AN ECOLOGICAL SURVEY

IN

NORTHERN MICHIGAN.

PREPARED UNDER THE DIRECTION OF

CHAS. C. ADAMS.

A Report from the University Museum, University of Michigan, published by the State Board of Geological Survey as a part of the Report for 1905.

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LETTER OF TRANSMITTAL.

OFFICE OF THE STATE GEOLOGIST,
LANSING, MICH., Oct. 30, 1905.

To the Honorable, the Board of Geological Survey of the State of Michigan:

Hon. Fred M. Warner, President.
Hon. L. L. Wright.
Hon. Patrick H. Kelley, Secretary.

Gentlemen:—I herewith transmit for publication, in the Annual Report of the Board for 1905, the following report. This is a contribution to the Biological Survey of the State, which the Legislature authorized you to supervise and execute by Act No. 250 of the Session of 1905. The following report is the result of a natural history survey made in the Porcupine Mountains and on Isle Royale by a party from the University Museum, University of Michigan. It is not a mere list of plants and animals, but a study of these forms in relation to their surroundings. It is thus a contribution to the natural history of the Upper Peninsula, and in addition to its scientific value will, I trust, be of use to teachers in all parts of this region and stimulate them in the study of the forms of life about them.

Very respectfully,
ALFRED C. LANE.

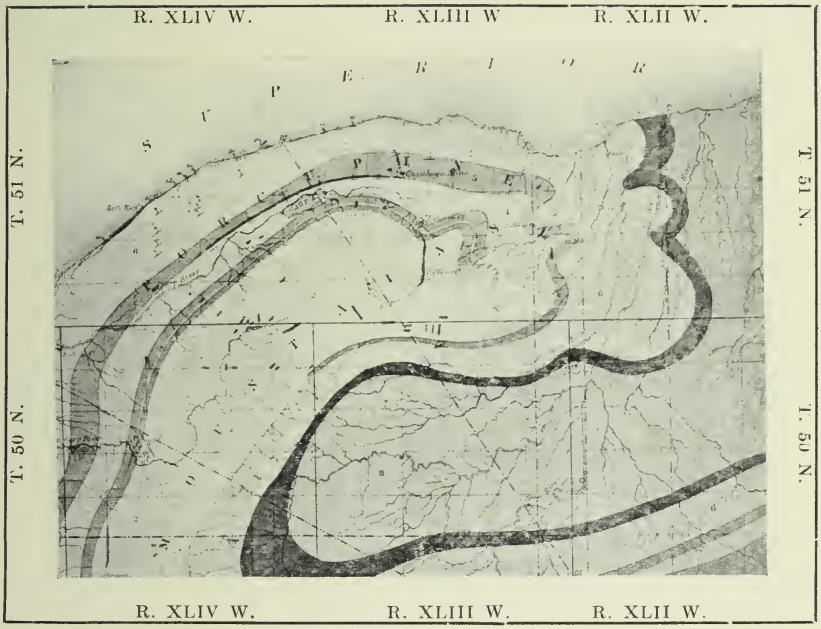

FIG. 1. Geological map of a portion of the Porcupine Mountains, Mich.

2. Quartz-porphyry. 3. Diabase, Diabase-amygdaloid ("Trap"). 4. Sandstone and Conglomerate. 5. Diabase and Diabase-amygdaloid ("Trap"). 6. Sandstone with thin bands of conglomerate. 7. Dark-grey Sandstone and Black Shale.—(After Irving).

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INTRODUCTORY NOTE.

During the summer of 1904 the University Museum of the University of Michigan sent a party to Northern Michigan. The aim of the expedition was to make an ecological study of the plant and animal life of the Porcupine Mountains in Ontonagon County and on Isle Royale. The Porcupine Mountains are about 120 miles west of Marquette, on the south shore of Lake Superior; Isle Royale, an island in Lake Superior, is near the north or Canadian shore. Almost nothing has been known of the Natural History of these localities, and collections from these regions have been almost completely lacking in the Museum. Civilization has already exterminated a large number of plants and animals from parts of Lower Michigan, so that it is especially desirable that records and collections be secured from these northern regions ere it becomes too late through the encroachments of civilization.

The expedition was made possible through the generosity of certain public spirited friends of the University, as the funds of the Museum are too limited to carry on this very important line of work, without special aid. The major part of the funds were the combined gifts of Mr. Bryant Walker, of Detroit, Hon. Peter White and Mr. N. M. Kaufman, of Marquette, and to these gentlemen in particular the University Museum is under great obligation. The Board of Regents of the University generously contributed the expense of transportation, not otherwise provided. Through the efforts of Mr. White the party received transportation or special rates in the Northern Peninsula. The Duluth, South Shore & Atlantic R. R. gave a special rate to the party, and the White Line Transportation Co., through Capt. W. H. Singer, general manager, gave free transportation to the party to and from Isle Royale. Through Mr. Henry Russel, the Michigan Central R. R. also gave the party a special rate. The Washington Club of Duluth, through Mr. John Panton, provided the party with excellent field headquarters upon their private grounds on Isle Royale. The Marble Axe Co., of Gladstone, Mich., presented the party with a set of useful camp articles. In addition to the services of the volunteer members of the party and those just mentioned many others have aided in various ways. In behalf of the Museum I wish to express my sincere appreciation for this coöperation.

The field party was in charge of N. A. Wood, the Museum taxidermist. He was assisted by A. G. Ruthven, who had charge of the scientific work, and who directed it along lines outlined by the writer. The other members of the party were Messrs. Otto McCreary, N. F. Macduff, Max M. Peet and W. A. Maclean. All members of the party, except the leader, were volunteers, and thus their contribution to the success of the expedition was of a very substantial nature. Without their aid nothing could have been accomplished. Upon Messrs. Wood and Ruthven fell the responsibility of the party in the field, and to their care and foresight is due, in a large measure, the success of the expedition.

The field party left Ann Arbor, July 11, after three weeks of unfortunate and unavoidable delay, and explored the Porcupine Mountains until August 13. These mountains rise rather abruptly from the south shore of Lake Superior, and in a succession of ridges reach the height of about 1400 feet, at about two miles in the interior. The entire region is inhabited only by scattered trappers, and the forests are practically in their original condition.

From the Porcupines (August 13), the party went to Isle Royale, about 60 miles northwest of Houghton, where they made a hasty examination of the lower end of the island, the party remaining here until September 5. The lateness of the season furnished an excellent opportunity to make observations on the fall migration of the birds, and these notes are of peculiar interest on account of the insular location.

After the return of the party from the field, the preparation of the report was begun at once and has been carried on as rapidly as circumstances would permit. As the volunteer members of the party have been busy with other duties the preparation of the reports, in some cases, represents considerable sacrifice on their part. In particular this has been the case with Mr. Ruthven, upon whom naturally fell the heaviest burden.

A very pleasant feature in connection with the preparation of this report has been the generous coöperation of a large number of naturalists. In behalf of the University Museum I wish to acknowledge our indebtedness to these persons, who have, in addition to furnishing information concerning the collections, and the determination of specimens, in some cases contributed papers.. The following list will show by whom the specimens have been determined.

Prof. Bruce Fink, Iowa College, Grinnell, Iowa. Lichens.
Dr. C. A. Davis, University of Michigan. Higher plants.
Mr. S. Alexander, Ann Arbor, Mich. Higher plants.
Dr. J. P. Moore, University of Pennsylvania, Philadelphia. Leeches.
Mr. Nathan Banks, U. S. Dept. of Agriculture, Washington. Spiders.
Mr. E. B. Williamson, Bluffton, Ind. Odonata.
Mr. J. R. De la Torre Bueno, New York. Hemiptera.
Mr. A. P. Morse, Wellesley College, Wellesley, Mass. Orthoptera.
Prof. A. J. Snyder, Springfield, Idaho. Lepidoptera.
Dr. W. M. Wheeler, American Museum Natural History, N. Y. Ants.
Mr. Bryant Walker, Detroit, Mich. Molluscs.
Dr. S. E. Meek, Field Columbian Museum, Chicago. Fish.
Dr. L. Stejneger, Smithsonian Institution, Washington. Amphibia.
Mr. Robert Ridgway, Smithsonian Institution, Washington. Birds.
Mr. H. C. Oberholser, Smithsonian Institution, Washington. Birds.
Dr. C. Hart Merriam, Biological Survey, U. S. Dept. Agriculture, Washington. Mammals.
Mr. W. H. Osgood, Biological Survey, U. S. Dept. Agriculture, Washington. Mammals.
Dr. Glover M. Allen, Boston Soc. Nat. History, Boston. Mammals.

This is also an appropriate place to express our obligations to Dr. A. C. Lane, State Geologist of Michigan, who furnished the party with maps and other information on Isle Royale and the Porcupine Mountains.

We are indebted to Mr. John F. Nellist for the contour map showing the location of the stations in the Porcupine Mountains, which he adapted from the map furnished by Dr. Lane.

A few remarks concerning the character of the field work, upon which the ecological reports have been based, will be of interest and also indicate the general bearing of such work. The aim of the present expedition was not directed primarily along the lines usually followed by natural history surveys. The aim was to secure *ecological facts and relations* concerning the plants and animals of the regions visited. In order to accomplish this, it was necessary not only to collect specimens but also to make observations concerning the relation of plants and animals to their environment. Mr. Ruthven was therefore instructed to run lines of survey across the region examined, in such a way as to include examples of all of the representative habitats or environments. These habitats were then to be examined in as much detail as time permitted. There is nothing unique in this method of selecting special localities, but in the detailed study of these various habitats special attention was given to the *relations of the biota* to its environment.* In this study attention was directed particularly to the forces and conditions composing the environment, in order that the dominant forces might be clearly recognized. This involved a careful analysis of the conditions, as it is only by such means that the laws of change can be recognized, and the dynamics of the habitat be understood. In this way, the habitat can be studied from the standpoint of *processes* rather than from that of the end result or effects of such forces, for it is very evident that if the habitats are to be understood it must be by a study of their laws of change.

Somewhat similar methods have been applied to special problems by a few plant ecologists, notably Cowles and his students, from whom many suggestions have been received, but such methods have not been applied to the study of both the plants and animals, and their interrelations, for any region. In the detailed application of this standpoint to the study of habitats, with its method of description in terms of *processes*, this report (Ruthven's section) is believed to be unique. That the ideal of interpretation, dynamically considered, has not been realized in the present ecological studies, will not be surprising to any one who understands the dynamic relations of ideals, or to one who has ever tried to depart from the customary static methods of working in order to think in terms of processes—dynamically.

