrus* is exactly like my specimens from San Joaquin, excepting that it has one more dorsal spine. *A. frenifera* is said to have more scales in the lateral line, but inasmuch as my specimens vary from twenty-two to twenty-six, it is also within the limits of the variation of *A. dorsigera*. *A. thayeri* is said to have a scaly dorsal, but some of my small ones are also slightly scaly. In other details all of the species are identical and I do not hesitate in considering them as synonyms of *A. dorsigera*. I found only one of Cope's many specimens to belong to this species. The remainder are *Cichlasoma bimaculatum*.

20. **A. paraguayensis** Eigenmann and Kennedy.

No. 2526, 5 cm., Campos Alegre, Rio Jauru, June 2, 1909.

No. 2527a-d, 7 and 8 cm., Sapucay, Paraguay, April 2 and 5, 1909.

No. 2528a-d, Bastos, June 29, 1909.

No. 2629a-b, 3.5 to 6 cm., Arequa, Paraguay, Lake Ipacary, April 18, 1909.

No. 2530, 5 cm., Soã Francisco, Bolivia (Paraguay basin), June 10, 1909.

No. 2531a-g, 2 to 5 cm., Villa Hays, Paraguay, April 11 and 13, 1909.

No. 2532a-b, 4 to 4.5 cm., Asuncion, Paraguay, March 28, 1909.

No. 2533a-e, 1.5 to 3 cm., Corumba, Rio Paraguay, April 27, 1909.

No. 2534a-k, 1-3 cm., Puerto Suarez, Bolivia, May 6 and 7, 1909.

No. 2535a-k, Posada, in Campos de Matto Grosso, June 29, 1909.

No. 2536, 4.3 cm., São Luiz de Cáceres, Rio Paraguay, May 26, 1909.

No. 2537, 4 cm., Santa Rita, Rio Santa Rita, June 12, 1909.

No. 2538a-b, 5 and 7 cm., San Joaquin, Bolivia, Sept. 5, 1909.

No. 2539a-m, 3 to 7 cm., São Luiz de Cáceres, Rio Paraguay, May 24, 1909.

No. 999, 3 cm., Puerto Suarez, Bolivia (Steinbach Coll.).

No. 2541, 1.6 cm., Asuncion, Paraguay, March 29, 1909.

In several of these specimens the snout is as long as the post-orbital portion of the head; pectorals 1.16 times the length of the head; depth 2.16 to 2.33; D. XIV, 8 to 10; A. III, 6 to 8; scales 3-22 to 24-7 or 8; pores  $\frac{15}{8}$ ; head 2.66; eye 3; five gill-rakers on the lower anterior arch.

21. **A. flavescens** (Cope).

*Habitat*.—Ambiacu. No specimens were obtained.

22. **A. subocularis** (Cope).

No. 2542a-b, 6.5 and 7.8 cm., Manaos, Nov. 29, 1909.

No. 2543, 11 cm., Manaos, Nov. 27, 1909.

This specimen has prolonged dorsal and anal rays, which extend beyond the tip of the caudal. Vertical fins more or less white-spotted. No. 2544a-c, 1.3 to 3 cm., Manaos, Nov. 29, 1909.

In some cases the fold of the lower lip is slightly interrupted. This character has little value in any of the cichlids examined. There are complete series of all the stages from a free to an interrupted fold in the same locality amongst specimens of the same size. The snout of the smaller is two-fifths the length of the head. The larger specimens agree with Regan's description.

23. **A. zamorensis** (Regan).

*Habitat*.—Ecuadorian Amazonia. No specimens were obtained.

24. **A. duopunctata**, sp. nov. (Plate LVI.)

No. 2573, *type*, 9.5 cm., Manaos, Nov. 29, 1909.

No. 2574, *cotype*, 7.5 cm., Manaos, Nov. 29, 1909.

D. XV, 9 to 11; A. III, 7; scales 3-26-9; pores 9-10; depth 2.25 to 2.33; head about 3; eye 3 in head; less than preorbital, and equal to the interorbital in the smaller, and less than the interorbital space in the larger specimen; three rows of scales on the cheeks; two rows of scales between the lateral line and the first dorsal rays; caudal peduncle seven-eighths as long as deep; pectoral fin distinctly longer than the head; snout as long as the postorbital portion of the head; maxillaries not quite extending to the vertical from anterior margin of eye; fold of lips not continuous; preoperculum scaleless; dorsal and anal fins scaleless; six gill-rakers on the lower anterior arch; the fourth dorsal spine a little more than one-third the length of the head, and the last dorsal spine fully one-half the length of the same; the dorsal spines almost subequal from the fifth; dorsal and anal rays extending beyond

the middle of the caudal, and ventrals reaching to the origin of anal; an indistinct lateral band passing the base of a large black spot on the lateral line beneath the last dorsal spines; some white to blue scales in and in front of a spot on the upper half of base of caudal; fins dusky, but not distinctly spotted; a white streak or band between the lateral line and lateral band, both in front of and behind the lateral spot; three or four bluish lines in front of the eyes, and about three lines of bluish spots on the cheeks, and some blue spots on the operculum.

This species appears to be more like *A. sapayensis* (which was considered by Pellegrin to be *A. rivulata*) than *A. zamorensis*, the only blue-spotted *Æquidens* so far reported from the basin of the Amazon, but blue spots are not specific characters. *Geophagus brasiliensis* and *G. gymnogetys* show all stages in the development of blue markings in the same locality. If the distinction drawn by Regan is of specific importance then my specimens represent good species, but I am inclined to believe that when more material is collected intermediate forms will be taken, and *Æquidens sapayensis*, *zamorensis*, and *dupunctata* will prove to be synonyms of *A. rivulata*. I have not seen any of the other species, and as I obtained only two specimens, this species may stand for the present.

#### Genus CICHLASOMA Swainson.

##### 25. *C. bimaculatum* (Linnæus).

No. 2578, 10 cm., Manaus, Nov. 27, 1909.

No. 2579a-b, 5 and 9.5 cm., Prazeres, Rio Sapon, Bahia, Feb. 11, 1908.

Only one row of scales between the lateral line and the first dorsal rays; all fins spotless and uniformly dark brown.

No. 2580a-g, 4.5 to 9.5 cm., Barreiras, Rio Grande, Bahia, Jan. 4, 1908.

Only the smallest one has spots on the vertical fins.

No. 2581a-o, 3 to 6.5 cm., Lagoa do Porto, Cidade da Barra, Bahia, Dec. 24, 1907.

No. 2582, 8 cm., Rio Paqui, Bahia, Nov. 14, 1907.

Dark brown pigment under the scales along the sides. Some of the Bahian examples have white spots on the scales of the sides.

No. 2583, 9 cm., Rio do Sonno, Goyaz, Feb. 1, 1908.

D. XV, 10; A. III, 9; scales 3-25-8; depth 2; head 3; pores 7; fins spotless and uniformly dark brown; coloration of the body that of typical specimens, from which it differs in having only three anal spines, spotless fins, and only one row of scales between the lateral line and the first dorsal rays.

No. 2584, 4.5 cm., Penedo, Rio São Francisco, March 22, 1908.

No. 2585*a-b*, 4 and 4.5 cm., Santarem, Dec. 9, 1909.

These specimens have a larger eye, rounder body, ocellated caudal spot, black lines along the rows of scales of sides, no distinct cross-bar, eye greater than the snout and equal to the interorbital space; the vertical fins are well scaled on their basal halves, in contrast to the Penedo specimen, which has a much more slender body, smaller eye, and eight distinct cross-bars on the sides. One of the Santarem specimens has five anal spines. I have not described the Penedo specimen as new, because all of the intermediate stages are found in the Rio São Francisco.

No. 2586*a-h*, 4 cm., Cidade da Barra, Lagoa Pereira, Dec. 23, 1907.

No. 2587, 5 cm., Alagoinhas, Rio Catu, Bahia, March 4, 1908.

No. 2588*a-d*, 5.5 to 6 cm., Joazeiro, Rio São Francisco, Nov. 28, 1907.

No. 2589*a-d*, 3.5 to 5 cm., Propria, Rio São Francisco, below the falls, March 30, 1908.

One has only three anal spines and twenty-three scales in the first series below the lateral line.

No. 2590*a-m*, 2.5 to 6.5 cm., Lagoa Salgado, Rio Salitre, Bahia, Nov. 10, 1907.

I cannot distinguish this species from *A. portalegrensis*, except for its having as a rule four anal spines. One spine more or less does not always have either generic or specific significance.

26. ***C. festivum*** (Heckel).

No. 2591*a-h*, 2.5 to 6 cm., Campos Alegre, Rio Jauru, June 2, 1909.

No. 2592*a-g*, 2 to 7 cm., Bastos, Rio Alegre de Guaporé, June 26, 1909.

No. 2593*a-b*, 4 and 4.5 cm., Santarem, Dec. 9, 1909.

No. 2594*a-d*, 3 to 4.5 cm., São Luiz de Cáceres, Rio Paraguay, May 24, 1909.

No. 2595*a-e*, 2.8 to 5 cm., São Antonio de Guaporé, July 30-Aug. 10, 1909.

No. 2596, 5 cm., Santarem, Dec. 15, 1909.

No. 2597, 7 cm., Manaus, Nov. 29, 1909.

No. 2598, 4.5 cm., San Joaquín, Bolivia, Sept. 4, 1909, in a lake.

No. 2599*a-e*, 2.8 to 4 cm., São Luiz de Cáceres, Rio Paraguay, May 23-27, 1909.

27. ***C. facetum*** (Jenyns). (Plate LVII.)

*C. autochthon* Günther, *C. oblongum* Castelnau.

The following specimens have the fold of the lower lip continuous.

As I have said before, this character has no value for distinguishing species.

No. 2607*a-l*, 6-10 cm., São João da Barra, Rio Parahyba, June 26, 1908.

The largest one has depth 1.75; head 2.67; eye 3.8.

No. 2608*a-w*, 2.5 to 6 cm., Bom Jardim, Minas, Rio Grande of the Parana, July 7, 1908.

No. 2609, 5.5 cm., Iporanga, Rio Ribeira, Dec. 1, 1908.

The color-bands are very distinct, and the basal halves of<sup>\*</sup> rayed dorsal and anal and the spinous dorsal and anal, ventrals, and tip of caudal are black.

No. 2610*a-m*, 4.5 to 9 cm., Muniz Freire, Rio Itapemerim, June 19, 1908.

No. 2611*a-m*, 2 to 7 cm., Entre Rios, Rio Parahyba, July 2, 1908.

No. 2612*a-d*, 3.5 to 6.5 cm., Rio Grande, Minas, Aug. 18, 1908.

No. 2613, 5 cm., Barra de Pirahy, Rio Parahyba, July 12, 1908.

No. 2614*a-p*, 3 to 9 cm., Campos, Rio Parahyba, June 14, 1908.

The largest specimen has A. VII, 9, and the depth is less than 2 in the length.

No. 2615*a-b*, 5.5 cm., Morretes, Parana, Jan. 3, 1909.

Heavy black lateral bands; depth more than two in the length; snout is longer and more slender than in a typical specimen; diameter of the eye less than the length of the snout and the interorbital space. Such specimens as a rule come from fast-flowing water, while the rounder-bodied, shorter-snouted, and larger-eyed form comes from lagoons and gentle currents.

No. 2617, 8 cm., Porto Alegre, Rio Grande do Sul, Jan. 24, 1909.

This specimen has four rows of scales on the cheeks and some of the rows on the sides have the scales with black and some with white centers.

No. 2618*a-l*, 2 to 5 cm., Campos, Rio Parahyba, June 13, 1909.

No. 2619*a-c*, 4.5 to 7 cm., Jaguará, Rio Grande, Minas, Aug. 18-19, 1908.

No. 2620*a-f*, 4 to 5.7 cm., Cachoeira, Rio Jacuhy, Jan. 26, 1909.

No. 2621*a-b*, 2.5 cm., Santa Rita de Jacutinga, Minas; in a lagoon above the high waterfall in the Rio Preto of Rio Parahyba, July 9, 1908.

No. 2622*a-b*, 6.5 and 12.3 cm., Lagoa Feia, Tocas, June 27, 1908.

No. 2623, 5 cm., Muniz Freire, Rio Itapemerim, June 18, 1908.

No. 2624a-b, 3 cm., Barra do Pirahy, Rio Parahyba, July 5, 1908.

No. 2625a-b, 3.5 and 4.5 cm., Xiririca, Rio Ribeira, Dec. 5, 1908.

No. 2626, 8 cm., Iporanga, Rio Ribeira, Dec. 1, 1908.

Eye goes 3.75 in head.

The following specimens have the folds of the lower lip interrupted.

No. 2627, 9 cm., Campos, Rio Parahyba, June 14, 1908.

No. 2628, 8.5 cm., Iporanga, Rio Ribeira, Dec. 1, 1908.

No. 2629a-f, 1.5 to 7 cm., Cachoeira, Rio Grande do Sul, Rio Jacuhy, Jan. 26, 1909.

No. 2630, 3.3 cm., Uruguayana, Rio Uruguay.

It has brown pigment lines along the rows of scales of the sides.

No. 2631, 2.5 cm., Santa Isabel, Rio Negro, Uruguay, Feb. 12, 1909.

No. 2632, 7 cm., Bom Jardim, Minas, Rio Grande, above the falls, July 7, 1908.

No. 2633a-c, 3.5 to 7 cm., Montevideo, Arroyo Miguelite, Feb. 7, 1909.

There is not as much difference between *C. facetum*, *C. autochthon*, and *C. oblongum* as there is between a large series of either *Crenicichla lepidota* or *Geophagus brasiliensis*. The only difference is a free or an interrupted fold, and there are all stages between these two extremes. These species are found in the same localities. Several other species of cichlids have both a free fold and an interrupted fold. In view of all this these names must be considered as synonyms.

28. *C. coryphænoïdes* (Heckel).

*C. temporale* Günther.

No. 2635a-c, 14 cm., Manaus, Rio Negro, Dec. 2, 1909.

No. 2637a-b, 14 and 15 cm., Manaus, Rio Negro, Nov. 15, 1909.

Depth 1.87; head 3; diameter of eye 3.75 in head; interorbital space 2.25 in head; fold of lower lip interrupted; scales 5-31-12; three or four scales between the lateral line and the base of first dorsal ray; D. XVI, 12 or 13; A. VI or VII, 9; ventrals extending about to middle of anal; pectorals four-fifths the length of head; caudal peduncle three-fifths as long as deep; dorsal and anal rays extending almost to tip of caudal; uniform dark brown, excepting white pectoral fins; a dark spot above the eye and another one above the lateral line, between the eleventh to the thirteenth dorsal spine, and a third indistinct spot at the base of the caudal; these three spots connected by a faint band; lines of pigment along the rows of scales of the lower half of the body; last rays of the dorsal with some small dark spots.

In about half of the details the specimens listed above agree with *Cichlasoma coryphænoides* and in the rest with *C. temporale* as described by Regan. As my specimens are intermediate in size, I regard *C. temporale* as a synonym of *C. coryphænoides*.

29. **C. biocellatum** Regan.

This species appears to be good, but I did not secure it.

30. **C. severum** (Heckel).

No. 2600a-e, 4 to 6.5 cm., São Antonio de Guaporé, Aug. 10, 1909.

No. 2601a-c, 4.5 and 6.5 cm., Santarem, Dec. 9, 1909.

One of these has no spots on the sides, and one has fifteen dorsal spines.

No. 2602a-d, 3.2 to 5 cm., São Antonio de Guaporé, July 30, 1909.

No. 2603a-e, 4.5 to 14 cm., São Antonio de Guaporé, July 23-Aug. 3, 1909.

D. XIV, 14.

No. 2604a-c, 2.5 to 3.5 cm., Bastos, Rio Alegre, June 26, 1909.

No. 2605a-c, 12 cm., Manaus, Nov. 15, 1909, 2605d, Santarem, Dec. 7, 1909.

One has no spots or cross-bars. The largest specimen has a tumid head like some males of *G. brasiliensis* (Quoy and Gaimard).

The specimen, 8.5 cm., from Santarem, has neither spots nor bars, but brown lines of pigment in each row of scales and four rows of scales on the cheeks.

31. **C. psittacum** (Heckel).

*Habitat*.—Amazon and Orinoco Rivers.

No specimens were taken by me.

32. **C. spectabile** Steindachner.

No. 2634a-b, 7 and 10 cm., Santarem, Dec. 15, 1909.

The diameter of the eye is equal to the length of the snout in the smaller specimen and less than the same in the larger one; depth 2.2 in the smaller and 1.9 in the larger one; obscure cross-bars and a distinct lateral band from the eye to the caudal spot; soft dorsal of the smaller one with a few brown spots; three or four more scales in the first row above the lateral line than in the first row below it; soft fins scaly at the base only.

No. 2636, 6 cm., Santarem, Dec. 6, 1909.

Scales above the lateral line a little smaller than those below it.

This specimen is intermediate between *C. spectabile* and *C. kraussi* as described by Regan; and if the scales above the lateral line of *C. kraussi* are not very much smaller than those below it, these specimens indicate that it is a synonym of *C. spectabile*.

Genus CRENICARA Steindachner.

33. *C. punctulata* Günther.

*Habitat*.—Amazonia and Guiana.

No specimens were obtained by the Expedition of the Carnegie Museum.

34. *C. maculata* (Steindachner).

No. 2638, 3 cm., mouth of Rio Machupo in Rio Guaporé, Aug. 27, 1909.

35. *C. altispinosa*, sp. nov. (Plate LVIII.)

No. 2639a, *type*, 5 cm., collected at night along a sand-bank in the Rio Marmoré, below the mouth of the Rio Guaporé, Sept. 19, 1909.

No. 2639b, *cotype*, 5.1 cm., same place and date.

No. 2640a-h, *cotypes*, 3.2-5.2 cm., taken in a large lake near San Joaquin, Bolivia, Sept. 4, 1909.

Body round and compressed; large ctenoid scales, two lateral lines composed of scales of the same size as those above and below it; jaws equal; mouth small; maxillaries not exposed and not extending to the front edge of the eyes; operculum and checks scaly, but the preoperculum scaleless and finely denticulated. Gill-rakers short, about six on the lower anterior arch. Caudal slightly emarginate. Ventrals behind the pectorals and in some cases extending beyond the origin of the anal. Teeth small, conical, and arranged in two rows in each jaw. P. 13; D. XV, 8 to 10; A. III, 7 or 8; depth 2.2; head 3; nares indistinct and not greatly different from the pores on the snout, situated about half-way between the eyes and the tip of the snout; eyes 2.8 in the head, a little greater than the length of the snout or the interorbital space; depth of preorbital three-fifths the diameter of the eye; four series of scales on the cheeks; scales 4-24-9 (in the first series below the lateral line); pores  $\frac{16-18}{8-10}$ ; greatly arched from the snout to base of the dorsal; the fourth dorsal spine much the longest and thirteen-sixteenths the length of the head; dorsal spines about subequal from the sixth to the last, none or them more than three-fifths the length of the head, the first two shortest,



the third, fourth, fifth, and sixth longest. The origin of the dorsal is above the opercular cleft; soft dorsal and anal scaleless, extending scarcely beyond the base of the caudal; pectorals about one and one-fourth times the length of the head; caudal peduncle as long as deep.

Dark bands beneath the eyes, continued above the eyes and meeting half-way between the eyes and the origin of the dorsal; dark operculum; fins usually colorless, the membranes between the first five dorsal spines sometimes black, and the edges of the anal and caudal sometimes dark; six dark lateral bands extending from the dorsal to near the lower part of the side; in some cases each row of scales has a more or less distinct dark brown line; in some cases there are white bands or lines from the eyes to the snout.

This species is easily distinguished from *Crenicichla punctulata* by its color, shape, scales, teeth, and long fourth dorsal spine. Some of these characters almost warrant the erection of a new genus for its reception.

Genus CRENICICHLA Heckel.

36. *C. semifasciata* Heckel.

? *Batrachops scotti* Eigenmann, ? *Crenicichla ocellata* Perugia.

*Habitat*.—Basin of the Rio de la Plata. No specimens were taken by the expedition of the Carnegie Museum.

37. *C. reticulata* (Heckel).

D. XXII, 10; A. III, 8; pores  $\frac{25}{12}$ ; scales 9-66-19; eye 4.5 in the head; interorbital 2.67; depth 4.33; head 3.33; four rows of teeth in the upper jaw and three in the lower; few spots in the dorsal fin; edge of dorsal and caudal dark; indistinct lateral bands, and each row of scales on the sides with a dark line.

No. 2642, 9 cm., Villa Bella, Rio Beni, Bolivia, Oct. 5, 1909.

I have compared specimens of *Crenicichla punctulata* Regan from Guiana with this species and find them identical.

38. *C. simoni*, sp. nov. (Plate LIX.)

No. 2646, *type*, 7.5 cm., Rio Paraguay at São Luiz de Cáceres, May 24, 1909.

No. 2647, *cotype*, 6.5 cm., same locality, May 26, 1909.

No. 2648a-b, *cotypes*, 5.6 cm., Puerto Suarez, Bolivia, May 6, 1909.

No. 2649, *cotype*, 5 cm., Corumba, Rio Paraguay, April 27, 1909.

No. 2650, *cotype*, 4.3 cm., Villa Hays, Paraguay, April 13, 1909.

D. XXII, 11; A. III, 7; pores  $\frac{23-24}{14-15}$ ; scales 8 or 9-61 to 66-15 to 19; teeth in three rows in each jaw; depth 4; head 3.25; eye 4; snout 4; diameter of eye 1.33 in the interorbital space; three rows of scales between the lateral lines; caudal peduncle three-fifths as long as deep; maxillaries extending almost to the middle of the eyes; eight gill-rakers on the lower anterior arch; depth of preorbital not more than one-third the diameter of the eye; last row of teeth faintly depressible; in some of the specimens the spinous dorsal does not have two rows of spots, but all have three rows of spots in the rayed dorsal; anal uniformly dusky; caudal with a dark margin at the end of a whitish band, which extends from the upper basal margin to the end of the median caudal rays; the other fins colorless; a small dark ocellated spot at the base of the caudal; sides and back crossed by from eight to eleven double dark bands; each row of scales on the sides with spots on the scales; a dark band from the eye to end of the operculum.

*C. cyanota* Cope has a more slender body and no dorsal spots, while *C. reticulata* (Heckel) has a much smaller eye. This species differs from the previously described Paraguayan forms in color, in the larger size of the eye in comparison with the interorbital space, and in the number of scales and spines. It is more closely allied to *C. cyanota*.

I have dedicated this species to Mr. Fleciano Simon of Corumba, who assisted me in various ways while I was collecting in the Rio Paraguay.

I find that the teeth of adult *C. vittata* and *iguassuënsis* are just as firm as in the supposed species of the genus *Batrachops*, which is based on large specimens. The last row of teeth of *C. lacustris* are one-half depressible and in *C. dorsocellata* are not depressible. *C. lepidota* and *saxatilis* have several rows of depressible teeth. As a rule the species of the genus *Batrachops* have three rows of teeth, but some have as many as six. The number of rows of teeth varies a great deal in all of the species of *Crenicichla*. Hence I consider the genus *Batrachops* as not tenable.

### 39. *C. cyanota* Cope.

No. 2643, 5.5 cm., Santarem, Dec. 9, 1909.

No. 2644a-c, 5.5 cm., San Joaquin, Bolivia, Sept. 4, 1909.

No. 2645, 7 cm., San Joaquin, Bolivia, Sept. 6, 1909.

Some have only sixty-four scales in the first series below the lateral line; some have D. XXIII, 11; the diameter of the eye is equal to the interorbital space and the length of the snout; depth about 5; scales on the sides of the body with brown spots arranged in the form of lines; four series of teeth in the upper jaw and three in the lower jaw.

40. **C. lepidota** Heckel.

No. 2651*a-b*, 9.3 and 12 cm., Cachoeira, Rio Jacuhy, Rio Grande do Sul, Jan. 26, 1909.

D. XVI, 14.

No. 2652*a-b*, 8.5 and 12.7 cm., Porto Alegre, Jan. 24, 1909.

One has a color-band below the eye like that of the type of *Batrachops scotti*.

No. 2653*a-e*, 4.3 to 9.8 cm., Cacequy, Rio Cacequy, Feb. 1, 1909.

As a rule the dorsal has sixteen spines. One specimen has a row of black spots along the edge of the entire dorsal, and the anal and caudal are uniformly black.

No. 2654*a-b*, 9.5 and 13 cm., Puerto Suarez, Bolivia, May 6, 1909.

One has prolonged dorsal and anal rays, which extend to the tip of the caudal.

No. 2655*a-c*, 14 cm., Porto Alegre, Jan. 22, 1909.

No. 2656*a-b*, 12 cm., Porto Alegre, Jan. 20-21, 1909.

These two specimens have some white scales.

No. 2657*a-b*, 5 and 11 cm., Sapucay, Paraguay, April 21, 1909.

No. 2658*a-b*, 13.5 and 14 cm., São Antonio de Guaporé, Rio Guaporé, Aug. 3, 1909.

These have unspotted black vertical fins.

No. 2659*a-d*, 5 to 7 cm., São Luiz de Cáceres, Rio Paraguay, May 24, 1909.

These, as is often the case, have bars in the vertical fins.

No. 2660*a-b*, 7 and 8 cm., Uruguayana, Rio Uruguay, Feb. 7, 1909.

No. 2661*a-c*, 5.3 cm., Puerto Suarez, Bolivia, May 6, 1909.

No. 2662*a-b*, 5.5 cm., Arequa, Paraguay, Lake Ipacary, April 8, 1909.

No. 2663, 4.5 cm., Asuncion, Paraguay, March 28, 1909.

No. 2664, 4.1 cm., São Antonio de Guaporé, Rio Guaporé, Aug. 9, 1909.

D. XVI, 12; A. III, 9; pores  $\frac{20-22}{9}$ ; scales 45 to 57; depth 4.25;

head 3; eye 4; caudal peduncle as long as deep; three series of teeth in the lower jaw. This specimen is less compressed, rounder, and a little more slender than a typical *C. lepidota* of the same size.

No. 2665*a-b*, 2.3 and 3 cm., Cacequy, Rio Grande do Sul.

No. 2666, 7.5 cm., Joazeiro, Rio São Francisco, Nov. 28, 1907.

This specimen has been bleached in denatured alcohol and has many white spots in the fins and scales; no band beneath the eye; the dorsal has twelve rays, which is often the number in this species.

No. 2667, 8 cm., Urucum Mts., near Corumba, May 2, 1909.

This specimen is very dark; head 2.67; the dorsal fin is edged with black, beneath which is a lighter streak, and the base is dark brown.

No. 2668*a-b*, 4.5 to 5.5 cm., Bastos, Rio Alegre, June 26, 1909.

More slender and less compressed than typical *C. lepidota*.

No. 2673*a-d*, 4.5-8.3 cm., São Antonio de Guaporé, July 30-August 3, 1909.

D. XVII, 15; A. III, 10; pores  $\frac{24}{9}$ . All of the specimens from the Guaporé river have about 45 scales in a median lateral series. Head 3; depth 4.5; eye 4 and equal to the snout and interorbital space; opercular band continuous along the side of body to base of caudal.

No. 2674*a-b*, 5.5-9 cm., San Francisco, Bolivia (Paraguay basin), June 10, 1909.

These specimens are identical with the Bastos specimens, both of which were preserved in formalin.

No. 2675*a-b*, 6 and 6.5 cm., Campos Alegre, Rio Jauru, June 3, 1909.

These have faint lateral and transverse bands.

No. 2676*a-h*, 4-6 cm., São Luiz de Cáceres, May 24, 1909.

No. 998, 6 cm., Puerto Suarez, Bolivia (Steinbach collection).

No. 2678*a-d*, 4-5 cm., Corumba, Rio Paraguay, April 27, 1909.

One has a distinct lateral band and another has a black caudal.

No. 2679, 8 cm., Salto das Cruzes, Rio Tieté, Sept. 22, 1908.

D. XVIII, 15; A. III, 9; pores  $\frac{23}{9}$ ; depth 3.75; head 2.8; eye 5 in the head; fins and body uniform dark brown with spots above the base of pectorals, at base of caudal, and in base of soft dorsal.

No. 2680, 5-6 cm., Cidade da Barra, Bahia, Lagoa Pereira.

Three of these specimens have the edges of the vertical fins very dark; four of them have spots in the vertical fins, an ocellated caudal, and pectoral spots. The following table will show the difference between the two forms of *C. lepidota* found in the Rio São Francisco:

The four specimens with dorsal  
and caudal spots.

D. XVI, 14 or 15;

A. III, 8;

Depth 4.33;

Head 3;

Pores  $\frac{21}{9}$ ;

Scales 34-37.

Three specimens without spots  
and with dark margins on fins.

D. XVI, 13;

A. III, 8;

Depth 4.17;

Head 3;

Pores  $\frac{22}{9}$ ;

Scales 39 or 40.

These two end variations show marked differences, but complete series of intergradations are found in the same localities. None of the São Francisco specimens have bars beneath the eyes, and all are smaller in size and more slender than typical specimens.

No. 2682, 7 cm., Santa Rita, Rio Preto, Bahia, Jan. 24, 1908.

No. 2683, 7 cm., Rio Itapicurú.

D. XVI, 12; A. III, 8; pores  $\frac{21}{9}$ ; scales 36; depth 4.33; head 3; eye 4.25.

No. 2684a-e, 4.3-5.2 cm.; Cidade da Barra, Lagoa do Porto, Dec. 24, 1907.

No. 2685, 5 cm., Rio Zinga, State of Bahia, Nov. 7, 1907.

This specimen is more like a typical *C. lepidota* than the São Francisco form, but it has no bars beneath the eyes.

No. 2686a-c, 3.5-7.5 cm., Rio Paqui, State of Bahia, Nov. 14, 1907.

No. 2687a-f, 8.5 cm., Queimadas, Rio Itapicuru, March 2, 1908.

No. 2688, 9.2 cm., Propria, Rio São Francisco below the falls, March 30, 1908.

D. XVI, 12; A. III, 9; scales 38; depth 4; head 2.8; eye 4.5 in the head, 1.5 in the snout and 1.25 in the interorbital space; vertical fins white-spotted; ocellated caudal and pectoral spots; fins not dark-edged; a dark lateral band, above which are five vertical bars; four series of teeth in each jaw.

No. 2689a-b, 5.5 and 6.5 cm., Santa Rita, Rio Preto, Bahia, Jan. 24, 1908.

The smaller specimen has 34 scales in the first series below the lateral line, the caudal peduncle is as long as deep, the vertical fins are unspotted, and the lateral band has five vertical bars above it. The larger specimen has white spots on some of the scales and on the vertical fins.

No. 2690, 4 cm., Urugayana, Rio Grande do Sul, Feb. 6, 1909.

No. 2691, 3.2 cm., Boqueirão, Rio Grande, Bahia, Jan. 9, 1908.

No bar beneath the eye, and thirty-six scales in the series below the lateral line.

No. 2691, 7 cm., Lagoa Pereira, Cidade da Barra, Bahia, Dec. 26, 1907.

The fins are spotted; there are forty scales in the first row below the lateral line.

No. 2693, 5-8 cm., sixty-seven specimens like the above sample from the same place, Dec. 23, 1907.

Ten of these have no spots on the vertical fins, which are black-edged, and one has forty-four scales in the first row below the lateral line. Fifty-four specimens have spots on their sides and on their vertical fins and ocellated caudal and pectoral spots. Three specimens are intermediate between these two forms.

No. 2694*a-b*, San Joaquin, Bolivia, From a large lake between the Rios Machupo and Marmoré, Sept. 4, 1909.

D. XVII, 13 or 14; A. III, 9 or 10; 43 or 45 scales in the first series below the lateral line; pores  $\frac{21-23}{8-9}$ ; one with four series of teeth in the upper jaw and the other with two series in each jaw; teeth easily depressible posteriorly; head 2.67 to 2.8; depth 3.5; eye 4 in the head, equal to the length of the snout and the interorbital space; maxillaries extending to below middle of the eyes; lower jaw slightly the longer; caudal peduncle not quite so long as deep; nostrils nearer the eyes than to the tip of snout; preorbital width not more than one-third the diameter of the eye; ten or eleven gill-rakers on the lower anterior arch; two rows of scales between the lateral lines and three rows between the lateral line and the last dorsal spine; pectorals and ventrals two-thirds the length of the head. A faint lateral band, above which are six faint vertical cross-bars; a small ocellated spot at the base of the caudal and another above the base of the pectorals; a bar on the operculum and another on the head beneath the eyes; vertical fins with alternating white and dark broken bars.

These specimens differ from typical *C. lepidota* in having only two series of teeth in the lower jaw. The rows of teeth in this species vary otherwise from three to six.

41. ***Crenicichla saxatilis*** (Linnæus).

No. 2695*a-c*, 8-9.5 cm., Santarem, Rio Amazonas, Dec. 9-15, 1909.

No. 2696*a-e*, 2-17.3 cm., Bragança, Pará, in a creek, Dec. 29, 1909.

No. 2697*a-d*, 13-20 cm., Belem, Pará, Dec. 19 and 27, 1909.

No. 2700, 3.5 cm., Manaus, Nov. 30, 1909.

*Crenicichla protens* (Cope) is a synonym of *C. saxatilis*.

42. *Crenicichla saxatilis lucius* Cope.

No specimens were obtained.

43. *Crenicichla jaguarensis*, sp. nov. (Plate LX.)

No. 2723, *type*, 5.2 cm., Jaguará, Rio Grande of the Paraná, Minas, Aug. 18, 1908.

No. 2724, *cotype*, 4.3 cm., taken at the same place and date.

It has four anal spines.

D. XIX, 11; A. III, 8, and IV, 7; depth 4.67; head 3; eye 4.33 in head, equal to the snout in the smaller specimen and two-thirds of it in the larger one, equal to the interorbital space in both; three series of teeth in the lower jaw, and four in the upper; pores  $\frac{22-25}{10-12}$ ; fifty to fifty-two scales in the first series below the lateral line; maxillaries extending to, or a little beyond, the anterior margins of the eyes; nostrils nearer the eyes than to the tip of the snout; depth of preorbital one-half the diameter of the eye; scales denticulated, excepting on the head and the lower part of the abdomen and thorax; two to two and a half rows of scales between the lateral line and the last dorsal spine, and two rows between the lateral lines; six or seven gill-rakers on the lower anterior arch; last dorsal spine about half the length of the head; caudal peduncle as long as deep; soft dorsal and anal not extending beyond the base of the caudal; pectorals two-thirds, and the ventrals five-eighths, the length of the head.

Brownish, with a black band around the snout and continued back of the eye on the operculum and indistinctly on the sides of the body, where it breaks up into about eleven short median cross-bars; the dorsal fin with two or three irregular series of dark spots; the anal and caudal with a few indistinct spots; all of the fins more or less dark-edged; a dark bar beneath the eye, slanting back toward the middle of the preoperculum; no spot above the pectorals; a very faint caudal spot at the end of the broken lateral line.

This species resembles *C. lacustris* more than either *C. saxatilis* or *lepidota*, but, as the description shows, it is as different from these three species as they are from each other.

44. *Crenicichla lacustris* Castelnau.

No. 2701, 8.5 cm., Xiririca, Rio Ribeira da Iguapé, Dec. 8, 1908.

No. 2702a-e, 7.2-11.5 cm., Morretes, Paraná, Jan. 4, 1909.

One has A. III, 10.

No. 2703a-i, 4.5-9 cm., Campos, Rio Parahyba, June 14, 1908.

One of these has about seventy-five scales in the first row below the lateral line.

No. 2704, 6.8 cm., Muniz Freire, Espirito Santo, Rio Itapemerim, June 18, 1908.

45. **Crenicichla iguassuënsis**, sp. nov. (Plate LXI.)

No. 2725, *type*, 14 cm., Porto União da Victoria, Rio Iguassú, Dec. 28, 1908.

No. 2726a-b, *cotypes*, 9.5 and 13 cm., same place and date.

One has no fin-spots and both have less prolonged snouts.

No. 2727a-b, *cotypes*, 1 and 7 cm., same place and date.

Interorbital space less than the diameter of the eye, which is almost equal to the length of the snout; eye 4 in the head; no bands on the sides and no bar beneath the eye.

No. 2728, *copy*, 14 cm., same place and date.

D. XX to XXII, 11; A. III, 8 or 9; pores  $\frac{23 \text{ or } 24}{10-17}$ ; scales 54 to 64 in the row below the lateral line; eye 4 to 5.33 in the head; snout 3 to 3.5; caudal peduncle 2 in the greatest depth and one-fourth longer than its own depth; diameter of the eye about .6 of the distance from the eye to the tip of the lower jaw in the type and about equal to the same in two of the smallest specimens; preorbital about three-fourths the diameter of the eye; edge of preoperculum vertical; four or five rows of teeth in each jaw; snout pointed and almost cylindrical in shape; in some cases the maxillaries extend to, but not past, the front edge of the eyes; two rows of scales between the lateral lines, in most of the specimens each row of scales has faint brown spots on them; bars, composed of spots (as described for *Batrachops scotti*) are found below the eyes in the larger specimens in some cases, but none occur in the younger ones; some have four or five distinct broad double dark brown bands over their backs and sides, while others are mottled like *C. lacustris*; no band on the operculum; as a rule the vertical fins are spotted with two or more series of dark brown spots, but in one example the fins are all colorless; all have a more or less dark ocellated caudal spot at the middle of the base of the caudal; the dorsal and anal scarcely extend to the middle of the caudal; the nostrils are nearer the eyes than to the tip of the snout.

This species is easily distinguished from *C. lacustris*, its nearest ally, by its pointed snout, narrower interorbital, spine, teeth, and color differences.



This fish is locally known as "*peixa da pedra*."

46. *Crenicichla macrophthalmalma* Heckel.

No. 2705, 6 cm., Manaus, Nov. 29, 1909.

D. XX, 9 to 11; A. III, 7 to 9; head 3 to 3.33; pores  $\frac{21-22}{10}$ ; 57 to 70 scales in the first series below the lateral line; depth 5 to 6; eye 4 in the head, equal to, or more than, the interorbital space, and equal to the length of the snout; nostrils about equidistant between the eyes and the tip of the snout or a little nearer the former; brownish, with a black band around the snout and continued back of the eyes on the operculum; some with faint lateral bands and cross-bars and nearly all with either spots or cross-bars on the caudal and some faint spots on the dorsal fin; some with dark margins on the vertical fins; all with a small more or less ocellated caudal spot.

I regard *Crenicichla wallacei* Regan as the young of *C. macrophthalmalma*. Young specimens from the Guaporé, Amazon, and Essequibo are identical. The extent of the maxillaries varies considerably. No. 2706a-g, 3.2-4.8 cm., São Antonio de Guaporé, Rio Guaporé, Aug. 10, 1909.

No. 2708, Villa Bella, Rio Beni, Bolivia.

Almost colorless and with the preoperculum more denticulated than in the other specimens.

No. 2707, 3.7 cm., Bastos, Rio Alegre, June 26, 1909.