As this method of thinking is not generally understood, it is occasionally applied in such a crude and general sense that its bearing can not be grasped when applied to special or concrete problems. There can be no question as to the general validity of this method, but what is now needed is to know how these processes are combined and related to produce particular environmental conditions or situations. It seems a very simple matter to give assent to the idea of the law of change, yet in its practical application this simplicity often vanishes at once when it is seen that it involves the relation of cause and effect. The organic environment is very complex and the ecologist, like the geologist has very frequently to deal with a complex of causes. But to be able even to refer a change to such a complex is often a distinct advance, as this involves a recognition of a problem requiring analysis, which is a further advance.

That these difficulties are not confined to the ecologist alone, but are obstacles which arise in any attempt as scientific interpretation, is worthy of special notice. We are thus able to see why certain naturalists apparently not recognizing or understanding the developmental processes which scientific ideas undergo, nor being acquainted with the tendencies of interpretation, dynamically considered, now making such rapid headway in ecological

*Biota—"the total of animal or plant life of a given region or period." Stejneger.

botany, geography, physiography, geology and psychology, are inclined to look upon such attempts in biology as merely a fad or a personal peculiarity of the student, and not of any particular consequence. Such ideas confuse the incidental with the essential and suggest a complete failure to grasp the situation or to realize the fundamental importance of stating explanations in terms of processes.

Furthermore, in several of the allied sciences, the methods of dynamical interpretation have already made considerable advance. Here then is a resource, at present largely unworked by many biologists, where a wealth of ideas and explanations lie strewn over the surface and only need to be picked up in order to be utilized by those acquainted with this method of interpretation. It is thus very apparent that as soon as ecological phenomena are investigated dynamically and expressed in terms of processes, this science will of necessity become more closely correlated with those allied sciences which have already availed themselves of such methods.

If the signs of the times are now read correctly, the most striking advance in scientific methods of thinking during the present century will be in the direction of interpretation from the standpoint of processes—dynamically.

April, 1905. CHARLES C. ADAMS,
University Museum, Curator.
University of Michigan.

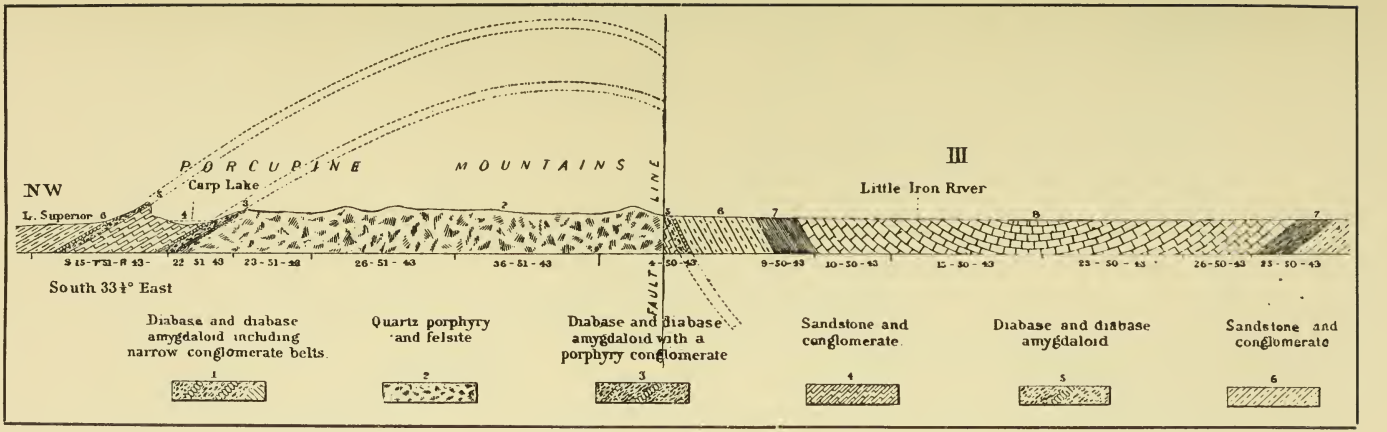

FIG. 2. Geological sections illustrating the structure of the Porcupine Mountains. (After Irving).

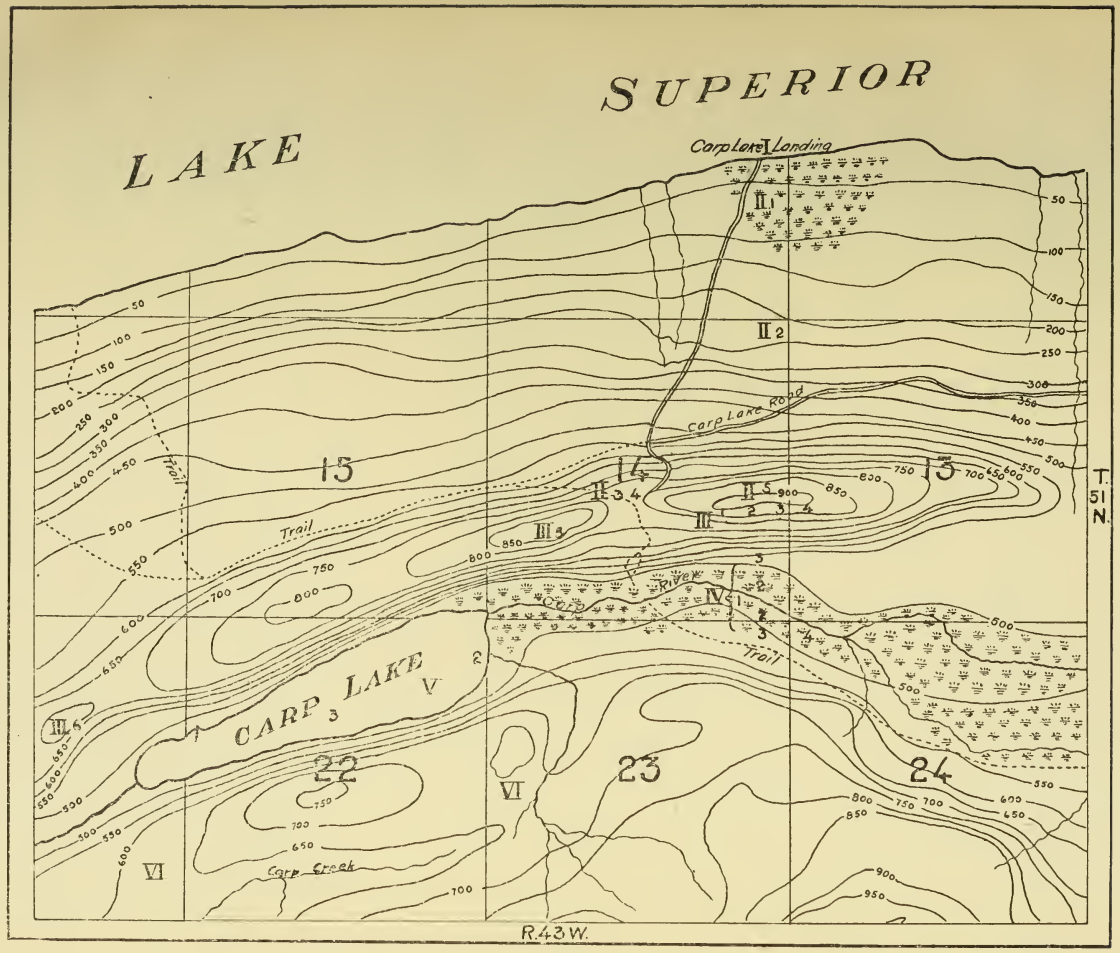

FIG. 3. Portion of the Porcupine Mountains showing location of field stations. Contour interval 50 feet. Altitudes above the level of Lake Superior, 601.19 feet.

AN ECOLOGICAL SURVEY IN THE PORCUPINE MOUNTAINS AND ISLE ROYALE, MICHIGAN.

A. G. RUTHVEN.

CONTENTS.

INTRODUCTION.

The following report is based upon the results of the University of Michigan Museum Expedition to the Northern Peninsula of Michigan. The field work covered a period from July 13 to September 5, 1904. From July 13 to August 13 was spent in the Porcupine Mountains; the remainder of the time on Isle Royale. After a short reconnaisance, a line was run through that part of the region presenting the greatest variety of habitats, and stations were established on this line at which collecting was done. This plan greatly aided keeping in mind the relation between the physical conditions and the biota, as topographic and vegetational features were made the basis for the location of stations. It also made it possible to examine a great variety of conditions and thus obtain representative collections.

There were six men in the party: Messrs N. A. Wood, Max M. Peet, N. F. Macduff, Otto McCreary, W. A. Maclean, and the writer. Having had some experience in this work, Mr. Macduff assisted the writer in running the line, and while doing this listed the flora of the stations as they were established. Mr. Wood's time was mostly spent in caring for the bird and mammal skins, and in this work he was assisted by Mr. Peet, who, in turn assisted by Mr. Wood did the trapping. Mr. Peet also spent some time

collecting birds. Mr. McCreary devoted his time to the study of the habitats of the birds and to the collecting of ants, and Mr. Maclean to collecting vertebrates alone. The invertebrates and cold blooded vertebrates were collected by the writer, with the assistance of the other members of the party.

Except in the case of the molluscs and birds, no attempt was made to make exhaustive lists of the different groups, owing to the lack of time. The collections include principally the representative forms in the different habitats, as is indicated in the description of the stations and in the annotated lists.

While running the line of survey and establishing the stations, the dependence of the biota on the environmental conditions, and the adjustment between these conditions and the plant and animal societies was given special attention. Much light was thrown on the interpretation of these interrelations by considering the physiography in its dynamic or unstable aspect. The physiography is the resultant of the geological formations and the agencies constantly at work modifying them. Since the biota is dependent on the physical conditions in the different habitats, it is also unstable. A knowledge of the present and past conditions, which can only be obtained through a knowledge of the processes involved, is therefore necessary to explain the origin and distribution of the life of this region.

Both of the localities worked are favorable for study from the ecological standpoint, for the primitive and natural order of life prevails practically free from the disturbing influences of man. The forests have not been lumbered, and, although mining has been done both in the Porcupines and on Isle Royale, the workings were all early abandoned, and the conditions of nature have reverted so nearly to their primitive order that the only evidences now remaining are caved-in shafts, and occasional growths of aspen and birch which mark the site of old clearings. The whole region is wilderness and practically uninhabited. For this reason, field headquarters were established in order to have a suitable place where provisions could be stored, and where the specimens could be properly cared for. Owing to the nature of the woods, travel was arduous and all extended trips had to be made with packs, making it difficult to care for specimens more than two days' journey from camp. This difficulty, in the Porcupine Mountains, was counterbalanced by the rough nature of the topography that made it possible to get a large variety of habitats within a comparatively small area. The territory covered by the survey was, therefore, limited to about twelve square miles, in order that representative habitats might be worked in some detail. On Isle Royale, the low relief made it necessary to extend the line much farther in order to get a variety of habitats. It was, for this reason, impossible to cover the ground in as much detail.

It is well at this time to acknowledge our indebtedness to Mr. David Allie, caretaker of the Carp Lake Mining Property in the Porcupine Mountains, who placed at our disposal a large double shack furnished with bunks, stove and dishes, and aided us in many other ways. We are also indebted to Mr. Charles Preulx and Michael Hollinger, caretakers of the grounds of the Washington Club, Isle Royale, who also assisted us in many ways.

PART I. PORCUPINE MOUNTAINS.

1. HISTORY.

The Porcupine Mountains are situated in the Northern Peninsula of Michigan, in Ontonagon County, near the west end of Lake Superior, between the Iron and Presque Isle rivers. They were acquired by the United States Government from the Mississippi and Lake Superior Chippewa Indians by virtue of a treaty concluded October 4, 1842. The territory included in this treaty was bounded on the north by Lake Superior; on the east by the Chocolate river; on the south by the Michigan-Wisconsin boundary line, and on the west by the Montreal river. Isle Royale was also included.

Shortly after the treaty was concluded, prospecting was begun, and during the period that followed the speculative fever ran high. The mere presence of trap rock was taken as an indication of the presence of valuable lodes of copper, and all the trap in the Porcupine Mountain region was soon secured by permits. Many shafts were sunk, especially in the first range where the junction of the trap and sandstone outcrops on the face of a cliff. It was soon found, however, that in this region there are no well defined lodes, the copper being scattered promiscuously in irregular seams through the trap. Before the expiration of the year 1848, according to Foster and Whitney ('49–'50, p. 80), nearly all of the companies had abandoned their locations, and there was scarcely a white man left in the region.

The workings, with the exception of three or four, were little more than prospect holes, and the impressions left upon the country by the presence of man have nearly all been obliterated. In this condition, the mountains have remained for fifty years. All about them the adjacent country has been lumbered, but, owing to the fact that the pines do not occur in extensive tracts, that the streams are not suitable for logging, and that up to a few years ago it was not thought worth while to lumber hardwoods and hemlock, the forests have thus far escaped destruction. With the exhaustion of the pine in Michigan, however, and the consequently increasing price of lumber, it has become profitable to lumber this timber, and the forests are being rapidly taken off of the Northern Peninsula. The lumbering about Ontonagon has nearly reached the great belt of hemlock on the east and north slopes of the first range. The extensive possessions of the mining companies will protect these forests for a time, but, with the increasing demand for lumber, it will be but a few years until these magnificant forests will be destroyed.

2. GEOLOGY.

It is not the purpose of this report to go into detailed discussion of the geology of the region in question. It is necessary, however, to have a general idea of the geological structure in order to understand the topography, for the topography is largely due to the different degrees of resistance offered by the outcropping rocks to erosion. The structural geology of this part of Michigan has been worked out in detail by several geologists, most notably

by Irving ('83), but little attempt has been made to correlate it with the topography, in which connection it chiefly concerns the distribution of animals and plants.

The rocks of this part of the Northern Peninsula belong to what is known as the Keweenawan Series, and may in a rough way be divided into three classes,—the basic or trap rocks, the porphyries or acid rocks, and the detrital rocks.

The basic rocks make up the greater part of the whole series. They are finely crystalline rocks formed by the slow cooling of molten lavas containing 45 per cent to 50 per cent of silica, and consist of a lower compact portion grading upward into a vesicular or amygdaloidal portion interstratified with bands of unaltered red sandstone and conglomerate which become more numerous near the top. These basic rocks are true eruptives and constitute successive lava overflows from fissure eruptions (Irving, '83, p. 139).

The acid rocks occur between layers of basic rocks and are in part, like the basic rocks, true eruptives. They are composed of materials which fuse with difficulty, owing to the presence of silica, and which consequently cool rapidly into rocks composed of large crystals embedded in a glassy or porcelain like matrix.

The detrital members of the series consist of sandstones, conglomerates and shales formed from acid, or less prominently basic, rocks.

The Keweenawan Series is divided by Irving into two divisions, the Upper and Lower Keweenawan. The Upper Division consists wholly of detrital material, while the Lower consists of alternating flows of lavas and sediments. Most of the Upper Division lies under Lake Superior, but it also underlies the broad plain between Portage Lake and the Porcupine Mountains. This plain is interrupted by the Porcupine Mountains but continues again to the south.

The Keweenawan rocks border nearly the entire area of the Lake Superior basin. Besides forming the larger part of Keweenaw Point and constituting the Michigan shore to the Montreal river, they occur in northern Wisconsin, eastern and northeastern Minnesota and occupy a great area about Lake Nipigon. The outcropping trap rocks in Michigan occur as a range extending from the end of Keweenaw Point southwestward into Wisconsin. From this range the detrital sandstones and conglomerates dip away toward the lake. In the vicinity of the Porcupine Mountains, an outcrop of trap, owing to a fold, leaves the main range and swings away toward the lake, in T. 50 N., R. 44 W., and returning joins the main range in T. 49 N., R. 45 W.; within this fold occur the rugged ranges of the Porcupine Mountains.

3. GENERAL TOPOGRAPHY.

The mountains rise from the south shore of Lake Superior, Fig. 1, in Township 51 North, Ranges 42, and 44 West; as a convex ridge parallel to the lake shore. Back of this ridge they extend to the south as steep ridges and knobs in T. 50 N., Rs. 42, 43, 44 and 45 W., and T. 49 N. Rs. 43, 44, and 45 W. The whole system comprises three fairly distinct parallel ridges that nowhere attain an alpine height; the highest point, according to the charts of the United States Lake Survey, being 1421 feet above the level of Lake Superior or 2022.19 feet above sea level. Unfortunately the territory covered by the topographic map of the Michigan Geological Survey does not embrace this section, so this record has not been verified. The altitudes

FIG. 4. General character of the rock beach, breaker line near shore, station I.

FIG. 5. Wave action on the Lower Beach, station I.

referred to in this report are, unless otherwise specified, above the level of Lake Superior. The elevation above sea level may be obtained by adding 601.19 feet to the given altitude (Wright, '05, p. 36).

The first ridge, rising from the shore of Lake Superior, reaches a height of 850 to 900 feet within a mile and a half. It then decends abruptly 400 feet into the valley of Carp river. This cliff consists of about 200 feet of vertical face, with a steep bare talus slope at the bottom which is composed of angular fragments of trap and sandstone rock weathered from the cliff above. As may be seen from the contour map, this talus slope grades down into the flood-plain of Carp river, except on Sections 21 and 22, T. 51 N., R. 43 W.; here the river widens out to form Carp lake and the talus decends into the lake. This great cliff extends nearly continuously across T. 51 N., R. 43 W., a distance of over six miles. Beyond Carp river the mountains rise in steep ridges and knobs, but with no precipitous cliffs, to the valley of the Little Carp river.

About three miles south of the west end of Carp Lake, on T. 50 N., R. 44 W., Section 2, Little Carp river widens out to form Little Carp Lake. This lake, which marks the end of the line of survey, is about half a mile long and a quarter of a mile in width, with very irregular shores formed by the surrounding hills.

The mountains are most easily reached from Ontonagon, Michigan. From here to Union Bay, there is a good but sandy road. After leaving Union Bay the road enters the mountains and runs along the north slope of the first ridge. This slope is terraced by old beaches which mark higher levels of Lake Superior, and the road ascends the mountains by these natural driveways, ascending from one beach to another in the less difficult places.

It is important to bear in mind that the present topography is not in a static condition but is being constantly changed by the forces acting upon it, and that it will continue to be changed and modified until the land has been reduced to base-level. It must also be borne in mind that forms of life are dependent on the environments formed by the physical conditions. These facts are as important from the ecological as from the physiographic standpoint, for with changes in the physical conditions there are associated changes in the dependent habitats. The present conditions are not sufficient, therefore, to explain the distribution of the present biota, and the past conditions can only be understood through a knowledge of the action of present forces in producing changes in the environments. It is for this reason that the present geological and topographical conditions have been considered.

4. LOCATION OF THE FIELD STATIONS.

The line of survey began at Lake Superior on the north and south line of Sections 11 and 12, Township 51 North, Range 43 West, and from here ran southwest up the north slope of the first range to a saddle in the crest at an elevation of 750 feet on Section 14. From this point a transverse line was run along the top of the range, to the west on Sections 14, 15, and 21, and to the east on Sections 14 and 13. From the saddle on Section 14, the main line was continued due south down the escarpment on the south side of the range, across the valley of Carp river to the east and west line of Sections 14 and 23. From this point it was run southwestward across the intervening ranges to the top of Government Peak on Section 27. Another line was run down the valley of Carp river from the north and south line of Sections 24 and 25 to the West end of Carp Lake on Section 21. Here it

turns to the south, crossing Sections 21 ,28, and 23, Township 51 North, Range 43 West, to Little Carp Lake on Section 2, Township 50 North, Range 44 West. It then turns to the east and follows the valley of Little Carp river about a mile and a half up stream. On these lines stations were established where different conditions prevailed. Their locations, Fig. 3, were as follows:

Station I. Beach of Lake Superior, Secs. 11 and 12, T. 51 N., R. 43 W.

Station II. North Slope of the First Range, Secs. 11, 12, 13, 14, 15, and 16, T. 51 N., R. 43 W.