This specimen is very slender, its depth being 7 in its length; head 3; eye 3.5 in the head, a little greater than the snout, 1.33 times the interorbital space and 3 times the preorbital width; maxillaries not quite extending to the front margins of the eyes; pores  $\frac{24}{9}$ ; two and one-half to three rows of scales between the lateral lines, and one row or less between the last half of the upper lateral line and the base of the dorsal; A. III, 7; D. XIX, 9; three rows of more or less depressible teeth in each jaw; eight gill-rakers on the lower anterior arch; scales about sixty in a median row below the lateral line; caudal peduncle one and one-half to two times as long as deep; nostrils nearer the eyes than to the tip of the snout; dark brown with a band around the snout extending back of the eyes to the base of the caudal, where it ends in a small black spot.

This species replaces *C. vittata* in the Amazon. The only marked

differences between these two species are the number of scales in the lateral series and the number of spines and rays.

47. *Crenicichla santaremensis*, sp. nov. (Plate LXII, fig. 1.)

The *type*, No. 2719, is 9.8 cm. long, and one *colype*, 2720, is 7.8 cm. long. They were taken in a grassy lagoon along the margin of the Amazon, three miles above Santarem, December 15, 1909.

D. XXI, 11; A. III, 6 or 7; depth 5; head 2.7; eye 3.33; preorbital one-third the diameter of the eye; snout one-third the length of the head; pores  $\frac{23}{14}$ ; interorbital space three-fifths the diameter of the eye; scales 68 to 75 in the first series below the lateral line; twelve rows of scales between the lateral line and the first dorsal spine; three rows of scales between the lateral line and the first dorsal ray, and two and one-half rows between the lateral lines; caudal peduncle slightly longer than deep; nine gill-rakers on the lower anterior arch; scales all well denticulated, excepting a small patch in front of the ventral fins; maxillaries extending beyond the front margin of the eye by one-fourth of its diameter; nostrils much nearer the eye than to the tip of the snout. Each scale in the lateral lines edged with black; a faint broad light brown lateral band crossed by four broad vertical bands; vertical fins in part edged with dark, but no spots or bars.

In some of the details this species resembles *C. macrophthalmia*, but *C. santaremensis* has a much longer eye, a much narrower interorbital and preorbital in comparison with the diameter of the eye; the nostrils are much nearer the eye than to the tip of the snout; the scales are all denticulated, excepting a few in front of the ventrals; the snout and head are longer. The description of *C. macrophthalmia* agrees much better with *C. wallacei* than with these specimens.

48. *Crenicichla vittata* Heckel.

No. 2709*a-b*, 5.3 and 6.8 cm., Corumba, Rio Paraguay, April 27, 1909.

No. 2710*a-c*, 2.3-3.2 cm., Villa Hays, Paraguay, April 3, 1909.

One has D. XXII, 14; less than eighty-four scales in the first series below the lateral line; fins slightly colored, the maxillaries almost extending to the front edge of the eyes.

No. 2711, 6 cm., Campos Alegre, Rio Jauru, June 24, 1909.

No. 2712, 6.3 cm., Corumba, Rio Paraguay, May 9, 1909.

No. 2713*a-e*, 5-22.2 cm., Uruguayana, Feb. 5, 1909.

D. XXII, 14; A. III, 9; pores  $\frac{29}{13}$ ; scales 81; depth 4.5; head 3.1;

snout 2.5 in the head; eye 6 in the head; interorbital space *4.5 times in the length of the head*. This species was not found in the Amazon.

49. **Crenicichla dorsocellata**, sp. nov. (Plate LXIII.)

No. 2721, *type*, 18 cm., Campos, Rio Parahyba, June 15, 1908.

D. XXII, 13; A. III, 9; pores  $\frac{25-27}{11-13}$ ; depth 5; head 3; eye 6.33; scales 62 in the first row below the lateral line; preoperculum almost entire; maxillaries extending to below the first third of eye; scales ctenoid, excepting on the ventral side and on top of the head; dorsal and anal rays not extending beyond the middle of the caudal; three rows of scales between the lateral lines and five rows between the lateral line and the first dorsal rays; caudal peduncle longer than deep; dorsal and anal fins rather high, being about one-half the length of the head; nostrils much nearer the eye than the tip of the snout; lower jaw distinctly the longer; five rows of teeth in the lower jaw and seven in the upper; ten gill-rakers on the lower anterior arch. Dark bar below the eye composed of faint spots; a small black spot at the base of the caudal; a faint broad lateral band from the eye to the base of the caudal; a very large distinctly ocellated dorsal spot between the fourteenth to the eighteenth spines; vertical fins slightly dark-edged, but not distinctly spotted; uniformly brown above, and white on the ventral side; in life the body is covered with red dots, which disappear in alcohol.

The nearest relative is *C. vittata*, from which it is easily distinguished by the large dorsal spot, eye 6.33 in head, more series of teeth, longer fin-rays, and maxillaries extending beyond the front edge of eyes.

No. 2722, 4.1 cm., Santarem, Igarapé de Irura.

D. XXII, 11; A. III, 7; eye 4; pores  $\frac{21}{10}$ ; scales 57; depth 5.5; no spot beneath the eye; a dark ocellated spot on dorsal spines. This small specimen differs in many details from the type. It also resembles *C. macrophthalma* and perhaps should be associated with it.

50. **Crenicichla acutirostris** Günther.

This species appears to be distinct, but I took no specimens.

51. **Crenicichla strigata** Pellegrin.

D. XXIII, 15; A. III, 11; pores  $\frac{26}{16}$ ; scales about 115; depth 5.5 to 6; head 3.25; eye 5.5 to 6 in head; snout 3.5 in head; interorbital space equal to length of snout and almost twice the diameter of the eye;

a broad lateral band from the eye to the tip of the caudal; four zigzag lines between and behind the eyes, two of them end at the upper edge of the operculum and the other two run along the sides near the base of the dorsal, where they unite with several short cross-bars on either side of the dorsal fin; fins dark-edged, but unspotted; no distinct caudal spot; scales faintly denticulated; five series of teeth in the upper and four in the lower jaw.

No. 2714a-b, 14 and 15 cm., Belem, Pará, Jan. 15, 1910.

52. *Crenicichla lugubris* Heckel.

No. 2717, 17 cm., Manaos, Nov. 18, 1909.

D. XXII, 16; A. III, 12; pores  $\frac{27}{15}$  or 16; scales 115 to 124 in first series below the lateral line; depth 4.5 to 5; head 3.5; snout 3 in head; eye 5.5 in the head.

No. 2718, São Antonio de Guaporé, July 26, 1909.

This example has faint traces of brownish spots on the under side of the head and both have traces of bars under the eyes, otherwise as described by Regan.

53. *Crenicichla cincta* Regan.

No. 2715, 17 cm., Belem, Pará, Jan. 15, 1910.

D. XXII, 15; A. III, 12; head 3; eye 5; depth 4.67; scales about 115; pores  $\frac{30}{15}$ ; color as given by Regan excepting that there are no spots in the dorsal.

54. *Crenicichla lenticulata* Heckel.

*C. ornata* Regan.

No. 2641a-d, 19-24 cm., Manaos, Nov. 15-Dec. 2, 1909.

D. XXII or XXIII, 17; A. III, 12; pores  $\frac{27-29}{17}$ ; scales 113 to 130; depth 5; head 3.33; eye 5.5 to 6.

The shorter one is colored like Regan's figure, but the larger one has no spots on the head, and the spots on the fins as well as on the body are broken up into blotches.

*C. ornata* Regan is a synonym of *C. lenticulata* Heckel. Regan's type is a smaller individual.

55. *Crenicichla johanna* Heckel.

No. 2716, 27 cm., São Antonio de Guaporé, Aug. 3, 1909.

D. XXII, 18; pores  $\frac{26}{17}$ ; scales 129; depth 4.5; head 3.5; eye 5.67 in head; uniform dark brown with no spots or bars.

## Genus RETROCOLUS Eigenmann and Bray.

56. *Retroculus lapidifer* (Castelnau).

No specimens were taken by me. *Habitat.*—"Amazonas."

## Genus HETEROGRAMMA Regan.

57. *Heterogramma agassizi* (Steindachner). (Plate LXIV.)

No. 2729, Manaus, Nov. 30, 1909. 3.6 cm.

Snout four-fifths as long as the diameter of the eye; D. XV, 6; A. III, 6; scales 2.5-23-8; depth 2.75; head 3; pores  $\frac{12}{3}$ ; diameter of eye equal to the interorbital space and four times the preorbital width; vertical fins red- and white-spotted; no caudal spot; a faint lateral band, but no cross-bars; a bar below the eye; pectoral fin about as long as the head; no distinct gill-rakers on the lower branch of the first arch; last dorsal spine seven-elevenths the length of the head; caudal peduncle seven-eighths to as long as deep.

No. 2730a-b, 1.2-2.5 cm., Santarem, Dec. 11, 1909.

Last dorsal spine five-ninths as long as the head; snout a little shorter than the diameter of the eye; lateral line in some cases with only a few pores and in others almost complete; D. XV, 7; A. III, 7; head 3; eye 3; depth 3 to 3.33; two rows of scales on the cheeks, and none on the preoperculum; scales 2-22 to 25-7; pectoral fin as long as the head; caudal peduncle as long as or a little longer than deep; a dark lateral band from the eye to base of caudal, with faint caudal spots and median lateral spots in a few cases; bands from the eyes to the mouth; only three have bars from beneath the eyes to the interoperculum; vertical fins with ashy white bars and spots; scales speckled with brown spots; depth of preorbital not one-half the diameter of the eye. These specimens do not agree with the description of the typical specimen. No. 2731a-c, 1.7-2.1 cm., San Joaquin, Bolivia, September 4, 1909.

Lateral lines incomplete; snout much shorter than the eye; last dorsal spine not quite one-half the length of the head; depth 2.8; head about 2.8; diameter of eye more than one-third the length of the head; no gill-rakers on the first arch; caudal peduncle about as long as deep; coloration like a typical specimen plus a spot on the lateral band.

58. *Heterogramma tæniatum* (Günther). (Plate LXV.)

No. 2732a-c, 2-3.6 cm., Bragança, Pará, Dec. 29, 1909.

One gill-raker on the lower anterior arch (one specimen with no

gill-rakers on the first arch); the snout in the largest specimen as long as the diameter of the eye; no distinct cross-bars; a lateral band and a caudal spot; last dorsal spine one-half as long as the head; no lines or stripes on the scales of the lower half of the body. No. 2733a-c, 2-2.5 cm., São Antonio de Guaporé (B. A. Maciel's rubber forest), Aug. 11, 1909.

These specimens might equally well be placed under *H. corumbæ* Eigenmann and Ward. One has no signs of lateral scale-stripes, one has faint signs of stripes, and one has stripes which resemble somewhat those of *H. corumbæ*. In some the lateral line is almost wanting, while others have twelve or more pores independently of whether there are lines on the sides, as in *H. corumbæ*, or not, as in *H. tæniatum*. One of these specimens has two lateral spots on the lateral line where it is intersected by the cross-bands. The most of the specimens of this genus have black membranes between the first two or three dorsal spines.

No. 2734a-d, 1.8-2.2 cm., São Antonio de Guaporé, Rio Guaporé, July 9, 1909.

Twelve pores in the lateral line; caudal peduncle four-fifths to as long as deep; snout shorter than the diameter of the eye.

No. 2735, Rio Tapajos at Santarem, Dec. 10, 1909.

No. 2736, 2.7 cm., Santarem, Dec. 15, 1909.

A slender lateral band and faint cross-bands; caudal spot; barred and spotted fins; all of the scales dusky-edged above and below the lateral line, but there are no stripes like those in typical *H. corumbæ*. No. 2737, 3.8 cm., São Luiz de Cáceres, Rio Paraguay, May 27, 1909.

Prolonged dorsal and anal rays; red and white spots with a pinkish tinge on the vertical fins; a caudal spot and lateral band; bars below the eyes and another from the eyes to the mouth; caudal peduncle about seven-eighths as long as deep; snout about equal to the diameter of the eye, which goes 3.5 times in the head, and is greater than the interorbital space; depth of the preorbital about one-fourth the diameter of the eye; depth 2.75 in the length; two or three gill-rakers on the lower branch of the anterior arch; scales 2-23-7; pectoral fin about as long as the head; three rows of scales on the cheeks and none on the preoperculum; last dorsal spine eight-thirteenths as long as the head; maxillaries extending to below anterior third of the eyes; D. XVI, 6; A. III, 6; membranes between the first dorsal spines not black.

No. 2738*a-c*, 1.7-1.9 cm., São Antonio de Guaporé, July 28-31, 1909.

No. 2739, 1.5 cm., Manaus, in a creek, Nov. 29, 1909.

No. 2740*a-b*, 1.1 cm., Posada, Campos de Matto Grosso, swampy plains of Rio Alegre, June 21, 1909.

They have caudal spots, bars below the eyes, dorsal dark-edged, and one has a faint lateral band with a spot on it.

The last seven specimens agree equally well with *H. corumbæ* or *H. tæniatum*, and not exactly with either. None have the typical stripes of *H. corumbæ*, but in other details they are nearly identical.

*Geophagus amanus* is a synonym of this species.

59. **Heterogramma tæniatum pertense**, var. nov. (Plate LXVI.)

No. 2741, *type*, 2.7 cm., Manaus, Nov. 29.

Depth 3.37; head 3.25; eye 2.67 in the head, greater than the snout and the interorbital space, and fully three times the preorbital width; membranes between the first dorsal spines not black; vertical fins red- and white-spotted; each row of scales both above and below the lateral line with dark-edged scales. Otherwise like *H. tæniatum*.

No. 2742, 2.2 cm., Santarem, Rio Tapajós, Dec. 10, 1909.

Like the above specimen except that there is no distinct lateral band.

60. **Heterogramma corumbæ** Eigenmann and Ward. (Plate LXVII.)

No. 2752, 2.5 cm., São Luiz de Cáceres, Rio Paraguay, May 24, 1909.

Indistinct stripes along the scales of the lower half of the body.

No. 2753, 3 cm., Corumba, Rio Paraguay, May 9, 1909.

Only two faint stripes behind the base of the pectorals; depth 3; head 2.5; caudal peduncle three-fourths as long as deep; upper lateral line with twelve developed pores; diameter of the eye 3 in the head; A. III, 5; otherwise as described by Regan.

No. 2754, 2.3 cm., Villa Hays, Paraguay, April 13, 1909.

The stripes typical of this species are very distinct, but the vertical fins are almost colorless.

No. 2755, 3 cm., São Luiz de Cáceres, Rio Paraguay, May 27, 1909.

61. **Heterogramma ortmanni** Eigenmann.

No. 2757*a-k*, 1.7-3 cm., Bastos, Rio Alegre of the Guaporé, June 26, 1909.

No. 2756, 3.1 cm., Manaus, Nov. 30, 1909.

A. III, 5; D. XV, 6; depth 2.5; head 3; interorbital space 3.33 in the head; last dorsal spine a little more than half the length of the head; otherwise like the typical form.

This species, from the Amazon basin and Guiana, differs but little from the Paraguayan *H. corumba*.

62. **Heterogramma trifasciatum** Eigenmann and Kennedy. (Plate LXVIII.)

No. 2743, 2.8 cm., São Luiz de Cáceres, Rio Paraguay, May 24, 1909.

Depth 3; head 3; diameter of eye 2.75 to 3; spines subequal from the fourth, which is fully one-half the length of the head, membranes between the dorsal spines greatly prolonged; prolonged ventral rays white and extending beyond the base of the caudal; caudal peduncle a little deeper than long; a broad lateral band; soft dorsal and anal spotted; a band in front of the eye and another one beneath the same; scales 2.5-23-8; an oblique band or stripe from the pectoral to the origin of the anal.

No. 2744*a-b*, 2-2.3 cm., Villa Hays, Paraguay, April 13, 1909.

Head 2.5; vertical fins spotless; anal and ventrals with black margins.

No. 2745*a-e*, 1.4-3 cm., São Luiz de Cáceres, May 26, 1909.

The smallest one is almost colorless.

No. 2746*a-b*, 1.5-3 cm., Campos Alegre, Rio Jauru, June 4, 1909.

No. 2748*a-j*, 1.8-2.5 cm., Bastos, Rio Alegre of the Rio Guaporé, June 26, 1909.

Twenty-two scales in the series below the lateral line; caudal peduncle as long as deep in some cases. These specimens are slightly more slender and less compressed than the typical Paraguayan forms, but otherwise they are identical.

No. 2750*a-i*, 1.2-2.8 cm., São Antonio de Guaporé, July 31-Aug. 11, 1909.

Color very faint; a faint spot in the middle of the lateral band; vertical fins spotless; preorbital one-fourth the diameter of the eye; lateral line incomplete; depth 3.2; pectorals as long as, or longer than, the head; little or no signs of oblique stripes from the pectorals to the origin of the anal. These specimens are intermediate between the typical form and the variety *maciense*.

No. 2758*a-b*, 1.7-2 cm., Campos Alegre, Rio Jauru, June 2, 1909.

No. 2759, 2 cm., São Luiz de Cáceres, Rio Paraguay, May 23, 1909.

63. **Heterogramma trifasciatum maciense**, var. nov. (Plate LXII, fig. 2.)

No. 2751*a-d*, 1.3-3.1 cm., São Antonio de Guaporé, July 9, 1909.



The largest specimen has D. XII, 7; the last dorsal spine is a little more than one-half the length of the head; depth 3.2; head not quite 3; eye 2.75 in the head and greater than the length of the snout and the interorbital space; depth of the preorbital about one-third the diameter of the eye; twelve or thirteen pores in the upper lateral line; scales 3-27-7; a dark lateral band; a very faint stripe from the pectorals to the anal in the largest specimen, but no stripes in the smaller ones; the membranes between the dorsal spines twice as long as the spines; fins spotless; no caudal spot. This variety is quite different from the typical Paraguayan form, but all stages of intergradation are present, and I have described it only as a variety in order to note the difference from the typical forms, which are also found in the Rio Guaporé.

64. **Heterogramma borellii** Regan. (Plate LXIX.)

*H. pleurotania* Regan.

No. 2760a-c, 2.2-2.5 cm., Villa Hays, Paraguay, April 11, 1909.

Last dorsal spine two-fifths the length of the head; depth 2.27 to 2.5; D. XV or XVI, 6; A. III, 5 or 6; three series of scales on the cheeks; lateral line incomplete; maxillaries extending a little beyond the front edge of the eyes; no distinct gill-rakers on the lower anterior arch; head 2.84 to 3 in length; interorbital space 2.6 in the head; pectorals not quite as long as the head; caudal rounded; a heavy oblique bar from the eye to the interoperculum; anal and ventral fins dark-edged; fins spotless, or as in *H. pleurotania*.

No. 2761, 3 cm., Corumba, Rio Paraguay, April 27, 1909.

D. XV, 6; A. III, 6; head 3; depth 2.5; last dorsal spine one-half the length of the head; scales 3-23-8; a black bar beneath the eyes; a dark broken lateral band traversed by faint cross-bars; anal and dorsal rays very long.

No. 2762, 2 cm., Corumba, Rio Paraguay, April 27, 1909.

D. XVI, 6; A. III, 7; vertical fins with black margins; base of the dorsal with a series of black blotches; the bars beneath the eyes almost meeting on the ventral side; last dorsal spine two-fifths the length of the head; a broken lateral band composed of seven blotches.

No. 2763a-c, 2.4 to 3.8 cm., Puerto Suarez, Bolivia, May 6, 1909.

Dark brown in color with blue spots on the head; the soft dorsal and the anals with a few spots; depth about 2.5; interorbital 3.67 in the head; last dorsal spine two-fifths the length of the head; a broken lateral band traversed in some cases by faint cross-bands.

No. 2764a-h, 2.4 to 3.8 cm., Puerto Suarez, Bolivia, May 6, 1909.

Dark brown with blue spots on the head; a broken lateral band with faint cross-bands; depth 2.33 in the largest specimen; head about 3; last dorsal spine two-fifths to one-half the length of the head; three or four series of scales on the cheeks.

After a careful study of these specimens I do not hesitate to regard *H. pleurotænia* Regan as a synonym of *H. borellii* Regan.

65. **Heterogramma ritense**, sp. nov. (Plate LXX.)

No. 2765a-d, Santa Rita, Rio Santa Rita of the Paraguay basin, June 12, 1909.

The *type*, No. 2765a, is 2.5 cm. long; the *cotypes*, Nos. 2765b-d, are 2 to 2.4 cm. long.

D. XV, 6; A. III, 6; depth 2.2; head 2.5; eye 3 in head, greater than the length of the snout and the interorbital space; preorbital about one-third the diameter of the eye; three rows of scales on the cheeks; three gill-rakers on the lobe and two on the lower branch of the first gill-arch; upper lateral line with seven to nine pores, the lower branch wanting; preoperculum scaleless; maxillaries extending to the front margins of the eyes; scales 2.5-21-7 (21 in a median lateral series); caudal peduncle half as long as deep; pectorals about as long as the head; seven more or less distinct cross-bands, but no lateral band; small caudal spot; faint band from the eyes to the mouth; bars beneath the eyes continued above the eyes on the top of the head; fins, excepting the base of the dorsal, which is black, colorless; dorsal spines about subequal from the fourth, which is one-half the length of the head.

The coloration, shorter and deeper body, fewer scales, gill-rakers, and shorter caudal peduncle separate this species from its nearest ally, *H. borellii*.

#### Genus GEOPHAGUS Heckel.

66. **Geophagus surinamensis** Bloch.

No. 2815, 6.3 cm., Santarem, Rio Tapajos, Dec. 6, 1909.

Nineteen dorsal spines, the fifth of which is more than one-half the length of the head.

No. 2817, 7 cm., Belem, Pará, Dec., 1909.

No. 2818a-b, 11 cm., São Antonio, Rio Guaporé, Aug. 10, 1909.

D. XVII, 11; A. II, 7; scales 8-34-11; pores  $\frac{21}{13}$ ; depth 2.5; head 3.25; fifteen gill-rakers on lower anterior arch; caudal peduncle one and

one-fourth times as long as deep; snout 2; eye 4; alternating light and dark bands on caudal fin; the other fins spotless.

No. 2819, 12 cm., Alcobaca, Rio Tocantins, Jan. 10, 1910.

The dorsal fin has eighteen spines, and is scaly at its base.

No. 2820a-c, 2.5 to 12.2 cm., Santarem, Dec. 12, 1909.

Vertical fins spotted, one with eighteen dorsal spines; the prolonged white ventral rays reach almost to base of caudal.

No. 2821, 16 cm., São Antonio de Guaporé, Rio Guaporé, July 23, 1909.

67. *Geophagus brasiliensis* Quoy & Gaimard.

No. 2768, 12 cm., Entre Rios, Rio Parahyba, June 10, 1908.

No. 2769a-t, 3.3 to 10.5 cm., Cachoeira, Bahia, Rio Paraguassú, April 14, 1908.

D. XV or XVI, 12; depth 2.33 to 2.5; caudal peduncle not quite as long as deep.

No. 2770a-h, 3.2 to 9.3 cm., Entre Rios, Rio Parahyba, June 1, 1908.

No. 2771, 9.9 cm., Campos, Rio Paraguay, June 15, 1908.

No. 2772a-e, 7-10 cm., Raiz de Serra near Santos, July 26, 1908.

Caudal peduncle longer than deep; depth 2.5.

No. 2773a-c, 11.2 to 12.7 cm., Porto Alegre, Rio Grande do Sul, Jan. 20, 1909.

These specimens are slightly deeper; the snout is shorter; D. XV, 11; the caudal peduncle is not as long as deep, in contrast to the Entre Rios specimens. They appear to be transitional between *G. brasiliensis* and *G. brachyurus*.

No. 2774a-c, 2.7 to 11.5 cm., Entre Rios, Rio Parahyba, June 2, 1908.

No. 2775a-u, 2.3 to 8.7 cm., Campos, Rio Parahyba, June 14, 1908.

D. XIV, 12; caudal peduncle three-fourths as long as deep; pectorals extending slightly beyond the origin of the anals; depth 2.25; head 2.75; eye 3.5 in the head.

No. 2776a-b, 10 and 11 cm., Porto Alegre, Rio Grande do Sul, Jan. 22, 1909.

No. 2777a-e, 6.8 to 9.3 cm., Raiz da Serra, Rio Mogy near Santos, July 27 and 28, 1908.

These specimens are more slender than examples having the same length taken in lagoons and slowly flowing water.

No. 2778a-s, 2.5 to 8.2 cm., Muniz Freire, Espirito Santo, Rio Itapemerim, June 9 and 18, 1908.

No. 2779a-d, 2.2 to 6 cm., São João da Barra, Rio Parahyba, June 24, 1908.

No. 2780, thirty-nine specimens, 1 to 8 cm., Campos, Rio Parahyba, June 13 and 15, 1908.

No. 2781a, 1.8 cm., Xiririca, Dec. 5, 1908.

No. 2781b-i, 3.4 to 4 cm., Iguapé, Rio Ribeira, Dec. 15, 1908.

No. 2782a-k, 2.5 to 6.4 cm., Minas, Rio Doce, May 26, 1908.

No. 2783a-b, 2.7 cm., São João da Barra, Rio Parahyba, June 22, 1908.

No. 2784a-c, 2.5 to 4.5 cm., Tocas, Lagoa Feia, June 27, 1908.

No. 2785, 3.5 cm., Rio Pelão, near Santos, July 31, 1908.

No. 2786a-f, 2.3 to 3.5 cm., Minas, Rio Doce, May 27, 1908.

No. 2787, 1.8 cm., Xiririca, Rio Ribeira da Iguapé, Dec. 5, 1908.

No. 2788, 11.2 cm., Lagoa Feia, Rio de Janeiro, June 16, 1908.

This specimen is very dark, and has peculiar tubercles on the gill-arches, which appear to be eggs, but are not.

No. 2789a-c, 4 to 9 cm., Morretes, Paraná, Jan. 2, 1909.

The largest specimen has the caudal peduncle longer than deep; depth 2.5, like the Raiz da Serra specimens, which also came from a rapid rocky stream.

No. 2790a-c, 3.4-4 cm., Morretes, Paraná, Jan. 4, 1909.

These smaller specimens are much more like the typical *C. brasiliensis*, having deeper bodies and shorter caudal peduncles than the larger examples from the same place; hence I infer that the change in the shape and form with age in such environment is due to individual adaptation and is not a fixed characteristic.

No. 2791, 11 cm., Porto Alegre, Rio Grande do Sul, January 21, 1909.

This specimen agrees with *G. brachyurus* in all details, excepting the length of the pectorals, a very variable character.

68. ***Geophagus brasiliensis iporangensis***, var. nov. (Plate LXXI.)

No. 2792a-e, 4.5-8.7 cm., Iporanga. From a mountain stream of the Rio Ribeira da Iguapé, Dec. 1, 1909. *Type*, No. 2792a.

D. XV, 11; A. III; depth 2.5; head 2.75; snout 2.12; diameter of eye 4 in the head; equal to the preorbital and interorbital space; maxillaries extending about midway between the posterior nares and the front margins of the eyes; fold of the lower lip interrupted; five series of scales on the cheeks; nine gill-rakers on the lower anterior arch; scales 4-28-9; one to two scales between the lateral line and the first dorsal rays; dorsal spines increase till the last one, which is two-fifths

the length of the head; soft fins scaleless; fin truncate; caudal peduncle one and one-fourth times as long as deep; pectorals not extending to the anal spines; fins almost spotless, being dark at their bases and black-edged; end of caudal peduncle and base of the caudal black, appearing like a large spot; a dark median lateral spot and a few or no blue spots on the head and the body.

The type is 8.7 cm. long and is an extreme in color and shape. There is greater difference between these specimens and the same-sized typical *G. brasiliensis* than there is between *G. brasiliensis* and *brachyurus*. If the intermediate stages did not exist, these specimens might warrant giving them specific rank.

69. **Geophagus brasiliensis itapicuruënsis**, var. nov. (Plate LXXII.)  
No. 2793a-g, 7-11.3 cm., Queimadas, Rio Itapicuru, March 2, 1908.

Caudal peduncle three-fourths as long as deep; one with D. XIII, 13; depth 2; head 2.63; eye 4; snout 2.1; interorbital space 3 in head; scales 5-26-8; dorsal, anals, and ventrals edged with black, only a few spots on the last dorsal and anal rays; four broad lateral bands with a median lateral spot on one of them below the ninth to the tenth scales of the lateral line; ten gill-rakers on the lower anterior arch; the long dark lateral spot is characteristic of all specimens from the Itapicuru. These specimens spawn like the sun-fish. The type is 11.3 cm. long.

No. 2794, 10.5 cm., Rio Paiaia, near Bom Fim, Nov. 8, 1907.

D. XIV, 12; A. III, 8; depth 2.5; head 2.75; eye 3.8; snout 2.16; scales 4-27-8; pores  $\frac{19}{10}$ ; gill-rakers on the lower anterior arch; caudal peduncle seven-eighths as long as deep; pectoral fins extend to the anal spines; vertical fins with a few spots, otherwise dark; no blue spots on the body; four heavy broad black cross-bands on sides and a heavy band below the eye; five rows of scales on the cheeks.

No. 2795, 9.5 cm., Rio Zinga, near Bom Fim, Bahia, Nov. 7, 1907.

Depth 2.33; head 3; caudal peduncle seven-eighths as long as deep. The shorter caudal peduncle, color, and rounder body are characteristic of all specimens from the Itapicuru. The form from the Paraguassu is intermediate between this variety and the typical Parahyban form.

70. **Geophagus balzanii** Perugia.

No. 2797, 4.5 cm., Campos Alegre, Rio Jauru, June 21, 1909.

No. 2798, 6.5 cm., Uruguayana, Rio Uruguay, 1909.

No. 2799a-e, 2.8-5.4 cm., Corumba, Rio Paraguay, April 27, 1909.

The smallest specimen has a caudal peduncle as long as deep; depth 2-2.4 in length of body.

No. 2800, 7.5 cm., Corumba, Rio Paraguay, April 28, 1909.

No. 2801a-e, 7.8-12.2 cm., São Luiz de Cáceres, Upper Rio Paraguay, May 27, 1909.

D. XIII or XIV, 13; A. III, 9; pores  $\frac{22}{9}$ ; depth 1.8; head 2.8; eye 4 in head; snout 1.67 in head; some have the fold of the lip interrupted, and some have soft dorsal not scaly, and some are fairly well scaled at their base.

No. 2802a-e, 3-5 cm., Puerto Suarez, Bolivia (Steinbach Collection).

Depth 2.33; head 2.8; snout 3 in the head; eye 2.5; interorbital space 3.5; preorbital 4; caudal peduncle about as long as deep, soft dorsal ranging from scaleless to fairly well scaled.

The young of this species appear to be different from the adults, which also have the soft dorsal ranging from scaleless to scaled (in one case some of the membranes between the last dorsal spines are scaly); some have spotted vertical fins and others do not, and some have the fold of the lower lip interrupted, while others are continuous. In view of all this the genus *Satanoperca* does not appear to be tenable.

#### 71. *Geophagus brachyurus* Cope.

No. 2871a-e, 5-6 cm., Uruguayana, Rio Uruguay, Feb. 7, 1909.

D. XII to XIV, 9 to 10; depth about 2.33; head 3; eye 3.5 to 4 in head, a little more than the preorbital and a little less than the interorbital width; scales 4-24 to 27-8 or 9 (counted in a median lateral series); eight gill-rakers on lower anterior arch; three or four rows of scales on the cheek; caudal peduncle about as long as deep; nares half-way between tip of the snout and the eyes; sides with about six double bands, the third having a dark spot; band below eyes meeting on top of head; vertical fins more or less white-spotted, some specimens with white bands on the spinous dorsal. One has a pectoral fin which reaches almost to the base of the caudal; at least the outer halves of the ventrals dark blue; some with brown pigment at the bases of the scales along the sides; two series of scales between the lateral line and first dorsal rays.

No. 2812a-e, 1-4 cm., Cacequy, Rio Grande do Sul, Feb. 1, 1909.

The very pointed snout is four-fifths the length of head; vertical fins

almost colorless; one scale between lateral line and first dorsal rays. No. 2813a-b, 2.5-4 cm., Cachoeira, Rio Grande do Sul, Jan. 26, 1909.

No. 2814, 7 cm., Porto Alegre, Rio Grande do Sul, Jan. 21, 1909.

D. XIV, 9; A. III, 8; depth 2; eye almost 4; preorbital about equal to interorbital and 4 in head; fold of lower lip not continuous; maxillaries not extending to the eye; eight to ten gill-rakers on the lower anterior arch; scales 5-24-10 (counted in a median lateral series); caudal peduncle .75 as long as deep; seven rows of scales on cheek; one scale between lateral line and first dorsal rays; caudal emarginate; pectorals extending beyond the origin of anal; bar through the eye and rather obscure cross-bars with a lateral spot; blue lines between the cheeks and preoperculum and some blue spots on the cheeks and the operculum; fins blue-black, especially the dorsal and ventrals, without spots; some faint bars on the dorsal; each scale with dark brown, which appears as broken lateral bands. Most of my specimens do not have pearly spots on the sides.

*Geophagus brachyurus* is very similar to *G. brasiliensis*, changing into the longer form, *G. gymnogenys*, on the one hand, and into *G. balzanii*, the rounder one, on the other. The extremes are quite distinct, but when one has all of the intermediate stages he could consider the three species identical. I have left them separate for convenience in speaking of the local variations.

*Geophagus australe* Eigenmann (1907) is identical with the smaller specimens of *G. brachyurus* except for the lateral spot, which is often lost with age.

#### 72. *Geophagus cupido* Heckel.

No. 2822a-d, 6.4-11 cm., São Antonio de Guaporé, Rio Guaporé, Aug. 10, 1910.

Snout 2.25; D. XVI, 10 and 11; three specimens have the fold of the lower lip interrupted, and one has it continuous; eye equal to the preorbital and the interorbital space.

No. 2823 a-b, 4.3 cm., São Antonio de Guaporé, Rio Guaporé, July 26, 1909.

The dorsal spine membranes are black-edged; the interorbital space is less than the diameter of the eye.

No. 2824, 6.5 cm., São Antonio de Guaporé, Rio Guaporé, July 31, 1909.

No. 2825, 5 cm., Santarem, Dec. 6, 1909.

Snout and interorbital space less than the diameter of the eye.  
No. 2826a-b, 7 and 9 cm., Villa Bella, Rio Beni, Bolivia.

D. XV, 10; A. III, 9; depth 2.25; head 3.25; eye 3; snout 2.16; scales 6-29-13; eight gill-rakers; pores in lateral line  $\frac{18}{13}$ ; indistinct cross-bands; caudal distinctly emarginate.

No. 2827, 10 cm., Bastos, Rio Alegre of Guaporé, June 26, 1909.

73. **Geophagus gymnogens** Hensel.

*G. brachyurus* Cope *partim*, *G. camurus* Cope.

No. 2803a-d, 11 and 12 cm., and a lot of young fish which came out of the mouth of some older one, Porto Alegre, Rio Grande do Sul, Jan. 22, 1909.

Depth 2.66; head 3.33; snout 2.2; scales nearly all gone from the cheeks (excepting parts of two or three rows); eight gill-rakers on lower anterior arch, pectorals longer than the head, reaching to the anal spines; the males with swollen heads.

No. 2804a-c, 10.8-11.5 cm., Porto Alegre, Jan. 24 and 27, 1909.

D. XIII or XIV; A. III, 8; depth 2.6; head 3+; eye about 4; scales 4-29-9.

No. 2505a-j, 7-10 cm., Porto Alegre, Jan. 20, 1909.

The females are always less highly colored.

No. 2806a-m, 3-9.7 cm., Porto Alegre, Jan. 21, 1909.

No. 2807a-b, two females, 5.7 and 7 cm., and some young, Cachoeira, Rio Grande do Sul, from Rio Jacuhy, Jan. 27, 1909.

The young ones were seen entering the mouth of an adult, which upon removal from the water ejected them. This same specimen has six complete rows of scales on the cheeks, and the loss of scales cannot be associated with the breeding season.

No. 2808a-c, 2.8-8.3 cm., Cachoeira, Rio Grande do Sul, Rio Jacuhy, Jan. 29, 1909.

These specimens also have five or six rows of scales on the cheeks. If there are no scales their absence is due to the death of the fish before it was placed in alcohol. Those which were put into alcohol alive have scales, while those taken from the market always had few or no scales on the cheeks.

No. 2809a-d, 3-6 cm., Uruguayana, Rio Uruguay.

No. 2810a-g, 4-7 cm., Cacequy, Rio Ibicuhy, Rio Grande do Sul, Feb. 2, 1909.

These specimens (both sexes) are more slender and much less colored



than the Porto Alegre specimens; all have scales on the cheeks and nearly all have a bar through the eye, faint bars and a spot on the sides. (Some of Cope's specimens labeled *G. brachyurus* belong to this species. *G. camurus* is also a synonym.)

74. ***Geophagus dæmon*** Heckel.

*G. acuticeps* Heckel.

No. 2842, 5.3 cm., Manaus, Nov. 29, 1909.

Twenty-one gill-rakers on lower anterior arch; depth 2.5; head 3; eye equal to the interorbital, a little more than the preorbital and a little less than the snout, all of which are about one-third of length of head; seven rows of scales on cheeks; A. III, 8; D. XIII, 12; scales 5-28-9 (in a median lateral series); caudal peduncle one and one-fourth times as long as deep; the pectoral fin reaching to anal; dorsal spines about subequal from the fifth, which is about two-thirds as long as the head; soft dorsal and anal not scaly at base; fold of upper lip continuous (another case where the fold of the lower lip is not of diagnostic character); caudal fin truncate; two rows of scales between lateral line and first dorsal rays. Olivaceous, with seven more or less distinct cross-bands and a faint caudal spot; soft dorsal and caudal with faint white and dark bars and spots; three or four spots in soft anal.

No. 2843a, 13 cm.; Manaus, November 27, 1909.

D. XIII, 11; A. III, 7; depth 2.5; head 3; pores  $\frac{19}{11}$ ; twenty-nine scales in a median lateral series; pectoral fin reaching past anal spines and much longer than the head; snout about 2 in head; interorbital space 3 in head; preorbital equal to the eye; caudal peduncle distinctly longer than deep; anal, ventral, and dorsal rays prolonged, those of soft dorsal reaching far beyond the tip of caudal and about four-fifths of the length of the body to base of caudal; two silvery blue lines from eye to mouth and several blue spots on head and scales of sides of body; soft vertical fins with bars and spots; a caudal spot; gill-arches in bad condition, but there are sixteen to nineteen gill-rakers on lower anterior arch; last dorsal spine about the length of the head; dorsal spines subequal from the fifth.

No. 2483b, 11.5 cm., Manaus, Nov. 15, 1909.

D. XIII, 12; pectoral fins much longer than the head; the dorsal spines increasing to the last one, which is two-thirds the length of the head; eighteen or nineteen gill-rakers on lower anterior arch; scales

4-31-9; eye 3.25 in head; snout 2.16 in head; depth 2.67; caudal peduncle one and one-fourth times as long as deep; fold of lower lip continuous; soft dorsal and anal scaleless; 2.33 scales between lateral line and first dorsal ray.

When variations due to size are considered, I am unable to draw any distinction between *G. acuticeps* and *G. daemon*. *Geophagus jurupari* and *daemon* are very closely related in the same manner as are *G. brasiliensis*, *gymnogenys*, *brachyurus*, and *balzanii*.

75. **Geophagus jurupari** Heckel.

*G. pappaterra* Heckel.

No. 2828, 17.3 cm., Bastos, Rio Alegre, June 28, 1909.