- Sub. 1. Arbor Vitae Swamp at Foot of Slope, Secs. 11 and 12.
- Sub. 2. North Slope, Secs. 11, 12 and 14.
- Sub. 3. Clearing in the Saddle, Sec. 14.
- Sub. 4. Aspen Zone about Clearing, Sec. 14.
- Sub. 5. Aspen Zone at Top of Ridge bordering the Bare Mountain Top, Secs. 13, 14, 15, 21, T. 51 N., R. 43 W.

Station III. Top of the first Range and the Southern Escarpment Secs. 13, 14, 15 and 21, T. 51 N., R. 43 W.

- Sub. 1. West Slope of the Ridge on Secs. 13 and 14.
- Sub. 2. Bare Mountain Top, Secs. 13 and 14.
- Sub. 3. Zone of Pines crossing First Range, Secs. 13 and 14.
- Sub. 4. East Slope of the Ridge on Sec. 13.
- Sub. 5. Mountain Top on Secs. 14 and 15.
- Sub. 6. Mountain Top on Sec. 21.

Station IV. Carp River Valley on Secs. 13, 14, 23 and 24, T. 51 N., R. 43 W.

- Sub. 1. Carp River, Secs. 14 and 24.
- Sub. 2. Flood-plain, Sec. 14.
- Sub. 3. Valley Slopes, Secs. 14 and 23.
- Sub. 4. Peat Bog, Secs. 14, 23 and 24.

Station V. Carp Lake, Secs. 15, 21 and 22, T. 51 N., R. 43 W.

- Sub. 1. Beach at West End of Lake, Secs. 21 and 22.
- Sub. 2. Delta at East End of Lake, Sec. 22.
- Sub. 3. Carp Lake, Sec. 22.

Station VI. Mountains between the Carp and Little Carp Drainage Systems, Secs. 21, 22, 23, 27, 28, 33, and 34, T. 51 N., R. 43 W.

Station VII. Little Carp Drainage System, Sec. 2, T. 50 N., R. 44 W., and Sec. 34, T. 51 N., R. 43 W.

- Sub. 1. Little Carp Lake, Sec. 2, T. 50 N, R. 44 W.
- Sub. 2. Beaver Meadow along Little Carp River, Sec. 34, T. 51 N., R. 43 W.
- Sub. 3. Little Carp River, Sec. 34, T. 51 N., R. 43 W.

5. THE BIOTA CONSIDERED BY STATIONS.

Station I. The beach of Lake Superior at the point studied is composed of outcropping strata of sandstone tilted at a considerable angle, Fig. 4. The nature of this shore has an important effect on the conditions of the beach. The effect of the beating of the waves of a lake is to cut into the shore as a horizontal saw. If the strata of this shore were perpendicular, the material would fall away from the face of the cliff as it was undermined, and the cliff would be vertical. The strata are inclined, however, so that as the lower part of the shore is cut into, the rock is removed more slowly, in blocks determined by the joint and bedding planes, Fig. 4. The edges of the truncated

strata form the bottom of a wave cut terrace off shore and determine the breaker line, Fig. 7. The submerged edges of these strata continue to be worn off by the abrasion of the material carried by the undertow until the surface of the terrace is more or less uniform.

On account of the exposure and the difficulty of obtaining a foothold, the environmental conditions are very severe, and the biota is limited both in individuals and species. The beach has been divided by physiographers into three parts, the Upper, Middle, and Lower Beaches, according to the influence of the hydro-dynamic factors. These factors, as Cowles ('99, pp. 112-175, and '01, pp. 56-57) has shown, have an important influence upon the environment of plants, so that the beach may be divided into the same divisions for our present purpose.

The Lower Beach is that portion of the shore exposed to the action of the waves during the summer months. At the point studied, Station I, owing to the dip of the strata, the water deepens rapidly off shore, and the breaker line is brought near to the beach, the lower part of which is thus exposed to the full force of the waves, Fig. 5. Exposed as it is alternately to the pounding of the waves and dessication in the sun the conditions are so severe that very little life can exist. The only form that is found here is the snail *Limnaea decollata* that occurs occasionally behind projecting outcrops, where it is to some extent protected from the direct force of the waves. This snail seems to be adapted to habitats of this nature, for it was found elsewhere only in rapid water in the larger rivers (Ruthven, '04, p. 192).

The Middle Beach lies above the Lower Beach and differs from it in not being exposed to the summer waves. It is, however, exposed to the action of the waves during the early winter months, while during the latter part of the winter the ice is shoved upon it in great ridges. It is thus, only during the growing season free from those conditions which make the Lower Beach practically uninhabitated, but certain conditions still make the habitat unfavorrable. Owing to the difficulty in gaining and retaining a foothold, the vegetation consists principally of lichens, *Lecidea lactea* and *Parmelia conspersa*, that are not dependent upon the substratum for nourishment. Along the exposed edges of joint and bedding planes, where disintegration is more rapid, a slight soil accumulates, Fig. 6. These crevices, as may be seen from the photograph, are taken possession of by several of the higher plant forms, but, owing to the short period that this beach is not exposed to the pounding of the waves, only the hardier plants can obtain a foothold, such as the Beach Pea,* Silvery Cinquefoil, Goldenrod, Pale Spiked Lobelia, Harebell and a few grasses, Fig. 6.

The fauna, probably owing in part to the lack of food, is also limited. The insects are represented by the butterflies, *Argynnis atlantis, Phyciodes tharos, Grapta gracilis, Grapta progne, Basilarchia arthemis,* and *Colias philodice,* and the dragonflies, *Aeschna clepsydra* and *Sympetrum costiferum;* forms that also occur on the Upper Beach. The spiders are more characteristic; *Epeira trifolium* and *patagiata* and *Linyphia phrygiana* spin their webs behind the outcropping strata, while *Pardosa lapidicina* runs about over the rocks. The destruction of this rock beach will probably destroy the habitats of these spiders, especially of those that spin webs, as it would be impossible for them to attach their webs on a sandy beach. The butterflies on the other hand are dependent upon the flowering plants, which are essentially crevice forms, so that their habitats would be increased by the comminution of the beach.

*All plant names in this report follow Britton's *Manual of the Flora of the Northern States and Canada*, 1901.

There are numerous pools on this beach, Fig. 6, in the angular spaces formed by the removal, presumably by ice, of portions of rock between the joint planes. These pools are, as a rule, above the reach of the highest waves, so that during the summer they are not flooded by the cold water of the lake. Their temperature is thus higher than the lake water. In several readings taken August 6, 7 and 8, the temperature of the water in these pools varied from 60° F. to 68° which was 10° higher than the lake water as it broke on the lower beach. The vegetation in these pools is very scanty, consisting chiefly of Algae which line the sides. The small number of species is probably due to their isolation and shallowness (6 to 18 inches), and to their smooth sides which make it difficult for the plants to gain a foothold. The fauna is much better represented than the flora. Besides a number of minute forms such as Crustaceans, Hydra, etc., there are a number of the higher aquatic forms characteristic of quiet water habitats. The insects are represented by water-boatmen, water-striders, and caddis-fly larvae, and the snails by *Physa ancillaria, Limnaea desidiosa, Planorbis parvus* and occasionally, near the Lower Beach by *Limnaea decollata.* These forms are found in all of the larger pools with the exception of *Limnaea decollata* which only occurred in the lower pools that are occasionally flooded by the waves. When these pools are flooded by an exceptionally high wave, they are often temporarily united with the lake and with each other which suggests a way by which certain forms may migrate along a shore of this kind. With the destruction of this beach these pool habitats will be destroyed, as pools of this kind cannot exist on a sandy beach.

The Upper Beach is above the reach of both summer and winter waves, and the environmental conditions are consequently more favorable than those of the Lower and Middle Beaches. The principal factor that still makes the habitat an unfavorable one for plants is the poor foothold afforded by the substratum. The soil, however, increases in amount at the edges of the joint planes thus affording a foothold for small trees and shrubs, Fig. 6, and to this soil is added a small amount of humus formed by decaying logs and annuals. Owing to these conditions, the flora presents a curious assemblage of forms. It is composed of the forms of the Middle Beach, Goldenrod, Beach Pea, Vetchling, Lobelia, Hare-bells, etc.; the fern, *Polypodium vulgare;* the heaths represented by the Bearberry, Great Bilberry and Dwarf Huckleberry that constitute the next society, and a number of trees and shrubs such as the Arbor Vitae, Mountain Maple, Mountain Ash, Large-leaved and Quaking Aspens, Juneberry, Eastern Ninebark, Dwarf Cherry, Wild Raspberry and Canadian Buffalo-berry, that in this region form a transitional zone between exposed habitats and the mesophytic forest. The fauna of this beach is in many respects similar to the fauna of the Middle Beach from which it cannot be distinctly separated. The forms found here which are not, as a rule, found also on the Middle Beach are the grasshoppers *Camnula pellucida, Circotettix verruculatus, Melanoplus atlanis* and *Melanoplus femoratus,* and the Lake Superior Chipmunk. The grasshoppers, as a rule, remain closely within the limits of this beach, with the exception of the forms of *Melanoplus* which are occasionally found also on the Middle Beach. The chipmunks are also seldom observed far from the drift logs that characterize this habitat.

The beach as a whole is thus, in a general way, divided into three habitats by the dominance of different processes which bring about different enviromental conditions, but these divisions, as may be seen from the photographs, are not sharply defined. The Lower Beach in general possesses

FIG. 6. Showing nature of the rock pools, crevice vegetation and lichens (white patches) of the Middle Beach, and the stunted crevice vegetation of the Upper Beach, station I.

FIG. 7. General character of the rock beach, breaker line off shore, station I.

little life, but near the upper limit of summer wave action a few straggling annuals come in that characterize the Middle Beach above, while near the upper limit reached by the winter waves and ice a few perennials of the Upper Beach occur. The biotic tension lines between these divisions also undergo occasional fluctuations, since the position of the tension line between the Lower and Middle Beaches is determined by the severity of the summer storms, while between the Middle and Upper Beaches it is determined by the height of the winter waves and ice.

Owing to the action of the waves, the beach as a whole is retreating inland, but as it retreats a wave cut and wave deposited terrace is being formed, and this by shallowing the water carries the breaker line off shore and lessens the effect of the waves, as illustrated in Fig. 7. The conditions of the Lower and Middle Beaches thus become more favorable, resulting in a progessive downward movement of the biota of the Middle and Upper Beaches respectively that decidedly narrows the beach zones.

On the other hand, the sinking of the coast in this region counteracts, in places, the tendency of the submarine terraces to decrease the efficiency of the waves. The deepening of the water near shore caused by this sinking of the coast brings the breaker line nearer shore, thus increasing the efficiency of the waves to such an extent that the beach habitats are being forced back into the adjacent swamps.

Station II. Substation 1. Back of the beach, at the foot of the first range, there often extends for considerable distances a narrow belt of arbor vitae swamp. This swamp owes its origin, according to Wright ('05, p. 37), to the general sinking of the beach of Lake Superior referred to in the discussion of the previous station. Gilbert ('97) in a discussion of this problem states that a general canting or tilting of the Great Lake Basins toward the southwest is taking place, as is indicated by the inclination of the beach lines of post-glacial lakes and by the drowned mouths of the rivers along the coast. It is evident that the rivers of the Porcupine region are drowned, as they are widened near their mouths into broad estuaries with adjacent swamps, and evidence that the tilting of the lake basin that is causing this is going on at the present time may be found in the submergence of standing trees along the lake shore, and in the discrepancy in the length of the section lines between different surveys, (Wright, '05, p. 37).

This sinking of the coast makes the conditions of a narrow zone just back of the beach too wet for some of the mesophytic forest forms that occupy the higher parts of the ridge, but at the same time it makes the conditions favorable for some of the forms of the arbor vitae swamp, so that this area is inhabited by certain forms characteristic of each of these habitats. The tree cover consists principally of the Arbor Vitae, with considerable Balsam Fir and some White Spruce and Paper Birch; the soil cover is characterized by the Running Pine, *Lycopodium clavatum*, and occasional clumps of Blue Flag. The molluscan fauna is very poorly represented, and the only shells collected were a few specimens of *Punctum pygmaeum* and *Zonitoides milium*. A single spider was taken here, *Dolomedes tenebrosus*. The mammals are those of the forest, such as the Southern Varying Hare, Southeastern Red Squirrel, etc., with the exception of the Lake Superior Chipmunk which was occasionally seen near the beach.

If the coast continues to sink, this swamp will approach more closely the conditions of the swamps of the river valleys and will become occupied more exclusively by the biota of the ordinary arbor vitae swamp, while

at the same time it will tend to retreat before the beach and invade the areas at present occupied by the mesophytic forest of the north slope.

Station II. Substation 2. Above the arbor vitae swamp, the north slope of the first range rises steeply to the top of the ridge and is covered by a dense mesophytic forest. The angle of this slope and the fact that it is formed by dipping strata, makes the drainage so rapid that the soil on the upper part tends to be washed downward and to accumulate at the bottom. The humus formed by the fallen twigs and leaves of the forest prevents in part superficial wash, and most of the water, for this reason, is conducted away under ground. The ravines are thus small and the streams transient. The lower parts of the slope support a dense hemlock forest in which there is deep shade, Fig. 8. The tree cover of this part of the forest consists principally of Hemlock associated with the Balsam Fir, Ironwood, Yellow Birch, isolated White Pines and a few Sugar Maples. The undergrowth of Ground Hemlock and Maple is very scanty, and the humus is thus composed chiefly of leaves and twigs of the Hemlock with the exception of localized accumulations of deciduous leaves from the maple underbrush. The soil cover is also scattered and is composed of the Large-leaved Aster, Wild Sarsaparilla, Twinflower, Goldthread, Maidenhair Fern, Wild Spikenard, Rattlesnake Plantain, Dwarf Dogwood, *Clintonia borealis*, and *Lycopodium lucidulum* and *clavatum*.

The fauna of the hemlock forest is also rich in species. Besides many insects and other invertebrates, there are a number of birds and the toad (*Bufo americanus*). The mammals are represented by the Canadian Porcupine, Northern Virginia Deer, Northern Plains Skunk, Woodchuck, Southeastern Red and Northern Flying Squirrels, Northeastern Chipmunk, Star-nosed Mole, Large Bobtail Shrew, and the Northern and Woodland Jumping, Canadian White-footed and Red-backed Mice. Owing to the predominance of conifers, it is to be expected that few shells would occur in this forest, but the accumulated leaves of the maple underbrush counteract the unfavorable nature of the coniferous humus and support a somewhat scattered molluscan fauna composed of *Zonitoides milium, Vitrea ferrea, Euconulus fulvus, Punctum pygmaeum, Helicodiscus lineatus, Strobilops virgo, Zonitoides exigua, Sphyradium edentulum, Carychium exile,* and *Agriolimax campestris.*

On the upper parts of the slope, the soil becomes thinner, and there is a noticeable change in the character of the forest. It is still mesophytic, but the Hemlock, Balsam Fir, Ironwood and Yellow Birch give way to a forest composed of the Sugar Maple, Basswood, and Paper Birch, in which the Sugar Maple predominates. This transition is gradual and while near the top of the ridge the Ironwood and Yellow Birch are practically absent, the Hemlock and Balsam Fir may still persist. The undergrowth in this part of the forest is much better developed, Fig. 9, and consists principally of Maple, Basswood and Ground Hemlock. The ground is covered to a depth of several inches with leaves, and the soil cover, although better developed, is practically the same as in the hemlock forest except that the Large-leaved Aster, Indian Pipe and Goldthread seem to become replaced by *Cinna latifolia*, White-flowering Raspberry, Fly Honeysuckle and Brake.

The changes in the environmental conditions with which are associated the changes in the composition of the flora toward the top of the slope do not seem to influence the fauna to a marked extent. As the tree cover is principally affected, the most marked change in the fauna is seen in the case of the birds, which are more closely associated with this type of vegetation.

Another change is the occurrence, on the upper part of the slope, of the Red-bellied Snake, *Storeria occipitomaculata*, which prefers dry, rather open woods. With the coming in of the deciduous forest, the humus becomes composed of leaves, and with this change in the nature of the humus is associated an increase, at least in the number of individuals, of molluscs. When the fallen leaves are examined, they are found to be connected by a film of water. Among these leaves seemed to be the favorite habitat of all the snails collected in these woods. The forms collected are *Zonitoides exigua Zonitoides arborea, Vitrea ferrea, Euconulus chersinus polygyratus, Helicodiscus lineatus, Punctum pygmaeum, Cochlicopa lubrica morseana, Sphyradium edentulum, Pyramidula striatella catskillensis, Strobilops virgo, Polygyra albolabris, Vitrea indentata* and *multidentata.*

It has been suggested (Whitford, '01, p. 301) that the presence of isolated White Pines in the mesophytic forest indicates a former dominance of xerophytic forms. This at once suggests an explanation for the origin of the present biota that is in accordance with the observed facts. When the waters of the glacial lakes receded and left the mountains exposed to denudation, the wash on this slope must have been considerable. The vegetation that first gained a foothold was probably a society analogous to that on the Middle Beach at the present time. These forms would be followed, as the conditions became favorable, by the heath society of the Upper Beach. At the bottom of the slope where the soil was thicker and the superficial wash less, the heaths were probably soon succeeded by the conifers that usually follow the heaths in this region. With the accumulation of humus in the coniferous forest, the superficial wash would become less, while the soil formed on the higher parts of the ridge would be held in front of the forest, permitting the coniferous types to ascend the slope and restrict the area occupied by the heaths.

As the coniferous forest became well developed at the bottom of the slope, owing to the more favorable edaphic conditions brought about by the accumulation of humus, the pine seedlings which require considerable light would no longer be able to develop. The seedlings of the deciduous trees, Maple, Basswood, Hemlock, etc., which would find a favorable habitat in the increased shade and humus of this forest, would then invade the coniferous forest as underbrush, so that, as the pines died off, they would be replaced by the forms of the present forest.

The fauna of this slope would have a history similar in many respects to that of the flora. If the slope was first invaded by the heath plants, it was probably at the same time invaded by the fauna that is associated with this society; a relation which would also hold in the case of the succeeding societies.

The conditions to which the forms in the different societies are adapted, or the habitats, would thus tend to migrate up the slope from the point of invasion, and the mountain top would be the scene of the extinction of the pioneer societies, the last place where they would be found. Since the mountains were islands for some time after the retreat of the ice sheet, the level at which this invasion of life took place presents an interesting question. Evidently it must either have taken place above one of the old beach lines while the mountains were yet islands, or after they had been joined to the main land by the subsidence of the lake. In the latter case, the invasion would have come in near the base of the mountains, as they are entirely surrounded by a low plain, but in either case the succession of societies would have been much the same, with the exception that in the former

case the migration of the societies would also have taken place down the slope, following the receding lake beach.

Station II. Substations 3 and 4. These substations are located in an artificial clearing and will not be discussed. The species that occur here will be found in the annotated lists.

Station II. Substation 5; and Station III. The north slope of the first range rises directly to the top of the ridge at an elevation of about 900 feet. Over the crest there is a sharp descent of several rods to the brink of the precipitous escarpment that overlooks the valley of Carp river, Fig. 10.

The effect of the dynamics of the mountain top are very conspicuous. The exposed rock is unprotected from the forces which cause disintegration, for as fast as it is broken up the particles are washed away, and thus the first soil to accumulate is in the exposed edges of joint planes. The soil washed down the north slope on Section 21, Fig. 11, is checked and held in front of the forest, which advances as the soil becomes sufficient to support it. On Sections 13 and 14, Fig. 10, the forest has advanced to the crest so that no soil from the bald areas is washed down the north slope. The soil formed on the south side of these areas, meeting with no obstruction, is washed over the precipice and accumulates in a narrow strip along the top of the talus slope, while that which is washed laterally from the top into depressions in the crest is also checked to a certain extent by the encroaching forest. The concentration of water in these inequalities causes them to be deepened into ravines, situated at right angles to the crest, and much of the material derived in this way is carried over the cliff and deposited as alluvial cones on the talus slopes below; these alluvial cones join the ravines above forming broad saddles across the ridge, Fig. 10. The face of the cliff is also exposed to weathering agencies that tend to pry loose portions of the rock between the joint planes. The larger fragments fall to the bottom of the cliff and go bounding down the talus slope, often starting minature landslides of the talus material. The slope thus lies at the angle of repose of the material and is very unstable, Fig. 17. As a rule, the larger the fragment the farther down the slope it will go before coming to rest, and the strip of fine material at the top of the slope, which was formed partly from the soil washed over the cliff from the bald areas above, receives constant additions from the fine material that is loosened from the cliff face. Toward the bottom of the slope, the conditions become more stable, and the talus blocks are being disintegrated and decomposed into a residual soil. The mountain top, cliff, and talus slope habitats thus offer virgin conditions for plant and animal societies, and it is in localities such as these that the pioneer societies are found.