D. XVI, 10; A. III, 7; depth 2.67; head 3; eye 4.5 in head, 2.75 in snout; 2 in preorbital and 1.33 in interorbital space; pectoral fin as long as the head and extending slightly beyond the origin of the anal; six rows of scales on the cheeks; caudal peduncle one and one-fifth times as long as deep; sixteen gill-rakers; fourteen rows of scales between the dorsal and pectoral fins, of which the middle rows have thirty-one scales; dorsal and anal fins scaleless; dorsal spines only slightly increasing from the fifth to the last, which is half as long as the head. In life this specimen was yellowish-brown with a dark band from the operculum to the base of caudal, where it ends in a black spot on the upper half of base of caudal; six black spots beneath base of dorsal, these spots being remains of cross-bars seen in smaller specimens; fins uniformly dark in color; no blue spots on the head; two scales between the lateral line and first dorsal rays. This specimen differs a great deal from *G. jurupari*, but the series of smaller specimens makes me feel sure that *G. pappaterra* is a synonym of *G. jurupari*.

No. 2829, 15 cm., São Luiz de Cáceres, Rio Paraguay, May 24, 1909.

D. XV, 10; A. III, 7; depth 2.5; head 3; snout about 2; eye 4.5; scales 4-29-10; pores  $\frac{19}{10}$ ; seventeen and eighteen gill-rakers on the first two lower anterior arches; caudal peduncle about as long as deep; preorbital one and two-thirds times the diameter of the eye; interorbital space one and one-fourth the diameter of the eye; pectorals about the length of the head and extending to the origin of the anal; fold of lower lip subcontinuous; vertical fins with a few spots; median lateral band with broken cross-bands; spines about subequal from the fourth, which is not quite half as long as the head.

No. 2830, 8.5 cm., San Joaquín, Bolivia, in a muddy lake near Rio Marmoré, Sept. 4, 1909.

D. XIV, 10; A. III, 7; depth 2.33; head 2.75; eye 3.75; snout 2; scales 4-29-10 (counted in a median row); sixteen gill-rakers; five or six faint broken cross-bands; small spot on upper part of base of caudal; a few spots in base of soft dorsal; pectoral fins extend to anal spines; last dorsal spine a little more than half of length of head. No. 2831, 15.5 cm., Manaus, Nov. 29, 1909.

D. XVI, 9; sixteen gill-rakers; twenty-nine scales in a median lateral series; pectorals reaching past the first anal spine; head with blue spots; very faint broken lateral band and a small caudal spot; edge of dorsal black; caudal peduncle as long as deep; vertical fins with a few white spots. This specimen had a small one in its mouth.

No. 2832, 14 cm., Manaus, Nov. 27, 1909.

D. XV, 10; A. III, 6; sixteen gill-rakers; several of the scales on the sides have silvery white spots, otherwise like the above specimen. No. 2833, 8.3 cm., Santarem, Rio Tapajos, Dec. 6, 1909.

Fifteen gill-rakers; caudal peduncle not quite as long as deep; a stripe between the eyes and another across the head just back of the eyes; six or seven cross-bands; dorsal and anal fins spotted; a small caudal spot; pectorals not quite reaching the anal.

No. 2834, 4.3 cm., São Luiz de Cáceres, Rio Paraguay, May 24, 1909.

A. III, 8; scales 30; caudal peduncle as long as deep; pectorals extending to origin of anal; three stripes between the eyes and one back of them; the faint lateral band crossed by about seven broken bands; vertical fins spotted; two light brown bands from the eye to the mouth; sixteen gill-rakers.

No. 2835a-c, 4.1-6.5 cm., Bastos, Rio Alegre, June 27, 1909.

D. XIV, 11; caudal peduncle longer than deep; sixteen gill-rakers; scales thirty; lateral band crossed by six faint bands; two or three stripes between and back of eyes; two stripes from the eyes to mouth.

No. 2836, 4 cm., Bastos, Rio Alegre, June 26, 1909.

No. 2837, 3.5 cm., Campos Alegre, Rio Jauru, June 3, 1909.

No. 2839, 3.5 cm., Posada, Campos de Matto Grosso (swampy plains in headwaters of Rio Guaporé), June 21, 1909.

Depth of body equals length of head, 2.67 in length of body; D. XIV, 10; A. III, 6; scales 29; caudal peduncle not quite as long as deep; six very distinct cross-bars and a median lateral band; dorsal fin barred and spotted, other fins plain; stripes between the eyes; two

bars from the eyes to the snout; very dark brown in color; sixteen gill-rakers.

No. 2840a-b, 5.5-7 cm., Rio Jauru, June 2, 1909.

The cross-bands are very distinct both above and below the median lateral band; two blue stripes from eyes to mouth; vertical fins spotted. No. 2841, 13.5 cm., Santarem, Dec. 6, 1909.

Caudal peduncle one and one-fourth times as long as deep; seventeen gill-rakers; very faint latera! and cross-bands; two stripes between eyes; vertical fins spotted; a few blue spots on the operculum; dorsal spines subequal from the fourth, which is a little more than half of the length of the head; head 3 in length; depth 2.75; pectorals just reaching to origin of anal.

It is interesting to note that all fishes from clear or dark water full of plants are always darker in color than those from muddy rivers or along clean sand-bars. Also, cross and lateral bands tend to break up into lateral spots or else to disappear entirely in the adult. In view of the specimens and observations taken in the field, I do not hesitate to consider *G. pappterra* identical with *jurupari*. It was based upon a very large specimen and is one of the end variations of *G. jurupari*. All of the intervening stages exist in the same locality.

#### Genus BIOTÆCUS Eigenmann and Kennedy.

##### 76. *B. opercularis* (Steindachner).

No specimens were taken by the expedition.

#### Genus SYMPHYSODON Heckel.

##### 77. *Symphysodon discus* Heckel.

*S. aquifasciatus* Pellegrin.

No. 2844a-d, 10.5-12.5 cm., Manaus, Nov. 15, 1909.

No. 2845, 10 cm., Santarem, Dec. 6, 1910.

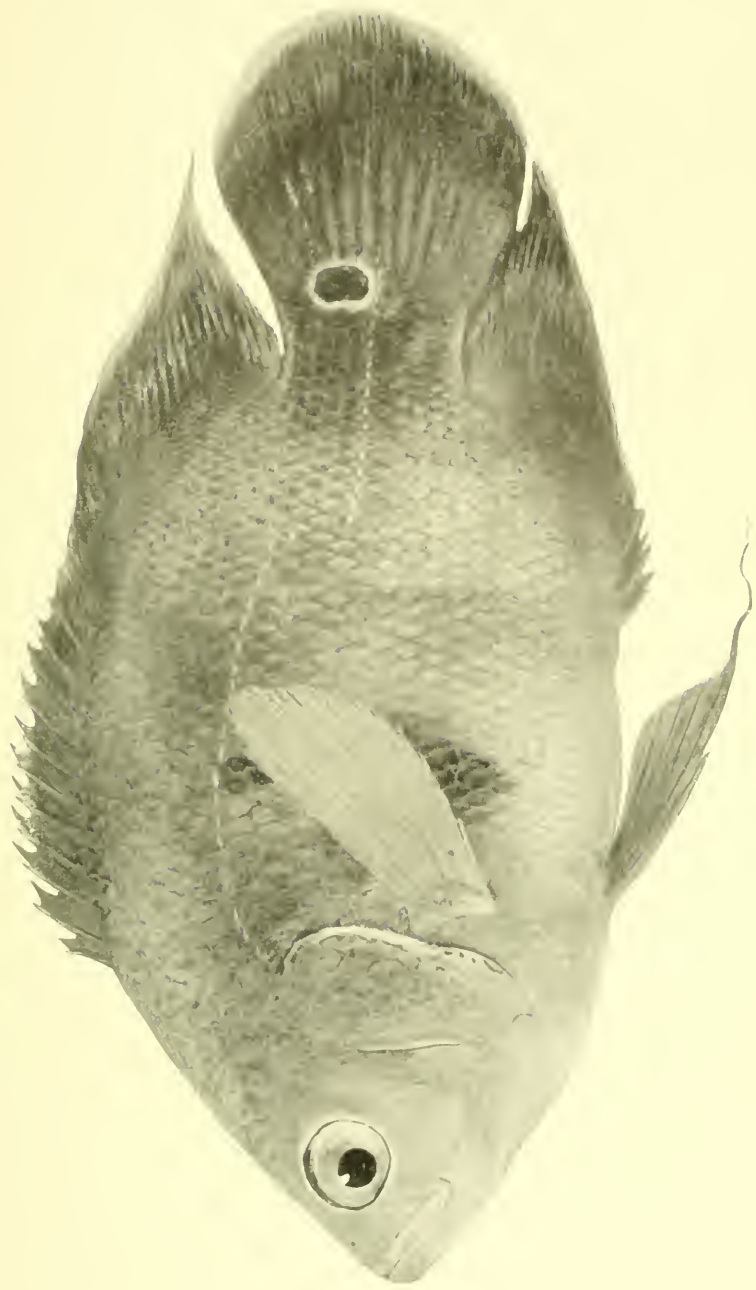
These specimens vary greatly in coloration in life. If put into alcohol after they have been dead for some time, the brilliant colors all entirely disappear. Pellegrin's variety *aquifasciatus* came from the market, and I consider it to be the same as *S. discus*.

#### Genus PTEROPHYLLUM Heckel.

##### 78. *Pterophyllum scalare* (Cuvier & Valenciennes).

*P. altum* Pellegrin.

No. 2846, 4-6 cm., Santarem, Dec. 7-15, 1909.



*Astronotus orbiculatus* Haseman. Type. 180 mm. C. M. Cat. No. 2515.

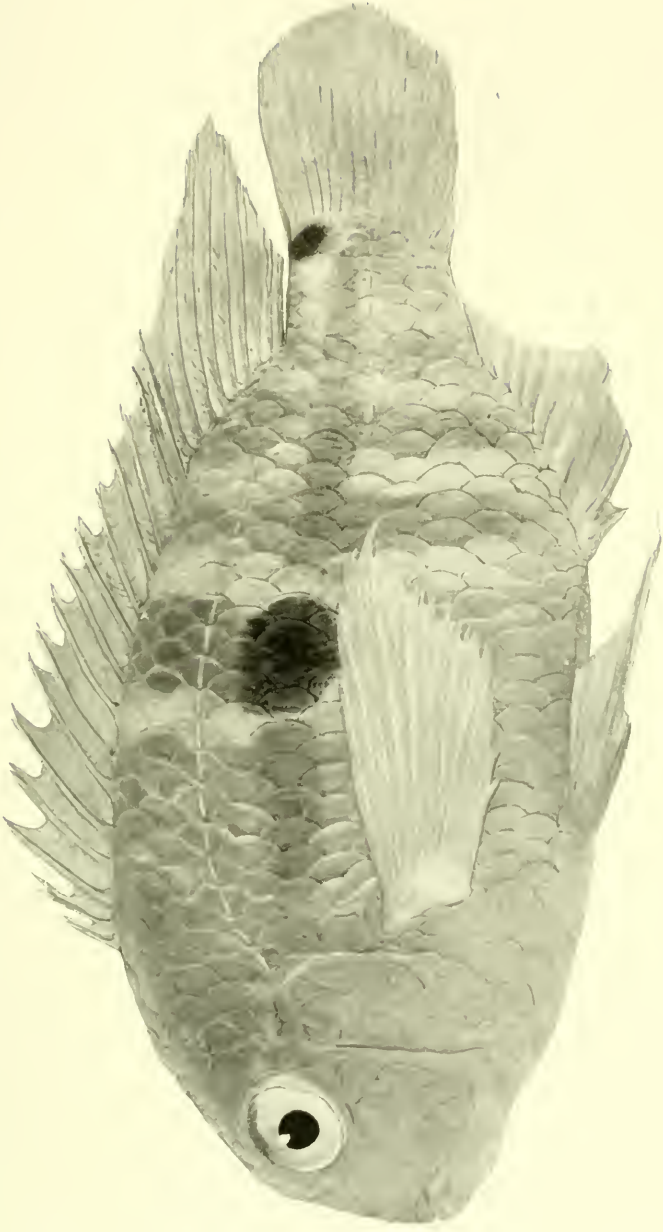




*Aequidens gadaborensis* Haseman, Type, 75 mm., C. M. Cat. No. 2575.

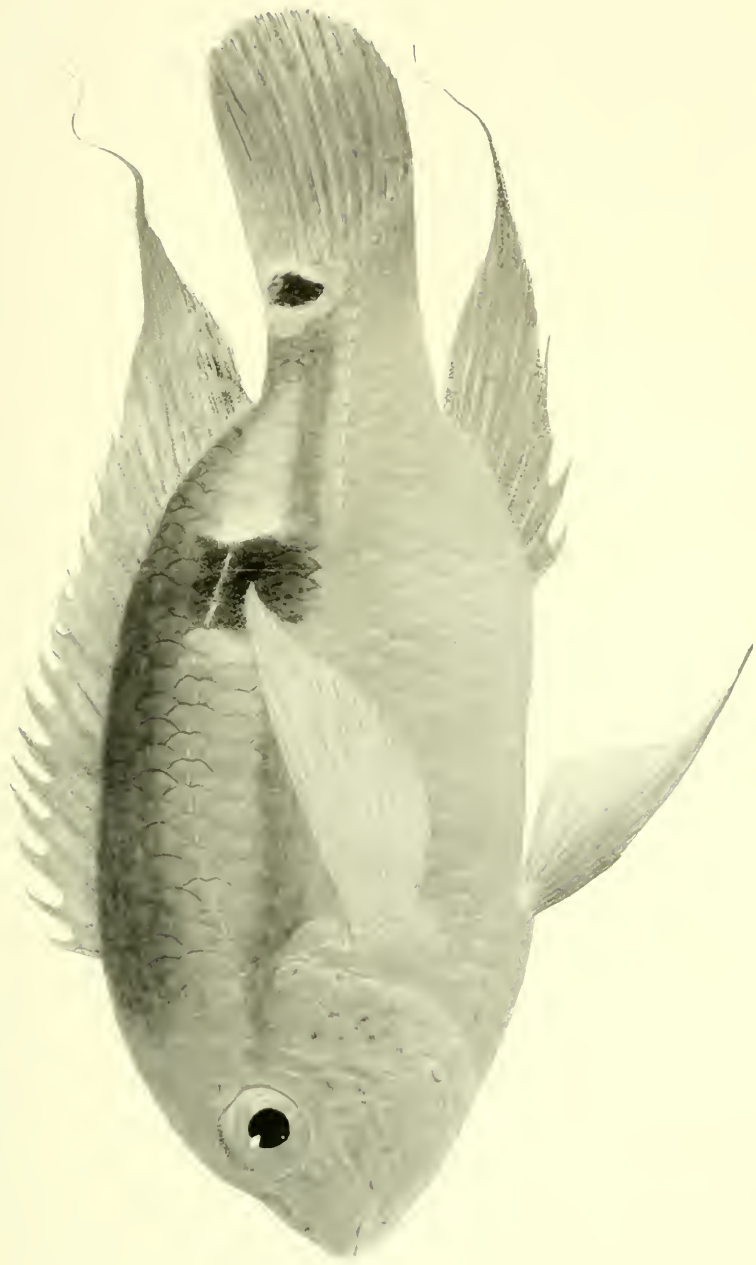






*Equidens arani* Haseman. Type, 181 mm. C. M. Cat. No. 2576.





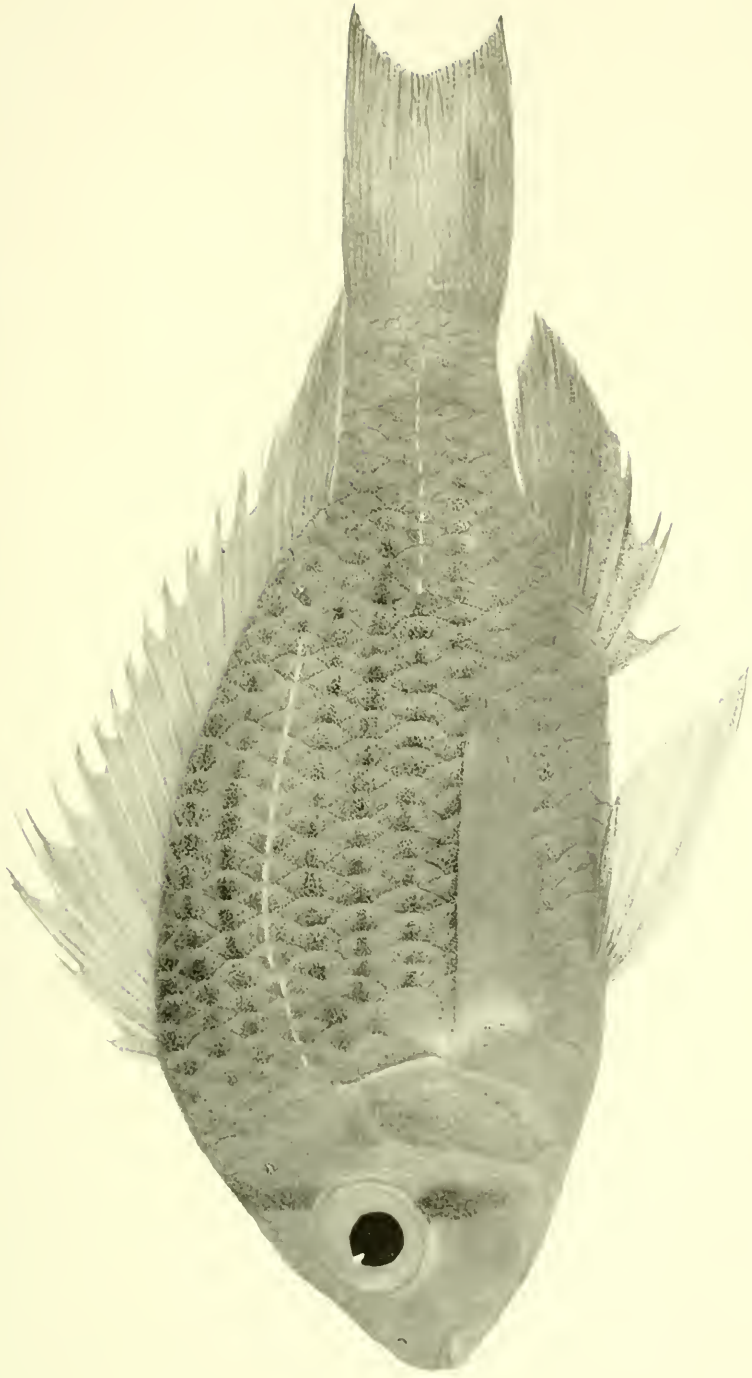
*Equidens duopunctata* Haseman. Type. 131 mm. C. M. Cat. No. 2574.





*Cichlasoma facctum* Jenyns. 83 mm. C. M. Cat. No. 2615.





*Crenicara allispinosa* Haseman. Type. 71 mm. C. M. Cat. No. 2639.







*Crenicichla simoni* Haseman. Type. 92 mm. C. M. Cat. No. 2646.







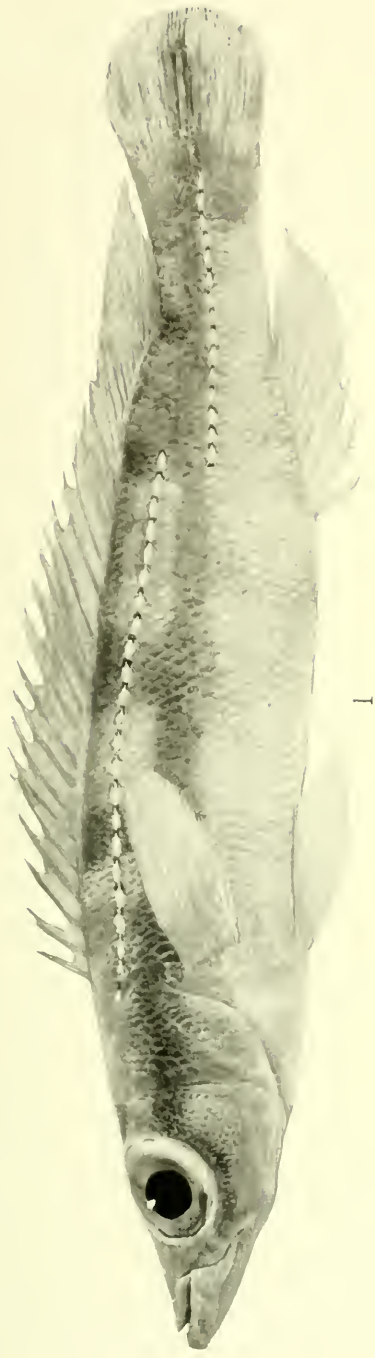
*Crenicichla jagatarensis* Haseman, *Type*, 65 mm. C. M. Cat. No. 2723.





*Crenicichla ignassuensis* Haseman. Type, 170 mm. C. M. Cat. No. 2725.





1. *Crenicichla santaremensis* Haseman. Type. 115 mm. C. M. Cat. No. 2719.  
2. *Heterogramma trifasciatum*, var. *maciliense* Haseman. Type. 21 mm. C. M. Cat. No. 2751.

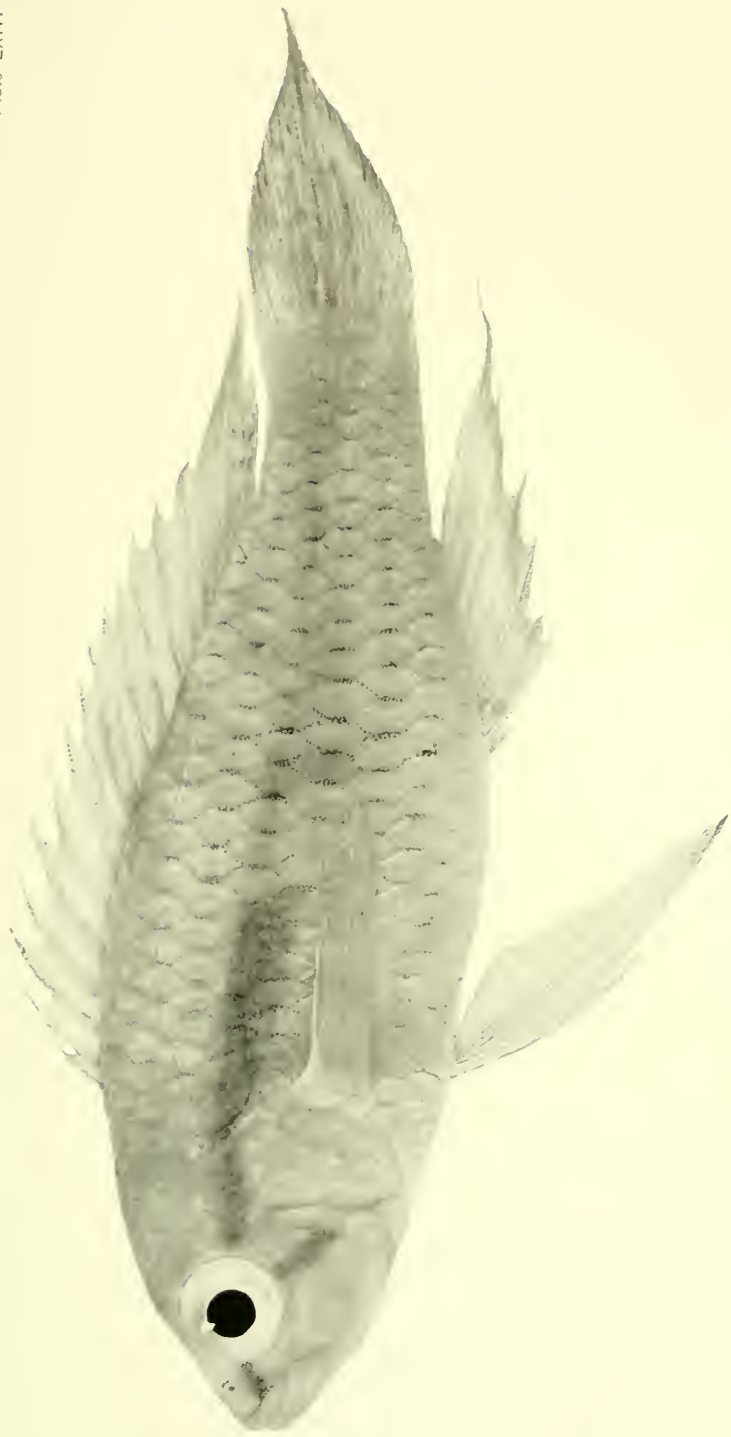






*Cronichia dorsocellata* Haseman. Type. 215 mm. C. M. Cat. No. 2721





*Heterogramma agassizi* (Steindachner), 50 mm. C. M. Cat. No. 2720





*Heterogramma tentatum* (Günther). 50 mm. C. M. Cat. No. 2732.





*Heterogramma tentatum*, var. *portense* Haseman. Type. 37 mm. Car. Mus. Cat. No. 2741.



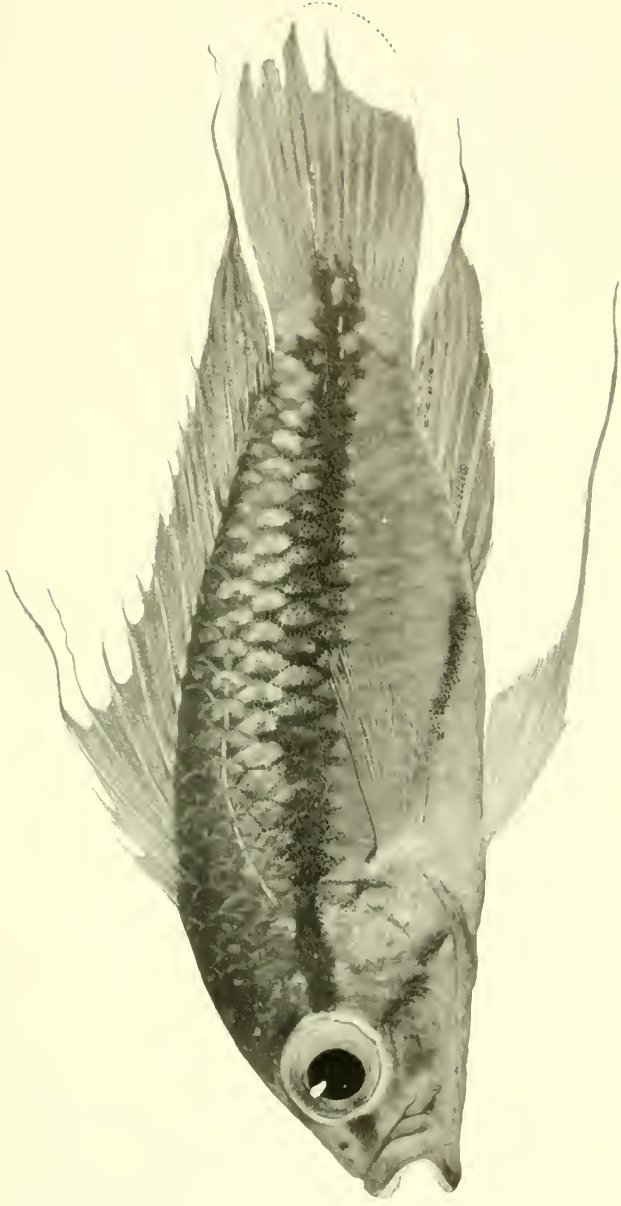




*Heterogramma corombe* Eigenmann and Ward, 31 mm., C. M. Cat. No. 2754.







*Heterogramma bifasciatum* Eigenmann and Kennedy. 39 mm. C. M. Cat. No. 2743.





*Heterogramma borellii* Regan. 14 cm. C. M. Cat. No., 2761.

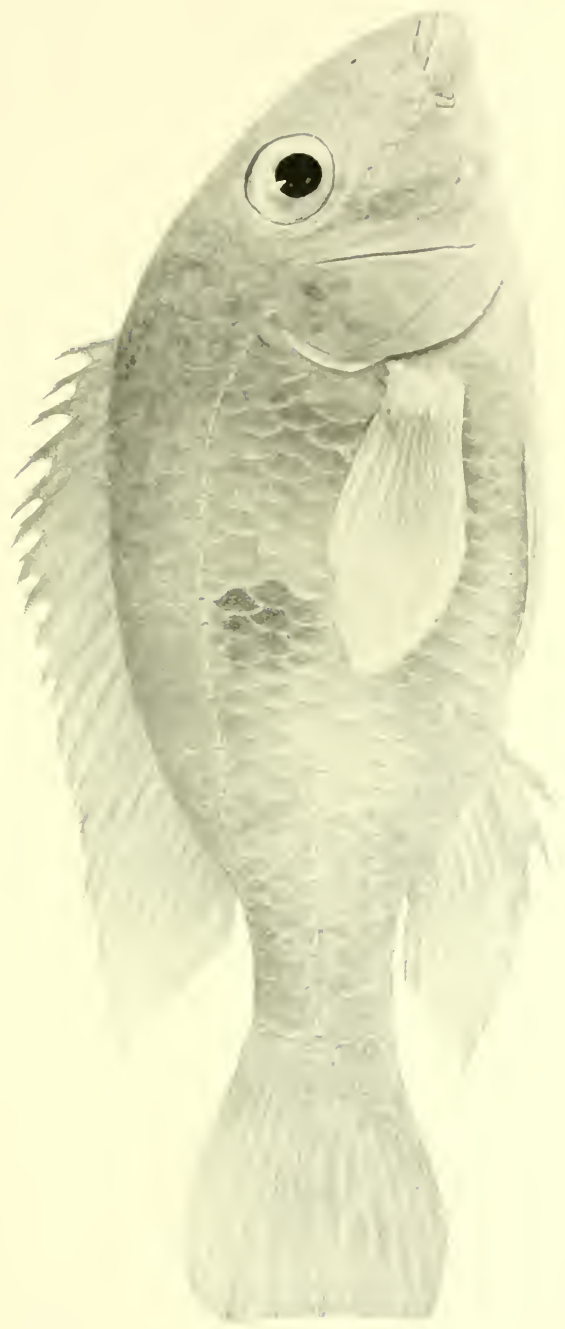




*Heterogramma rilense* Haseman. Type, 36 mm. C. M. Cat. No. 2765.







*Geophagus brasiliensis*, var. *iporangensis* Haseman. Type. 113 mm. C. M. Cat. No. 2792a.







No. 2847a-c, 8-9 cm., Manaus, Nov. 25-27, 1909.

No. 2848, 5 cm., Manaus, Nov. 29, 1909.

This specimen has eleven gill-rakers on the lower anterior arch; D. XII, 26; A. VI, 28; five rows of scales on the cheeks; forty-two scales in the row below the lateral line; fourteen scales between the first dorsal spine and the lateral line; thirty-three scales between the origin of the ventrals and the lateral line; caudal peduncle about half as long as deep; depth 11 in the length. In regard to the smaller scales this specimen is somewhat like *P. altum*, but in most of the details it is within the limits of *P. scalare*.

*Note.*—As Mr. Haseman's account of the genus *Heterogramma* leaves the impression that the species are scarcely distinguishable, I have had photographs prepared of all the species mentioned except *H. ortmanni*, which is soon to be figured (*Memoirs Carnegie Museum*, V, 1911, pl. —).—CARL H. EIGENMANN.

## XIX. SOME NEW SPECIES OF FISHES FROM THE RIO IGUASSÚ.

BY JOHN D. HASEMAN.<sup>1</sup>

The Iguassú River rises in the Serra do Mar east of Curytiba, Paraná, near the Atlantic Ocean. It flows westward for about a thousand miles over a sand-capped plateau, which is on the average about one thousand meters above sea-level. The river has several rapids and falls, the largest of which, the Salto de Iguassú, is near its junction with the Rio Paraná. This fall is about two hundred feet high and has a volume of water one-third larger than that of Niagara. In a distance of about one thousand miles the river descends nearly three thousand feet. I feel sure that the Salto de Iguassú is older than the present fauna of the lower La Plata.

The fauna of the upper isolated Iguassú is remarkable. There are no turtles and no alligators. There are about twenty-five species of fishes. Most of these have near relatives in neighboring streams, and indeed many of them differ very little from their relatives in the near-by streams, but their constant variation in this region, isolated as they are by the large Iguassú Falls, gives warrant for describing them as new.

The origin of this ichthyic fauna is in doubt. Stream piracy has not taken place, and cannot explain the peculiar life of the upper Iguassú basin, for the fishes of the headwaters of highland streams do not exist in the basin. The Indians and natives told me of cases where they had taken fishes from below the water-falls to above them, and it is possible that some of them have been brought up thither in that way. The long-necked bird, "biguas," nearly always carries cat-fishes, especially the mailed cat-fishes, which it has caught, to stones, and beats them to death before swallowing them. On one occasion I saw one of them fighting with another bird of the same species over a fish, which it had caught below the Avanhandava Falls of the Rio Tieté, and which it dropped into the river above the fall. Such

<sup>1</sup> This is the fifth article published by the Carnegie Museum upon the results of the Expedition to Central South America, 1907-1910.

incidents probably often occur at the smaller falls, where flocks of these long-necked fishing birds fight over their catches. As a rule "biguas" are only able to take catfishes; even if they caught smaller scaled fishes they would probably swallow them at once. How some of the small scaled fishes come to be above the fall, I cannot explain, unless they crossed over from the headwaters of the neighboring Tibagy, where the divide is low and short. There is, however, a fatal objection to this view, found in the fact that *Ilopias malabaricus*, the king of land-travelers, has not crossed over to the Iguassú basin. I have taken young *Ilopias* fully three miles from the nearest creeks, swimming up the narrow Goyaz highland trails, and am at a loss to account for its absence in the upper basin of the Iguassú.

RHAMDIOPSIS, gen. nov.

Related to *Heptapterus* and *Leptoglanis*.

Barbels flattened, anal and adipose fins prolonged, both more or less united to a rounded caudal; dorsal slightly in front of ventrals; pectoral with a slender, weak, and soft-tipped spine; fontanel extending to occipital process, but faintly separated by a bridge back of eye; eye without free margin; teeth in narrow bands in each jaw. No vomerine teeth; head (in places) almost naked and granular; a minute rudimentary spine at the base of the first ray of the dorsal.

1. *Rhamdiopsis moreirai*, sp. nov. (Plate LXXIII.)

No. 2849, *type*, 7.8 cm., from Serrinha Paraná, Rio Iguassú, Dec. 22, 1908.

No. 2849, *cotype*, 5.6 cm., from Serrinha Paraná, Rio Iguassú, Dec. 22, 1908.

D. 7, plus faint rudimentary spine fastened to first ray; A. 21; P. 1, 7; C. 30, including accessory rays; V. 7; depth 5.5 to 6; head .5; pectorals half the length of head and about equal to the depth of the same; width of head about five-sixths of its length; head almost round, very little depressed, profile gently arched from dorsal to snout; caudal portion of body compressed; origin of anal fully as far forward, if not farther, than the adipose; anal and adipose separated from the caudal by a notch in the membrane uniting them. Origin of dorsal slightly in front of ventrals, both of which are small and short; distance between the dorsal and adipose greater than the length of the dorsal. Origin of dorsal to tip of snout about .5 in the length and less than 3 in the total length; none of rays produced; eye small, without free

margins, 7 in length of head, a little over 3 in snout; snout 2.33 in head, slightly greater than interorbital space; barbels all flattened towards the tip, with somewhat membranous margins on one edge; maxillary barbels not extending to end of pectorals; mental barbels all extending a little beyond the base of the pectorals; humeral process pointed and very minute; jaws rather weak and subequal; teeth in bands in each jaw, no vomerine teeth; snout rounded and little or not flattened; lateral line not entire, being composed of several white thick patches along median lateral portion of body, in some cases extending to base of caudal; color almost uniform dark brown with some mottling as in *R. quelen*; lower sides yellowish white; caudal, adipose, and basal halves of dorsal and anal colored uniformly dark brown like body; pectorals and ventrals colorless; head covered with many round white pores almost as large as nares; posterior nares less than distance of orbital diameter from the eye, anterior nares near the edge of the snout; occipital process not united with the dorsal plate; head in part almost naked and granular.

I take great pleasure in dedicating this species to Senhor Carlos Moreira, Secretary of the Geological Survey of Brazil, who devoted much time in assisting me during my stay in Brazil.

Genus HEPTAPTERUS Bleeker.

2. *Heptapterus stewarti*, sp. nov. (Plate LXXIV.)

*Type* and only specimen, No. 2850, from Serrinha Paraná, in a creek about one-half mile from the Rio Iguassú, Dec. 23, 1908. Rare and not known to natives.

D. 9; A. 30; P. I. 8; V. 6; C. 25+4 accessory rays on both sides, in folds of skin which connect the adipose and anal with caudal:

	Mm.
Length of body to base of caudal . . . . .	56
Length of head . . . . .	13
Greatest breadth of head at base of pectorals, which is greatest body breadth . . . . .	10
Greatest depth of head . . . . .	7
Diameter of eye . . . . .	1.5
Length of snout . . . . .	5
Interorbital space . . . . .	4.2
Origin of dorsal from tip of snout . . . . .	21
Origin of ventrals from tip of snout . . . . .	23
Origin of anal from tip of snout . . . . .	31
Origin of adipose from tip of snout . . . . .	31



Base length of adipose . . . . .	24
Base length of anal . . . . .	18

Teeth in bands in each jaw; no vomerine or palatine teeth; base of dorsal equal to its height and greater than the distance between it and the adipose. Ventrals and pectorals small and of equal size, a little more than half the length of head; no rays of any fins prolonged; anal and adipose long and of about same height and extent; pectorals with a short rudimentary spine, less than half the length of its longest rays, without teeth or hooks on either side; no external signs of either a dorsal spine or plate; no occipital process; eye small, without face margin; head covered with skin; barbels terete; fontanel not extending far back of eyes; caudal rounded; body and head slightly depressed to origin of dorsal, posterior portion greatly depressed but not tapering; barbels small, maxillary barbels scarcely reaching past the base of pectoral, mental barbels not reaching the same; snout round; jaws almost equal; lips small; numerous pores on head; nares all equidistant, set in angles of a square, and the distance between them greater than the distance between the eyes and the posterior nares.

Uniform light brown in color without any distinct marking, the basal third of dorsal fin dark.

I have dedicated this species to Mr. Douglas Stewart, who in various ways assisted me during and after the Expedition to Brazil.

After comparing this specimen with others representing the different genera of *Pimelodinæ* without free orbital margins, I consider it a *Heptapterus*, even though it has a rudimentary pectoral spine.

#### Genus RHAMDIA Bleeker.

##### 3. *Rhamdia branneri*, sp. nov. (Plate LXXV.)

No. 2851, *type*, 10.3 cm. } From a creek of the Rio Iguassú, near Ser-  
 No. 2852, *cotype*, 10 cm. } rinha Paraná, Brazil, December 24, 1908.