If the results of the processes at work on this ridge be summarized, it is evident that they are tending to lower the ridge toward a base leveled plain, thus changing the present conditions toward those found on the lower parts of the north slope.

Station II. Substation 5; and Station III. Substations 1 and 4. The biota of the north slope of the first range, pushes through the saddles and down the alluvial cones on the south side and mingles with the biota of the forest in the valley of Carp River, Fig. 10. From the north side and the saddles it extends upward and surrounds on three sides the bare areas of the higher parts of the ridge, but, owing to the changed environmental conditions, it becomes modified in its composition near the crest. The Hemlock and Balsam Fir and finally the Sugar Maple become replaced by a zone of aspen and oak, consisting principally of the Quaking Aspen, Paper Birch, Red and

FIG. 8. Hemlock forest, showing dense shade and lack of undergrowth, station II. 2.

Burr Oaks, associated with the Mountain Maple, Large-toothed Aspen, Mountain Alder (*Alnus alnobetula*), several willows and scattered Red and White Pine. The underbrush and soil cover of this zone is composed of *Polypodium vulgare*, Juneberry, Scarlet Sumac, Bush Honeysuckle, Eastern Ninebark, Great Bilberry, Round Leaved Dogwood, Dwarf Cornel, Narrow-leaved Cow-wheat, Low Snowberry, *Polypodium vulgare*, and *Lycopodium clavatum, complanatum* and *selago*; *Linnaea americana* may also be mentioned.

Higher up the mountain the soil cover becomes replaced by the Bearberry, Dwarf and Low Black Blueberry, New Jersey Tea, and Creeping Wintergreen. The White Pines still persist, but the shrubs mostly disappear, and the oaks and aspens associated with *Juniperus nana* become very scrubby, often forming small mats on the slight soil, Fig. 12.

As in case of the vegetation, the range of many of the animals of the mesophytic forest reaches an upward limit in the aspen zone, where they occur mingled with other forms that replace them on the bald areas. Thus the molluscs become noticeably fewer in individuals in this zone; *Zonitoides exigua, Cochlicopa lubrica, Vitrea ferrea, Euconulus fulvus, Helicodiscus lineatus and Carychium exile* seem to drop out of the fauna entirely, while *Punctum pygmaeum, Sphyradium edentulum, Zonitoides milium* and *arborea*, and *Strobilops virgo*, by changing their habitats from the damp fallen leaves of the mesophytic forest to the dry soil held by the heaths, are able to persist. Mingled with these forms was found for the first time *Bifidaria curvidens*. Similarly the only grasshopper that occurs in the mesophytic forest (*Tettix*) is replaced in the aspen zone by *Melanoplus luridus, fermoratus* and *islandicus, Chloealtis abdominalis* and *conspersa*, and *Camnula pellucida*, while the Northeastern Chipmunk, Northern Plains Skunk, Woodchuck, and the woodpeckers, owls, chickadees, nuthatches, etc. are mostly replaced by the Lake Superior Chipmunk, Junco, Robin, and Bluebird. The smaller mammals such as the mice, moles and shrews seem to persist without noticeable diminution in abundance.

Station III. Substations 2, 5 and 6. On the mountain top beyond the limit of the aspens and oaks, the biota is composed almost exclusively of the forms that appear in the upper part of the aspen zone. The heaths, represented by the Bearberry and Creeping Wintergreen, with the Dwarf and Low Black Blueberry and New Jersey Tea, form a large dense mat beyond the aspen zone, that extends in long tongues along the crevices on the bare top, Fig. 11. On the denser portions of this mat occur widely scattered White and Red Pines with many dead stumps, Fig. 13.

On the bare mountain top, the flora consists only of the lichens, *Lecidea lactea, Lecanora conspersa* and *cinera, Parmelia conspersa*, and *Stereocaulon coralloides*, on the surface of the rock, and a crevice vegetation of Harebell, Three-toothed Cinquefoil, Wild Wormwood, Evening Primrose, *Panicum xanthophysum, Polypodium vulgare, Polystichium lonchitus, Asplenium trichomanes*, and *Solidago bicolor, lanceolata, juncea* and *erecta*.

The molluscs, *Punctum pygmaeum, Euconulus chersinus polygyratus, Zonitoides milium, Strobilops virgo, Vitrea indentata* and *Bifidaria curvidens*, that characterize the upper part of the aspen zone, also occur in the larger heath mats, associated with *Acanthinula harpa. Bifidaria curvidens* greatly predominates in this fauna. Dead specimens of *Helicodiscus lineatus* and *Succinea avara* are often found in the rock crevices near the brink of the cliff, but these were probably blown here as they could hardly exist in this habitat, being moisture loving forms. The characteristic insects of this station are the dragonfly, *Sympetrum obtrusum*, the butterflies, *Argynnis cybele*,

Thecla edwardsii, and the grasshoppers, *Chloealtis abdominalis* and *conspersa*, *Melanoplus fasciatus*, *amplectens* and *islandicus*, *Circotettix verruculatus*, and *Atlanticus pachymerus*.

The Cliff. Owing to the precipitous nature of the cliff, the rock fragments are removed as fast as they are split off the parent rock, and the environmental conditions of the cliff face remain uniformly severe. The only vegetation that can exist consists of the lichens, *Gyrophora* (*Umbilicaria*) *vellea*, *Amphiloma* (*Pannaria*) *languinosum*, and *Biatora lucida*, that manage to obtain a foothold on the face of the rock, but these are invariably destroyed as the rock weathers away. On the ledges, however, where the conditions are more permanent, a number of plant forms may gain a foothold, the extent of the vegetation depending upon the age and size of the ledge. On the fresher ledges the only plants are the lichens, among the representative forms of which may be mentioned *Stereocaulon coralloides*, *Parmelia conspersa* and *Lecidea lactea*. Where a slight soil has accumulated, the Harebell, *Panicum xanthophysum*, *Polystichium lonchitus*, Three-toothed Cinquefoil, and Goldenrods may occur. While on the larger ledges, which often possess several inches of soil, the Bearberry, New Jersey Tea and other forms of the heath society, together with the Juneberry, White and Red Pine, *Juniperus nana*, Arbor Vitae and Northern Poison Oak may obtain a foothold, Fig. 14.

The fauna of the cliff face is also very limited. The ledges are too small to support a characteristic fauna, but ants grasshoppers and dragon-flies are often found here. The butterfly, *Grapta gracilis*, was occasionally seen in considerable numbers on the cliff face, but the only animal that can be said to be characteristic of this habitat is the Raven which nested here.

Station III. Substation 3. Where the cliff is broken by large ledges, Fig. 15, the conditions are more stable, and the vegetation consists principally of a growth of Red and White Pine and an undergrowth of Reindeer Lichens and heath plants, that extends up the cliff and across the mountain top. Where these belts of pine join the mesophytic forests of the north slope and river valley, the undergrowth is predominated by the Sugar and Mountain Maples and Quaking Aspen. The fauna of these belts is peculiar. Although the Pine Warbler and Crossbills are often seen here, the belt is too small to support an extensive pine forest fauna, while at the same time it is, perhaps, the deposit of pine needles that excludes the molluscs of the mountain top and mesophytic forest.

Talus Slope. Where the precipice is not broken by large ledges, the fragments of rock that weather from its face fall to the talus slope below. The finer material collects along the top of the slope, at the foot of the cliff, and supports a vegetation composed of a number of species, Fig. 10. Among the more prominent of these are the Thorn Apple, Red Oak, Quaking Aspen, Wild Red Cherry, Round-leaved Dogwood, Juneberry, Bearberry, New Jersey Tea and scattered White and Red Pine. Below this zone the talus slope is strewn with dead wood and recently fallen trees, mostly pines, Fig. 16. Where the cliff is composed of trap, Substation 6, the blocks which fall from its face are large, and the talus slope is practically devoid of vegetation with the exception of scattered patches of lichens, principally *Parmelia conspersa*, Fig. 17. Where the cliff is composed of sandstone, the talus material is finer and often supports a scattered vegetation of White and Red Pine, Paper Birch, Wild Cherry, Northern Poison Oak, and Virginia Creeper. Toward the bottom of the slope, the first vegetation that occurs are the lichens, principally *Lecidea lactea* and *Parmelia conspersa*, the latter

predominating. These forms cover more or less completely the surface of the talus fragments. Farther down *Stereocaulon coralloides* and *Lecanora conspersa* are added to this society which is dominated on the lower part of the slopes by the Reindeer lichens, *Cladonia rangiferina* and *alpestris*, that often occur superimposed on the remains of the other lichens. These are replaced toward the bottom of the slope by the Bearberry, New Jersey Tea, *Polypodium vulgare*, Raspberry, Wild Red Cherry, Mountain Maple, Paper Birch, Quaking and Large-toothed Aspens, Beaked Hazelnut, Blackberry, Brake, and Bush Honeysuckle, that in turn give way to the typical mesophytic forest forms of the river bottom.

The environmental conditions as regards the fauna are more unfavorable than on the mountain top. The only forms that are found here are a few ants in the narrow zone of vegetation at the top, and occasional grasshoppers and dragon-flies on the bare slope below. Near the bottom of the slope the Lake Superior Chipmunk was often seen running about over the rocks and among the bushes that fringe the forest. Forms from the mesophytic forest of the river valley such as the Garter Snake and Northeastern Chipmunk are also occasionally seen here.

When the biota of the mountain top and north slope are listed by habitats, the genetic explanation suggested for the forest of the north slope is enforced. It is evident that certain groups of forms are, in a general way, dependent on certain environmental conditions. The action of the forces which bring about these conditions tend to modify those that exist at any one time, so that the biota must adjust itself to the new conditions or be exterminated. This is especially noticeable on an elevated area. It was shown in the discussion of the topography that the effect of physiographic processes on the ridge in question was to reduce it to a base-leveled plain. The environmental conditions are thus being changed and modified in the direction of the conditions that prevail on the lowland at the foot of the mountain. These conditions are brought about first on the lower parts of the ridge, so that the habitats of the lowland biota are extended at the expense of cliff habitats, and correlated with the changing conditions a succession of societies occurs. This may be easily seen from the top of the ridge, Fig. 11. The first plants to get a foothold on the bare rocks are those of the lichen society, such as *Lecidea lactea* and *Parmelia conspersa*, that form large patches over the exposed rock surfaces. The wash and decay from these mats is at first mostly washed away down the slopes. As soon, however, as the processes of weathering have opened the edges of the joint planes, the soil accumulates in them and with it a small amount of organic material from the lichen mats. The conditions thus become favorable for a crevice vegetation consisting of certain mosses, the Harebell, Cinquefoils, Goldenrods and grasses. As the soil, held in the crevices by the plant roots, increases in amount, the conditions become still more favorable, and the crevices are invaded by the heaths from the extensive mat that surrounds the mountain top on three sides, in front of the mesophytic forest. The dense mats formed by the heaths do much to make the edaphic conditions more favorable by holding the soil as it is formed, checking that which is washed from higher areas, and by accumulating the humus formed by the decay of the vegetation.

The first society to gain a foothold on the lichen mat is represented by the White and Red Pines, and the next by the forms of the aspen zone. In many instances, the Quaking Aspen, which is one of the hardiest plants of this zone, follows the heaths along the crevices before the pines can obtain a foothold, but in any case the pine stage is but poorly represented, probably owing

largely to the exposure of this habitat to wind, Fig. 12. The aspen zone is in turn succeeded by the biota of the mesophytic forest type. This succession prevails on the north, east and west sides of the crest. On the south side, owing to the presence of the precipice, the soil accumulates only to a slight extent and the succession only progresses as far as the heath or pine stage. The biota of the cliff and upper part of the talus slopes are not in the succession, for owing to the fact that the material is removed nearly as fast as it is formed, the conditions remain practically the same, and the forms only gain a temporary foothold. It is true that on the ledges there is a more or less definite succession of societies leading up to the pine stage, but it rarely proceeds beyond this stage, while it is liable to be destroyed before this stage as is shown by the debris that accumulates on the talus below. The biota of these habitats is evidently derived from the mountain top. A large percentage of the seeds of the vegetation on the south side of the crest is washed over the cliff with the soil. Many of the ants and snails of this area probably have a similar fate, while it is a common sight to see grasshoppers on the mountain top caught by the wind, when on the wing, and carried over the precipice to light on the talus slope below. The biota of the narrow strip of finer material at the top of the talus slope, owing to the more favorable soil conditions and the shade furnished by the cliff, is composed of forms that occur in the pioneer societies both on rock and soil habitats, and it is thus a complex pioneer society. The strip of finer material is only formed at the foot of the cliff and migrates with it, leaving its lower edge to be covered by the larger talus blocks as the cliff retreats. The biota thus becomes practically destroyed, and the conditions change toward those of the talus slope. At the foot of the talus slope the conditions are nearly the same as on the mountain top. The pioneer forms are the lichens that cover the rocks and hold the material as the rocks disintegrates. The soil that is formed accumulates rapidly among the talus blocks and becomes in time sufficient to support the reindeer lichen society. As the soil continues to increase, the forms of the heath society push onto this mat, followed in turn by the climax forest society, the pioneer forms of which generally extend well up the slopes. The most prominent form among the pioneers of the climax forest on the talus slopes is the Paper Birch, broken and twisted individuals of which are often found well within the range of falling rock fragments. As Harvey ('03, p. 37) has suggested for Mt. Ktaadn, it seems to be adapted to this habitat by its flexibility.

There is thus a series of lowland societies steadily encroaching on the cliff habitats from all sides, as the physical processes reduce the ridge toward sea level. The order of succeeding societies is generally the same in a particular region. Cowles ('01) and Whitford ('01) both give the pine stage as generally following the heath society in northern Michigan, but on the cliff habitats in the Porcupine Mountains, owing to the effect of the wind and the shallow soil, the coniferous society may be nearly, if not entirely, left out of the succession. In this case, an entire stage in the order of succession is made impossible by a particular combination of the environmental conditions, and the fact is enforced that habitats are composed of a complex of physical conditions. This is further shown by the dwarfed nature of the aspens and oaks that border the "bald" areas. These trees often grow as shrubby mats, owing to the breaking off of their tops by the wind. This is undoubtedly due indirectly to the presence of the escarpment, for on higher ranges to the south, which possess no escarpment, the mesophytic forest covers the highest peaks with no noticeable decrease in the size of the trees.

FIG. 9 Deciduous forest, showing character of undergrowth, station II. 2.

The fate of the pines on the exposed top of this ridge, the scrubby nature of the aspens and oaks, and the fact that the tops of a large percentage of the living pines are dead, suggests that the timber lines on some mountains may be greatly influenced by wind.

Station IV. Substation 3. Beyond the limit of the falling rock fragments on the talus slope, where the rocks have been disintegrated and decomposed to form a soil, the Paper Birch, Mountain Maple, Aspen and Mountain Ash become mixed with the Sugar Maple, Balsam Fir and Basswood, that gradually predominate to the exclusion of the Aspen and Mountain Ash. In the forest near the bottom of the slope, Hemlock forms a part of the tree cover and occasionally predominates to such an extent that a hemlock forest results similar in composition to the hemlock forest at the foot of the north slope. More often, however, the Sugar Maple predominates in this forest, associated with the Balsam Fir, Basswood and Ironwood, with scattered Hemlocks, and White Pines, thus making it similar in composition to the mesophytic forest of the north slope with which it is connected through the saddles. The ground cover and fauna are also practically the same and need not be listed.

Station IV. Substation 2. Owing to the flat nature of its valley, Carp river above Carp Lake is a slow meandering stream that is doing practically no vertical cutting, Fig. 18. It is easily turned from side to side, and, as it is deflected toward one side of its valley, it tends to cut into it, while on the other side of the bend, owing to the decrease in the velocity of the current, part of the load is deposited to form mud flats. The river thus tends to broaden its valley at the expense of the neighboring divides and to build up its flood-plain with a part of the material derived in this way. The material that is not deposited on the mud flats is carried on until the stream reaches Carp Lake, where again, owing to its diminished velocity, the stream deposits much of its load in the lake, forming a large delta at the mouth of the river. On the flood-plain of the river, Fig. 18, the deciduous forest either gives way to a coniferous society characterized by the Tamarack, Spruce, Arbor Vitae and Black and White Ash, which in turn grades toward the river into an extensive alder thicket, or, where the valley is narrow, the coniferous society may be nearly or entirely absent, and the hardwood forest grade directly into the shrub society. The shrub society is largely composed of the Hoary Alder (*Alnus incana*) associated with several willows, occasional Tamaracks, and scattered clumps of Red-osier Dogwood. The undergrowth in these thickets is not extensive; among the more noticeable forms are the Skunk Cabbage, Sensitive and Cinnamon Ferns, Skull Cap, and several species of violets.

The fauna is characterized by a great increase in the number of birds; the warblers and sparrows are especially conspicuous. This is also the habitat of the Red Backed Salamander (*Plethodon cinereus*) and the Wood Frog (*Rana sylvatica cantabrigensis*). For some undetermined reason, the molluscs seem to be very poorly represented in this society.

Between the alder thickets and the river, in the broader portions of the valley, there is often a well defined zone of vegetation characterized principally by the Dwarf Cassandra. Between the two societies the Hoary Alder and Dwarf Cassandra occur mingled with the Wax Myrtle, High Bush Blackberry, American Meadow Sweet, and Few Flowering Cranberry. Toward the river, the Hoary Alder, Willows, Red-osier Dogwood and Tamarack occur only in scattered clumps among the Cassandra that forms a low dense thicket. Less prominent but conspicuous forms in this society are the Pale

St. Johns Wort, Joe Pye Weed, Swamp Milk Weed, Running Swamp Blackberry, Marsh Cinquefoil, Ladies Tresses, Marsh Bell Flower, Creeping Snowberry, *Solidago uliginosa*, and a number of grasses and sedges among which are *Eriophorum cyperinum, Calamagrostis canadensis, Deschampsia flexusa, Panicularia canadensis, Scirpus cyperinus, Carex viridula, riparia,* and *filiformis.* Owing to the low height of these forms, the habitat is open, and the fauna is similar in many ways to the fauna of the mountain top, but, owing to its proximity to the river, several new forms are added. The more characteristic forms are the butterflies, *Argynnis cybele var.* (near *leto*), *Argynnis atlantis* and *Basilarchia arthemis;* the dragon flies, *Gomphus spicatus, Lestes unguiculatus, Calopteryx aequabilis* and *Sympetrum obtrusum,* and the grasshoppers, *Atlanticus pachymerus, Stenobothrus curtipennis, Podisma glacialis, Melanoplus islandicus* and *Scudderia pistillata.* It might be expected that this habitat would be favorable for reptiles and amphibians, but while it is the habitat of the Garter Snake, *Thamnophis sirtalis sirtalis,* the dense entangled nature of the vegetation apparently excludes the frogs.

The cassandra zone extends only to the river bank, where it generally mingles with a narrow zone of alders on the low natural levees, but a number of grasses and sedges, *Juncus effusus, Calamagrostis canadensis, Scirpus cyperinus, Dulichium arundinaceum, Carex filiformis, viridula* and *riparia,* push out on the mud flats to the edge of the water, Fig. 19, and form a transition society between the cassandra zone and the aquatic forms of the river.

The fauna of these flats is also transitional between the aquatic and terrestrial habitats. This is illustrated by the presence of the turtle, *Chrysemys marginata,* and the frogs, *Rana clamitans* and *septentrionalis,* which are amphibious and thus intermediate in habits between the two habitats. The birds are the waders and shore birds that find their food here; among these may be mentioned the sandpipers, snipes, herons, and bitterns. Although by no means limited to this habitat, and to be more properly listed with the fauna of the mesophytic forest, the Canadian Porcupine is a conspicuous form on these flats where it may often be seen, singly or in groups of two or three, feeding on the pads of the water lilies.