D. I. 6; A. 10; V. 6; P. I. 8; head 3.75; depth 5.25; eye 2.5 in the snout, 2 in interorbital space and 6 in the head; origin of dorsal 2.75 in length to base of caudal; dorsal inserted in front of ventrals; dorsal spine weak, small, without teeth and less than one-half as long as the longest rays of the same; pectoral spine long and slender, with teeth on both edges and 2.5 times in the length of head; caudal not lobed to its base and lower lobe the larger; none of fins with produced rays; few pores on head; occipital process pointed, not reaching the dorsal plate; fontanel more or less oval in shape, not extending back of eyes;

teeth in bands in each jaw of about uniform depth; abdominal portion of body deeper than the caudal; eyes without very distinctly free margins; adipose about 3.66 in length of body; predorsal region only slightly arched and little depressed; snout rounded; jaws about equal, upper slightly the longer; in some of the alcoholic specimens parts of the head are almost bare, bony or granular; barbels all short and terete; maxillary barbels not reaching past the base of dorsal; postmental barbels not reaching the base of pectoral and the mental barbels not reaching half-way to the base of the pectorals; color about the same as *Rhamdia quelen*, brownish, with darker brown spots and blotches, and the tips of all of the fins dark; no lateral band.

This species is easily distinguished from *Rhamdia quelen* by its shorter rounded barbels, shorter adipose, and shorter body in comparison to length of head.

No. 2853 (collector's number 2211), from Rio Iguassú, Dec. 30, 1908, is called "bagre amarilla" because it is yellow in life. It has eleven anal rays; adipose 3.33 in length of body; eye 3 in snout; mental barbels slightly longer than typical specimen from the creek. I name this species in honor of Dr. J. C. Branner, who kindly assisted me at the beginning of my long journey.

3a. ***Rhamdia branneri voulezi***, var. nov. (Plate LXXVI.)

*Type*, No. 2854 (collector's number 2179), 12.2 cm., from Porto União da Victoria, Rio Iguassú, Dec. 27, 1908. Larger than the typical specimens of *R. branneri* and the dorsal with I. 7 rays. It is almost white in color, with a much longer occipital process, which, however, does not quite reach the dorsal plate; the dorsal fin is higher and the pectoral spine longer than in the other specimens. I consider these differences sufficient to make this a variety, which I call *voulezi*, in remembrance of Mr. Antonio Voulez, a Frenchman of Serrinha Paraná, who in various ways assisted me, even to catching some of the specimens. The postmental barbels of this variety reach past the base of the pectoral and the maxillary barbels reach almost to the origin of the adipose. The only example is 12.2 cm. long.

Two other large specimens, Nos. 2855*a-b*, from Porto União da Victoria, show different color-patterns, one being lead-color and the other having a white ventral, which gradually changes into a uniformly dark dorsal. All agree in having shorter barbels, and rather large eyes, but the four last mentioned specimens have a slightly freer margin to their eyes; all have a thick, rounded two-lobed caudal, which is not

parted to its base, and the lower lobe is somewhat more extensive. Each specimen is in some details distinct and might be given specific rank, but I believe that all have been recently derived from *Rhamdia quelen*, which has arrived by some accident above the Iguassú Falls, where few enemies of fish exist.

Genus PIMELODUS Lacépède.

4. *Pimelodus ortmanni*, sp. nov. (Plate L, fig. 2.)

The *type*, No. 2856, measures 16 cm., and comes from Porto União da Victoria, Rio Iguassú, Dec. 27, 1908.

D. I. 6; A. 10 or 11; P. I. 9; eye 2 to 3.5 in snout, 1.5 to 1.8 in interorbital space and 1.5 in distance between anterior and posterior nares; head 3.5 to 4 in the length; depth 4.33 to 5.5; depth of caudal peduncle 3.5 in head; body rather slender and round; lips rather thick and reflexed; barbels all shorter than in *P. clarias*, maxillary barbels not reaching past anal; postmentals not beyond middle of pectorals and mentals not beyond base of pectorals; humeral process rather slender and pointed; front edge of dorsal and pectoral spines almost smooth and both shorter than the length of the head; no vomerine or pterygoid teeth; upper lobe of caudal longer than the head; head more or less granular and the posterior part almost naked in older specimens; adipose about 5 in length; intermaxillary teeth present; gill-rakers 4 to 6-13 to 17 on first arch.

Back with few to several irregular dusky spots; sides with three to six irregular rows of dark brown blotches in the smaller examples; the number of rows fewer, the spots larger in larger examples. Some have almost no color, while others are mottled because of the mixture of spots.

The *cotype*, No. 2857, has a total length of 20 cm.; head granulated, with little or no skin on posterior part; spots large; eye 2.5 in snout; depth 4.33; head 3.5. This shows that the fish gets thicker and larger with age and has fewer spots. The *cotype* was taken at the same place and date as the *type*.

*Cotype*, No. 2858, 25 cm.; eye 3.5 in snout; depth 4.16; caudal faintly spotted. This variety is locally known as "pintado grosso," and represents about the maximum size of this species, which is the largest fish found in the Iguassú basin above the big falls. Same locality.

*Cotypes*, Nos. 2859a-b. Two small examples from the same locality;

one 11 and the other 9.5 cm. long, with the upper jaw, as in the other examples, slightly protruding; inner edge of caudal lobes dusky and lower lobe with a dusky band in its middle; outer half of dorsal dusky, with small pigment dots, while its basal half is white; ventral side silvery white.

No. 2860a-b, *cotypes*, 9.5 and 14 cm.; rather slender, resembling the type in shape, etc., but more spotted and the spots almost extending to the ventral side.

This species is distinguished from *P. clarias* by fewer gill-rakers on the lower branch of the first gill-arch, having 5-24, 4-14, 6-17, 6-13, 5-15 and 5-15. It has evidently been derived from *P. clarias*, which has in some way found a habitat above the Iguassú Falls, where it is well separated from the present parent form below the falls. *Pimelodus clarias* is not found anywhere in the swampy headwater streams coming from the Brazilian table-land. I think it may have been deposited above the fall by water-birds, especially those known by the natives as "biguas," or by the Indians themselves.

I take great pleasure in dedicating this species to Dr. A. E. Ortmann.

#### Genus PYGIDIUM Meyen.

##### 5. *Pygidium davisii*, sp. nov. (Plate LXXVII.)

*Type*, No. 2862, Serrinha Paraná, Dec. 23, 1908.

D. 7 + a stay; A. 5, and a stay or rudimentary ray; V. 5, and only one-half the length of the anal; head 5.5 in length and heart-shaped;

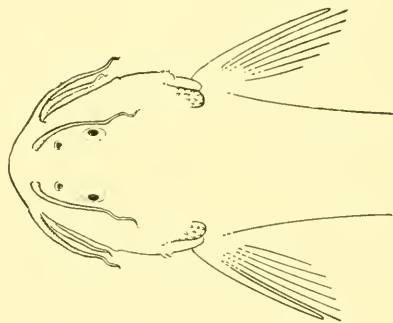


FIG. 1. *Pygidium davisii*. Dorsal view of head.

body slender, and the anterior part round, its greatest depth 8 to 9 in the length to base of its caudal; part back of the dorsal fin much

compressed; the caudal peduncle of the same width throughout its entire length and with several accessory caudal rays imbedded in the fatty marginal band of skin; depth of caudal peduncle three-fourths that of the body and about half the length of the head; mouth rather small, its width being one-third of the length of the head; eyes small, 3 in interorbital, which is two-thirds the length of the snout; nares separated by the distance of an orbital diameter, and the posterior nares more than the distance of an orbital diameter in front of the eyes; teeth in two rows in each jaw. Origin of the dorsal much nearer the tip of caudal than tip of the snout; origin about half-way between that of ventrals and anal; no fin-rays produced; origin of anal under the posterior part of dorsal; caudal almost rounded or slightly truncate; all three pairs of barbels of almost equal length, none extending beyond the base of the pectoral.

In life four were yellow, mottled with a dark subpattern. One very small example was almost white, having only a few faint brownish spots; one resembled in color *P. tania* Steindachner, from the western slopes of Peru. The color-patterns vary. Some specimens have a dark lateral band from the head to the base of the caudal, with one or more series of spots or blotches above it; others are mottled, others yellowish, and some are almost colorless. The fins are plain, rarely with isolated minute dusky spots. Origin of ventrals about half-way from tip of snout to tip of caudal; greatest depth of head not quite half of its length.

No. 2861*a-i*, 2.1 to 4.5 cm. All were taken from a small sandy shady creek, rocky in places, and flowing at the base of Serrinha into the Rio Iguassú near Serrinha Paraná, Dec. 23, 1908, during flood season.

The color-pattern of the type is intermediate between the extremes.

This species is much more slender than *P. proops*, and has a differently shaped head, and there are other minor differences. It is apparently more closely allied to *P. tania* Steindachner of the western slopes of Peru.

I have named this fish in honor of Dr. Davis of Corumba, who in various ways assisted me during the latter part of my journey.

#### Genus GLANIDIUM Lütken.

#### 6. *Glanidium ribeiroi*, sp. nov. (Plate LXXVIII.)

*Type*, No. 2877, 13.7 cm., Porto União da Victoria, Paraná, Brazil, from the Rio Iguassú, where they are locally known as "bocado."

*Cotypes*, Nos. 2683a-e, 9.2-10.5 cm., from the same place.

D. .5 (.4 and a filament in two of the small examples); A. 9 or 10; V. 5; P. .5; C. 18; eye 5.5 to 6.25 in head, 1.5 to 2 in snout, less than 1 between nares, 3.5 to 3.75 in interorbital space; depth of body 4.5 to 5 (4.66 in type); head 3.5 to 3.75 in length; length of dorsal spine 2.5 in that of head; length of pectoral spine 1.75 in the same; length of caudal peduncle from adipose to median base of caudal 1.5 in length of head; least depth of caudal peduncle 2.5 to 3 in length of head; average thickness of caudal peduncle in its depth .7; length of anal about the same as that of the ventrals; origin of anal and adipose almost opposed; in the type the humeral process is four-fifths as long as the pectoral spine; the fins, excepting the dorsal and caudal, are colorless; some have the caudal margined with dark as in typical *G. albescens*; some have about four rows of larger basal caudal spots, which are followed by about the same number of finer spots with the inner surfaces of the lobes edged with white; head and back covered with larger spots, which fade into peppered sides; entire ventral surface white; maxillary barbels reaching to end of, or beyond, the humeral process; mental barbels not reaching more than half of the distance to the bases of pectorals; cleft of mouth not extending past the anterior margin of the eyes.

This species is closely related to *G. albescens*, two examples of which from the Rio Paranáhyba (Entre Rios) in some details resemble the specimens from the Iguassú, but their bodies are not so round, and are more compressed posteriorly, their pectoral and dorsal spines are longer, their caudal peduncle is narrower, their caudals more deeply forked, and their depth less than in the examples from the Iguassú. One specimen of *G. albescens* from Porto Alegre, Rio Grande do Sul, has an even mottled color-pattern composed mostly of small brown spots on the back and sides, as well as the posterior ventral surface, but its total length is 14 cm., against the 13.7 cm. of the type specimen from the Iguassú River, and its caudal peduncle is only half as thick as deep, in contrast with five-sevenths for the various specimens from the Iguassú. The Porto Alegre example also had D. I. 5, but I. 4 is commoner in the case of *G. albescens*. A small specimen 2.5 cm. long, from the Rio Ribeira da Iguapé, is more slender and more compressed posteriorly, and possesses a distinct color-pattern made up of very heavy dark blotches, bands, and spots, especially over the dorsal and upper half of the lateral surfaces; the rest of the body,

excepting the white ventral surface, is peppered with brown. In other details it agrees with *G. albescens*, of which it is probably the young, locally known as "bureva."

I take pleasure in naming this species after Senhor Alipio de Miranda Ribeiro, Secretary of the National Museum in Rio de Janeiro.

Genus IMPARFINIS Eigenmann & Norris.

(*Rhamdioglanus* von Ihering.)

7. *Imparfinis hollandi*, sp. nov. (Plate XLVIII, fig. 2.)

*Type* unique, No. 2864, Porto União da Victoria, Rio Iguassú, December 27, 1909. Known as "guasco."

D. 8; A. 10; V. 6; P. I. 8; length to base of caudal 23 cm.; greatest depth 1.9 cm.; length of head 5.2 cm.; length of snout 1.9 cm.; inter-orbital width .9 cm.; length of maxillary barbels 2.3 cm.; origin of dorsal opposite or above that of ventrals, and 8.8 cm. from tip of the snout; opercular breadth of head 3.3 cm., which is as wide as any part of the body; origin of anal behind that of adipose and 7.8 cm. from base of caudal; anus 10.5 cm. from tip of snout; diameter of eye .8 cm., equal to the distance to the posterior nares; length of pectoral spine 1.4 cm.; pectorals and ventrals rounded; head as well as anterior part of body greatly depressed, while in region of origin of adipose the body is rather round and posteriorly it is compressed; dorsal and anal rays rather long; pectoral spines blunt, untoothed and weak; adipose about 7.5 cm. long, low and continuous with the caudal; caudal peduncle 1.4 cm. deep; orbit without free margins; upper rays and edge of caudal 5.1 cm. long, while lower edge is 3.4 cm.; teeth in bands broadest in middle and narrowing toward the sides; lips rather rough and thick; lower lip greatly reflexed; barbels terete and very short. occipital process not quite reaching dorsal plate; fontanel long and slender, reaching to back of the eyes; darker above and lighter below; fins all more or less dusky without markings, the dorsal and anal darkest; in life there are three fairly distinct bands, one back of head another in dorsal region, and the third at the origin of the adipose.

This species is easily distinguished by the shape of its body, and by the lips, short barbels, peculiar caudal, etc.

It is said to be abundant and easily taken during the dry season (May to October), and to reach eighteen inches in length.

## Genus PLECOSTOMUS Gronovius.

8. *Plecostomus derbyi*, sp. nov. (Plates LXXIX-LXXXI.)

Rare, only one example, No. 2865 (another having been eaten by ants), from Porto União da Victoria, taken in a trap called "cova," December 27, 1909. Length 9.5 cm. to base of caudal.

D. I. 7; A. 5; P. I. 6; V. I. 5; C. 16; depth 5.16; head 4.5 (from tip of snout to humeral process); 28 scutes in lateral line; eye 4 in the snout and 2.5 in interorbital space; belly about one-half covered with small granules; three faint ridges on the head; humeral keels extending on to base of the ventrals; no lateral keels or bony spines to scutes; caudal peduncle almost rounded; similar on all sides; base of dorsal longer than distance intervening between it and the adipose; last dorsal ray half as long as the first; tip of the snout granular; the temporal plates almost carinate; the length of the barbels about equal to diameter of eye; seven scutes between dorsal and adipose fin; caudal emarginate, with lower edge the longer; thirteen scutes between the anal and caudal; outer edge of pectoral with many short spiny processes; width of head at front edge of humeral process greater than the length of same from tip of snout to same place; ventrals almost as long as the pectorals; all fins with rows of spots between the rays, being less distinct on the caudal; ventral surface plain; dorsal surface and head covered with small round spots increasing in size posteriorly. In life there are three distinct and three indistinct dorso-lateral bands, the ones which pass through the rayed dorsal and at base of adipose being most distinct; the faint band over posterior part of head is continued to form a broad bar below each eye.

This species is characterized by the smaller eye, which is one-third less in size than in *P. plecostomus*, by the less elevated occipital, the color, and by the plates being more numerous than in *P. plecostomus*, from which it has apparently been evolved after an accidental arrival above the Iguassú Falls.

It is with great pleasure that I name this species in honor of Dr. O. A. Derby, who has spent thirty-five years in the cause of science in Brazil, and who rendered me more assistance than any other man in South America. A great deal of the success of the Expedition of the Carnegie Museum to South America is indirectly due to Dr. Derby.



## Genus FITZROYA Günther.

9. *Fitzroya eigenmanni*, sp. nov. (Plate LXXXII.)

*Type*, No. 2866, female, 4.3 cm. in length, Serrinha Paraná.

*Cotypes*, No. 2867*a-d*, female, 3.5 cm.; female, 3.8 cm.; male, 4 cm.; male, 3.3 cm.; collected near Serrinha Paraná, Brazil, three miles from Rio Iguassú, Dec. 23, 1908, in a small wooded swampy creek, sandy and stony in places, with clear cool water.

P. 14; D. 7; A. 7; V. 6; caudal fin rounded; head scaly; mouth almost terminal; snout blunt; top of head and snout flat; scales rather large. Males and females of about equal size; first three anal rays make the tube of the slightly prolonged anal of males. One has the entire anal rolled up in such a way that no rays are visible, and has a three-fingered tip. The alimentary canal is shorter than the length of the body and does not appear to contain any mud.

Jaws strong and thick; upper jaw protractile; teeth prominent but easily detached; diameter of eye less than length of snout, almost 2 in the interorbital and about 4 in the head; head 4 in length of body; depth of body almost equal to the length of head; anal of males tubular in young, tip with three fingers or lobes in older specimens; scales thirty, and those of the posterior part of the median lateral row with peculiar dark central pits or holes. Origin of dorsal nearer the tip of caudal rays than the snout, and slightly in advance of first anal rays (except in two of the younger specimens). Almost cylindrical in shape, and abdomen not much enlarged, while posterior part of body is compressed. All fins colorless; rather broad darkish lateral band more or less complete in adults, but broken into blotches in young; dorsal side dusky, and a dusky band below distinct lateral band; ventral surface yellowish white.

This specimen was caught under stones in rapid water, where it acts like *Characidium*.

I take great pleasure in naming this species in honor of Dr. C. H. Eigenmann.

## Genus CNESTERODON Garman.

10. *Cnesterodon carnegiei*, sp. nov. (Plate LXXXIII.)

*Type*, No. 2868, female, 4 cm., abdomen swollen on account of food. From Serrinha Paraná, December 22, 1908.

*Cotypes*, No. 2869, 22 males, 1.5 cm. to 2.5 cm.; 33 females, 2.2 cm. to 4 cm. Serrinha Paraná, Rio Iguassú, Dec. 22, 1908.

*Cotypes*, No. 2872a-m, 5 females, 2.5 cm. to 3 cm.; 8 males, 2 cm. to 2.4 cm.; Serrinha Paraná, in a creek of Rio Iguassú, Dec. 24, 1908.

No. 2871a-e, 5 females, 2.5 cm. to 3.25 cm.; Porto União da Victoria, Rio Iguassú.

No. 2870a-o, 8 males, 2.1 cm. to 1.8 cm.; 7 females, 2.6 cm. to 2.8 cm. Porto União da Victoria, Rio Iguassú, Dec. 27, 1908.

No. 2873, 16 males, 1.5 to 2 cm.; 11 females, 2 cm. to 3.5 cm.; Arroyo Miguelete, Montevideo, February 17, 1909.

No. 2874, 10 males, 1.9 to 1.4 cm.; 13 females, 1.5 to 2.5 cm.; Uruguayana, Brazil, February 6, 1909.

D. 8; A. 8; P. 9; V. 5 or less; lower jaw somewhat longer, one complete series of closely set chisel or narrow incisor teeth unhooked; scales 29 to 32 in a median lateral series; body rather elongate, slightly compressed in front and depressed posteriorly.

Depth 3.5; head 4 2, diameter of eye 3 in length of head and slightly greater than the length of the snout. The anal of the males is much nearer the tip of snout than the base of caudal. The front edge of first prolonged anal ray (the third anal ray) has a patch of fine teeth located about one-third of the distance from the tip to the base. The mouth opens above. The dorsal is inserted behind origin of anal and about half-way between the base of caudal and posterior edge of opercular flap. The fins are all colorless and the ventrals are very small. The sides are without spots, or with from one to nine blotches or spots (most frequently there are nine). The older females are dark above and have light-colored abdomens. The males are always smaller and have a circular dark anal ring, prolonged as a dark median black line along the keel of caudal peduncle.

I take great pleasure in dedicating the species to Mr. Andrew Carnegie.

#### Genus CHARACIDIUM Rheinhardt.

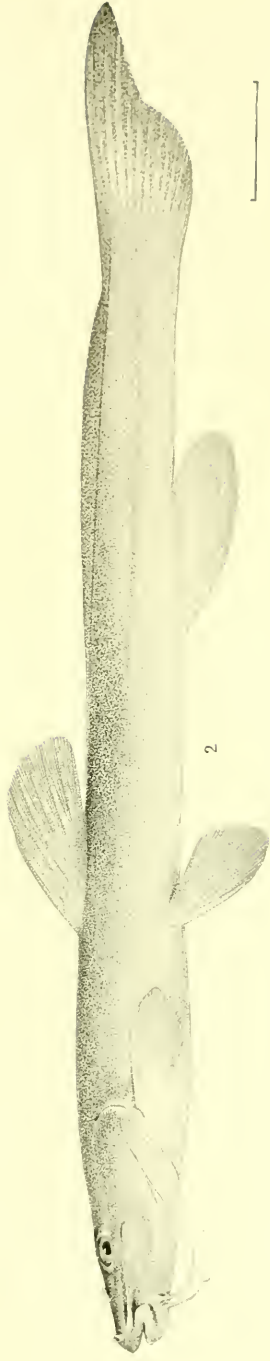
##### 11. *Characidium fasciatum* Rheinhardt.

No. 2875, Serrinha Paraná, and No. 2876a-b, Porto União da Victoria, Rio Iguassú. Above the Iguassú Falls in the Iguassú River.

D. 10 or 11; A. 7; P. 10; V. 9; length 4.4 cm.; depth 1 cm.; head 1.1 cm. long; eye .3 cm., which is a little greater than the length of the snout; pectoral 1.3 cm. long; head 5 in total length; eleven or twelve scales between origin of dorsal and head; lateral line 4.5 to 5-36 to 38-3; lateral line complete or nearly so; pectorals reaching base of

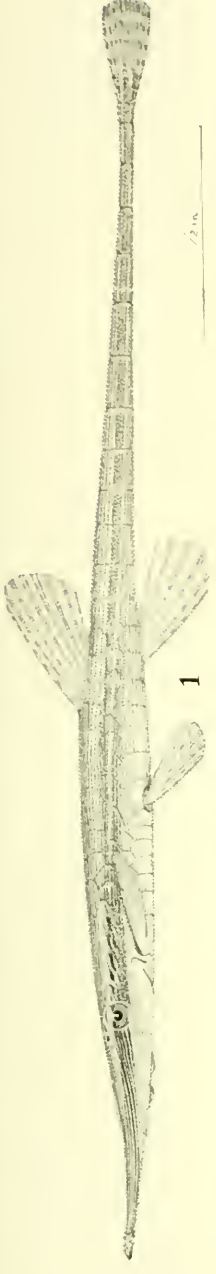


$\frac{1}{2}$  in.



1. *Bunocephalus depressus* Haseman. Type, 65 mm. C. M. Cat. No. 2984.  
2. *Imparfinis hollandi* Haseman. Type, 230 mm. to base caudal. C. M. Cat. No. 2864.





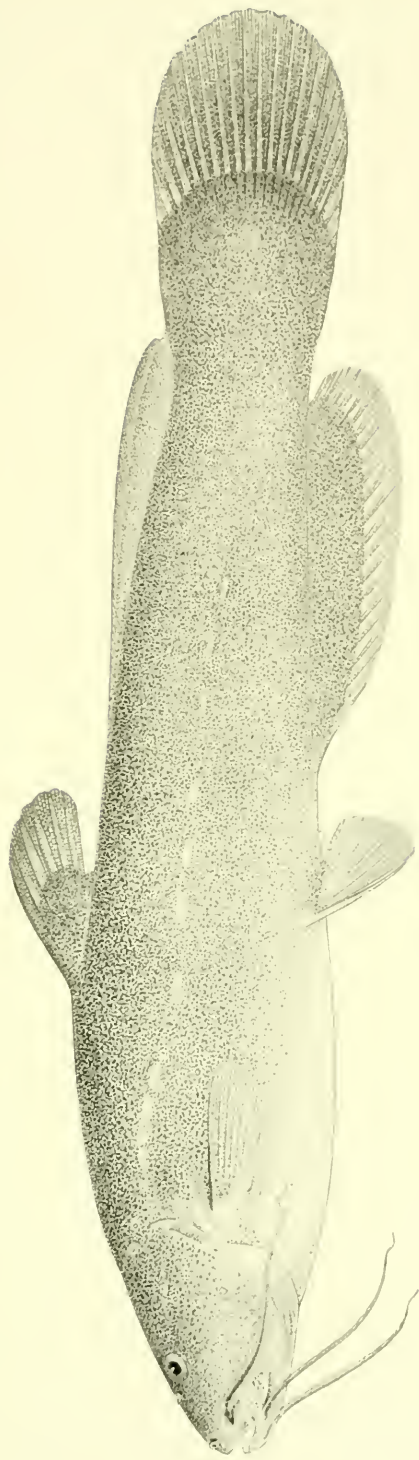
1



2

1. *Acestridium discus* Haseman. Type. 72 mm. C. M. No. 2985.  
 2. *Pimelodus orbmanni* Haseman. Type. 163 mm. C. M. No. 2857.





$\frac{1}{2}$  in.

*Khamdipopsis morcirai* Haseman. 93 mm. C. M. Cat. No. 2849.

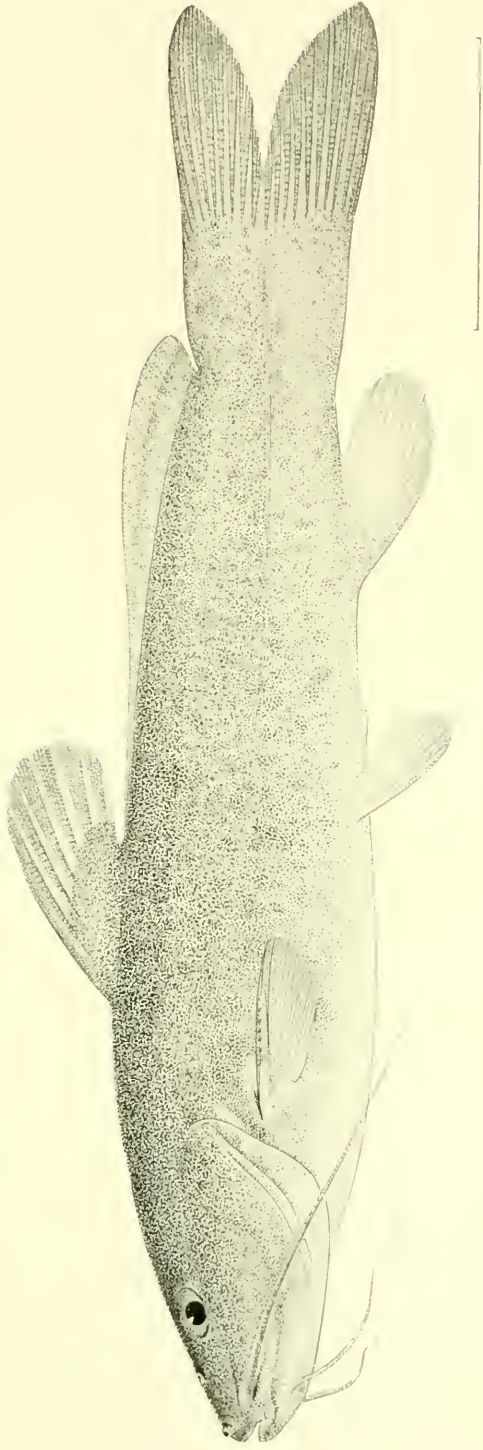






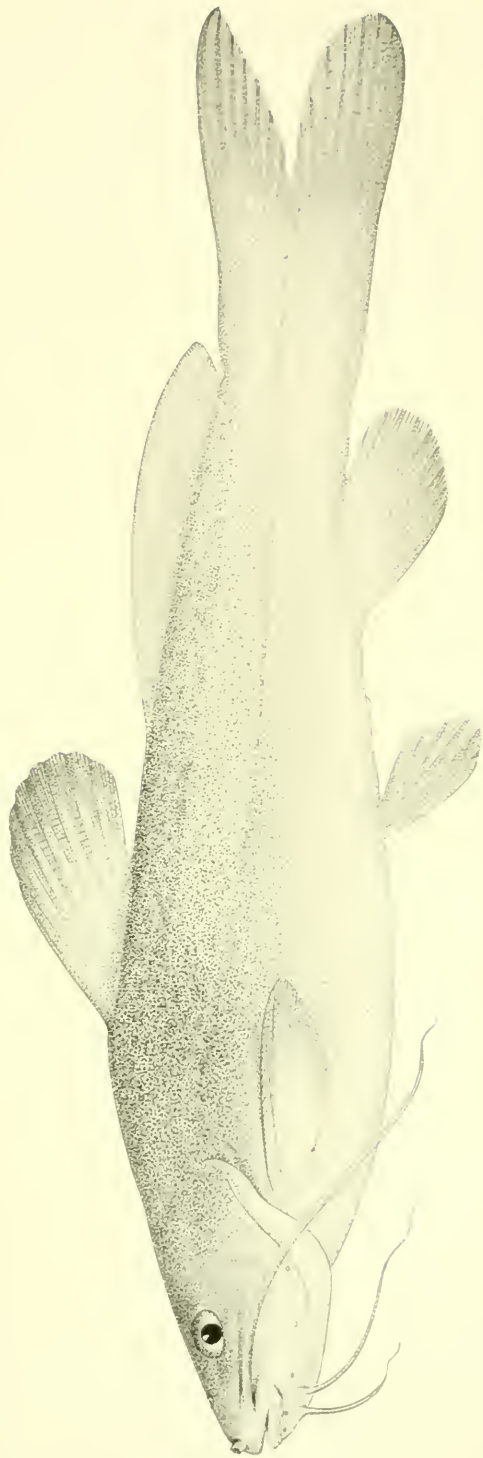
*Heptapterus stewarti* Haseman. Type. 76 mm. C. M. Cat. No. 2850.





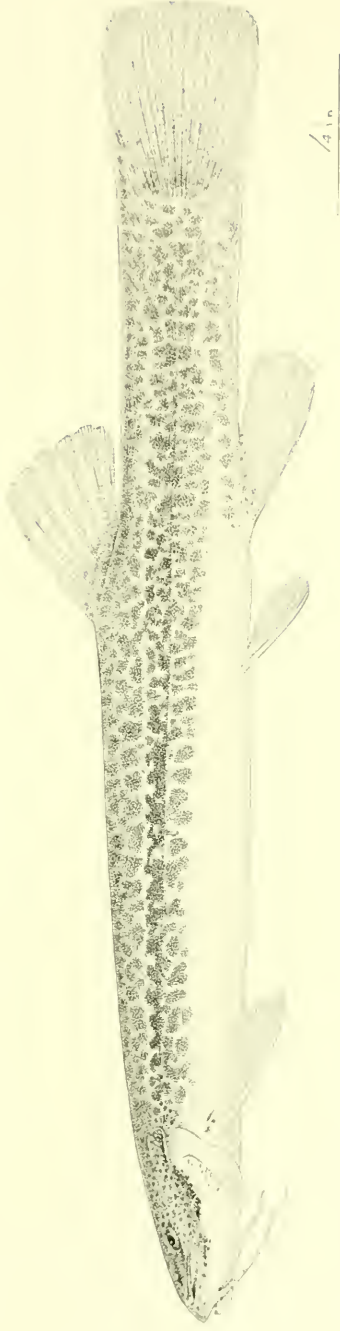
*Rhundia banneryi* Haseman. Type, 137 mm. C. M. Cat. No. 2854.





*Rhamdia branneri*, var. *roulei* Huseman. Type. 150 mm. C. M. Cat. No. 2854





*Pygidium darisi* Haseman. Type. 52 mm. C. M. Cat. No. 2861.







*Giantidium ribetiroi* Haseman. Type. C. M. Cat. No. 2877.





*Plecostomus derbyi* Haseman. Type. 126 mm. C. M. Cat. No. 2865.





*Piccostomus derbyi* Huseman. Dorsal view of type.





*Plecostomus derbyi* Haseman. Ventral view of type.

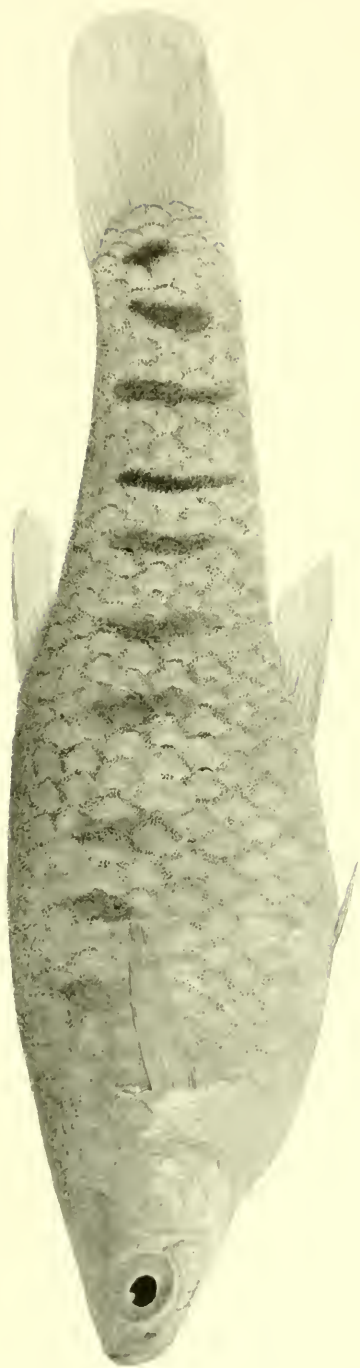






*Fiteroya eigenmanni* Haseman. Type. 43 mm. to base caudal. C. M. Cat. No. 2866.





*Cnesterodon carnegiei* Haseman. Type, 49 mm. to base of caudal. C. M. Cat. No. 2868.



ventrals, which in turn reach base of anal; least depth of caudal peduncle .5 cm.; length of caudal peduncle from base of anal to median base of caudal .8 cm.; seven to eight bars, more distinct and slender in younger examples; a median silvery bluish to dark lateral line or narrow band along sides from head to base of caudal; this lateral line very fine in young specimens and never more than the breadth of an orbital in older examples; all specimens with a very minute dark spot at end of lateral line on base of caudal, not more than one-third the size of the eye; the fins colorless as a rule, but some with a dusky tinge.

I cannot distinguish these specimens from those coming from the Rio das Velhas. *C. etheostoma* (Cope) is also a synonym of *C. fasciatum*.

Genus CRENICICHLA Heckel.

12. *Crenicichla iguassuensis* Haseman.

This species has been described elsewhere in these ANNALS (*cf.* Vol. VII, 1911, p. 352).

XX. A CONTRIBUTION TO THE ORNITHOLOGY OF THE  
BAHAMA ISLANDS.

BY W. E. CLYDE TODD AND W. W. WORTHINGTON.

INTRODUCTION.

BY W. E. CLYDE TODD.

In the fall of 1908 the writer suggested to the well-known ornithological collector, Mr. Willis W. Worthington of Shelter Island Heights, New York, the desirability of making a collecting trip to the Bahama Islands. Mr. Worthington at length agreed to such an undertaking, and also to give the Carnegie Museum the refusal of his prospective collections, nearly all of which were in fact eventually acquired. Beginning work on New Providence the last week in December of that year, he visited in succession Great Inagua, Acklin Island, Watlings Island, Andros, and Abaco, thus covering the group fairly well, so far as faunal districts are concerned. Although considerable collections were made in other branches, birds were naturally the primary consideration. As the law now stands in the Bahamas, licenses to collect birds for scientific purposes do not permit the holder to take more than *six* specimens of any one kind—a most embarrassing restriction, which will make it very difficult and expensive to secure fresh material from this region in the future. Through the granting of a license to Mr. Worthington's assistant, however, the limit was increased to twelve specimens, and in only a few instances was this number exceeded, and then only by inadvertence. Despite such an unfortunate drawback, and the exigencies of travel and sundry other inconveniences under which Mr. Worthington labored, he was unusually successful in securing specimens of the rarer and more interesting Bahaman land-birds, among them a remarkable and unexpected new species of warbler from the island of Abaco, and he was able also to add a few additional species to the Bahaman avifauna, besides getting numerous new records for the various islands. As he was entirely dependent upon irregular sailing-vessels for transportation, he was unable to visit any of the colonies of sea-birds on the isolated

cays, and the water-birds in general are with but few exceptions sparsely represented in his collections. Of the endemic land-birds, however, all but five species are included, as well as a fair representation of the winter residents and transient visitants. In all there are five hundred and ninety-one beautifully prepared specimens, which are now the property of the Carnegie Museum, excepting forty-three skins retained by the collector for himself. The entire collection, however, made between December 28, 1908, and May 8, 1909, has been available for the preparation of the present report.

The critical study and comparison of this material, supplemented in many cases by additional specimens from other sources, has thrown new light upon the status and relationships of a number of the Bahaman forms, concerning some of which there seems to have been considerable misapprehension. The conclusions and results set forth herewith, although they may possibly not prove acceptable to such ornithologists as find it incumbent to give nomenclatural recognition to every trifling variation exhibited, have been conscientiously and (it is hoped) consistently worked out, with due regard to scientific standards. In several instances, where the available material was inadequate, no formal changes in the generally accepted nomenclature have actually been made, although doubts have been freely expressed. Some attention has been given to the sequence of plumages in certain of the species, and to other variations.

In a paper of the present scope it would be manifestly superfluous to attempt any comprehensive review of the literature of Bahaman birds, this having already been so well done by Mr. Joseph H. Riley (in Shattuck, *The Bahama Islands*, 1905, 347-350). Mr. Riley has also discussed in outline the zoögeographical position of the Bahamas, adopting Mr. Frank M. Chapman's conclusions originally published in the *American Naturalist*, XXV, 1891, 528-539. Mr. Riley seems to have been the first to claim distinct faunal rank for the southern islands of the group as discriminated from those to the northwest, but aside from this no detailed analysis of the distribution of the Bahaman avifauna seems to have yet been attempted, so that it may be well to consider the question further. Two hundred and two species (including subspecies) of birds have now been recorded from the Bahamas, two of which (*Colinus virginianus floridanus* and *Passer domesticus*) have evidently been introduced by human agency within recent times, leaving an even two hundred species native to

the islands. Of these one-half (more or less) are winter residents, transients during migration, or merely casual or accidental visitants, leaving about one hundred species known or believed to breed. Let us eliminate first the species known or reasonably assumed to be of general distribution throughout the group, designating the endemic forms with an asterisk (in this as in succeeding lists).

<i>Colymbus dominicus dominicus</i>	<i>Anous stolidus stolidus</i>
<i>Podilymbus podiceps</i>	<i>Himantopus mexicanus</i>
<i>Puffinus lherminieri</i>	<i>Catoptrophorus semipalmatus</i>
<i>Phaëthon americanus</i>	<i>semipalmatus</i>
<i>Pelecanus occidentalis</i>	<i>Octhodromus wilsonius wilsonius</i>
<i>Fregata aquila</i>	<i>Hamatopus palliatus</i>
<i>Ixobrychus exilis</i>	<i>Columba leucocephala</i>
<i>Phanicopterus ruber</i>	<i>Zenaidura macroura (macroura?)</i>
<i>Ardea herodias herodias</i>	<i>Zenaida zenaida</i>
<i>Herodias egretta</i>	<i>Cathartes aura aura</i>
<i>Egretta candidissima candidissima</i>	<i>Buteo borealis (subsp.?)</i>
<i>Dichromanassa rufescens</i>	* <i>Pandion haliaëtus ridgwayi</i>
<i>Hydranassa tricolor ruficollis</i>	<i>Aluco pratincola pratincola</i>
<i>Florida cærulea</i>	* <i>Amazona leucocephala bahamensis</i>
* <i>Butorides virescens bahamensis</i>	<i>Crotophaga ani</i>
<i>Nycticorax nycticorax nævius</i>	<i>Coccyzus americanus americanus</i>
<i>Nyctanassa violacea</i>	<i>Coccyzus minor maynardi</i>
<i>Ajaia ajaja</i>	* <i>Chordeiles virginianus vicinus</i>
<i>Pæcilonetta bahamensis</i>	<i>Tyrannus dominicensis dominicensis</i>
<i>Deidrocygna arborea</i>	* <i>Myiarchus sagræ lucaysiensis</i>
* <i>Rallus crepitans coryi</i>	* <i>Mimus gundlachii gundlachii</i>
<i>Gallinula galeata galeata</i>	<i>Polioptila cærulea cærulea</i>
<i>Fulica americana</i>	<i>Vireosylva calidris barbatula</i>
<i>Larus atricilla</i>	* <i>Vireo crassirostris crassirostris</i>
<i>Gelochelidon nilotica</i>	* <i>Dendroica petechia flaviceps</i>
<i>Sterna maximæ</i>	<i>Dendroica discolor</i>
<i>Sterna sandwicensis acutifluida</i>	* <i>Cæreba bahamensis</i>
<i>Sterna dougalli</i>	* <i>Pyrrhulagra violacea violacea</i>
<i>Sterna antillarum</i>	* <i>Tiaris bicolor bicolor</i>
<i>Sterna fuscata</i>	
<i>Sterna anætheta</i>	



It will be observed that the above list of fifty-nine species is composed very largely of water-birds and a few others of more or less general distribution in tropical America. Deducting the above from the list of breeding species leaves forty-one forms whose distribution within the group is more or less restricted, and these again may be divided into two categories. In the first are placed thirty-one forms which are in general confined to the more northern and western islands:

<i>Phalacrocorax auritus floridanus</i>	* <i>Blacicus bahamensis</i>
<i>Geotrygon chrysis</i>	<i>Mimus polyglottos polyglottos</i>
* <i>Chæmepelia passerina bahamensis</i>	* <i>Mimocichla plumbea</i>
* <i>Speotyto cunicularia cavicola</i>	<i>Sitta pusilla</i>
* <i>Saurothera bahamensis bahamensis</i>	* <i>Callichelidon cyanooviridis</i>
	* <i>Dendroica flavescens</i>
* <i>Saurothera bahamensis andria</i>	* <i>Dendroica pityophila</i>
* <i>Dryobates villosus maynardi</i>	* <i>Dendroica vigorsii achrustera</i>
* <i>Dryobates villosus piger</i>	<i>Seiurus aurocapillus</i>
* <i>Centurus nycanus nycanus</i>	* <i>Geothlypis rostrata rostrata</i>
* <i>Centurus nycanus blakei</i>	* <i>Geothlypis rostrata tanneri</i>
* <i>Centurus nycanus bahamensis</i>	* <i>Geothlypis rostrata coryi</i>
* <i>Nesophlox evelynæ</i>	* <i>Agelaius phæniceus bryanti</i>
* <i>Riccordia ricordii bracei</i>	* <i>Icterus northropi</i>
* <i>Riccordia ricordii æneoviridis</i>	* <i>Spindalis zena zena</i>
* <i>Tolmarchus bahamensis</i>	* <i>Spindalis zena townsendi</i>

Ten species, on the other hand, are more or less restricted to the more southern and eastern islands, as follows:

<i>Sula cyanops</i>	* <i>Speotyto cunicularia bahamensis</i>
<i>Sula leucogastra</i>	* <i>Nesophlox lyrura</i>
<i>Phalacrocorax vigua mexicanus</i>	<i>Tyrannus cubensis</i>
<i>Oxyechus vociferus rubidus</i>	<i>Mimus polyglottos orpheus</i>
<i>Chæmepelia passerina exigua</i>	<i>Margarops fuscatus fuscatus</i>

Of course, no hard and fast line, geographically speaking, can be drawn between the Inaguan Fauna, as it may be called, and the Bahaman Fauna proper, some species of each group having a much more extensive distribution than others, resulting in an overlapping of the two faunas in certain of the intermediate islands. Indeed, three species, *Chæmepelia passerina bahamensis*, *Nesophlox evelynæ*, and *Mimus polyglottos polyglottos*, might be referred to our first list

above (comprising species of general distribution in the islands), were it not for the fact that they do not occur on Great Inagua, where their places are taken by allied forms. The Inaguan Fauna possesses only two forms peculiar to itself, *Speotyto cunicularia bahamensis* and *Nesophlox lyrura*, and is characterized in general more by the *absence* of numerous species found in the northern islands than by the presence of a distinctive element of its own.

It would naturally be supposed that of all the Bahaman group Great Inagua, from its proximity to Cuba, would show the closest correspondence in its avifauna to this neighboring island, but such is very far from being the case. For instance, *Speotyto cunicularia bahamensis*, *Nesophlox lyrura*, *Margarops fuscatus fuscatus*, *Cæreba bahamensis*, and *Pyrrhulagra violacea violacea* do not even have generic representatives in Cuba, and must have reached Great Inagua from some other direction. The Ground Dove of Great Inagua is identical with the form occurring on Mona Island (*Chamepelia passerina exigua*), not with the Cuban bird. Barring the water-birds on the list, whose distribution is possibly dependent on local causes and therefore of no especial significance in the present case, there is in fact only *one* species characteristic of the Inaguan Fauna, *Tyrannus cubensis*, which is clearly and exclusively of Cuban origin, and this is not a common bird. *Oxyechus vociferus rubidus* and *Mimus polyglottos orpheus*, although occurring in Cuba, are found also in Haiti, whence they may have reached Great Inagua, in common with other Bahaman forms which have evidently entered the islands by the same route.

As a matter of fact, it is the northernmost islands of the group, Great Bahama, Abaco, Andros, etc., whose avifauna most nearly resembles that of Cuba, from which it has obviously been largely derived. It is certainly significant that such a characteristic Cuban form as *Dendroica pityophila* should occur in the Bahamas (so far as known) only on Great Bahama and Abaco, the two islands farthest distant from Cuba. Again, *Centurus nyeanus bahamensis* from Great Bahama more closely resembles its "original stock" form, the Cuban *Centurus superciliaris*, than do either *Centurus nyeanus blakei* of Abaco or *C. n. nyeanus* of Watlings Island, indicating that the influx took place by way of Great Bahama. The distribution of *Geotrygon chrysis*, *Saurothera bahamensis* (and subspecies), *Riccordia ricordiï* (and subspecies), *Tolmarchus bahamensis*, *Blacicus bahamensis*, and *Mimocichla plumbea* also presents cases which argue more or less

strongly for the point sought to be emphasized. This is in striking contrast with the case in the southern islands.

Another point to which attention should be called is the occurrence in the Bahamas, and especially in the northern and western islands, of certain forms whose affinities are decidedly with others from Mexico and Central America. *Icterus northropi*, which is very close to *Icterus prothemelas*, is a striking instance of this. In a recent paper the present writer has given reasons for believing that *Geothlypis rostrata* is more closely related to certain Mexican species than to *G. trichas*. *Spindalis zena* finds its nearest ally in *Spindalis benedicti* of Cozumel Island. Some of the Bahaman species whose antecedents are obviously Central American have spread over the group more generally, as for instance *Nesophlox evelynæ* (allied to *N. bryantæ* of Costa Rica), *Virco crassirostris* (very close to *V. ochraceus*), and *Cæreba bahamensis* (near *C. caboti* of Cozumel Island). All three of these forms, it must be noted, have undergone more or less modification upon entering the easternmost islands of the group, amounting to the differentiation of a distinct species in the case of *Nesophlox*.

To recapitulate:

1. The resident avifauna of the Bahama Islands is not homogeneous, but differs to some extent at the respective extremities of the group.
2. The avifauna of the northwestern islands resembles that of Cuba more closely than does that of the southeastern islands.
3. There is a very considerable Central American element in the Bahaman avifauna, more prominent in the northwestern islands.

From the facts thus far set forth we may deduce certain inferences regarding the derivation of the composite resident avifauna of the islands. The one hundred species composing it may be divided into five categories, as regards their specific antecedents and present distribution.

1. Species of more or less general distribution in tropical America, and therefore of no especial value in predicating faunal affinities. Nearly all the water-birds belong to this class.
2. Species identical with, or closely allied to, certain forms found in Haiti, and which have doubtless reached the Bahamas from that source, by way of Great Inagua. Examples of this class are *Margarops fuscatus fuscatus* and *Tiaris bicolor bicolor*. This element is not a very large one, and in some cases has not spread beyond the Inaguan Fauna.

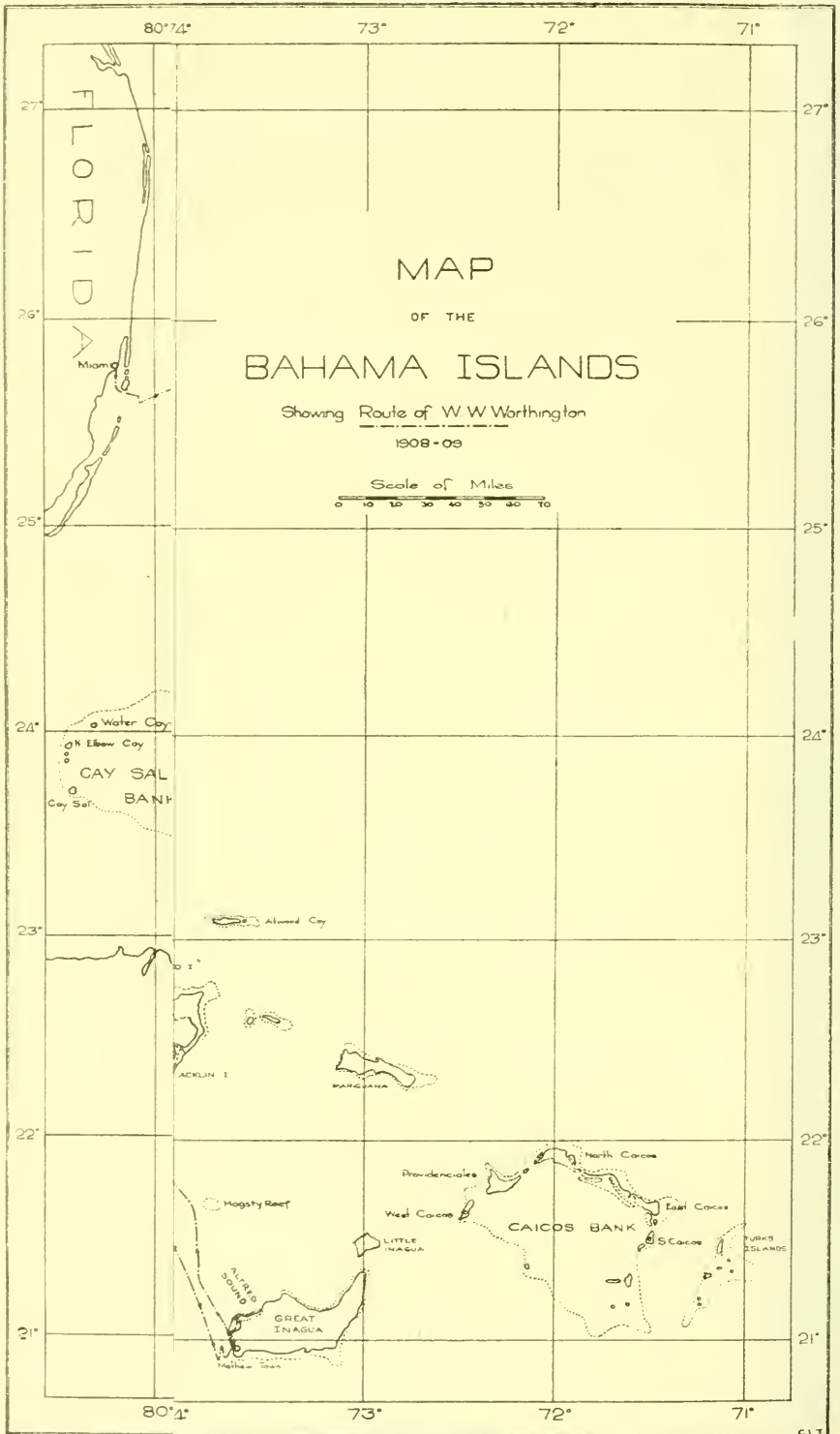
3. Species obviously of Cuban origin, as for instance *Riccordia riccordii*, *Centurus nyanus*, and *Saurothera bahamensis*, with their respective subspecies. So far as Cuban forms are concerned, it is very doubtful if Great Inagua has to any extent "served as a gateway for many species of West Indian origin which are now distributed throughout the Bahamas," as suggested by Mr. Chapman in his paper above mentioned. Although in the case of forms of such general distribution throughout the islands as *Myiarchus sagræ lucaysiensis*, *Dendroica petechia flaviceps*, etc., there is no clue to the original place of entrance, it seems quite evident that certain other forms have gone from Cuba directly to the northern Bahamas, and thence spread more or less extensively over the group. Under such circumstances the probabilities are strongly in favor of nearly all the species belonging to this class having reached the Bahamas by way of the northernmost islands, rather than by way of Great Inagua, which island was probably about the last to be reached.

4. Species which have reached the northern Bahamas from Mexico and Central America, and have spread more or less extensively to the southeastward, as for example *Icterus northropi*, *Vireo crassirostris*, and *Nesophlox evelynæ*.

5. Species which have apparently been derived from the neighboring Peninsula of Florida. This element, which is not so large as might be anticipated, is illustrated by *Agelaius phæniceus bryanti*, *Dryobates villosus maynardi*, *D. v. piger*, and *Sitta pusilla*, and is likewise more pronounced in the northwestern islands. As pointed out by Mr. Riley, "the fact must not be lost sight of that several birds of extreme southern Florida, where the same conditions are said to prevail as in the Bahamas, have reached there probably by way of the Bahamas and not *vice versa*." In the judgment of the writer this statement should be extended to include a number of additional species which are not confined to southern Florida.

In explanation of the seemingly fortuitous occurrence in the Bahamas of so many species of more or less obvious Cuban and Central American origin, and of the anomalous circumstance that in nearly every case such have apparently entered the islands from the northwestern extremity, spreading thence to the southeastward, it is suggested that the course of the Gulf Stream, which sweeps close by Great Bahama and Andros, may have been a factor in the populating of these islands by strays from more southern regions. The part





that ocean currents play in the distribution of plant and animal life is one that cannot be overlooked, and the facts in the present case strongly suggest such an explanation. Whether a similar study of other forms of life would accord with such a theory as is here proposed, however, is an important question.

Previous writers, in discussing the origin of the Bahaman avifauna, have drawn their conclusions almost entirely from a consideration of the endemic species, attaching no especial significance to the local distribution (within the group) of either these or various other forms of more extensive range. But that a study of such facts as these may furnish a more definite clue to the relationships of the avifauna at large, and to the respective sources of its component elements, is a proposition scarcely to be questioned in view of the circumstances of the present case. There is still much to learn regarding the detailed distribution of certain species, and our knowledge of the avifauna of many islands in the group is as yet incomplete. Whether or not the provisional conclusions herein set forth will require material modifications further field-work alone can decide.

In conclusion it is a pleasure for the writer to acknowledge his indebtedness to the authorities of sundry institutions whose collections of Bahaman birds have been consulted in the preparation of the present report. Thanks are due especially to Messrs. Outram Bangs of the Museum of Comparative Zoölogy, Frank M. Chapman and Waldron DeWitt Miller of the American Museum of Natural History, Charles B. Cory, Wilfred H. Osgood, and Arthur W. Henn of the Field Museum of Natural History, Robert Ridgway, Charles W. Richmond, and Joseph H. Riley of the U. S. National Museum, and Harry C. Oberholser of the Biological Survey, for assistance of this kind and for numerous other courtesies.

#### NARRATIVE OF THE EXPEDITION.<sup>1</sup>

BY W. W. WORTHINGTON.

I left Shelter Island Heights, N. Y., for the purpose of making an ornithological reconnoissance of the Bahama Islands, on November 21, 1908, going by way of Greenport directly to New York City, where I boarded the Clyde Line steamer "Iroquois," bound for Jacksonville, Florida. The voyage was uneventful, save for our being detained for thirty hours off the bar at Jacksonville by a heavy fog, so that we did not reach our destination until November 25. The following

<sup>1</sup>Cf. Plate LXXXIV.

day I proceeded to Eau Gallie, on the Indian River, where I was joined by Mr. Clark Irwin, who was to be my assistant on the trip. Here I remained until December 17, doing a little collecting in the neighborhood, going thence to Miami, from which bustling and fast-growing little city schooners ply to the Bahamas at more or less regular intervals. Here we found the staunch schooner "Fearless," a seaworthy-looking vessel of about fifty tons, moored at a wharf in the mouth of the Miami River, and proudly flying the British flag. She was taking in a cargo of lumber, and was due to sail the following Sunday, December 20, so we engaged passage with Captain Kemp at once, and found that there were some twenty-odd other passengers on the list, mainly colored laborers returning from Florida to their homes in the Bahamas. We went on board with our baggage on Sunday morning, and were assigned to berths in the cabin, and were soon acquainted with the crew—all native Bahamans, part white and part colored.

Casting off at nine-thirty in the morning, our voyage to the Bahamas was really begun, but it did not proceed very far, as the "Fearless" was so deeply laden that she caught on the coral rock bottom of the river, and notwithstanding the best efforts of a small tug to pull her off, remained fast until the rising tide floated her at four in the afternoon, when we made another and successful start, and reached Biscayne Bay just at sunset. The wind was light, but did not die out completely until we had reached the lower end of Biscayne Key, where we came to anchor for the night. The next morning we got under way at eight o'clock, with a light head wind, and stood off to the edge of the Gulf Stream and back several times, but the wind still kept ahead, and was so light that the captain did not think it prudent to attempt crossing, as the rapid current would carry us northward far out of our course, so we ran in back of Fowey Rocks Light and anchored for the night. The next morning, December 22, the wind having hauled in our favor, we stood across for the Biminis, sighting land from aloft at three o'clock, while a half-hour later North Bimini Island was in sight from the deck. We passed just north of Moselle Bank, and not far from a large four-masted schooner recently wrecked there. Darkness overtook us while still sailing on our easterly course, and that night a heavy "norther" came down upon us. When we came on deck the next morning we found the "Fearless" close-reefed, and wallowing through heavy seas. Berry Islands were



sighted at six o'clock, and an hour later we passed the lighthouse, where the breakers were throwing the snowy spray high over the rocky bluffs—a pretty sight indeed. Our course was now shaped for Nassau, and the high land on New Providence was sighted from aloft at one o'clock. A little after two o'clock the city was in sight from the deck, and at half past three (December 24) we finally reached our destination.

Interviews were had with Mr. Julian Potter, U. S. Consul, Hon. W. Hart Bennett, Colonial Secretary, and His Excellency Sir William Grey-Wilson, Governor of the Bahama Islands. The authorities treated us very courteously, and promised us every assistance in their power in carrying on our work. Lodgings were then secured for the night, and we presently retired, but not to sleep. It is the custom on Christmas Eve to allow the colored population to "celebrate" without interference. Assembling at dark in companies, arrayed in barbaric masquerade costumes, they parade the streets, exploding firecrackers, blowing horns, and beating drums and tin pans. The din continues the entire night through, rendering sleep impossible. Friday being Christmas, all business was at a standstill, and our baggage was not released until noon on Saturday, on notice from the Colonial Secretary that collecting licenses would be granted. At my request a license was issued to my assistant, allowing us to double the number of specimens in our series. In the meantime, through the kindness of Mr. Charles Lightbourne, we were able to secure for our headquarters a vacant bungalow, situated on the crest of the Blue Hills, about three miles south of Nassau, commanding a view of the city on the north and the sea on the south, and to this we removed our outfit during the afternoon, and got settled and ready to begin work the following Monday. We engaged as a cook a colored "boy," whom Mr. Lightbourne recommended, and who was quite a character in his way.

Our bungalow was situated in the midst of what had once been a large sisal farm, but which through years of neglect had reverted to the original wild and overgrown condition, a thicket of weeds and shrubbery growing close up to the building, affording excellent opportunities for the study of birds right at hand. A short distance farther along the ridge was the dwelling of Mr. Lightbourne's sister, surrounded by an orchard of orange, grape-fruit, wild fig, and numerous other trees, to which place access was given us by the owner. Excursions were made to the "Farms," some six or seven miles to the

southwest of our headquarters, where considerable tracts of corn, cane, sweet potatoes, and other vegetables and fruits were under cultivation, and also to the sea beach to the south, while the region of the Blue Hills was quite thoroughly explored. The word "Blue" is in this case a corruption of "Ballou," the name of a former owner of a large part of this section. The term is applied to a ridge of coral limestone, averaging a hundred feet or less in height, and extending east and west for several miles in the northern part of the island. The surface is extremely rough and sharp, eroded limestone formation protruding everywhere, interspersed with caves, and with "potholes" varying from a few inches to several feet across, often ten or even twenty feet deep, and with perpendicular sides. These potholes are found throughout the hills, and also in the level pine barrens all the way across the island almost to the sandy south shore, and together with the rough surface make traveling very difficult or even dangerous. More than once, while pushing through the dense thicket, I suddenly found myself on the very brink of a yawning hole, hidden by vines and creepers, and into which a fall might easily have resulted in serious injury. In the crevices of the rock is a scanty soil, which supports a surprisingly thick and heavy growth of shrubbery, called "coppet," while the plain to the southward is covered by scattering pines. At intervals through this "pine barren," as it is called, are low thickets, with tangled masses of vines and creepers, and a few maguey plants here and there. In the pine barren were found such birds as the Ani, Bob-white, Bahama Pine Warbler, and some other warblers, wood-peckers, and fly-catchers, while the Bahama Thrush, Nassau Lizard Cuckoo, and Thick-billed Vireo kept to the thickest coppet. On the hills, and thence northward to Nassau, considerable tracts had been cleared and planted to cocoanut palms, oranges, and pineapples, but most of the fields on the hills had been neglected, and had grown up to bush again, except the tract near our quarter before mentioned. A wild fig tree growing here, which was in full fruit during our stay, attracted numerous Black-backed Spindalis, Bahama Bullfinches, Bahama Bananaquits, and several other species, while the low shrubbery and flowering plants along the roadsides were the favorite haunts of the Bahama Grassquit and Bahama Wood-star. A good road is maintained by the government, running direct to the south shore of the island, as well as others running east and west on either side of the Blue Hills, which enabled us to extend our investigations much

farther in those directions than would have been possible otherwise. The south shore, like all sand-beaches in the Bahamas, is composed of disintegrated coral rock and shells, while shallow sand-flats extend for miles off the actual shore-line. Just back of the beach are a few small lagoon-like ponds, with scattered mangroves. This region was remarkably deficient in bird-life, only a few Bahama Red-wings and Bahama Green Herons being seen about the ponds.

Work was carried on from this base until January 21, when passage was taken on the fifty-ton mail schooner "Estrella," under the command of Captain Storr, bound for Great Inagua, the southernmost island of the group, but making numerous detours and stops on the way, to deliver and receive passengers and mails. We got away from the Nassau wharf on Friday morning, January 22, with a hold full of cargo of almost endless variety, and a cabin full of passengers—all colored except ourselves—but, as in the case at Miami, we did not get very far. Before we were fairly out of the harbor, with a strong head wind, and a current running against us like a mill-race, beating down between Hog Island and Potters Cay, the steering gear gave way as we attempted to come about, and instead of making the tack as intended the "Estrella" ran with considerable force on the rocky shore of Potters Cay, where she remained until again floated by a gang of wreckers at nine P.M. on January 23, when she was anchored in the stream for a fresh start. Early the next morning we got under way, beat up around the east end of New Providence, and laid our course southeast by east, with a good stiff trade breeze from the northeast. By noon New Providence had sunk below the horizon, and Highborn Cay was in sight on the port bow. We passed Ship Channel Light at seven P.M., and entered the deep blue waters of Exuma Sound, laying a course for Cat Island. On the morning of January 25 we got a faint glimpse of the south point of Eleuthera Island, looming out of the haze to the northward, but it soon faded from view. A stiff breeze was blowing and the "Estrella" was jumping around in a rough sea, but we found smoother water under the lee of Little San Salvador, and spent the rest of the day beating dead to windward, sunset finding us three or four miles off Bennet's Harbor, Cat Island. We continued on with a light wind and reached Arthur Town, our first stopping-place, at eight P.M. Our journey was resumed after the mails had been put ashore, but the wind died out, and until the next morning we lay becalmed, several miles to the west

of Cat Island, which appeared as a long undulating dark line on our port side. A light breeze just after sunrise wafted us in towards "The Bight," our second port of call, but it presently died out, and the mails were sent ashore in a small boat, the distance being about eight miles. At noon we got a breeze from the northwest and in a little over an hour had dropped anchor off the settlement.

After landing some cargo here, and replenishing our water supply, we started for Rum Cay about five P.M., with a light but fair wind, rounding Hawk's Nest Point three hours later, and were soon in the blue water off soundings. We were aroused on the morning of January 27 by a thud on deck, and upon going up found that a large dolphin had been caught on the trolling line, and we witnessed its wonderful changing colors while dying. We had been becalmed all night, with Cat Island still in view, the sea smooth as glass and clear as crystal. Several more dolphins were hanging about, but they would not bite at a baited hook. The captain succeeded in getting a ten-pounder, however, with an improvised spear. We ate heartily of these animals, with no ill effects, and they proved a very welcome addition to the rather meager bill of fare served on these boats. We got a breeze at last and resumed our voyage, passing Conception Island at two o'clock, and came to anchor at Port Nelson, Rum Cay, at seven-fifteen. After landing mails and cargo we left this port on January 28, timing our departure so as to make Clarence Harbor, Long Island, the following morning, as it cannot be entered except in daylight. No land was in sight, however, the next morning, so we ran west until we sighted Long Island, and spent the entire day beating down to Clarence Harbor against a light head wind, coming to anchor inside the bar just after sunset. I sometimes slept in a stay-sail on the cabin roof, and rousing up at four o'clock on the morning of January 30, I had a fine view of the constellation of the Southern Cross, poised in the heavens above the low hills at the south side of the harbor. Later I made a short visit ashore, where the destruction wrought by the hurricane of the previous October was everywhere evident. The large church on the hill at the back of the town, as well as many houses, were mere piles of ruins, and the people were living in huts and make-shifts. This place, as well as Rum Cay and Watlings Island, were in the direct path of the hurricane, and suffered heavy loss. The most valuable part of the "Estrella's" cargo on this particular trip was certain bags of money, sent by the Government to the various local

magistrates for distribution among the needy, ostensibly as a loan, but I was informed that there was little probability of repayment. Efforts to secure some fresh provisions here met with practically no success.

Our next stop was Bird Rock Light, which was reached at three P.M. the same day (January 30). Mail and cargo were landed in a heavy wind and sea, the small boat being anchored just on the edge of the breakers, and the packages swung to land by means of a long derrick on the shore. The seamanship, strength, and agility exhibited by the boatmen throughout these islands is truly marvelous. Another stop was made at Crooked Island, where we were detained until after dark, and where we secured some delicious oranges from two passengers who come on board. The wind being in the wrong direction for us to land at the usual anchorage in front of the settlement at Fortune Island, we kept on around the south end of the island, and anchored in smooth water at nine P.M., remaining there over Sunday, January 31. We had a welcome addition to our bill of fare in the shape of fresh fish—margate-fish, grunts, hind- and squirrel-fish—which the crew caught with hand-lines during the night. We left Fortune Island about noon on February 1, with fair weather and a stiff northeast breeze, and sighted the high hills on the south end of Acklin Island, and Castle Island Lighthouse at two-thirty, arriving at the latter some two hours later, hauling in a large barracuta on the trolling line. Here the lightkeeper's wife and daughter were put ashore with difficulty, as the wind was blowing half a gale and heavy seas were running, and we then bore away on our course for Great Inagua, on the last, longest, and roughest leg of our outward voyage. With a reefed mainsail, the "Estrella" fairly flew up the hills and down the valleys of the long high seas, and the man at the wheel had a strenuous time to keep her straight on the course. Dawn of February 2 found us only about five miles off the low-lying shores of Great Inagua, and we dropped anchor in the open roadstead in front of Mathewtown (there being no harbor) at eight o'clock.

Upon going ashore we met Mr. Charles Sargent, U. S. Consul, also Mr. F. H. Boucher, who had a turtle- and fish-breeding plant at Alfred Sound, on the north side of the island. As it was said to be a good locality for our purpose, we arranged to move up there with our outfit, which was transferred to Mr. Boucher's small auxiliary sloop "Tortuga," and we got away at eleven o'clock the next day. Rough

seas were encountered off Middle Point, and we got drenched, but made good progress until we rounded Northwest Point, where we found heavy breakers rolling entirely across the mouth of Alfred Sound, making entry impossible, so we put back behind the point and anchored in a sheltered cove. We landed, and walked overland to the Sound, and up the shore about seven miles to Mr. Boucher's place, leaving our baggage to be brought around by the boat as soon as possible. It arrived the following morning, all safe, with the exception of our supply of plaster, which the water had ruined. The "camp" consisted of several well constructed steel-roofed buildings, situated on a sandy ridge separating a series of large lagoons from the sound, along which they extend for several miles, their mouths having been closed with heavy walls of broken coral rock. About these lagoons there was a considerable growth of mangroves, where Bahama Yellow Warblers, Bahama Clapper Rails, Bahama Green Herons, and Yellow-crowned Night Herons found congenial haunts. On the sandy beaches, among the low bushes, where the ground was in places undermined by the holes of gigantic land-crabs, were found Mona Ground Doves and Cape May Warblers, while in the heavier growths Gundlach Mockingbirds and Pearly-eyed Thrashers made their home. Back of the lagoons the mainland is very low and flat for a considerable distance, with a low growth of cactus and shrubbery. On February 5 we made an excursion to "Calefavor Pond," a large salt water lagoon lying about six or seven miles to the southeast of the head of Alfred Sound, with which it is probably connected during the rainy season. Besides ourselves, the party consisted of Mr. Boucher, Mr. Sargent, and two negroes. We proceeded about three miles in two boats, and then in the lighter boat until we could row no farther, when we dragged it a long way through the shallow water, and finally had to carry it, requiring our combined strength, for about half a mile, but we failed to get it into the pond, as miles of dry flats still intervened, so we were obliged to explore the pond by wading. We had come primarily in search of Flamingoes, but, although we saw plenty of signs, only one individual was actually observed. In the center of the pond, which was a half-mile or more across, was a mangrove island, where a small colony of Roseate Spoonbills was nesting, together with some Reddish Egrets and Yellow-crowned Night Herons. On a subsequent visit a number of Man-o'-war-birds were observed, and one secured, while a few Black-bellied and Semipalmated Plover were noted on the edge of the lagoon, lower down.

We remained at Alfred Sound until February 17, when, our supplies getting low, we decided to return to Mathewtown, and getting our outfit on board an 18-foot open boat, started out at eight in the morning, reaching our destination safely shortly after three that afternoon. We made Mathewtown our headquarters until March 2, collecting in the vicinity, and making several excursions to the "Horse Pond," a large wooded fresh water swamp about a mile back of the town, containing the largest growth of trees in the neighborhood, growing in water from one to three feet deep. This was a favorite haunt of the Antillean Tree Duck, Pied-billed and West Indian Grebes, Florida Gallinule, Sora Rail, and some other water-birds, while several species of warblers held forth in the trees. We visited also the salt ponds still farther back of the town, and explored the adjoining country in various directions. The whole southwest corner of the island is a level plain, covered everywhere with a dense coppet or thicket of shrubbery from ten to twenty feet high, except on the "roads" and a few small clearings, the coral rock formation protruding more or less everywhere, and in the bright sunshine producing in the fields, and especially on the roads, an almost intolerable white glare. This coppet was the home of such birds as the Bahama Banan-aquit, Blue-gray Gnatcatcher, Thick-billed Vireo, and Maynard Cuckoo, while along the paths and roadsides, and about the clearings, were found the Bahama Grassquit, Antillean and Gundlach Mocking-birds, Mona Ground Dove, and Inagua Wood-star.

Fortunately we were able to secure passage directly to Acklin Island, and thence to Watlings Island, by special arrangement with Captain Heastie, of the schooner "Whisper," of only nine tons, but a very seaworthy little craft. We were under way at eleven A.M., March 2, with our course laid for Hogsty Reef, but as it was not in sight at sunset, although we knew by the smoother water that we were under its lee, we bore away in the direction of Castle Island Light, which was sighted about midnight, and we ran in under the south end of Acklin Island some four hours later and hove to until daylight. The next morning (March 3) we worked up the west side of Acklin Island, making numerous stops for passengers and freight, and reaching our destination at Gold Rock anchorage late in the afternoon. All our time and efforts during our brief stay on this island were devoted to a strenuous quest for Bahama Parrots, of which an account is given in the notes under that species. The topography is very

similar to that of the other islands, but more cacti of several kinds were noted, and the high coppet in which the parrots breed attains almost the dignity of a forest, many of the trees being large enough to afford nesting cavities.

Leaving Acklin Island on March 8, we stood across to Fortune Island, anchoring off the settlement to leave passengers and mails, but finally got away at one-thirty P.M. on March 9. A heavy wind blew up from the east, so we ran in to the Crooked Island anchorage to wait for better weather for the long run of about seventy miles, through the open ocean, here from twelve hundred to two thousand fathoms deep, which in a heavy wind gets up a nasty sea. We left the anchorage at ten P.M., and as soon as we passed around Bird Rock we encountered strong winds and heavy seas, and although we kept going, we had a very rough and uncomfortable night, the little "Whisper" shipping one large sea, which nearly carried both helmsman and compass overboard, and we had difficulty in holding ourselves in the berths below, not to think of sleeping. At sunrise on March 1 there were mountains of water on all sides, and no land in sight, but Watlings Island was finally sighted at eight-thirty, Sandy Point passed at ten o'clock, and anchor dropped off Cockburn Town at noon. We were welcomed by Mr. C. G. Rigby, the resident magistrate, and given a comfortable room at his house, and our thanks are due him for numerous favors. The surface of this island is broken and hilly, much like that of New Providence, and covered with the same kind of coppet, but there is no pine barren. A large salt water lake takes up the greater part of the middle portion of the island, visited by several species of ducks, and the home of one or more rookeries of Mexican Cormorants. Bordering the lake are large patches of mangrove swamp, affording shelter for Bahama Yellow Warblers, Maryland Yellow-throats, Bahama Green Herons, and Bahama Clapper Rails. There is an outer sand-beach in most places, affording a feeding ground for shore-birds. Large magnolia trees near the landing at Riding Rock, and cabbage palms scattered over the northwestern portion of the island, nearly all show the work of woodpeckers. Maynard Cuckoos and Pearly-eyed Thrashers were found in the dense coppet, West Indian Grebes in the small ponds back of the beach, while Zenaida Doves were common about the cultivated tracts. The Bahama Duck breeds here about the grassy edges of the ponds. There seemed to be a notable scarcity of certain of the smaller birds



here, however. Our explorations extended to the east side of the island, to the monument which marks the first landing-place of Columbus, and to Iguana Cay in the lake, where we secured some iguanas.

On April 5 we sailed on the trading sloop "Mayflower" for Nassau, touching at Port Howe, Cat Island. We reached Nassau on April 8, where we were delayed a full day by inability to secure our mail, it being Good Friday and a holiday. We engaged passage on the sponger "Florence" for Staniard Creek, Andros Island, but a heavy storm came up from the northeast and continued all night, so that all the vessels in the harbor had to haul off from the docks and lay at anchor to prevent damage. Although it was still blowing heavily on Sunday a start was made a little after seven in the morning, and we passed the west end of New Providence three hours later. Land on Andros was sighted shortly before one o'clock, and we came to anchor at Staniard Creek a little after two. This is the name applied to a narrow and shallow lagoon separating a low, narrow, sandy island about two miles long from the mainland of Andros, a few miles south of Saddleback Cay. This small island is mostly covered with a low growth of bushes on the outer side, while on its inner side, as well as on the mainland opposite, are extensive cocoanut groves, which are the home of the Northrop Oriole. A considerable part of the land near the village is under cultivation. On the mainland beyond the creek is a large muddy flat with low stunted mangroves, and back of that a strip of coppet, which gradually merges into the pine barrens covering the interior of the island.

We remained on Andros just a week, and the following Sunday (April 18) found us aboard the sponging schooner "Champion," bound for Nassau. We were obliged to run down the coast for several miles to pick up the balance of our boat's crew, but finally headed for Nassau about ten o'clock. The wind was light and ahead, however, so that we only made the west end of New Providence that evening, anchoring near Gaulin Cay for the night. Resuming our voyage the next morning, we beat slowly up to Nassau, arriving shortly after one o'clock. Our business there was quickly despatched on this occasion, and we presently found that the schooner "Jemima" was to sail for Abaco the next day, so passage was engaged with Captain Sanders, and for the first time since our arrival in the Bahamas we sailed with a white captain and crew. We left Nassau at four-thirty P.M.

on April 20, with a light breeze, passed Hole-in-the-wall Light at five-thirty the following morning, and Cherokee Sound at two P.M., and anchored for the night at Spencer's Point, opposite Pelican Harbor, shortly after four o'clock. We were advised to go to a place called "Sand Bank," on the mainland of Abaco, opposite Whale Cay, and one of the crew offered to carry us there from Green Turtle Cay, the *Jemima's* destination. An entire day (April 22) was consumed in getting from Spencer's Point to Green Turtle Cay, which we reached a little after seven in the evening, and another day in getting a boat and provisions, transferring our outfit, and making the trip to Sand Bank, which we finally reached at sundown on April 23. We moved into a palmetto shack with plenty of mosquitoes for company, and after a bite of supper crawled under our mosquito bars for some much needed rest, beginning work the following morning. The locality proved to be a good one for our purpose. There was a high ridge next the coast, taken up with an orange and sapodilla orchard, and back of this ridge a strip of thick, high coppet, with an undergrowth of ferns, which extended into the pine barrens beyond. The pine trees here were much larger than any we saw elsewhere on the islands, and afforded congenial haunts for the Bahama Pine Warbler, Cuban Warbler, Yellow-breasted Warbler, and Abaco Hairy Woodpecker. In the tops of the tall dead trees we found the Bahama Swallow nesting, while the Tanner Yellow-throat found a home among the luxuriant growth of ferns beneath. Water-birds of all kinds, however, were conspicuous by their absence.

We remained at Sand Bank until April 30, when we sailed for Spencer's Point in the small schooner "Northeastern," arriving the following day, securing accommodations with a Mr. Sweeting, near the large saw-mill plant of the Bahama Lumber Company, which gave us the advantage of long hand-car rides into the forest on the tramway line. The general aspect of the country at this point is about the same as at Sand Bank, and the avifauna quite similar. Back of the high ridge along the coast, and extending nearly to Sweeting's Village on the southeast side of the island, was the largest coppet we encountered. It was thirty or forty feet high in places, and contained many large trees, but for some reason it was exceedingly poor in bird-life.

Although the captain of the "*Jemima*" had promised to call for us Sunday or Monday, May 10, to take us to Nassau in time for the mail steamer for New York on May 13, he failed us utterly, but for-

tunately the Bahama Lumber Company's large tug "Admiral Dewey" was billed to meet the same steamer, so we engaged passage at once, and started for Nassau about seven o'clock P.M., May 12, in a howling northeaster, the captain stating it was the roughest trip he had ever made. Every available bunk and locker was occupied, and we were obliged to remain up all night, the most of which was passed on the top of the pilot-house, with a firm grip on the railing to keep from being pitched overboard. However, we reached port safely before five the next morning. The gale continued, accompanied by rain squalls, and our business in Nassau was accomplished between showers. The Ward Line steamer "Seguranca" lay in the offing, and at noon passengers and baggage were put aboard, and three hours later we swung around into our course for New York. Our last sight of Nassau was through gusts of rain, driven over a heaving sea by a northeast gale.

The details of the expedition have been given thus to show some of the discomforts and delays bound to be encountered in such a trip in the Bahamas as we undertook to make. These could be avoided only by having one's own conveyance, which would be unduly expensive, as vessels of sufficient size to insure safety would cost ten or fifteen dollars a day. Otherwise one has to take chances of getting from place to place on whatever offers, to live on the roughest kind of fare, and to mess with negroes, which, although often not over-clean, are all fine boatmen, and one is quite likely to reach his destination while in their care. I wish here to express my thanks to all natives of the Bahamas who aided us in our travels, and especially to His Excellency Sir William Grey-Wilson, Governor of the Bahamas, Captain Boddam-Whetham, Hon. W. Hart Bennett, Colonial Secretary, all of Nassau; to Mr. Charles Sargent, Acting U. S. Consul, and Mr. Frank H. Boucher of Great Inagua; to Mr. C. G. Rigby, magistrate at Watlings Island; and to Mr. Charles Lightbourne and Miss Mary Lightbourne of the Blue Hills, near Nassau, for special courtesies.

#### CRITICAL NOTES.

BY W. E. CLYDE TODD.

The sequence of species in the present paper is the same as in Mr. Joseph H. Riley's "List of Bahaman Birds" (in Shattuck, *The Bahama Islands*, 1905, 358-368), while the nomenclature is based

upon the American Ornithologists' Union Code. Under each species the number of specimens in the collection is specified, with the several localities represented. All measurements are in millimeters.

1. *Colymbus dominicus dominicus* Linnæus.

Five specimens: Great Inagua (Mathewtown); Watlings Island.

Only two adult specimens are included, one from each locality, and both females. They measure as follows: wing, 90 and 92; culmen, 22 and 20. After having critically studied the series upon which *Colymbus dominicus brachypterus* Chapman was based, as well as additional material from Costa Rica and Jamaica, I am strongly inclined to doubt the validity of the subspecies in question. The supposed color-characters fail to hold good; while the difference in size seems too slight and inconstant to alone justify subspecific separation. Averages are as follows:

	Wing.	Culmen.
Two males from Cuba . . . . .	97	25.5
Two females from Cuba . . . . .	94	21
Two females from the Bahamas . . . . .	91	21
Eight males from Texas . . . . .	87.5	22
Five females from Texas . . . . .	84.3	19
Three males from Costa Rica . . . . .	94	25
One female from Costa Rica . . . . .	94	21

There is thus an obvious sexual difference in size, which must be taken into account in making comparisons. Examples from Costa Rica approach typical *dominicus* so closely that if *brachypterus* be deemed worthy of recognition at all it will be necessary to restrict the name to the birds from Texas and Mexico. Compare also, in this connection, the measurements given by Mr. Cory (*Birds Bahama Islands*, 1890, 222) for the Bahaman bird, as well as Messrs. Salvin and Godman's remarks on the same subject (*Biologia Centrali-Americana*, Aves, III, 1904, 443).

Both adults are in full breeding dress, with dark throats, although Mr. Ogilvie-Grant (*Catalogue Birds British Museum*, XXVI, 1898, 521) says that "the black throat *begins* to appear early in May" (*italics mine*). "Iris bright orange yellow, bill black, tip white; tarsi and toes black above, plumbeous below."

Three birds from Watlings Island, March 12, have already attained the juvenal dress, and are fully as large as adults. In these the crown is dusky, with some white mottling, obsoletely indicating median and lateral stripes; the sides of the head, however, are mottled in-

definitely with dusky and white; the throat is white, with an obsolete dusky submalar stripe; the lower parts, except the dusky sides, flanks, and upper breast, are also white, with practically none of the dusky mottling of the adult. "Iris pale brown amber; bill brownish, with lower mandible whitish, except at base."

2. **Podilymbus podiceps** (Linnaeus).

Four specimens: Great Inagua (Mathewtown).

The single adult has the throat black, with a few white-tipped and wholly white feathers. The young birds are in natal plumage.

3. **Phalacrocorax vigua mexicanus** (Brandt).

One specimen: Watlings Island.

This individual is completing a moult, which involves the remiges and rectrices, as well as the feathers of the head and neck, the light-colored feathers being replaced by darker. Hence I infer that it is an immature bird moulting into adult plumage, the under parts having already become deep black.

It is surely odd that this bird has not been certainly detected on any of the other islands in the group.

4. **Fregata aquila** Linnaeus.

One specimen: Great Inagua (Calefavor Pond, 6 miles east of Alfred Sound).

"Iris dark hazel."

5. **Phœnicopterus ruber** Linnaeus.

One specimen: Great Inagua (Mathewtown).

This individual has numerous black feathers along the cubital edge, also dusky ones on the head and neck—doubtless remains of the immature dress.

6. **Dichromanassa rufescens** (Gmelin).

Six specimens: Great Inagua (Calefavor Pond, 6 miles east of Alfred Sound).

Of the four adults, two are in the white phase and two in the blue, one of the latter, however, showing a number of white feathers on the breast and abdomen—a condition somewhat unusual in this species, but not unknown. The two young birds, whose heads are still thickly covered with the natal down, are also in the white phase.

7. **Hydranassa tricolor ruficollis** (Gosse).

Two specimens: Great Inagua (Alfred Sound; Calefavor Pond, 6 miles east).



Only one bird fully adult, the other showing worn and faded rufous-tipped wing-coverts, which characterize the first nuptial plumage.

8. *Butorides virescens bahamensis* (Brewster).

Nine specimens: New Providence (Blue Hills); Great Inagua (Alfred Sound, Mathewtown); Watlings Island.

MEASUREMENTS OF ADULTS.

No.	Sex.	Locality.	Wing.	Tail.	Tarsus.	Culmen.
30606 <sup>1</sup>	♂ vix ad.	Blue Hills, New Providence. . . .	158	53	45	57
30740 <sup>1</sup>	♂ ad.	Alfred Sound, Great Inagua. . . .	167	59	43	58
30806 <sup>1</sup>	♂ ad.	Alfred Sound, Great Inagua. . . .	165	59	43	60
30859 <sup>1</sup>	♂ vix ad.	Mathewtown, Great Inagua. . . .	169	57	44	61
30929 <sup>1</sup>	♀ ad.	Watlings I. . . . .	163	59	40	58
99428 <sup>2</sup>	♂ ad.	Andros . . . . .	163	58	46	59
99429 <sup>2</sup>	♂ vix ad.	Andros . . . . .	148	52	39	52
99430 <sup>2</sup>	♀ ad.	Andros . . . . .	164	57	49	57
8 adult	males	from eastern U. S., average. . . . .	179	65	51	61

The difference in size between this form and true *virescens* is evident from the above table, while the color-differences are obvious upon comparison, the Bahaman bird being decidedly paler. Granted that these differences are of subspecific value, the relationship of the present form to the bird of the West Indies and Central America remains to be considered. Mr. Riley has separated the West Indian bird under the name *maculata* of Boddaert (*Smithsonian Miscellaneous Collections*, Quarterly Issue, XLVII, 1904, 278), giving as characters the smaller size, more plumbeous crest, and less pronounced and less tawny edgings to the wing-coverts. Messrs. Thayer and Bangs, however, commenting on this statement (*Bulletin Museum Comparative Zoölogy*, XLVI, 1905, 143), find the color-characters unstable, and are furthermore unable to separate Bahaman birds from those from the other West Indian Islands. They adopt the name *maculata* to cover all specimens from the Bahamas, Greater and Lesser Antilles, Central America, and continental South America, taking size alone as the criterion for separation. But after comparison of considerable material from Central America and Colombia I cannot verify the alleged difference in this respect. Colombian specimens, indeed, average larger if anything, and I should unhesitatingly refer the entire series to true *virescens*. A series of adults selected at random from several of the more northern West Indian islands seems to differ from

<sup>1</sup> Collection Carnegie Museum.

<sup>2</sup> Collection American Museum Natural History.

United States specimens in being slightly more brownish on the abdomen, while their average size is a trifle less, but these differences seem scarcely worthy of nomenclatural recognition. They are quite distinct from the Bahaman bird, however. The pale color of the latter Messrs. Thayer and Bangs attribute to bleaching in an arid habitat, and they furthermore belittle the value of color-characters in this species. The present series tends to invalidate this objection, since all the specimens are in comparatively fresh plumage; moreover, the young birds differ in the same way. It may be added that every one of the Bahaman birds shows decidedly broader edgings to the wing-coverts than any continental examples seen, although this is well known to be an extremely variable character in this species.

Adult: "iris straw-color; legs pale yellowish."

Young (No. 30804), still showing remains of the natal down adhering to the crown and back feathers: "iris pale straw-color; bill pale yellowish horn, base and culmen blackish; naked skin at base, and feet and legs, pale yellowish green." This individual, from Alfred Sound, Great Inagua, February 15, indicates that the species breeds very early in the season. Another specimen, from Mathewtown, February 24, is marked as having the testes much enlarged, and evidently breeding or about to do so, although it has not yet acquired the adult nuptial plumage, which is indicated merely by a few of the long green dorsal feathers just coming in, and grayish feathers on the abdomen. A bird from New Providence, January 1, is somewhat further advanced.

9. *Nycticorax nycticorax nævius* (Boddaert).

Four specimens: Great Inagua (Calefavor Pond, 6 miles east of Alfred Sound).

All young birds in the streaked plumage, with remains of the natal down still adhering to the crown feathers. The species must nest very early in the season. "Iris yellow; legs pale greenish."

10. *Nyctanassa violacea* (Linnæus).

Two specimens: Great Inagua (Calefavor Pond, 6 miles east of Alfred Sound); Watlings Island.

11. *Ajaia ajaja* (Linnæus).

Five specimens: Great Inagua (Calefavor Pond, 6 miles east of Alfred Sound).

In a chick only a few days old, and covered with pure white down,

the characteristic form of the bill is already manifest. The adults are all in high plumage, with bright crimson lesser wing-coverts and upper and under tail-coverts. Comparison of a series of this species discloses a considerable sexual difference in size, particularly marked in the bill, which in the male is decidedly longer and with a broader tip.

12. *Pœcilonetta bahamensis* (Linnæus).

Three specimens: Watlings Island.

Adult: "iris red; bill plumbeous, olive-tinged above, with basal patch crimson; feet olive."

A young bird (No. 30939, Watlings Island, March 23) is assuming the juvenal dress, and already resembles the adult below. In the downy stage the general color is dull brown, with a white stripe on the flanks and an illy-defined pale superciliary stripe. The throat and cheeks are white also, as in the adult. "Iris light hazel; feet smoky drab; bill-spot brownish."

13. *Colinus virginianus floridanus* (Coues).

Five specimens: New Providence (Blue Hills).

After carefully comparing these specimens with examples from peninsular Florida I find myself unable to appreciate any of the characters pointed out either in the original description of *Colinus "bahamensis"* (Maynard, *Appendix to Catalogue of the Birds of the West Indies*, 1899) or by Mr. Cory (*Auk*, IV, 1887, 225), although I have examined the latter's original material in this connection. Every one of the distinctive features which are urged by these authors occur as well in numerous individuals of the Florida bird. Moreover, the species is said to have been introduced, and the fact that it occurs on New Providence alone of all the islands in the group renders it practically certain that such was actually the case. Under these circumstances I can see no further reason for maintaining the Bahaman bird as a recognizable form, and it should accordingly stand as above.

14. *Rallus crepitans coryi* Maynard.

Nine specimens: Watlings Island; Andros (Staniard Creek).

TABLE OF AVERAGE MEASUREMENTS.

	Wing.	Culmen.	Tarsus.
<i>R. c. crepitans</i> , two males.....	150	61	51
<i>R. c. waynei</i> , three males.....	135	63	51
<i>R. c. coryi</i> , four males.....	149	61	51
<i>R. c. crepitans</i> , five females.....	137	59	45
<i>R. c. waynei</i> , four females.....	135	60	47
<i>R. c. coryi</i> , five females.....	139	56	46
<i>R. c. coryi</i> , type.....	139	53	44



Mr. Worthington's success in securing a series of this rail, which is one of the most difficult of Bahaman birds to collect, renders it possible for the first time to make adequate comparisons to determine its status. In addition to the above specimens, I have studied in this connection the material in the American Museum and the Field Museum. The present form is strikingly different from its nearest mainland representative, *R. c. waynei*, being decidedly paler in general coloration. It is in fact nearer *R. c. crepitans* of the Atlantic coast from Virginia northward, but is obviously paler. The difference in measurements between these forms is inconsequential, although *R. c. waynei* seems to average a trifle smaller than either of the others, with a slightly longer bill. The type specimen of *coryi*, which I have examined, although marked a male, is almost certainly erroneously sexed, so that Mr. Sennett's diagnosis of this as a short-billed form is misleading. Neither has it anything to do with any of the forms of *R. longirostris*, as he seems to intimate (*Auk*, VI, 1889, 163). In making comparisons in this group care must of course be taken to choose specimens in the same condition of plumage, as wear and fading cause great changes. Bahaman individuals taken from April to June are very pale indeed, in some cases being buffy white below.

In all probability all the Bahaman records for *crepitans* refer to the present form, whose previously known range is considerably extended by Mr. Worthington's investigations.

"Iris reddish brown; bill orange brown, culminal ridge and tip blackish, feet pale brownish orange" or "olive gray."

15. **Porzana carolina** (Linnaeus).

Two specimens: Great Inagua (Mathewtown).

16. **Gallinula galeata galeata** (Lichtenstein).

Three specimens: Great Inagua (Mathewtown).

One bird is in first nuptial plumage, the frontal shield being small, and the throat mottled with white.

17. **Pisobia minutilla** (Vieillot).

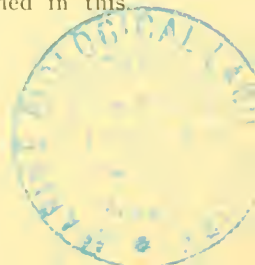
Three specimens: New Providence (south coast); Great Inagua (Alfred Sound).

These are all in full winter dress, with no sign of prenuptial moult.

18. **Helodromas solitarius solitarius** (Wilson).

One specimen: Great Inagua (Mathewtown).

This specimen is not matched by any others examined in this



connection. It is evidently not in winter dress, for the crown and breast are distinctly streaked. The spotting above is buffy, however, as in winter, and there is a buffy suffusion on the breast also. The body-plumage appears worn, which ought not to be the case if the bird had just passed through a prenuptial moult.

19. **Squatarola squatarola** (Linnæus).

One specimen: Great Inagua (Alfred Sound).

An adult in full winter plumage, with no sign of prenuptial moult, although the freshness of some of the body-feathers in contrast with the general plumage suggests that they have been recently renewed.

20. **Oxyechus vociferus rubidus** Riley.

One specimen: Great Inagua (Mathewtown).

Compared with four winter specimens from Florida, this bird is noticeably smaller in size, the wing measuring only 150 mm., while in two Florida females it is 162 and 168 mm. respectively. In general coloration the Great Inagua bird is paler, with the rusty edgings of the upper parts more pronounced. It agrees well in these respects, however, with summer specimens from Jamaica and Cuba, and evidently belongs to the form renamed as above by Mr. Riley (*Proceedings Biological Society of Washington*, XXII, 1909, 88). Examination of a considerable series of summer adults from Great Inagua in the collection of the Field Museum abundantly confirms the conclusion just announced. Owing, however, to the peculiar makeup of the skins satisfactory wing-measurements cannot be taken, but the general difference in size between these birds and United States specimens is obvious at a glance. The amount of rusty feather-edging is a more variable character. The form under consideration seems clearly entitled to recognition, although I have been unable to discover any other recent references bearing on its subspecific discrimination. It is of course not surprising to find that this is the form inhabiting Great Inagua, which is so near the West Indies proper, but several skins from Watlings Island (in the Field Museum collection) and at least one from Eleuthera (No. 36511, Rock Sound, November 15, 1891), obviously belonging to the same small race, raise an interesting question regarding its occurrence on the other islands of the group. True *vociferus* is found as a winter resident throughout the range of the present form.

21. **Ægialitis semipalmata** (Bonaparte).

Two specimens: Great Inagua (Alfred Sound).

Both are apparently immature birds, with the plumage rather worn and faded, showing no traces of paler feather-edgings, but as yet no indications of prenuptial moult.

22. *Octhodromus*<sup>1</sup> *wilsonius wilsonius* (Ord).

Three specimens: Watlings Island.

These specimens (all males) exhibit a very decided suffusion of rusty ochre on the nape and sides of the head, so pronounced, indeed, as to have rendered further comparisons desirable in order to ascertain their status. Examination of a considerable series from various United States localities discloses the fact that a certain proportion of the individuals show this coloration, supposed to be characteristic of *O. w. rufinucha* (Ridgway), to a greater or less extent. Indeed, the type of this form, which has been examined in this connection, is no more rufescent than many of the northern specimens, and in my opinion is nothing more than a migrant from the north. No unquestioned resident birds from Jamaica (the type locality of *rufinucha*) have been seen, but Mr. Hellmayr (*Abhandlungen der K. Bayer. Akademie der Wissenschaften*, XXII, 1906, 715) states that birds from Jamaica and Trinidad agree in being readily distinguishable from true *wilsonius*, and a series from the Dutch West Indies in the Field Museum which I have studied bears out this conclusion. The differential characters of the two forms stand out more clearly in the female sex, in which the sides of the head and the pectoral collar are much more rusty in the series in question than in any of the United States examples, but the alleged difference in the color of the lores does not hold good. But whether the name *rufinucha* can properly be applied to this form is open to question, as I have already intimated. The matter is complicated by our lack of precise knowledge regarding the winter range of the two forms (cf. Cooke, *Bulletin Biological Survey*, No. 35, 1910, 93, 94). Mr. Hellmayr, in the paper before referred to, insists that the type of *Charadrius crassirostris* Spix belongs to the northern form—a conclusion in my judgment open to grave doubt, if for no other reason than the unlikelihood of *wilsonius* ever migrating so far south in winter as Brazil.

<sup>1</sup>Mr. Gregory M. Mathews, in two recent papers published in the *Notitæ Zoologicae*, proposes a large number of changes in generic terms. *Eupoda*, for example, replacing *Octhodromus*. Several other names used in the present paper are also affected, but pending the verification of the proposed changes none of them are formally adopted here.

There is a specimen in the Carnegie Museum (No. 8887) from Buri-taca, Colombia, September 18, 1899, which is an exact counterpart of Spix's description and plate, and I suspect is an immature bird of the resident form. In this view of the case, the subspecies of the Wilson Plover breeding in South America and the Antilles would stand as *Octhodromus wilsonius crassirostris* (Spix). All Bahaman skins so far examined belong to true *wilsonius*.

23. ***Arenaria interpres morinella*** (Linnaeus).

One specimen: Great Inagua (Alfred Sound).

This individual is still (February 12) in winter dress.

24. ***Columba leucocephala*** Linnaeus.

Five specimens: New Providence (Blue Hills); Abaco (Sand Bank).

Two of the New Providence examples have the dull grayish crown said to be characteristic of the immature bird, but in all three skins many of the old and worn brownish feathers have been replaced with fresh bluish slate feathers, especially in the case of the scapulars, wing-coverts, and remiges. It would appear, however, that this moult is not complete, as I can find no evidence of actual replacement going on (that is, growing feathers in sheaths), and the two Abaco birds (both females, however), although taken so much later in the season, show the same condition, some of the feathers being quite fresh while others are obviously worn.

"Iris white; cere and feet crimson."

25. ***Zenaida zenaida*** (Bonaparte).

Twelve specimens: Great Inagua (Alfred Sound); Watlings Island; Abaco (Sand Bank, Spencer's Point).

Considerable individual variation exists in the color-pattern of the middle rectrices, which in some specimens are immaculate brown, while in others they show a well-defined dusky bar, with every intermediate degree between these two extremes of style. One individual is albinous in this part, the two middle rectrices and some of the upper tail-coverts being mottled and clouded with white.

"Feet dark (or pale) crimson; iris dark hazel."

26. ***Chæmepelia passerina bahamensis*** (Maynard).

Six specimens: New Providence (Blue Hills).

Mr. Maynard's name *bahamensis* was based on birds from New Providence (*cf.* Bangs, *Auk*, XVII, 1900, 286), which are obviously smaller and paler than Florida examples—but not so pale as *C. p.*

*pallescens*, as stated by Mr. Riley (in Shattuck, *The Bahama Islands*, 1905, 352)—while the bill is wholly dark (in the dry skin; unfortunately the colors when fresh are not stated).

27. ***Chæmepelia passerina exigua*** (Riley).

Ten specimens: Great Inagua (Alfred Sound, Mathewtown).

This series differs from the New Providence birds in smaller size and decidedly paler coloration, averaging paler even than *C. p. pallescens*. Upon comparison they prove to be referable to the form from Mona Island, Porto Rico, described by Mr. Riley as *Columbigallina passerina exigua* (*Proceedings United States National Museum*, XXIX, 1905, 171). The discovery that two readily separable but intergrading forms of the Ground Dove inhabit the Bahama Islands is in line with other facts of distribution already known, and will be discussed more fully in another connection.

There is a young bird in juvenal dress from Mathewtown, February 26, indicating that the species breeds very early.

28. ***Falco columbarius columbarius*** Linnaeus.

One specimen: New Providence (Blue Hills).

29. ***Amazona leucocephala bahamensis*** (Bryant).

Six specimens: Acklin Island (Pompey Bay).

"Iris grayish yellow; bill white; feet yellow."

The present series, secured by Mr. Worthington after strenuous efforts, taken in connection with the specimens in the American and the Field Museums, has afforded a fair basis for determining the status of this form, whose standing as a subspecies has been considered doubtful. First, as regards relative size, the following table of measurements gives the necessary data:

No.	Sex.	Locality.	Wing.	Tail.	Culmen.	Depth of Bill.
30888 <sup>1</sup>	♀	Pompey Bay, Acklin I. . . . .	201	123	29	32
30889 <sup>1</sup>	♂	Pompey Bay, Acklin I. . . . .	210	129	32	33
30890 <sup>1</sup>	♂	Pompey Bay, Acklin I. . . . .	211	132	30	33
30891 <sup>1</sup>	♀	Pompey Bay, Acklin I. . . . .	203	124	28	32
30892 <sup>1</sup>	♀	Pompey Bay, Acklin I. . . . .	205	125	29	30
30893 <sup>1</sup>	♂	Pompey Bay, Acklin I. . . . .	208	127	—	33
16191 <sup>2</sup>	♀	Northeast Point, Great Inagua. . . . .	199	125	29	29
16977 <sup>2</sup>	♂	Mare Pond, Great Inagua. . . . .	200	118	30	30
16979 <sup>2</sup>	♂	Mare Pond, Great Inagua. . . . .	196	124	29	—

<sup>1</sup> Collection Carnegie Museum.

<sup>2</sup> Collection Field Museum.

The three Great Inagua birds were collected in June and July, and being somewhat worn they naturally average a little less in length of wing and tail. Following are the measurements of Cuban examples of *Amazona leucocephala leucocephala*:

No.	Sex.	Locality.	Wing.	Tail.	Culmen.	Depth of Bill.
57294 <sup>3</sup>	♀	Trinidad, Cuba . . . . .	188	107	25	29
57295 <sup>3</sup>	♀	Trinidad, Cuba . . . . .	184	108	24	27
57296 <sup>3</sup>	♀	Trinidad, Cuba . . . . .	184	107	26	28
57297 <sup>3</sup>	♂	Trinidad, Cuba . . . . .	196	104	26	28.5
4634 <sup>2</sup>	♂	————, Cuba . . . . .	187	104	26	29
— <sup>2</sup>	♂	Yateras, Cuba . . . . .	180	99	24	27
— <sup>2</sup>	♀	Yateras, Cuba . . . . .	180	103	24	26

Allowing for an obvious sexual difference in size, the Bahaman birds are thus considerably larger than those from Cuba, with a much heavier bill. In color the respective series differ as follows: in the Bahaman bird the abdominal purplish red patch is more restricted, the white crown-patch extends farther back, and the red area at the base of the outer rectrices is duller and smaller, the color being mostly confined to a strip along the shaft on the inner web. In the Cuban bird this red area is sometimes mixed with yellow. None of the Bahaman examples, however, show any red on the under wing-coverts, and I am at a loss to know what Mr. Cory means by this phrase in his description (*Birds of the West Indies*, 1889, 183), but all show a few pinkish or yellowish feathers bordering the white crown behind. Besides being smaller, females differ from males in having less red on the rectrices, while all the subspecific characters are accentuated, and the red area of the throat seems larger than in Cuban birds. While Great Inagua specimens perhaps have a little more red below than those from Acklin Island, on the whole the Bahaman series is quite uniform, and suffices to demonstrate the validity of *bahamensis* as a subspecies. Were there no such striking color-differences, the larger size alone would be diagnostic. The form described from Grand Cayman by Mr. Cory (*Auk*, III, 1886, 497), under the name *Chrysotis caymanensis*, I find upon examination ought probably to stand as a third subspecies, *Amazona leucocephala caymanensis*.

### 30. *Crotophaga ani* Linnæus.

Eight specimens: New Providence (Blue Hills); Andros (Staniard Creek); Abaco (Spencer's Point).

"Iris dark hazel."

<sup>2</sup> Collection Field Museum.

<sup>3</sup> Collection American Museum.

Saving only the single Andros specimen, the above birds are all in a curiously mixed plumage, the result perhaps of a partial moult, some of the feathers being old and worn and brown, while adjacent feathers are new and bright, although fully grown. This condition, which may be noticed in other species of this family, affects not only the body-plumage, but the remiges and rectrices and their coverts as well, apparently in no particular order, as is the case in a "regular" moult.

31. *Saurothera bahamensis bahamensis* Bryant.

Six specimens: New Providence (Blue Hills).

"Iris light hazel; skin over eye, and edge of lower eyelid, scarlet vermilion; feet bluish horn."

MEASUREMENTS.

No.	Sex.	Locality.	Wing.	Tail.	Culmen.	Depth of Bill
30573	♀	Blue Hills, New Providence.....	158	242	58	13.5
30642	♂	Blue Hills, New Providence.....	154	242	50	12.5
30643	♂	Blue Hills, New Providence.....	157	254	55	12
30678	♀	Blue Hills, New Providence.....	147	235	51	12
30713	♀	Blue Hills, New Providence.....	159	260	55	14
30714	♀	Blue Hills, New Providence.....	159	263	55	14

It will be noted that the series, taken as a whole, shows considerable individual variation in size, one specimen being as small as the form from Andros. Although all of these birds are in comparatively fresh plumage, none have tails measuring up to those given by Mr. Miller (*Auk*, XI, 1894, 165).

32. *Saurothera bahamensis andria* Miller.

One specimen: Andros (Staniard Creek).

"Iris hazel; skin around eye scarlet vermilion, except white spot directly under eye."

Besides the above specimen, I have examined one skin in the American Museum and three in the Field Museum, the series measuring as follows:

No.	Sex.	Locality.	Wing.	Tail.	Culmen.	Depth of Bill.
30994 <sup>1</sup>	♂	Staniard Creek, Andros.....	150	238	50	13
76561 <sup>2</sup>	♂	Andros.....	150	240	50	13
6685 <sup>3</sup>	♂	Andros.....	154	262	48	12.5
6686 <sup>3</sup>	♀	Andros.....	143	243	49	14
12540 <sup>3</sup>	♀	Andros.....	155	255	50	15

<sup>1</sup> Collection Carnegie Museum.

<sup>2</sup> Collection American Museum.

<sup>3</sup> Collection C. B. Cory, in Field Museum.

The characters originally ascribed to this form by Mr. Miller (*Auk*, XI, 1894, 164) seem to apply to these specimens, but I cannot regard them as being of more than subspecific value. As has been pointed out above, some individuals of *S. b. bahamensis* are fully as small, with small bills likewise. The general colors of *S. b. andria*, however, are a shade darker, especially below, while the rufous chestnut of the wings externally is more prominent.

33. *Coccyzus minor maynardi* Ridgway.

Twelve specimens: Great Inagua (Mathewtown); Watlings Island; Abaco (Spencer's Point).

"Iris dark hazel; rim of eyelids yellow; rest of bare skin lead-colored; feet light gray."

Some slight variation is exhibited in the depth of the buffy of the under parts, but the series as a whole shows a very constant difference in this respect from a similar series from the Greater Antilles, which Mr. Riley (*Smithsonian Miscellaneous Collections*, Quarterly Issue, XLVII, 1904, 285) calls *Coccyzus minor nesiotus* (Cabanis and Heine). To this statement there is one conspicuous exception; a female from Abaco (No. 31137), which is indistinguishable in size and coloration, so far as I can see, from San Domingo examples, being fully as richly colored beneath. In the large series of this species in the collection of the Field Museum there are several specimens showing a similar richness of color, notably two from Andros (Nos. 12377 and 12379), while examples from the Caicos Islands are also rather deeply colored. Whether such individuals actually represent true *nesiotus*, which is said to straggle northward occasionally to Florida, or are merely abnormally dark-colored examples of the resident Bahaman bird, is an undecided question.

34. *Dryobates villosus maynardi* Ridgway.

Ten specimens: New Providence (Blue Hills); Andros (Staniard Creek).

This fine series exhibits the distinctive subspecific characters with remarkable uniformity. All the specimens have a slight brownish wash on the breast, approaching some of the Pacific Coast forms of this species in this respect. The scarlet nuchal crescent of the male is remarkable for its brilliancy and width, showing little tendency to divide medially, as is so markedly the case in *D. v. auduboni*, the nearest mainland form. In almost every specimen there are a few scattered white feathers on the fore part of the crown. A female from New



Providence (No. 30589) has a couple of black spots on one of the outermost rectrices, indicating a variation in the direction of the following form.

35. *Dryobates villosus piger* Allen.

One specimen: Abaco (Sand Bank).

The characters claimed for this form are obvious in the case of the present example. It measures as follows: wing 102 mm.; tail 61; exposed culmen, 24.

36. *Sphyrapicus varius varius* (Linnaeus).

Three specimens: New Providence (Blue Hills); Great Inagua (Mathewtown); Watlings Island.

Three different plumages are represented. The New Providence bird is an immature female, with a sprinkling of red feathers on the crown; the Watlings Island bird (March 27) is an immature female which has nearly completed the first prenuptial moult; while the example from Great Inagua is an adult male in full plumage.

37. *Centurus nyanus nyanus* Ridgway.

Nine specimens: Watlings Island.

"Iris red brown; bill black; feet pale olive."

The acquisition of this fine series of a bird at one time presumed to be extinct (*cf.* Nye, *Auk*, XVI, 1899, 273), but more recently (1903) detected by Mr. Riley (*cf.* *Auk*, XX, 1903, 434), enables its characters and relationships to be determined with more precision than heretofore. In the first place, in my judgment Mr. Riley has gone too far in reducing the Bahaman forms to subspecies of the Cuban *Centurus superciliaris* (*cf.* *Auk*, XXII, 1905, 355), as I shall endeavor to show further on, and in any event *C. n. nyanus* would seem the least closely related to the Cuban species of all three forms. Compared with *C. n. blakei*, of which a good series of both sexes is available, its differential characters are more obviously of a subspecific nature. Taking up the males first, we find that the principal differences are as follows: in *nyanus* the frontal feathers are crimson, scarcely paler than the crown and nape, while in *blakei* this frontlet is very pale, in some examples being merely tinged with crimson. The black postocular spot, which is very small or absent in *nyanus*, is large and prominent in *blakei*, reaching backward almost even with the hinder margin of the auriculars. In the females the first-named difference also holds good, while the latter one is even more pronounced, the black postocular

spot being confluent behind with a black band on the crown in *blakei*, while in *nyeanus* this black is almost wholly concealed by the brownish white feather-tips. The crimson nuchal crescent is not so broad in the females of *blakei*, while in both sexes of the latter the abdominal red averages less in extent. There is practically no difference in size, nor yet in general color, the differences of such a nature as were indicated in the original description not holding good in the present series. However, the type of *nyeanus*, which I have consulted in this connection, is not only much whiter about the head, but also has a larger black postocular spot than any of the specimens now before me; and is misleading to that extent, the real differentiating characters being those I have specified.

## MEASUREMENTS.

No.	Sex.	Locality.	Wing.	Tail.	Culmen.	Tarsus.
30900	♂	Watlings I.	129	90	34	21
30913	♂	Watlings I.	125	88	33.5	21
30919	♂	Watlings I.	125	82	33	20
30934	♂	Watlings I.	127	88	31	23
30937	♂	Watlings I.	130	94	33	22
30945	♂	Watlings I.	130	94	33.5	22
30907	♀	Watlings I.	129	89	28.5	20
30914	♀	Watlings I.	125	93	30	20
30926	♀	Watlings I.	129	91	28	21

38. *Centurus nyeanus blakei* Ridgway.

Eight specimens: Abaco (Sand Bank, Spencer's Point).

"Iris deep brown-red; bill black; feet grayish horn."

## MEASUREMENTS.

No.	Sex.	Locality.	Wing.	Tail.	Culmen.	Tarsus.
31051	♂	Sand Bank, Abaco.	133	85	31	19
31101	♂	Spencer's Point, Abaco.	130	89	31	20.5
31124	♂	Spencer's Point, Abaco.	129	89	32	22
31150	♂	Spencer's Point, Abaco.	127	92	32	20
31066	♀	Sand Bank, Abaco.	128	87	27	20
31102	♀	Spencer's Point, Abaco.	129	90	29	22
31125	♀	Spencer's Point, Abaco.	127	86	28	20
31149	♀	Spencer's Point, Abaco.	130	89	27	20

In conformity with the previous discussion, this form should stand as above. The present series is quite constant, as is also the type series, which has been studied in this connection.

The Cuban *Centurus superciliaris*, besides being much larger than any of the Bahaman forms, averages much whiter on the wings, sides

of head, and middle rectrices, and seems specifically distinct, if equal weight be attached to characters deemed of specific value in other woodpeckers of this genus. Of the three Bahaman forms, that from Great Bahama, which must be called *C. nyanus bahamensis* Cory, is oddly enough nearest the Cuban bird in color, although farthest removed therefrom geographically. Thus, it is more decidedly tinged with yellowish green both above and below, and has more red on the abdomen, but this red is pinkish, not vermilion as in the other forms. It resembles *blakei* in having a decided black postocular spot, and *nyanus* in having a frontlet of deeper red, but differs from both in having a very decided tinge of yellowish green on the back, as above noted. Three specimens in the Field Museum measure as follows:

No.	Sex.	Locality.	Wing.	Tail.	Culmen.	Tarsus
20345	♀	Great Bahama.....	128	92	28	22
20346	♂	Great Bahama.....	132	92	30	24
20349	♂	Great Bahama.....	124	90	29	22

The distribution of the Bahaman *Centuri* is very curious, as they are apparently absent on certain islands where conditions seem favorable for their existence.

39. **Nesophlox<sup>1</sup> evelynæ** (Bourcier).

Seven specimens: New Providence (Blue Hills); Andros (Staniard Creek); Abaco (Sand Bank).

40. **Nesophlox lyrura** (Gould).

Twelve specimens: Great Inagua (Alfred Sound, Mathewtown).

The series includes two immature males, distinguished by the presence of a few glittering purple feathers on the throat, the plumage otherwise resembling that of the female.

41. **Riccordia ricordii æneoviridis** Palmer and Riley.

Ten specimens: Andros (Staniard Creek); Abaco (Sand Bank, Spencer's Point).

The three birds from Andros are slightly smaller than those from Abaco, and the single male is somewhat more brightly colored. The examination of additional material, placed at my disposal by Mr. Bangs, fails to substantiate the supposed distinction, however. Indeed, the brightest male examined is one from Elbow Cay, Abaco (No. 14973, Bangs Collection), showing some coppery-bronze feather-tipping

<sup>1</sup> Cf. Ridgway, *Proceedings Biological Society of Washington*, XXIII, 1910, 55.

both above and below. Mr. Bangs' birds were all taken in July and August, which may possibly account for their more brilliant coloration. Mr. Riley has kindly compared both series with the type of *R. r. bracei* of New Providence, at present unique. This specimen is a mummy, with the wings and tail being renewed by moult, while "the green of the throat is quite different from Abaco birds; it comes near a silvery chromium green, in some lights inclining to oil green." Altogether it is different from any other Bahaman specimen examined, but that it is anything more than an abnormal specimen of the ordinary Bahaman bird I very much doubt. New Providence has been more thoroughly explored than any other island of the group, and no other examples have come to light. The distinctness of the Bahaman bird from that of Cuba has also been questioned, but not having actually compared them I accept for the present the name *aneoviridis* for the former, while at the same time venturing the prediction that they will prove to be practically identical, as contended by Mr. Bonhote.

42. ***Tyrannus dominicensis dominicensis*** (Gmelin).

Twelve specimens: Watlings Island; Abaco (Spencer's Point).

The fresh condition of the plumage in this series indicates a pre-nuptial moult recently completed, some examples still retaining, however, old and worn tertials, which the moult has apparently passed by.

43. ***Tolmarchus bahamensis*** (Bryant).

Nine specimens: New Providence (Blue Hills); Andros (Staniard Creek).

Although no signs of moult going on are visible in any of this series, some individuals are duller and more worn, with the crown-patch more restricted and duller. These are characters supposed to belong to the females, but it seems possible that they may indicate immaturity instead. The example from Andros, taken three months later, is still more worn and faded.

44. ***Myiarchus sagræ lucaysiensis*** (Bryant).

Thirteen specimens: New Providence (Blue Hills); Great Inagua (Mathewtown); Andros (Staniard Creek); Abaco (Sand Bank).

This is merely a slightly differentiated subspecies of the Cuban *M. sagræ*, averaging grayer above, with less contrast between the crown and back—a feature quite marked in the Cuban bird. There is no appreciable difference in size, however. Regarding the yellowish suffusion of the posterior under parts, there can be no question but

that it is a seasonal feature, characteristic of the fresh plumage, and fading with the advance of the breeding season. Although conspicuous in both the New Providence and Great Inagua birds, it is barely indicated in the specimens from Andros and Abaco, and I find precisely parallel changes in a series of the allied form from Cuba.

45. *Blacicus bahamensis* (Bryant).

Twelve specimens: New Providence (Blue Hills); Andros (Staniard Creek); Abaco (Sand Bank).

The examples from Andros and Abaco, being more or less worn and faded, have almost entirely lost the yellowish suffusion of the under parts, so obvious in the fresh-plumaged specimens from New Providence, while the grayish white edgings of the secondaries have also become obsolete. These changes are the same as take place in the last species, as above noted.

While I follow Mr. Ridgway in recognizing *Blacicus*, it is difficult to see any good reason for its separation from *Myiochanes*, judging from the present species alone.

46. *Mimus polyglottos polyglottos* (Linnæus).

One specimen: Abaco (Spencer's Point).

In common with Messrs. Cory, Allen, and Ridgway, I find that the Mockingbird of the northern Bahamas, represented by the above specimen, is clearly referable to the continental form. The specimen in question is somewhat worn, but agrees well in color and size with a Florida example in similar condition, especially as regards the tail-pattern. It measures: wing 115 mm.; tail 122; culmen 18.

47. *Mimus polyglottos orpheus* Linnaeus.

Twelve specimens: Great Inagua (Alfred Sound, Mathewtown).

Compared with *M. p. polyglottos*, the Great Inagua bird, by reason of its decidedly smaller size, whiter under parts, and more extensively white tail, would seem to be sufficiently distinct to stand as a full species, but its distinctness from the other Antillean forms is open to question. After examining the fine series of West Indian Mockingbirds in the Field Museum, as well as considerable additional material in other collections, I am very doubtful as to the propriety of recognizing more than one form. The characters relied on by Mr. Ridgway to separate *orpheus*, *dominicus*, and *elegans* from each other prove upon comparison to be all very subtle and more or less inconstant—the relative proportions, relative amount of white on the wings and tail,

etc., all varying in the series from Great Inagua, Porto Rico, and Haiti to such an extent that I fail to see the desirability of keeping the birds from these islands separate on such flimsy grounds. Inagua birds, however, *average* smaller, with a relatively shorter tail, usually about equal to the wing, and as a rule have slightly less white at the base of the primaries, and while, as before remarked, all these differences are subtle and inconstant, they would seem to entitle the present birds to subspecific rank rather more than do the characters ascribed to those from Haiti, for instance. As in *M. p. polyglottos*, males average more white on the innermost primary and third rectrix than do females. I do not think that much dependence can be placed in the color of the upper parts, as this is greatly influenced by wear and fading.

A specimen in juvenal dress (February 24) resembles the same stage of *M. p. polyglottos*, but is obviously smaller, while the outer rectrices are clouded with dusky at the tip. It is marked "iris gray; gape pale yellowish; bill and feet blackish." In adults the iris is "amber yellow" or "brown amber."

48. *Mimus gundlachi gundlachi* Cabanis.

Twenty-one specimens: New Providence (Blue Hills); Great Inagua (Alfred Sound, Mathewtown); Andros (Staniard Creek).

After a careful study of this series of finely prepared and fairly comparable specimens I can find no differences whatsoever that would justify the recognition of a subspecies "*bahamensis*." There is certainly no constant difference in color, and the average difference in size between the Great Inagua and Andros birds is a negligible quantity. A series from both Eleuthera and Great Inagua in the Field Museum vary considerably in color, some being much browner than others. Under such circumstances I can see nothing in the subspecific distinctions sought to be established, at least on the assumption (almost certainly justified) that Great Inagua examples are typical *gundlachi*.

A specimen from Andros, April 14, has badly diseased feet, the tarsi having horny flap-like growths one-half inch wide attached to their posterior face, though the bird was said to be fat and otherwise in good condition.

"Iris amber brown, brownish yellow, or dark amber; feet blackish horn."

49. *Dumetella carolinensis* (Linnaeus).

Two specimens: New Providence (Blue Hills); Abaco (Sand Bank).

Both examples are in perfectly fresh plumage, even the Abaco specimen, although taken so late in the season as April 28, showing no sign of wear or fading, as do birds taken in the United States at this season.

50. **Margarops fuscatus fuscatus** (Vieillot).

Thirteen specimens: Great Inagua (Alfred Sound); Watlings Island. "Iris pale straw-color; bill and feet light brownish horn."

The white edgings to the tertials, so conspicuous in fresh-plumaged birds, such as those from Great Inagua in the present series, are very evanescent, and are soon lost by wear, having almost disappeared in the specimens from Watlings Island.

51. **Mimocichla plumbea** (Linnaeus).

Twelve specimens: New Providence (Blue Hills); Abaco (Sand Bank).

Individuals in first nuptial plumage may be readily distinguished by the worn and brownish primaries, secondaries, and primary-coverts, in contrast with the fresher wing-coverts, tertials, and body-plumage, indicating a prenuptial moult involving these parts. The rectrices are possibly also affected, as they are much fresher in some specimens than in others.

52. **Polioptila cærulea cærulea** (Linnaeus).

Fourteen specimens: New Providence (Blue Hills); Great Inagua (Alfred Sound, Mathewtown); Abaco (Sand Bank, Spencer's Point).

After very careful critical study of an ample and comparable series of specimens of most excellent quality, I confess my inability to discriminate the supposed subspecies "*casiogaster*." It is quite true that the examples from New Providence and Great Inagua may represent winter migrants from the United States, but this cannot be said of the six specimens from Abaco, one of which is marked as a breeding bird which would have laid within a few days. These Abaco specimens do not differ in any perceptible respect (allowing, of course, for their slightly more worn condition) from the rest of the series, nor from birds from Florida and Pennsylvania, unless it is considered that a wing-measurement averaging two millimeters less is a difference of subspecific value. It is therefore necessary to reduce *P. c. casiogaster* to a synonym of *P. c. cærulea*.

The Great Inagua specimens show more or less feather-renewal about the head and throat, which is of course to be considered as a prenuptial moult.

53. *Vireosylva calidris barbatula* (Cabanis).

Twelve specimens: Andros (Staniard Creek); Abaco (Sand Bank, Spencer's Point).

54. *Vireo griseus griseus* (Boddaert).

One specimen: Andros (Staniard Creek), April 14.

The first Bahaman record for this species, although one not unexpected. Whether it represents a resident or a migrant bird, or is merely a straggler, is an open question. The specimen agrees well with examples from Florida referable to this form.

55. *Vireo crassirostris crassirostris* (Bryant).

Twenty-nine specimens: New Providence (Blue Hills); Great Inagua (Alfred Sound, Mathewtown); Andros (Staniard Creek).

"Iris gray; feet and bill dark plumbeous, with base of lower mandible paler."

*Lanivireo crassirostris* was originally described from New Providence, and the type specimen (now in the collection of the U. S. National Museum) is an individual about midway between the extremes of color exhibited by the series from this island (*cf.* Bangs, *Auk*, XVII, 1900, 289). In 1886 Mr. Cory described a vireo from Grand Cayman under the name *Vireo alleni* (*Auk*, III, 1886, 500), to which species he later (*Catalogue West Indian Birds*, 1892, 153) referred all his bright-colored examples from various islands of the Bahaman group, indicating also that many specimens were intermediate in their characters. Meanwhile, however, Mr. Ridgway had described the bright-colored Bahaman bird as *Vireo crassirostris flavescens* (*Manual North American Birds*, 1887, 476), stating that, "although occurring together with true *V. crassirostris* on several islands, this form occurs exclusively on Rum Cay and Concepcion Island, while only the true *V. crassirostris* is found on Abaco and New Providence." Ignoring for the moment the question of *alleni* versus *flavescens*, let us consider the status of the Bahaman birds. Contrary to Mr. Ridgway's implication, the series of twelve specimens from New Providence in the present collection presents a perfect gradation in intensity of coloration, ranging from the dullest-colored examples to birds absolutely indistinguishable, so far as I can see, from the average of the bright-colored yellow specimens from Great Inagua. The five skins from Andros all represent the extreme or typical development of the gray or dull-colored style, although it would seem that this is in part seasonal, due to some extent at least to wear and fading.



Two other specimens from Andros in the collection of the American Museum are much yellower, although collected in May, while a third, dated April 18, is almost as pale below as *Vireosylva magister*. In the Field Museum collection there are eighteen skins from Andros, more or less badly discolored by preservative, but as nearly as can be determined all "intermediates." The remainder of the Field Museum series may be allocated as follows (employing the nomenclature currently accepted):

Great Bahama: 1 nearly typical *flavescens*, 8 intermediates.

Abaco: 8 *crassirostris*, 2 intermediates, 1 *flavescens* (not quite typical).

Eleuthera: 2 *crassirostris*, 1 intermediate, 30 quite typical *flavescens*.

New Providence: 6 *crassirostris*, 4 intermediate, 1 *flavescens*.

Biminis: 1 *crassirostris*, 1 intermediate, 1 *flavescens*.

Mariguana: 17 *flavescens*, in rough plumage, but mainly typical.

Great Inagua: 24 adult, 13 young *flavescens*, 1 *crassirostris*. This latter specimen (No. 25338), together with a skin (No. 40100) in the American Museum collection taken at the same time and place (North-west Point, June 2, 1879) is much worn and faded, and cannot otherwise be matched.

Caicos: 9 *flavescens*.

A series of young birds from Great Inagua, taken between June 27 and August 4, 1891, in the Field Museum collection, are interesting in that they show the new yellow feathers of the under parts, characteristic of *flavescens*, being directly assumed by postjuvinal moult. The juvenal dress is white below, shaded with yellow on the sides and crissum, the yellow of the sides of the head indicated, but much paler than in the adult, the back more grayish.

The color-differences between typical birds of the two supposed forms are sufficiently evident upon comparison, and considered alone are obviously of subspecific value. As is quite natural also (at least in the case of other than insular forms) intermediate examples occur. So far all is well, but when we come to correlate the distribution of the two forms with definite geographic areas we at once encounter difficulties. For, while in general it would seem that the dull bird reaches its extreme development and predominance in the more western and northern islands of the Bahaman group, and the bright bird similarly in the more southern and eastern islands, we find in the intermediate islands a most puzzling series of intergrades between the two forms, as

well as typical examples of each form occurring well within the area of predominance of the other. The question is complicated by the consideration that we are dealing here, not with a continuous land area of distribution, but with a group of islands, which condition constitutes a visible (though not insuperable) barrier to the extension of the range of a sedentary species such as the present one is believed to be. Thus, while the occurrence of individuals of typical *crassirostris* on Great Inagua in the breeding season could scarcely be accounted for on the assumption that they were migrants from the northern islands, it would be equally difficult to call in a like theory to explain the presence of *flavescens* on New Providence during the winter months. It is customary to account for the exceptional or occasional occurrence of birds outside their generally recognized geographical limits by saying that such individuals are "migrants" or "strays," but I fail to see how such an explanation could well apply in this case. In short, *Vireo crassirostris flavescens* is not, strictly speaking, a geographical race or subspecies, since its distribution does not coincide with any definite area as distinguished from that occupied by *V. c. crassirostris*. We might suppose that this is a case of as yet imperfect subspecific segregation through individual variation, the bright-colored birds having become the more completely localized. But that these two supposed forms can be considered as anything more than color-phases of a single species is exceedingly doubtful when we remember that a *precisely parallel variation* obtains in at least two closely allied continental species of this genus, *Vireo ochraceus* and *Vireo carmioli*. It would be interesting to know whether the pale and bright birds breed together and what is the immediate result, or whether their local habitats are different. This is a question for the field naturalist to settle.

I have examined Mr. Cory's series of *Vireo alleni* from Grand Cayman and Cayman Brac, eighteen specimens in all. Many of these are discolored by the preservative used, and all are in wretched plumage with the sole exception of the type, which lacks the tail. After comparing these specimens carefully with Bahaman birds I cannot verify any of the distinctive characters alleged to exist, but until better and comparable material is available I should hesitate to pronounce the two identical, as in such case the area of distribution would be divided by the island of Cuba, which is occupied by another form, *Vireo gundlachii*.

56. **Callichelidon cyaneoviridis** (Bryant).

Twelve specimens: Andros (Staniard Creek); Abaco (Sand Bank).

57. **Mniotilta varia** (Linnæus).

One specimen: New Providence (Blue Hills), January 11.

This example seems to be in perfectly fresh plumage, and is apparently an immature male, with black auriculars and streaked breast, but a pure white throat.

58. **Helmitheros vermivorus** (Gmelin).

Two specimens: New Providence (Blue Hills); Abaco (Sand Bank), April 29.

The Abaco specimen apparently represents the latest spring migration date known from the Bahamas for this warbler.

59. **Compsothlypis americana americana** (Linnæus).

One specimen: Great Inagua (Mathewtown), February 19.

I refer the single specimen obtained to this subspecies with little hesitation, as it agrees best therewith in both color and measurements.

60. **Dendroica tigrina** (Gmelin).

Fourteen specimens: New Providence (Blue Hills); Great Inagua (Alfred Sound, Mathewtown); Watlings Island; Andros (Staniard Creek), April 12, 17.

According to Prof. Cooke (*Bulletin Biological Survey*, No. 18, 1904, 50), this species has not been recorded as *wintering* on New Providence, or elsewhere in the Bahamas north of Rum Cay, so that the present record becomes of interest.

After a careful study of this fine series of beautifully prepared specimens I find nothing to throw any light on the question of the prenuptial moult in either the young or the adult birds. In fact, not a single male specimen shows unmistakable evidence of moult. Two male examples from New Providence, December 29 and January 1, are obviously immature, agreeing closely with September birds from Pennsylvania, after due allowance has been made for the loss of the ashy feather-tips by abrasion, which leaves the under parts brighter yellow and the streaks more distinct. A third specimen (Alfred Sound, Great Inagua, February 4) is similar, except that the crown is becoming more blackish anteriorly and the auriculars more orange brown, although I can detect no evidences of new growth, nor does an examination of an ample series of fall specimens indicate that the blackening of the crown could be due to wear alone. Three males

that I take to be adult (bearing dates of January 14, 15, and February 10 respectively), on the other hand, might easily be transformed into the usual spring plumage by wear and by the replacing of the yellow auriculars with orange brown—a transformation whose completion is illustrated by a bird in high plumage taken on Andros April 12. The same remarks apply to the series of females, except that there is one specimen from Andros, April 17, showing a few new feathers coming in on the chin. A great deal of individual variation is manifest in this species, affecting the general intensity of coloration, extent of white on the rectrices and wing-coverts, etc. There is one female in the present series (Watlings Island, March 26) which is almost as bright as some of the immature males.

61. ***Dendroica petechia flaviceps*** Chapman.

Thirteen specimens: Great Inagua (Alfred Sound, Mathewtown); Watlings Island; Andros (Staniard Creek).

The present series comprises nine males and four females. Of the former there are two specimens, from Alfred Sound and Staniard Creek respectively, which differ from the others in their grayish scapulars and worn rectrices, primaries, and secondaries. The edgings of the two latter are narrower, duller, and more grayish than ordinarily, contrasting conspicuously with those of the bright and fresh tertials. Turning now to the females (all from Alfred Sound) we find a precisely similar variation and an even more accentuated difference, the two most worn specimens being the most grayish above and with the most white beneath. One specimen (No. 30750) is olive grayish above, with irregular patches of fresh brownish yellow feathers; below saffron yellow, the sides more grayish, with patches of brighter yellow; the remiges brownish, narrowly edged with olive grayish like the back, except the tertials and two of the secondaries on one wing, which are edged with bright olive green. The other dull female (No. 30779) is dull yellowish olive green above, the hindneck tinged with grayish; below, from the breast down, extensively whitish; the tertials, some of the secondaries and most of their coverts are fresh and edged with olive green. Although I hesitate to differ from so distinguished an authority as Mr. Ridgway, who moreover has had the advantage of a far greater amount of material for study in this connection, I feel convinced that the specimens above described point to a conclusion opposite to that he has reached respecting the significance of this plumage (*cf. Birds of North and Middle America*,

11, 1902, 516). It is only necessary to assume that the prenuptial moult is more or less incomplete, not involving the tail or wings (except the tertiaries and perhaps a few of the secondaries), and sometimes not all of the wing-coverts and body-plumage, to account for the peculiarities in question. As is often the case, the moult is less extensive in the female birds, but I have examined at least one immature male (No. 21759, Cory Collection, Abaco, March 17, 1891, erroneously sexed as a female) whose appearance would suggest that such a suppression is not confined to that sex.

The wing-formula in this species is more or less obscured in the case of worn specimens, which are difficult to distinguish from *Dendroica aestiva*. Unfortunately I have not been able to make any extended comparisons of the present form with the Cuban bird, and the characters assigned for its separation do not appear to me very trenchant.

62. *Dendroica cærulescens cærulescens* (Gmelin).

One specimen: New Providence (Blue Hills).

A male in the plumage of the first winter, with no sign of moult. The amount of black on the back would indicate that it was a bird from the southern Alleghanies, assuming that *cairnsi* is a valid form, which in my opinion is exceedingly doubtful.

63. *Dendroica coronata* (Linnæus).

One specimen: Watlings Island. March 13, a female in worn first winter dress.

64. *Dendroica dominica dominica* (Linnæus).

Two specimens: New Providence (Blue Hills).

These two examples (both females) measure as follows: wing, 59 and 62 mm.; tail, 44 and 47.5; exposed culmen, 12 and 13. Eight females from the United States average: wing, 64; tail, 48; exposed culmen, 14. Besides being slightly smaller, they are paler, and have less black on the forehead than any individuals in a large series before me from Florida, South Carolina, and Georgia. Thinking that they might represent an undescribed local form, I secured the loan of the Bahaman and West Indian series of this species in the Field Museum for comparison. But after a very careful study of this material I am unable to verify this supposition. It is true that there are a few individuals whose measurements are slightly below the average and whose colors are more or less pale, but in most cases such are obviously immature birds, and I am not disposed to give these characters any

other significance. On the other hand, there are a number of specimens, all taken from November to January inclusive, which are slightly larger than the average, as well as more richly colored, the yellow of the throat sometimes taking on an orange hue, approaching that of the Blackburnian Warbler. These are unquestionably adult birds in fresh feather. Wear and fading affect the plumage in this species very markedly.

Mr. Riley writes me that he based his listing of this species as a resident in the Bahamas on the smaller size of the "resident" birds. But, so far as I know, there is no record of its occurrence there in the summer before July, and it is known to move southward from the United States as early as this (*cf.* Cooke, *Bulletin Biological Survey*, No. 18, 1904, 84). Until specimens actually taken while breeding are forthcoming it would seem very unsafe to set it down otherwise than as a winter visitor to the islands.

65. *Dendroica flavescens* Todd.

Four specimens: Abaco (Sand Bank, Spencer's Point).

One individual has been renewing some of the rectrices, perhaps lost by accident.

There is little to add to the original account of this species (*Proceedings Biological Society of Washington*, XXII, 1909, 171). The type is now No. 31144 of the Carnegie Museum collection. It is certainly odd that such a distinct and peculiar form should have developed on Abaco alone of all the group, and it would be interesting to know how the conditions obtaining in its local habitat differ from those in some of the other islands, Andros for example. Indeed, I anticipate its discovery on Great Bahama, if not also on Andros. Its characters would suggest that it had been derived from individuals of *Dendroica dominica dominica* which may have remained behind to breed.

66. *Dendroica pityophila* Gundlach.

Thirteen specimens: Abaco (Sand Bank).

This species is apparently so rare in collections that Mr. Ridgway did not have a single Bahaman specimen before him for description when writing his *Birds of North and Middle America*. Cuban examples are also few in number, but those which I have examined and compared with the present fine series fail to show any differences which cannot be accounted for by the effects of wear. Moreover, after a critical comparison of the type series (seven skins) of Mr. Cory's

"*bahamensis*" in the Field Museum collection with the Cuban birds, I fail entirely to appreciate any of the characters ascribed to the former. All his specimens are worn and faded, and unless skins in absolutely fresh plumage show decided differences the name "*bahamensis*" must necessarily be relegated to synonymy, despite the gap in the distribution of the species.

The female differs from the male in being duller, with the black streaks on the sides of the breast much less distinct, in some specimens barely indicated.

67. *Dendroica vigorsii achrustera* Bangs.

Twenty-five specimens: New Providence (Blue Hills); Andros (Staniard Creek); Abaco (Sand Bank, Spencer's Point).

In addition to the above, I have studied the series of Bahaman Pine Warblers in several other collections, as indicated by small index-figures in the following table of measurements.

Even after due allowance has been made for different degrees of wear, it will be observed that the series from Abaco averages about the same as those from the other islands, except as regards the bill, which is slightly larger. The type of *Dendroica vigorsii abacoensis* Ridgway (No. 108479 of the above table) proves to be an exceptionally brightly colored bird, though a few New Providence individuals in comparable plumage are fully as bright. Upon comparing the series from Abaco with an equal one from New Providence I can find no constant differences in color, but only in the size of the bill. As I do not consider that the latter difference in itself justifies subspecific separation, I judge it better not to formally recognize "*abacoensis*." Specimens from Andros and Great Bahama are likewise indistinguishable, while three examples from San Domingo, although badly worn, seem no different from Bahaman birds in the same state of plumage, except for their slightly smaller bills.

The color-differences between this form and *D. v. vigorsii* are obvious and constant when specimens of the same age, sex, and condition of plumage are compared. Mr. Bangs had only females in *first* nuptial dress before him when he wrote his description, as shown by an inspection of his series. Adult females are much brighter, nearly as bright in fact as adult males, the resemblance being much closer than in the case of the continental form. Moreover, the males vary in precisely the same way, being much duller in color in first winter and first nuptial plumages than in fully adult dress. There is thus a curious

No.	Sex.	Locality.	Date.	Wing.	Tail	Culmen
74627 <sup>1</sup>	♂	(New Providence?)		69	53.5	12
108680 <sup>1</sup>	♂	New Providence.	Apr. 19, 1886.	69	55	12
3351 <sup>9</sup>	♂	Nassau, N. P.	Mar. 6, 1897.	65	53.5	12
76600 <sup>3</sup>	♂	Nassau, N. P.	May 20, 1902.	67.5	56	12
76601 <sup>3</sup>	♂	Nassau, N. P.	May 21, 1902.	67	53	12
30569 <sup>4</sup>	♂	Blue Hills, N. P.	Dec. 28, 1908.	69	57	12
30613 <sup>4</sup>	♂	Blue Hills, N. P.	Jan. 2, 1909.	69	56	11.5
30627 <sup>4</sup>	♂	Blue Hills, N. P.	Jan. 4, 1909.	70	57	12
30636 <sup>4</sup>	♂	Blue Hills, N. P.	Jan. 6, 1909.	69	56	12
30722 <sup>4</sup>	♂	Blue Hills, N. P.	Jan. 19, 1909.	69	56	11.5
26004 <sup>5</sup>	♂	Nassau, N. P.	Jan. 23, 1879.	68	58	11
26005 <sup>5</sup>	♀	Nassau, N. P.	Jan. 21, 1879.	62	52	12
30614 <sup>4</sup>	♀	Blue Hills, N. P.	Jan. 2, 1909.	65	52	12
30615 <sup>4</sup>	♀	Blue Hills, N. P.	Jan. 2, 1909.	67	55	11.5
30662 <sup>4</sup>	♀	Blue Hills, N. P.	Jan. 9, 1909.	67	57	12
31022 <sup>4</sup>	♀	Staniard Creek, Andros	Apr. 17, 1909.	63	54	11
31023 <sup>4</sup>	♀	Staniard Creek, Andros	Apr. 17, 1909.	65	51	11
31043 <sup>4</sup>	♂	Sand Bank, Abaco	Apr. 26, 1909.	69	56	13
31057 <sup>4</sup>	♂	Sand Bank, Abaco	Apr. 27, 1909.	69	56	13.5
31070 <sup>4</sup>	♂	Sand Bank, Abaco	Apr. 28, 1909.	66	53	13
31145 <sup>4</sup>	♂	Spencer's Point, Abaco	May 7, 1909.	67	55	12.5
31154 <sup>4</sup>	♂	Spencer's Point, Abaco	May 8, 1909.	67	53	13
31157 <sup>4</sup>	♂	Spencer's Point, Abaco	May 8, 1909.	70	59	13
108479 <sup>1</sup>	♂	Abaco.	Apr. —, 1886.	70	57	13.5
31044 <sup>4</sup>	♀	Sand Bank, Abaco	Apr. 26, 1909.	68	58	12.5
31056 <sup>4</sup>	♀	Sand Bank, Abaco	Apr. 27, 1909.	67	54	12.5
31156 <sup>4</sup>	♀	Spencer's Point, Abaco	May 8, 1909.	68	53	13
25993 <sup>5</sup>	♂	Great Bahama.	June 29, 1891.	65	53	12
25994 <sup>5</sup>	♂	Great Bahama.	June 29, 1891.	65	53	12
25995 <sup>5</sup>	♀	Great Bahama.	June 29, 1891.	66	59	12
14979 <sup>2</sup>	♂	Great Bahama.	July 18, —.	67	54	13
25999 <sup>5</sup>	♂	La Vega, San Domingo	July 12, 1883.	68	53	11
25996 <sup>5</sup>	♀	La Vega, San Domingo	July 10, 1883.	63	51	11
26006 <sup>5</sup>	♀	La Vega, San Domingo	July 12, 1883.	63	48	11

discrepancy in this respect between the Bahaman and the continental form, in which the immature males are practically indistinguishable from the adults so far as color-characters are concerned. What is the significance of this fact?

<sup>1</sup> Collection U. S. National Museum.

<sup>2</sup> Collection E. A. and O. Bangs.

<sup>3</sup> Collection American Museum.

<sup>4</sup> Collection Carnegie Museum.

<sup>5</sup> Collection Field Museum.



68. *Dendroica palmarum palmarum* (Gmelin).

Four specimens: New Providence (Blue Hills); Great Inagua (Alfred Sound, Mathewtown).

The two Great Inagua specimens (February 16 and 24) both show slight traces of prenuptial moult on the crown.

69. *Dendroica discolor* (Vieillot).

Five specimens: New Providence (Blue Hills); Great Inagua (Mathewtown); Watlings Island.

So far as I can discover only one of these individuals shows any trace of moult in progress; this is an immature female taken January 16, while a male dated January 4 seems to be in perfect plumage. Upon comparison none of these specimens show the characters ascribed to resident Bahaman birds by Mr. Ridgway (*Birds of North and Middle America*, II, 1902, 608, footnote).

70. *Seiurus aurocapillus* (Linnæus).

One specimen: New Providence (Blue Hills).

71. *Seiurus noveboracensis notabilis* Ridgway.

Four specimens: New Providence (Blue Hills); Great Inagua (Mathewtown); Watlings Island.

Although Mr. Ridgway places all but one of the Bahaman references under true *noveboracensis*, the present examples prove upon comparison referable to *notabilis*.

72. *Geothlypis trichas trichas* (Linnæus).

Seventeen specimens: New Providence (Blue Hills); Watlings Island; Andros (Staniard Creek); Abaco (Sand Bank).

Three immature males from New Providence (January 6, 9, and 12) show the beginning of the prenuptial moult, as also does a young female from Andros (April 14). A male from Andros, which seems to be adult, shows decided feather-renewal taking place on the throat and sides of the head, while another from Abaco taken a little later (April 26) has a few new feathers coming in on the chin. This is scarcely to be deemed conclusive evidence of a regular prenuptial moult in the adult, however.

Considerable exception has been taken in some quarters to the action of the American Ornithologists' Union Nomenclature Committee in refusing recognition to a subspecies "*brachidactyla*." A study of the series of Yellow-throats in the Carnegie Museum has failed to enable me to discriminate this supposed form, whose alleged characters seem to me very subtle indeed. The measurements of the

Bahaman series, it may be added, are a little larger than the average, owing to the generally fresher condition of their plumage.

73. ***Geothlypis rostrata rostrata*** Bryant.

Four specimens: New Providence (Blue Hills); Andros (Staniard Creek).

As the present writer has already (*Auk*, XXVIII, 1911, 237-253) critically discussed the case of the large Bahaman *Geothlypis*, it will be necessary only to allude briefly to the conclusions reached. It seems very certain that there is only one form on any particular island, age and season being responsible for the differences which have led to the description of so many forms. In the present series only one specimen is comparable with the type of *rostrata*, which is an immature bird; the others are adults ("*maynardi*"). The Andros specimen agrees with other examples from that island which I have examined in being somewhat smaller and otherwise slightly different from the average New Providence bird, but the differences do not seem of sufficient importance in my judgment to justify the recognition of a subspecies "*exigua*."

74. ***Geothlypis rostrata tanneri*** Ridgway.

Eight specimens: Abaco (Spencer's Point, Sand Bank).

Two of these are birds in immature (first nuptial) dress, representing the supposed form "*incompta*." They are markedly worn and dull, in contrast to the adults taken at the same time.

75. ***Setophaga ruticilla*** (Linnæus).

One specimen: New Providence (Blue Hills), January 14.

This is an unquestionable winter record, and apparently the most northern one as yet reported, although the species is common as a transient throughout the Bahamas.

76. ***Cœreba bahamensis*** (Reichenbach).

Fifteen specimens: New Providence (Blue Hills); Great Inagua (Mathewtown); Andros (Staniard Creek); Abaco (Spencer's Point).

A study of this series (all but four of which are adult males) confirms Mr. Cory's statement (*Auk*, VIII, 1891, 297) that Great Inagua examples have larger bills than those from the more northern Bahamas. Actual measurements in this case show an average of 17 mm. for the bill of the Great Inagua birds, and 14.6 mm. for that of the others. Moreover, the collector has taken pains to note that the bare skin of the gape in the former is "whitish, not red, as in New Providence

birds." I have examined also the large series of this species in the collection of the Field Museum, which confirms in general the above observations. Specimens from the Caicos Islands constantly have longer bills than the average, while those from Great Bahama Island, at the other extremity of the group, seem to have bills shorter even than New Providence birds. I am unable to discover any other constant differences, however, that would justify formal subdivision of the species, particularly as the vast majority of Bahaman specimens could not be assigned to either form.

An individual in full juvenal dress was taken at Spencer's Point, Abaco, on May 5.

77. *Agelaius phoeniceus bryanti* Ridgway.

Eleven specimens: New Providence (Blue Hills); Andros (Staniard Creek); Abaco (Sand Bank, Spencer's Point).

The seven adult males included in this series have the following average measurements: wing, 116 mm.; tail, 87; culmen, 24.5. Four adult males from peninsular Florida average: wing, 116; tail, 92; culmen, 24. Neither comparison nor actual measurement discloses any appreciable average difference in the size and shape of the bill between these two series, and I fail to see how the males of *floridanus* and *bryanti* can be distinguished from each other. In the case of the females, however, the differences are sufficiently evident, and may be accepted as being of subspecific value. Bahaman females are much whiter below than those from Florida, and seldom show traces of the pinkish suffusion on the throat which is often so conspicuous a feature in the latter. This statement is based mainly on a study of the large series of this subspecies in the collection of the Field Museum, there being only two females in the present lot. Two males from Abaco are in first nuptial plumage.

78. *Icterus northropi* Allen.

Thirteen specimens: Andros (Staniard Creek); Abaco (Sand Bank). "Iris hazel" (adult male).

Dividing this series into four sets, according to sex and age, there are three adult males, four adult females, three immature males, three immature females—the immature birds being of course in first nuptial plumage. Two of the adult females are indistinguishable (except as regards the under tail-coverts, mentioned below) from the adult males, being fully as bright so far as I can see, while the other two

are slightly duller and more worn. In the adult males the longer under tail-coverts are distinctly spotted with black, in the two brighter females they are indistinctly clouded with dusky, while in the rest of the series these feathers are immaculate.

Turning now to the young birds, it is evident that their peculiar mottled plumage, so well illustrated in the plate of this species (*Auk*, VIII, 1891, pl. I), is the result of a limited prenuptial moult, affecting the body-plumage to a greater or less extent, and frequently also some of the wing-coverts, remiges, and rectrices, as shown by the series before me. This moult averages more extensive in males than in females, the former showing more of the new black feathers above and on the throat and breast, although this replacement varies considerably in different individuals, no two of which are alike in this respect.

I note that the single specimen from Abaco (No. 31035, immature male, April 24) is somewhat more deeply colored (more saffron yellow below and less grayish above) than the rest of the series. This bears out Mr. Cory's remark (*Auk*, VIII, 1891, 350), presumably based on adult birds, but an examination of the single adult male from Abaco now in the Field Museum collection fails to confirm this statement.

The nearest relative of this species seems to be *Icterus prothemelas* (Strickland) of Central America, but it will be noted that in first nuptial plumage the two species are quite unlike, due to the difference in the extent of the prenuptial moult. *Icterus northropi* is unfortunately as yet unknown in juvenal dress, and it would certainly be interesting to learn how it compares with its allies at this more primitive stage.

79. ***Spindalis zena zena*** (Linnæus).

Twelve specimens: New Providence (Blue Hills).

Individual variation affects the amount of chestnut tinge on the breast, of black on the tips of the outer rectrices, and of dark shading or streaking on the sides and flanks. One of the above specimens approaches the phase of plumage called *Spindalis zena* "*stejnegeri*" in this latter respect.

80. ***Spindalis zena townsendi*** Ridgway.

Ten specimens: Abaco (Sand Bank).

"Iris dark hazel."

Although taken several months later in the season than the New

Providence birds, which, if anything, would tend to obscure the characters of the present form through the wearing off of the olive feather-edgings of the back, only one of the present series of seven males approaches typical *zena* in this respect, so that the Abaco subspecies seems well entitled to recognition. I fail, however, to find any differences whatever between the females of the two forms.

81. *Passerina cyanea* (Linnaeus).

Great Inagua (Mathewtown, February 19); Andros (Staniard Creek, April 15); Abaco (Spencer's Point, May 8).

All three localities are new records, and the date at which the Great Inagua specimen was taken would suggest that the species was a winter resident there. At any rate, it is certainly more than "occasional in the Bahamas in migration" (*A. O. U. Check-List*, ed. 3, 1910, 285). The Andros specimen is a young male which, although taken at a date when the species has already reached the Middle States on its northward migration, has only about half completed the prenuptial moult.

82. *Pyrrhulagra violacea violacea* (Linnaeus).

Fifteen specimens: New Providence (Blue Hills); Great Inagua (Alfred Sound, Mathewtown); Andros (Staniard Creek); Abaco (Spencer's Point).

Two adult males from Great Inagua are somewhat smaller than the rest of the series, verging thus toward *P. v. affinis* (Baird) from the neighboring island of Haiti, but I can see no color-differences. Abaco birds are not distinguishable in any way from New Providence examples. The small specimen from Abaco referred to by Mr. Bonhote (*Ibis*, 1903, 289), which he has courteously forwarded to me for examination, is, it is true, rather smaller than the average, the bill especially, but is matched very closely by some of the series before me, so that the fact would seem to have no special significance.

A female in first winter dress (30639, Blue Hills, January 6) differs from a male in the same stage (30570, Blue Hills, December 28), not only in its smaller size, but in being decidedly more olivaceous, less grayish, especially below, and in the paleness and restriction of the rufous areas. The young male seems to have recently acquired fresh rectrices (except the middle pair) and outer primaries, judging from their darker color and unworn condition. In the character and extent of the moult this species thus resembles *Passerina cyanea*.

83. *Tiaris bicolor bicolor* (Linnæus).

Thirteen specimens: New Providence (Blue Hills); Great Inagua (Alfred Sound, Mathewtown); Watlings Island; Andros (Staniard Creek); Abaco (Spencer's Point).

I judge that the individuals with most black below are the older birds, the lighter-colored ones being most probably in first winter or first nuptial dress, as the case may be.

84. *Passerculus sandwichensis savanna* (Wilson).

Two specimens: New Providence (Blue Hills); Andros (Staniard Creek), April 13.

## FIELD NOTES.

BY W. W. WORTHINGTON.

In the following list such of the locality records as are new for the several species are designated by an asterisk.

1. *Colymbus dominicus dominicus* Linnæus. WEST INDIAN GREBE.

\*Great Inagua, \*Acklin Island, Watlings Island.

A female taken at Mathewtown February 23 was apparently brooding, as shown by a large denuded patch on the abdomen, and ruptured capsules in the ovary. Fully grown young were taken on Watlings Island March 12.

2. *Podilymbus podiceps* (Linnæus). PIED-BILLED GREBE.

\*Great Inagua.

Common at Horse Pond, a large wooded swamp near Mathewtown, where downy young were taken February 20 and 22.

3. *Puffinus lherminieri* Lesson. ANTILLEAN SHEARWATER.

North end Exuma Sound (January 25, April 8), \*Long Island (15 miles east, January 29), off \*Castle Island (February 1), off \*Great Inagua (March 2), south of \*Watlings Island (March 10).

This species was noted only at sea during trips from island to island, as above.

4. *Phaëthon americanus* Ogilvie-Grant. YELLOW-BILLED TROPIC-BIRD.

Abaco.

A few were seen sailing high in the air off Cherokee Sound, April 21.

5. *Sula leucogastra* (Boddaert). BOOBY.

Noted only at sea in Exuma Sound and between \*Long Island and Fortune Island, also south of \*Castle Island (February 1).

6. *Phalacrocorax vigua mexicanus* (Brandt). MEXICAN CORMORANT.  
Watlings Island, (? Cat Island).

Common at the lake on Watlings Island, where there was an abandoned rookery, which we visited on March 16. The nests were built in the fringe of mangrove on the east side of the lake near the lighthouse, and were made of sticks, and covered with excrement. As they were as a rule at an elevation of but six or ten feet they were readily examined, and many were found to contain dead young, about half-grown, in various stages of decomposition. No reason could be assigned for this mortality.

7. *Pelecanus occidentalis* Linnæus. BROWN PELICAN.

\*Great Inagua, Andros.

Apparently not common. A single individual landed on the beach near the lighthouse at Mathewtown, February 25, but I was unable to get within gunshot.

8. *Fregata aquila* Linnæus. MAN-O'-WAR-BIRD.

\*Ship Channel Cay (January 24), Cat Island (Long Rock, January 25, The Bight, January 26, off Port Howe, April 7), Great Inagua, \*Acklin Island, Watlings Island, Abaco. †

Usually observed sailing high in the air, but on one occasion a number were seen doing the "dipping act" at Calefavor Pond, Great Inagua, where a single specimen was secured February 11.

9. *Phœnicopterus ruber* Linnæus. AMERICAN FLAMINGO.

Great Inagua, Abaco.

On February 5 a trip was made to Calefavor Pond, some six or seven miles to the southeast of Mr. Boucher's camp at the head of Alfred Sound, in search of Flamingoes, the locality being a noted feeding-ground. The birds were said to frequent two large bunches of mangrove in the center of the pond, but although tracks were seen, and some feathers picked up, only a single Flamingo was observed, circling high overhead, his brilliant plumage flashing in the bright sunlight. That the birds had recently been using this series of flats and shallows as a feeding-ground, however, was amply attested by their numerous "feeding-rings"—circular marks about the size of a wagon-wheel, formed by the birds, while in search of their favorite food (a small snail), standing in one place in the shallow water and stirring up the bottom in a circle as far as they can reach. These rings show very plainly after the water has dried up, and the dry flats and shallows

for miles around were completely covered with them. We were told that Flamingoes were found dead in hundreds after the hurricane of October, 1908. The only specimen secured was taken February 20, near Mathewtown. At Abaco the negroes were offering for sale wings and other parts of the plumage of recently killed Flamingoes, while we were informed that they are found on Acklin Island also.

10. *Ardea herodias herodias* Linnæus. GREAT BLUE HERON.

New Providence, Great Inagua, \*Acklin Island, \*Watlings Island, \*Abaco.

Not common, and exceedingly wary, as they are shot for food at every opportunity. Mr. Boucher informed us that they are very destructive to the young green and hawk-billed turtles in his turtle-rearing lagoons, devouring them as soon as hatched.

11. *Dichromanassa rufescens* (Gmelin). REDDISH EGRET.

\*Great Inagua, \*Watlings Island.

Rather common at Calefavor Pond, Great Inagua, where a colony was breeding in a small clump of mangroves, the nests containing good-sized young at the time of our visit (February 5). While both phases were represented, white birds predominated. I am of the opinion that many of the Bahaman records of the American Egret really apply to the present species in the white phase. The species was once recorded on Watlings Island, March 16.

12. *Hydranassa tricolor ruficollis* (Gosse). LOUISIANA HERON.

\*Great Inagua, Watlings Island.

Noted at Calefavor Pond, February 5, Alfred Sound February 11, and on Watlings Island March 11. On February 17, while en route from Alfred Sound to Mathewtown, a Louisiana Heron came in past us from the open sea, acting as if much fatigued, but finally making the shore, a mile distant. As the nearest land in the direction from which it came is Acklin Island, it had apparently made the flight of seventy-five miles.

13. *Florida cærulea* (Linnæus). LITTLE BLUE HERON.

\*Watlings Island, Andros.

Not common, and, together with the last species, everywhere hunted for food by the inhabitants.

14. *Butorides virescens bahamensis* (Brewster). BAHAMA GREEN HERON.

New Providence, Great Inagua, Watlings Island, Andros, Abaco.



Quite common throughout the islands, frequenting the edges of shallow lagoons and the adjoining mangrove thickets.

15. *Nycticorax nycticorax nævius* (Boddaert). BLACK-CROWNED NIGHT HERON.

\*Great Inagua.

Young birds in the streaked plumage were taken at Calefavor Pond on February 5 and 8, where this species was associated with the following.

16. *Nyctanassa violacea* (Linnæus). YELLOW-CROWNED NIGHT HERON.

Great Inagua, \*Acklin Island, Watlings Island, Andros, Abaco.

Common throughout the Bahamas, according to our experience. A young bird was secured at Calefavor Pond on February 5, where this species was quite numerous, while an adult was shot on Watlings Island March 19.

17. *Plegadis autumnalis* (Linnæus). GLOSSY IBIS.

A single individual of this species was seen at Calefavor Pond, \*Great Inagua.

18. *Ajaia ajaja* (Linnæus). ROSEATE SPOONBILL.

Great Inagua.

A small colony of perhaps a half-dozen pairs were nesting in the mangroves at Calefavor Pond. The nests were built of sticks, about ten or twelve feet above the water, and at the time of our visit (February 8) contained either young or eggs in an advanced state of incubation.

19. *Erismatura jamaicensis* (Gmelin). RUDDY DUCK.

\*Watlings Island.

One was seen on the lake March 15.

20. *Marila marila* (Linnæus). GREATER SCAUP DUCK.

Watlings Island.

A few were noted on the lake March 15.

21. *Pœcilonetta bahamensis* (Linnæus). BAHAMA DUCK.

Great Inagua, \*Acklin Island, \*Watlings Island.

This duck was noted only in small ponds in out-of-the-way places, being a bird of very retiring habits, and hunted persistently for food. Two adults and one young bird were shot on Watlings Island, March 12 and 23.

22. *Dendrocygna arborea* (Linnæus). ANTILLEAN TREE DUCK.  
Great Inagua, \*Watlings Island.

Not uncommon, but exceedingly shy and retiring, as it is so persistently hunted for food. A deserted nest was found February 20 at Horse Pond, near Mathewtown. It was built between the roots of an upturned tree in the middle of the swamp, where the water was about two and one-half feet deep, and composed of a few sticks and dry leaves, with some traces of the original downy lining. It contained four addled eggs, white in color, but much soiled, two of which showed signs of incubation. Their shells were exceedingly hard and tough. Glimpses of an old Tree Duck were had, but it was too shy to permit approach within gunshot.

23. *Colinus virginianus floridanus* (Coues). FLORIDA BOB-WHITE.  
New Providence.

Not uncommon in the pine barrens back of the Blue Hills, but much oftener heard than seen. The nature of the ground makes it very difficult to secure them, even with dogs, as rapid walking is out of the question, except along the roads. The specimens which were made up as skins were brought to us alive by Mr. Charles Lightbourne.

24. *Rallus crepitans coryi* (Maynard). BAHAMA CLAPPER RAIL.  
\*Great Inagua, \*Watlings Island, Andros, Abaco.

This is a common species throughout the Bahamas, wherever mangrove swamps adapted to its needs occur. Here the birds may be heard calling every day, but it is seldom that a glimpse is had of them, so closely do they keep themselves concealed in the dense and tangled growth. Although numerous on Great Inagua, all our efforts to secure specimens there proved fruitless, and not until we reached Watlings Island were we successful. Here we found one small lagoon, bordered by a thick but low growth of mangrove shoots, where, as shown by their tracks, they evidently came out to feed. We built blinds, and spent many hours in waiting, but were rewarded by securing a series of seven specimens. Two more were taken later at other localities, but merely by chance. In the oviduct of a female shot March 22 there was an egg ready for deposit. Its ground-color was light clay, rather sparingly spotted and speckled with dull reddish brown and obscure lilac shell-markings, the ground-color exactly matching some eggs of the Wayne Clapper Rail from Florida. It measured 1.72 by 1.19 in.

25. *Porzana carolina* (Linnæus). SORA RAIL.

\*Great Inagua, \*Watlings Island.

Not uncommon as a winter visitor in certain suitable situations. Two were secured near Mathewtown February 19.

26. *Gallinula galeata galeata* (Lichtenstein). FLORIDA GALLINULE,  
Great Inagua, \*Watlings Island.

Rather common at Horse Pond, near Mathewtown, where a set of seven eggs, in an advanced stage of incubation, was taken on February 22. The nest was composed of dried pond-grasses and weeds, and was built in a cluster of young shoots in the top of a stump, a foot or more above the water, and at some distance from the shore. Such a situation, like that of the Tree Duck previously mentioned, was evidently more from necessity than from choice.

27. *Fulica americana* Gmelin. AMERICAN COOT.

\*Great Inagua.

A few were seen at Horse Pond, near Mathewtown, but they were very shy indeed.

28. *Larus atricilla* Linnæus. LAUGHING GULL.

\*Cat Island (The Bight, January 26, Port Howe, April 6), Watlings Island, Abaco (Spencer's Point, May 3).

At a house on Watlings Island there was a tame bird of this species, which had been reared from a nestling. It was said to eat bread and table scraps readily, and walked around as unconcerned as the chickens with which it associated.

29. *Sterna maxima* Boddaert. ROYAL TERN.

New Providence, \*Fortune Island, Great Inagua, \*Acklin Island, \*Cat Island, Abaco.

Rather sparingly distributed throughout the islands in the winter.

30. *Sterna fuscata* Linnæus. SOOTY TERN.

Abaco and at sea.

Large flocks of Sooty Terns were seen far from land in "Tongue of Ocean" on our voyage from Nassau to Andros on April 11.

31. *Himantopus mexicanus* (Müller). BLACK-NECKED STILT.

Watlings Island, Andros.

A small flock visited Staniard Creek, Andros, about the middle of April.

32. *Gallinago delicata* (Ord). WILSON SNIFE.

New Providence, \*Great Inagua, \*Watlings Island.

Found sparingly at certain suitable localities.

33. *Macrorhamphus griseus griseus* (Gmelin). RED-BREASTED SNIPE.

\*Great Inagua.

A single individual was noted at Alfred Sound February 10.

34. *Pisobia minutilla* (Vieillot). LEAST SANDPIPER.

New Providence, Great Inagua, \*Acklin Island, \*Watlings Island, Abaco.

Sparingly distributed as a winter resident, and usually found associated with other species of shore-birds.

35. *Pelidna alpina sakhalina* (Vieillot). RED-BACKED SANDPIPER.

\*Great Inagua.

A flock of this species was seen February 3, during the course of a sail from Mathewtown to Alfred Sound.

36. *Ereunetes pusillus* (Linnæus). SEMPALMATED SANDPIPER.

Great Inagua, \*Andros.

A flock of this species was observed February 3 near Middle Point, Great Inagua, and a single bird was noted at Staniard Creek, Andros, April 12.

37. *Calidris leucophæa* (Pallas). SANDERLING.

\*Fortune Island, \*Watlings Island.

A party of three passed close by the mail schooner as we lay at anchor off the south end of Fortune Island February 1, and another party of four, in company with an equal number of Turnstones, were seen close to the Columbus Monument on Watlings Island, March 15.

38. *Totanus melanoleucus* (Gmelin). GREATER YELLOW-LEGS.

\*Watlings Island, Andros.

Not common. Two were flushed from a mangrove lagoon on Watlings Island, March 23, and a single individual was noted on Andros, April 12.

39. *Totanus flavipes* (Gmelin). YELLOW-LEGS.

Watlings Island.

This species was noted in a mangrove lagoon on March 22 and 23, on the latter date in company with the Greater Yellow-legs.

40. *Helodromas solitarius solitarius* (Wilson). SOLITARY SAND-PIPER.

\*Great Inagua.

The Solitary Sandpiper was seen on several occasions at Horse Pond, Inagua, where a single bird was taken February 22.

41. *Actitis macularia* (Linnaeus). SPOTTED SANDPIPER.  
 New Providence, \*Great Inagua, \*Abaco.  
 Not common. The last was noted at Sand Bank, Abaco, April 28.
42. *Squatarola squatarola* (Linnaeus). BLACK-BELLIED PLOVER.  
 New Providence, \*Great Inagua, \*Acklin Island, \*Watlings Island, \*Abaco.  
 Quite evenly distributed as a winter resident throughout the islands, but not common. As a rule it was found in small parties on the ocean beach.
43. *Oxyechus vociferus vociferus* (Linnaeus). KILLDEER.  
 New Providence, \*Cat Island (January 26), \*Rum Cay (January 28), \*Long Island (Clarence Town, January 30), Acklin Island, Watlings Island.  
 A common and generally distributed winter resident throughout the Bahamas.
44. *Oxyechus vociferus rubidus* Riley. WEST INDIAN KILLDEER.  
 Great Inagua.  
 Quite common near Mathewtown, where a single individual was secured February 23.
45. *Ægialitis semipalmata* (Bonaparte). SEMIPALMATED PLOVER.  
 Great Inagua, \*Watlings Island, Abaco.  
 A winter resident, but not common. The latest record was from Sand Bank, Abaco, April 28.
46. *Othodromus wilsonius wilsonius* (Ord). WILSON PLOVER.  
 \*Watlings Island, Andros.  
 A party of three individuals was seen on the ocean beach at the north end of Watlings Island March 26, all of which were secured. Two were noted here previously, on March 14.
47. *Arenaria interpres morinella* (Linnaeus). TURNSTONE.  
 New Providence (January 17), Great Inagua (Mathewtown, February 12 and 25), Watlings Island (March 15).  
 Not common, the above being the only records.
- [— *Hæmatopus palliatus* (Temminck). AMERICAN OYSTER-CATCHER.  
 \*Watlings Island.

Although the birds themselves were not actually seen, tracks which were unmistakably made by this species were observed March 27 on the ocean beach, plainly moulded in the sand, and obviously made since the previous high tide.

— *Jacana spinosa* (Linnæus). MEXICAN JACANA.

According to Mr. D. J. Sweeting (one of Mr. Cory's old collectors), a Mexican Jacana was killed near \*Mathewtown a few years ago. Mr. Sweeting saw and tried to purchase the specimen, but the prize was secured instead by the captain of some vessel, by whom it was carried off.]

48. *Columba leucocephala* Linnæus. WHITE-CROWNED PIGEON.

New Providence, \*Acklin Island, Abaco.

Only scattering individuals were seen during our stay, and I was informed that it was their habit to spread all over the various islands except during the breeding season, when they congregate in immense nesting colonies on the smaller and more isolated outer cays. Two females taken at Sand Bank, Abaco, April 24 and 27, showed no enlargement of the ovaries.

49. *Zenaida zenaida* (Bonaparte). ZENAIDA DOVE.

Great Inagua, \*Acklin Island, Watlings Island, Andros, Abaco.

The Zenaida Dove is rather common and generally distributed, but is exceedingly shy, being hunted and trapped so persistently for food. It is, indeed, excellent eating. On Watlings Island we saw the birds caught in the common "cob-house" figure-four traps, and on several occasions they were brought in and offered for sale.

50. *Chæmpelia passerina bahamensis* (Maynard). BAHAMA GROUND DOVE.

New Providence, Cat Island (The Bight, January 26, Port Howe, April 6), Watlings Island, Andros, Abaco.

Abundant throughout the islands, frequenting fields and open places in general, roadsides and edges of woods or coppet. On account of its small size it is little persecuted, and in consequence is tame and unsuspecting.

51. *Chæmpelia passerina exigua* (Riley). MONA GROUND DOVE.

\*Great Inagua.

Abundant on Great Inagua, where a series of ten specimens was secured. The same remarks apply to this form as to the last.

52. *Cathartes aura aura* (Linnæus). TURKEY BUZZARD.

Andros, Abaco.

Only a very few seen.

[This reference is placed provisionally under true *aura*, pending the examination of Bahaman specimens.—W. E. C. T.]

53. *Pandion haliaëtus ridgwayi* Maynard. BAHAMA OSPREY.

\*Cat Island (The Bight, January 26), Great Inagua, Acklin Island, \*Fortune Island (March 9), \*Abaco.

Mr. Boucher informed me that this species, as well as the Great Blue Heron, was very destructive to the young green and hawk-billed turtles on Great Inagua, and that accordingly it was shot at every opportunity. On April 26, at Sand Bank, Abaco, an Osprey was seen flying over whose head appeared to contain dark markings, similar to the northern form.

[Mr. Riley writes me that since his "List of Bahama Birds" was published he has seen the type of *Pandion ridgwayi* Maynard, and that it is apparently a good form.—W. E. C. T.]

54. *Falco peregrinus anatum* Bonaparte. DUCK HAWK.

Watlings Island.

On one occasion a Duck Hawk was seen pursuing a duck in the lake.

55. *Falco columbarius columbarius* Linnæus. PIGEON HAWK.

New Providence, Watlings Island, Andros.

Not common. One taken on New Providence January 7 had just been in pursuit of a flock of Bob-whites.

56. *Falco sparverius sparverius* Linnæus. AMERICAN SPARROW-HAWK.

New Providence, \*Great Inagua, \*Acklin Island, \*Andros.

Not common.

[The subspecific identification is doubtful.—W. E. C. T.]

57. *Accipiter velox* (Wilson). SHARP-SHINNED HAWK.

\*Great Inagua (Mathewtown, February 22), \*Acklin Island.

58. *Amazona leucocephala bahamensis* (Bryant). BAHAMA PARROT.

Great Inagua, Acklin Island.

Although we did not ourselves meet with parrots on Great Inagua they are nevertheless common there, especially in the northeast portion of the island. We saw caged birds which had been taken there, and talked with certain parties who had seen parrots in a wild state the day before the conversation. The birds do much damage

in the cornfields, tearing away the husks and often eating as much as half of the ear. Concerning our experience with parrots on Acklin Island I can do no better than quote from my note-book, under date of March 4. "We turned out at daybreak, and after breakfast joined the guide whom we had engaged the night before, and started into the parrot country, back from 'Gold Rock' settlement. We saw corn destroyed by parrots about five miles south of Spring Point, but no birds were heard or seen. We met a resident of Pompey Bay, however, who had seen a flock the previous evening, so we dismissed our first guide and proceeded with the new one, going still farther south over very rough country until about two o'clock, when we reached the point where they were seen the previous evening. It is their habit to remain quiet through the heat of the day, coming out of cover to feed in the morning and evening, when their noisy chattering is sure to betray their presence, so we sat down to await their appearance. We had rested perhaps an hour thus, when some parrots were heard in the distance. Slipping up on them, we finally caught sight of one bird, which was shot, while two others we had not seen, but which were feeding in the same 'synagogue bush,' only about ten feet from the ground, flew off, one of them badly wounded, but it did not fall in sight, and was not found. Again we sat down, and in about fifteen or twenty minutes another bird was heard, approached within range, and secured. Although we remained in the vicinity until nearly sunset, shifting our station from time to time, no others were heard or seen, so we started for Pompey Bay, where we intended to pass the night. We had gone scarcely a mile on our way when two parrots flushed wildly with a loud chattering, but although we followed them for some distance they would not permit us to approach within one hundred yards. As night was close at hand we retraced our way to the 'road' and resumed our journey to Pompey Bay, where we arrived after dark in a somewhat fagged-out condition.

"March 5. We were up at daylight, and after a hasty breakfast, and having engaged our guide to try to get some more parrots for us, we started on the return journey, finally arriving at our headquarters at ten o'clock, with blistered feet, and otherwise exhausted." That evening our guide sent us two parrots which he had shot for us, and as we were leaving the island just at sunset on March 8, the last skiff to come off to the schooner brought us two more which our first guide



had succeeded in getting. We were told that had we landed at Pompey Bay and hunted from that point southward our chances for obtaining a larger number would have been much better, with much less of the hard traveling, of which one who has never been across country in the Bahamas cannot realize what even a few miles means.

59. *Crotophaga ani* Linnaeus. ANI.

New Providence, \*Acklin Island, Watlings Island, Andros, Abaco.  
Not uncommon, and generally distributed.

60. *Saurothera bahamensis bahamensis* Bryant. NASSAU LIZARD CUCKOO.

New Providence.

Not uncommon in the high coppet or thicket, but, for so large a bird, very difficult to obtain, or even observe. Uttering its call only at quite long intervals, and with every facility for keeping well concealed, it is much more numerous than would at first be supposed. We were fortunate in securing six specimens, none of them very far from our bungalow in the Blue Hills.

61. *Saurothera bahamensis andria* Miller. ANDROS LIZARD CUCKOO.  
Andros.

Much less common than the New Providence bird, and its call more seldom uttered. Only one was taken, in dense thicket back of Staniard Creek. Others were heard, but it proved impossible to get within sight.

62. *Coccyzus minor maynardi* Ridgway. MAYNARD CUCKOO.

Great Inagua, \*Acklin Island, Watlings Island, \*Abaco.

Our first specimen was taken February 19, in thick, low coppet just outside of Mathewtown. It was not uncommon on Watlings Island, and five specimens were taken at Spencer's Point, Abaco, early in May. Inhabiting as it does the thickest coppet, it would seldom be found were it not for its betraying notes.

63. *Ceryle alcyon* (Linnaeus). BELTED KINGFISHER.

\*Great Inagua, \*Acklin Island, \*Watlings Island.

Not common.

64. *Dryobates villosus maynardi* Ridgway. BAHAMA HAIRY WOOD-PECKER.

New Providence.

Not uncommon on this island, but not found outside of the pine barrens so far as our observations went.

65. *Dryobates villosus piger* Allen. ABACO HAIRY WOODPECKER.  
Abaco.

A single female was taken April 26, in the pine barren at Sand Bank.

66. *Sphyrapicus varius varius* (Linnæus). YELLOW-BELLIED WOODPECKER.

New Providence, Great Inagua, \*Watlings Island.

A winter resident, but not common. The borings, so prominent in the trees about the landing at Cockburn Town, Watlings Island, which at first we supposed had been made by the following species, we now attribute to the present one.

67. *Centurus nyeanus nyeanus* Ridgway. NYE WOODPECKER.  
Watlings Island.

Our main purpose in visiting Watlings Island was to secure if possible a few specimens of this rare or "apparently extinct" woodpecker. A fine series of nine skins was obtained, six males and three females, and as our explorations covered only about one-third of the island there are undoubtedly plenty of them left for propagation. Indeed, we were told by some of the natives that they were plentiful on a certain part of the island that we did not visit, but such statements are, of course, not to be depended upon. There is no doubt, however, but that the birds are sparingly distributed throughout the entire wooded portion of the island. They keep in or near the very thickest coppet or shrubbery, carrying on their search for food leisurely in the larger of the low trees and the scattering palmettoes. The contents of such of their stomachs as were examined consisted mainly of tree-boring grubs and ants. Their note is a peculiar tree-toad-like croak, similar to that of the Red-bellied Woodpecker. Our first specimen was taken March 12, in thick coppet back of Victoria Hill settlement in the northwest part of the island, and later on others were taken in the same general region, as well as elsewhere. On one occasion a male bird was detected directly overhead in thick coppet in bottom-land. Upon backing off in order to shoot the bird kept following, as if impelled by curiosity, and it was with some difficulty that the proper shooting distance was attained. Other individuals met with were similarly fearless. The females taken showed little or no signs of breeding.

68. *Centurus nyeanus blakei* Ridgway. ABACO WOODPECKER.  
Abaco.

A series of eight specimens were secured, two at Sand Bank and six at Spencer's Point. The first specimen was taken April 26, feeding in a sapodilla tree in a fruit-orchard, near the water-front. At Spencer's Point their chief attraction seemed to be the telegraph poles along the railroad line into the timber, and it is likely that they mistook the significance of the humming of the wires. They were apparently mated, as in each instance a pair were observed together.

69. *Chordeiles virginianus vicinus* Riley. BAHAMA NIGHTHAWK.  
Andros, Abaco.

A single bird seen high in the air at Staniard Creek April 15, and another at Spencer's Point May 5, were the only ones noted.

70. *Nesophlox evelynæ* (Bourcier). BAHAMA WOOD-STAR.

New Providence, Acklin Island, Watlings Island, Cat Island (Port Howe, April 6), Andros, Abaco.

Common throughout the northern islands, but strange to say not detected at Spencer's Point. A nest of this species found on Green Turtle Cay, April 23, was saddled on a horizontal branch of a wild fig tree in a dooryard of the village, twelve feet from the ground. It was partly supported on one side by a smaller branch, and was composed of white cotton-fiber, the outside covered with small pieces of dry plant-bark and bits of dead leaves. It measured one and three-fourths inches wide by one and one-half inches high, with a cavity three-fourths of an inch wide and deep. It contained two pure white eggs, far advanced in incubation. The female was seen on the nest.

71. *Nesophlox lyrura* (Gould). INAGUA WOOD-STAR.

Great Inagua.

Abundant, and noted at every locality we visited. In the vicinity of Mathewtown it was partial to the blossoms of a species of agave, and was quite tame and fearless. Mr. Mortimer, with whom we lodged, brought us one he had killed with a switch.

72. *Riccordia ricordii æneoviridis* Palmer and Riley. ABACO  
HUMMINGBIRD.

Andros, Abaco.

A few were seen and three were taken at Staniard Creek, Andros. It was more common on Abaco, although by no means numerous. Some tall sisal plants in full bloom were a special attraction for this species at Sand Bank on the latter island.

73. *Tyrannus dominicensis dominicensis* (Gmelin). GRAY KING-BIRD.

Watlings Island, Andros, Abaco.

One of the few conspicuous land-birds of the Bahamas, always perching on some prominent dead branch and carrying on business strictly in the open. It is a summer resident only, and the first was seen March 27 on Watlings Island. It was noted at Staniard Creek, Andros, April 12, and had become common on Abaco by the first week in May.

74. *Tolmarchus bahamensis* (Bryant). BAHAMA PETCHARY.

New Providence, Andros.

Quite common in the pine barrens back of the Blue Hills, but not noted elsewhere except at Staniard Creek, Andros, where, however, it is not numerous. It is very tame and unsuspecting, sitting sedately on some dead branch or stub, and sallying forth at intervals to snap up a passing insect. This and the next species are called "Tom-fool" by the colored inhabitants.

75. *Myiarchus sagræ lucaysiensis* (Bryant). BAHAMA CRESTED FLYCATCHER.

New Providence, Great Inagua, Acklin Island, Andros, Abaco.

Moderately common and of general distribution throughout the Bahamas. It prefers the cooler shade of the more secluded thickets, and is seldom seen in the open.

76. *Blacius bahamensis* (Bryant). BAHAMA WOOD PEWEE.

New Providence, Andros, Abaco.

Not uncommon, frequenting thickets and edges of pine barrens.

77. *Mimus polyglottos polyglottos* (Linnæus). MOCKINGBIRD.

\*Long Island, Andros, Abaco.

The Mockingbird was common at Clarence Town, Long Island, January 30. A single pair were seen at Staniard Creek, Andros, but they were so very shy that they could not be approached within gunshot, despite the most cautious stalking. A few were seen on Green Turtle Cay, April 23, and we managed to secure a single specimen at Spencer's Point on May 3.

78. *Mimus polyglottos orpheus* (Linnæus). ANTILLEAN MOCKING-BIRD.

Great Inagua.

Abundant, especially in the vicinity of Mathewtown, where they

must breed very early, as fully grown young in the spotted plumage were taken on February 24.

79. *Mimus gundlachii gundlachii* Cabanis. GUNDLACH MOCKING-BIRD.

New Providence, Great Inagua, \*Acklin Island, Watlings Island, Cat Island (Port Howe, April 6), Andros.

Quite common, but shy and retiring in its habits, keeping itself well concealed in the thick coppet, except when singing, when it mounts to some more elevated perch, whence it darts quickly back to cover at the least alarm.

80. *Dumetella carolinensis* (Linnaeus). CATBIRD.

New Providence, Great Inagua, Watlings Island, Andros, Abaco.

Nowhere very common, but apparently of general distribution as a winter resident, and tame and familiar as in its summer haunts.

81. *Margarops fuscatus fuscatus* (Vieillot). PEARLY-EYED THRASHER.

Rum Cay, Great Inagua, Watlings Island.

The first individual was seen at Rum Cay, January 28, unconcernedly seeking food in a yard in the village of Port Nelson. It was very common on both Great Inagua and Watlings Island, but in habits was rather shy and retiring, keeping out of sight in low coppet and the edges of mangrove swamps. A little "squeaking," however, would usually bring the bird out for a glance at the intruder, two or three being often in sight at once. Much of their time is spent on the ground, scratching about among the dry leaves in search of food, after the manner of the Towhee. The species is called "Paw-paw bird," "Thrasher," or "Jack" by the natives.

82. *Mimocichla plumbea* (Linnaeus). BAHAMA THRUSH.

New Providence, Abaco.

This handsome species is much more common than it is conspicuous. Keeping as it does in the deepest portions of the shadiest thickets, and flitting silently out of sight at the least intrusion, it is very difficult indeed to observe. We discovered that the birds were in the habit of coming out into the open more frequently at dusk, when most birds were retiring for the night, feeding along the paths and edges of clearings.

83. *Poliophtila cærulea cærulea* (Linnaeus). BLUE-GRAY GNAT-CATCHER.

New Providence, Great Inagua, \*Acklin Island, Andros, Abaco.

Common throughout the Bahamas, seeming to prefer the pine barrens in the northern islands, but equally at home in the more open coppet on Inagua and Watlings Island. A nest was built within thirty feet of our palmetto shack at Sand Bank, Abaco, during the last week in April. It was placed in the upright fork of a mango tree, eighteen feet from the ground, surrounded by smaller branches, but little supported by them. Cotton, dry leaves, and strips of plant-fiber were the materials used in its composition, the lining being pale dun-colored plant-down. There was but slight attempt at outside decoration—merely a few bits of dead leaves and lichens stuck on, in striking contrast to the usual elaborately finished structure of this species in the Eastern States. It measured as follows: diameter, outside, two and three-eighths inches, inside, one and one-half inches; depth, outside, two inches, inside, one and one-eighth inches. It was finished ready for the eggs, and then for some unknown reason abandoned.

84. *Vireosylva calidris barbatula* (Cabanis). BLACK-WHISKERED VIREO.

Andros, Abaco.

A summer resident, first noted April 13 at Staniard Creek, Andros. A few were found at Sand Bank the latter part of April, and it was common at Spencer's Point by May. In habits it is very similar to the Red-eyed Vireo.

85. *Vireo griseus griseus* (Boddaert). WHITE-EYED VIREO.

A male bird of this species was taken at Staniard Creek, \*Andros, on April 14, this being the first record for the Bahamas.

86. *Vireo crassirostris crassirostris* (Bryant). THICK-BILLED VIREO.

New Providence, Great Inagua, \*Acklin Island, \*Watlings Island, Andros, Abaco.

Very common and generally distributed throughout the various islands. It occurs as an inhabitant of almost every thicket, where it may be observed in leisurely pursuit of food, and uttering its song at regular intervals throughout the day.

87. *Progne subis subis* (Linnæus). PURPLE MARTIN.

Miss Lightbourne of the \*Blue Hills showed us an adult male mounted bird of this species, which she had captured alive in her villa during the winter of 1899-1900. The bird came into a vacant room to roost for several nights, and she contrived to catch him and put him in a cage, but he died during the first night of captivity, and she had him

mounted by a local taxidermist. She informed me that he was apparently perfectly well and in good condition when captured. This is the first Bahaman record for this species.

88. *Hirundo erythrogastra* Boddaert. BARN SWALLOW.

\*Abaco.

Four individuals noted at Spencer's Point May 4, bound northward, were the only ones seen.

89. *Callichelidon cyaneoviridis* (Bryant). BAHAMA SWALLOW.

New Providence, \*Great Inagua, Andros, Abaco.

A few were seen on the south shore of New Providence and near Nassau in January. With the exception of a single bird observed at Alfred Sound, Great Inagua, February 3, it was not again recorded until our return to Nassau on April 10. Our first specimens were secured at Staniard Creek, Andros, April 14, on which occasion the birds appeared in numbers towards evening after a shower, circling around the settlement near the houses, and exhibiting no shyness whatever. Our experience on Abaco a little later on was much the same. The birds would seem to lay up during the heat of the day, coming out at sunset and in cloudy weather to feed, appearing in dozens at certain favorable places, and remaining in evidence until dusk. On one occasion (April 24) one was seen to gather a mouthful of seaweed and fly out of sight directly inland, towards the pine barren. Two days later, following up this clue, we discovered their breeding haunts. The nests were built in cavities (after the manner of the Tree Swallow), in very tall dead pines, fifty or more feet from the ground, and were utterly inaccessible, as the trees were unsafe to climb. The birds were seen leaving and in the vicinity of the holes. At Spencer's Point Bahama Swallows frequented the log boom of the Bahama Lumber Company, feeding around the wharf and log piles daily, and so tame that on one occasion I was able to knock two of them down with a stick a few feet long.

90. *Riparia riparia* (Linnæus). BANK SWALLOW.

\*Abaco.

On May 10, while at the lumber dock at Spencer's Point, just before leaving for Nassau, I saw two swallows which flew differently from the Bahama species, and waiting until they came closer I found that they were Bank Swallows. The grayish brown back, dark breast-band, short square tail, and quick jerky flight were unmistakable. This is the first Bahaman record for the species.

91. *Mniotilta varia* (Linnæus). BLACK-AND-WHITE WARBLER.  
 New Providence, \*Great Inagua, Watlings Island, Andros, Abaco.  
 Not uncommon as a winter resident throughout the islands. It was noted at Spencer's Point, Abaco, as late as May 6.
92. *Helmitheros vermivorus* (Gmelin). WORM-EATING WARBLER.  
 New Providence, Great Inagua, \*Abaco.  
 A winter resident, but not common. The latest record was for Sand Bank, Abaco, April 29.
93. *Compsothlypis americana americana* (Linnæus). PARULA WARBLER.  
 Great Inagua, Andros.  
 Not common.
94. *Dendroica tigrina* (Gmelin). CAPE MAY WARBLER.  
 New Providence, Great Inagua, \*Acklin Island, Watlings Island, Andros, Abaco.  
 The Cape May Warbler is a winter resident, and according to our experience is one of the most common warblers at that season. It was noted on Abaco as late as the first week in May.
95. *Dendroica petechia flaviceps* Chapman. BAHAMA YELLOW WARBLER.  
 Great Inagua, Watlings Island, Andros, Abaco.  
 This species is common throughout the Bahamas wherever there are suitable tracts of mangrove, which are its chosen haunts, and far from which it seldom wanders.
96. *Dendroica cærulescens cærulescens* (Gmelin). BLACK-THROATED BLUE WARBLER.  
 New Providence, Watlings Island, Andros.  
 A not uncommon winter resident.
97. *Dendroica coronata* (Linnæus). YELLOW-RUMPED WARBLER.  
 New Providence, Great Inagua, \*Acklin Island, \*Watlings Island, Andros.  
 Common throughout the winter months. The bulk leaves by the last of March.
98. *Dendroica striata* (Forster). BLACK-POLL WARBLER.  
 \*Abaco.  
 Only one record, referring to a single transient individual seen at Spencer's Point May 4.



99. *Dendroica dominica dominica* (Linnaeus). YELLOW-THROATED WARBLER.

New Providence, Great Inagua, Watlings Island.

Not uncommon in the pine barrens back of the Blue Hills in January, but seldom noted elsewhere.

100. *Dendroica flavescens* Todd. YELLOW-BREASTED WARBLER. Abaco.

Four examples of this fine new species were taken, three at Sand Bank the last week in April, and one at Spencer's Point on May 7, two of each sex. They were found near the edge of the pine barrens, feeding well up in the pines, and in their movements and song resembled the Yellow-throated Warbler very closely. The species doubtless occurs throughout the two Abacos, at least as far as the pine barrens extend. The sexual organs showed no signs of activity.

101. *Dendroica pityophila* Gundlach. CUBAN WARBLER. Abaco.

Common in the pine barrens at Sand Bank, and noted at Spencer's Point also, but less common. Like the last species, they keep well up in the pines, associating with the Bahama Pine Warblers, and it is doubtful if they ever leave such situations.

102. *Dendroica vigorsii achrustera* Bangs. BAHAMA PINE WARBLER. New Providence, Andros, Abaco.

Common wherever there are pine barrens, and doubtless not going beyond their extent. They seldom come near the ground to feed, confining themselves to the upper branches much more closely than the bird of the Eastern States.

103. *Dendroica palmarum palmarum* (Gmelin). PALM WARBLER.

New Providence, Cat Island (The Bight, January 26), Great Inagua, \*Acklin Island, Fortune Island (March 9), Watlings Island, Andros. A common and generally distributed winter resident.

104. *Dendroica discolor* (Vieillot). PRAIRIE WARBLER.

New Providence, Great Inagua, Watlings Island, Andros.

A not uncommon species in many places.

105. *Seiurus aurocapillus* (Linnæus). OVEN-BIRD.

New Providence, Great Inagua, \*Acklin Island, Watlings Island, Andros, Abaco.

Common throughout the islands, where it is called "Walk-easy" by the natives. It was observed as late as May 3 at Spencer's Point, Abaco, where it doubtless breeds.

106. *Seiurus noveboracensis notabilis* Ridgway. GRINNELL WATER THRUSH.

New Providence, Great Inagua, Watlings Island.

Not uncommon as a winter resident.

107. *Geothlypis trichas trichas* (Linnæus). MARYLAND YELLOW-THROAT.

New Providence, Watlings Island, Andros, Abaco.

Common in the northern islands in winter, remaining as late as April 27 on Abaco. It was numerous on Watlings Island March 19.

108. *Geothlypis rostrata rostrata* Bryant. BRYANT YELLOW-THROAT.

New Providence, Andros.

Although special search was made for this species, only four specimens (all males) were secured, three on New Providence and one on Andros. Two of these were shot on the edge of the pine barrens, just south of the Blue Hills, and another in high coppet. From their persistence in keeping in the very thickest covert, which is here so dense that one can scarcely force his way through, and into which one can see but a very few feet, it is very difficult to catch even a glimpse of them. The only note which was ever heard was a short chirp, in no way distinctive. On one occasion a pair were seen together, but the female readily eluded capture.

109. *Geothlypis rostrata tanneri* Ridgway. TANNER YELLOW-THROAT.

Abaco.

More common in proportion than the New Providence bird, eight specimens being secured, all males. They are shy and retiring, keeping in the shady nooks of the thickest shrubbery and ferns, rarely venturing into plain sight, so that nearly all of those taken were secured by snapshots, as they flitted through the shadowy depths of the thickets. A female once came and worked through the thick growth around the base of an orange tree, within a few feet of our palmetto shack at Sand Bank.

110. *Setophaga ruticilla* (Linnæus). AMERICAN REDSTART.

New Providence, Great Inagua, Andros, \*Abaco.

The Redstart is not common in the Bahamas, according to our experience. It was found in open growth and pine barrens. The last was seen at Sand Bank, Abaco, April 26.

111. *Cœreba bahamensis* (Reichenbach). BAHAMA BANANAQUIT.

New Providence, Cat Island (The Bight, January 26, Port Howe, April 6), Great Inagua, \*Acklin Island, Watlings Island, Andros, Abaco.

Abundant throughout the various islands, being partial to cocoanut groves, open woodland, and the vicinity of dwellings. On one occasion at the Blue Hills I had an opportunity of watching one of these birds at close range, as it was feeding on some bits of grape-fruit pulp which had been dropped over the veranda railing. It was satisfying its appetite by *licking* the shreds with its tongue, darting this member out and in with a very rapid motion, reminding one of a snake.

112. *Agelaius phœniceus bryanti* Ridgway. BAHAMA RED-WING.

New Providence, Andros, Abaco.

Common in suitable localities in the northern islands, about the edges of lagoons, ponds, and mangrove swamps.

113. *Icterus northropi* Allen. NORTHROP ORIOLE.

Andros, Abaco.

At Staniard Creek, Andros, where there are large cocoanut groves, we found the Northrop Oriole quite common, and readily secured a dozen specimens during our brief stay, all within a radius of two miles. I predict that the species will be detected on this island wherever cocoanut groves occur. Passing almost all their time as they do in the tops of the cocoanut palms, feeding among the thick leaves, blossoms, and clusters of nuts, and being more than a little inclined to play at the game of "hide-and-seeK"—with the chances all in their favor—one might spend a considerable time in a grove where they are common, and yet scarcely ever see one. An occasional note, however, betrays their presence. One of their notes sounds like a hoarse "*chi-chot, chi-chot,*" with accent on the first syllable, while others remind one of some of those of the Baltimore Oriole. They sing and breed in the immature plumage. At Sand Bank, Abaco, where there are no cocoanut palms, we nevertheless found them not uncommon in tall coppet, and very tame. On one occasion a young male allowed me to pass my gun-barrels within a foot of him.

114. *Spindalis zena zena* (Linnæus). BLACK-BACKED SPINDALIS.

New Providence, Cat Island (Port Howe, April 6), Andros.

One of the most abundant and conspicuous of the characteristic land-birds of the northern Bahamas. They came in large numbers

to feed in the wild fig trees near our headquarters at the Blue Hills, and were very tame, feeding fearlessly within a few feet of us.

115. *Spindalis zena townsendi* Ridgway. ABACO SPINDALIS.  
Abaco.

Common at Sand Bank, inhabiting coppet, and noted at Spencer's Point also.

116. *Passerina cyanea* (Linnæus). INDIGO BUNTING.  
\*Great Inagua, \*Andros, \*Abaco.

Not common. It was noted at Spencer's Point, Abaco, as late as May 8.

117. *Pyrhulagra violacea violacea* (Linnæus). BAHAMA BULL-FINCH.

New Providence, Great Inagua, Andros, Abaco.

Common in coppet and thick woodland, often coming to the wild fig trees to feed.

118. *Tiaris bicolor bicolor* (Linnæus). BAHAMA GRASSQUIT.

New Providence, Great Inagua, Acklin Island, Watlings Island, Andros, Abaco.

Abundant in fields and thickets, and along the highways.

119. *Passerculus sandwichensis savanna* (Wilson). SAVANNAH SPARROW.

New Providence, Andros.

Not common; noted in fields and pine barrens. It was taken on Andros as late as April 13.

120. *Passer domesticus domesticus* (Linnæus). EUROPEAN HOUSE SPARROW.

New Providence.

A few were noted in the town of Nassau.

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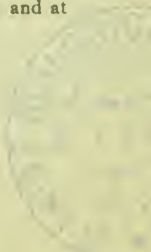
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