Owing to the steepness of the sides of the valley, the entire succession of societies is only found in the broader parts, for where the river swings toward the side of the valley the flood-plain is destroyed, and the cassandra, alder and coniferous societies are all limited to a single narrow zone between the river and the deciduous forest.

If the different flood-plain societies be compared with the succession of forms in a tamarack swamp as given by Transeau ('03, pp. 403-404), a remarkable similarity will be revealed. The societies that occur in the bogs of more southern localities are here spread out over the entire flood-plain of the river, and the tamarack swamps of Indiana, Illinois and southern Michigan are minature reproductions of the flood-plain conditions in this region.

Station IV. Substation 4. There are, however, areas where more typical bog conditions prevail, so that in the wider parts of the valley the bog types may attain a much better development. In these areas, the bog societies are not arranged in concentric zones, as in the southern bogs, but are, as the flood-plain societies, more or less parallel to the river. The succession is much the same as on the flood-plain and in the southern bogs. The sedge zone grades into a zone composed largely of Dwarf Cassandra associated with the Rose, Juneberry, High Bush Blackberry, Wax Myrtle, American Meadow Sweet, Swamp Honeysuckle, and Cranberry, that is in turn followed by a society composed largely of Balsam Fir, Tamarack and White Spruce,

FIG. 10. Escarpment of the First Range, looking west, showing the cliff and talus slope, station III. 5, and Carp Lake, station V, in the distance.

the under growth of which consists principally of Dwarf Cornel, Creeping Snowberry, Labrador Tea, Pitcher Plant and Gold Thread on a thick carpet of Sphagnum and other mosses.

The fauna of these bogs is not characteristic. The mammals are represented by Hoy's Shrew, Southeastern Red Squirrel and Red-backed Mouse, and the molluscs by *Zonitoides arborea, Zonitoides exigua, Pyramidula striatella catskillensis, Pyramidula asteriscus, Helicodiscus lineatus, Strobilops virgo, Punctum pygmaeum, Vitrea ferrea, Sphyradium edentulum,* and *Pallifera hemphilli.* all forms that are abundant in the deciduous forest.

That certain forms, for example the Pitcher Plant and Sphagnum, that characterize the southern tamarack swamps are also restricted to the same habitat in this region, and the fact that the climax flood-plain society is evidently of the deciduous forest type, suggests that the cassandra and coniferous societies will be ultimately replaced in the flood-plain succession. But, on the other hand, the wide distribution in this region of many of the forms that are largely confined to bogs further south, such as the Balsam Fir, Dwarf Cornel and Red-backed Mouse, Starnosed Mole, and Southern Varying Hare, indicate that the conditions which permit the boreal forms to hold certain swamps to the south are here more wide spread; while the similarity between the bog and flood-plain societies indicates, as might be expected, that the more nearly related habitats are the most noticeably and probably the first to be modified by the change of conditions.

Station IV. Substation 1. The amphibious forms of the mud flats grade into the aquatic forms of the river by such marginal forms as *Dulichium arundinaceum* and *Sagittaria.* The slow current of the river is an important factor in determining the nature of this habitat, as it results in conditions similar to those that prevail in ponds, thus permitting a biota adapted to pond conditions to gain a foothold. The vegetation, although poorly represented, is decidedly of the quiet water type, being composed principally of the Yellow Pond Lily, and *Myriophyllum,* and to a small extent of the Sweet Scented White Water Lily, and *Potamogeton natans,* Fig. 19.

The fauna also shows the effect of the slow current, but, owing to lack of data on the habitats of the different forms, it is impossible to determine definitely to what extent it is modified by the changing conditions. It is, however, evident in a general way, for the forms that occur here are all forms that occur in ponds as well as streams, while the characteristic river forms that occur in the streams after they leave the mountains are apparently not represented. For example, the molluscs found here, *Amnicola limosa, Ancylus parallelus, Valvata tricarinata, Physa sp.* and *Planorbis exacuous, hirsutus* and *campanulatus,* were all found on the vegetation and are forms that, according to Baker, inhabit ponds and streams with aquatic vegetation and mud bottom, but *Limnaea decollata,* that occurs on the bare rocky bottom in the swift waters of the lower parts of the river, is apparently absent. The fish are represented by the Fine Scaled Sucker, Horned Dace, Spawn Eater, Trout Perch, Yellow Perch, and *Nototropis cayuga.* The Horned Dace is, according to Forbes, almost entirely confined to brooks and small streams. It is very abundant in Carp river, especially in the head waters, and may thus be taken to represent the stream conditions that still prevail, but in the quiet waters near the lake, there are associated with it the deeper, quiet water, bottom feeders, the Yellow Perch and Sucker, while the characteristic stream forms such as the Brook Trout and Grayling were not found. Certain other forms are so closely associated with this habitat that they must be listed here; the more conspicuous of these are the dragon flies,

Calopteryx aequabilis, *Aeschna clepsydra* and *Plathemis lydia*, and the Kingfisher, Muskrat, etc.

Station V. Substation 3. The biota of Carp Lake indicates that the environmental conditions are very similar to those that exist in the river above it but are even more pond-like. The fish are the same with the exception of the Horned Dace, which was not found here. The Sucker and Yellow Perch seem to predominate. Toward the shore the bottom becomes covered with vegetation, chiefly *Myriophyllum*, among the leaves of which, especially in the axils, occur the snails, *Amnicola limosa* and *Valvata tricarinata*. This society soon becomes mixed with *Potamogeton natans* that forms a large well defined zone. On the inner margin of this zone, the Tape Grass, *Vallisneria spiralis*, often occurs in extensive mats but does not form a definite zone. The next zone of importance is composed largely of the Yellow Pond Lily that is replaced near shore by the Canada Rush, *Juncus canadensis*, that becomes largely mixed in shallow water with the Scouring Rush, *Equisetum fluviatile*.

Station V. Substation 1. Where this marginal rush zone extends to the shore, the bivalves, *Sphaerium simile*, *Anodonta marginata*, and *Pisidium sp.*, and the univalves, *Planorbis bicarinatus*, *campanulatus* and *deflectus* are found in the silt and on the small stones.

On the fine sand of the narrow beach, *Equisetum hyemale* associated with the Horned Bladderwort (*Utricularia cornuta*), Nodding Ladies Tresses, and Seven Angled Pipewort forms a scattered vegetation behind which comes an alder thicket which is followed in turn by the mesophytic forest types.

Station V. Substation 2. The delta that is being formed by the river at the east end of the lake is similar in many ways to the mud flats along the river and presents similar but more extensive environmental conditions. On the submerged part of the delta, *Juncus canadensis* is mostly absent from the rush society which is extensive and composed principally of *Equisetum fluviatile* associated on the inner margin with *E. hyemale* and *littorale*. These forms are replaced on the area that is ordinarily unsubmerged, by *Dulichium arundinaceum*, *Carex filiformis*, *riparia* and *viridula*, associated on the dryer areas with *Calamagrostis canadensis*, *Scirpus cyperinus*, *Agrostis hyemalis*, *Eupatorium purpureum*, *Deschampsia flexusa*, *Panicularia canadensis*, *Solidago uliginosa*, Swamp Milkweed, Nodding Ladies Tresses, Pale St. Johnswort and Marsh Cinquefoil.

The fauna also shows the similarity between the conditions of this habitat and the mud flats. The dragon flies found here are *Enallagma hageni*, *Nehalennia irene*, *Enallagma carunculatum*, *Ischnura verticalis*, *Hagenius brevistylus*, *Gomphus spicatus*, *Aeschna clepsydra* and *Plathemis lydia* Of these *Enallagma hageni* is the characteristic form and occurs in considerable numbers. The birds, as on the mud flats, are the waders and shore forms such as the Carolina Rail, Great Blue Heron, American Bittern, Solitary Sandpiper and Wilson's Snipe. The nature of the habitat is also shown by the presence of most of the amphibian species of the region. The frogs are represented by *Rana pipiens brachycephala*, *clamitans*, and *septentrionalis*. No turtles were observed, but the Garter Snake, *T. sirtalis sirtalis* was taken several times.

The grass and sedge society passes directly into an alder society without an intervening cassandra zone, and the forms of the alder society are in turn followed by the forms of the deciduous forest.

It was shown in the discussion of the topography that the tendency of an

Fig 11. "Bald" on the top of the First Range, station III. 6, showing the bare rock, heath plants in crevices, scattered pines and stunted aspens that characterize this habitat.

Fig 12. The zone of stunted aspens, station II. 5, surrounding the "bald." The pine stumps show the effect of the wind.

agraded stream is to cut into the sides of its valley, and to build up a plain at its own level by the deposition in its channel of the material derived in this way. It was also pointed out that areas representing different stages in this process are characterized by different biota. Since the process is still going on it is necessary to consider the biota in reference to the changing conditions. The nature of the changes which Carp river produces on the topography is determined by its low gradient and slow current. As it meanders over its flood-plain, the mud flats that are formed on the inner side of the bends are extended into the stream by the deposition of material on their inner margin. The quiet water and favorable substratum on the submerged parts of these flats afford a favorable habitat for the pond or quiet water forms of life. As the deposition of the streams during floods builds these flats above the ordinary level of the river, the conditions become unfavorable for the aquatic forms, which are compelled to migrate outward; at the same time, however, they become favorable for the amphibious forms of the grass and sedge zone that gradually push out and occupy the flat as it becomes dry enough. The continued deposition during floods, and the accumulation of plant remains continue to raise the level of the mud flats, and, as the conditions become dryer, they support successively the cassandra, alder and the deciduous forest types of life. Where the river cuts into the sides of the valley, the flood-plain is destroyed, and its societies are limited to a single narrow zone between the deciduous forest and the river; in this zone, the littoral, cassandra and coniferous societies may be entirely lacking, but the alder society is nearly always represented.

Carp Lake may be considered as the river expanded and covering its flood-plain to the sides of the valley, and the changes that are going on are very similar to those that are being produced by the river. The conditions however, are more pond-like for the current that the river possessed above the lake is lost, so that there is no lateral corrasion. Deposition is going on all about the margin, owing to wash from the sides of the valley and the deposits made at the mouth of the river, so that the aquatic conditions are being changed into the terrestrial in a manner analagous to the development of a mud flat into a flood-plain, and the successive zones referred to in the discussion of the biota are steadily encroaching on the lake.

Different stages in the destruction of the lake may be observed nearly every where about its shores, but, owing to the dominance of different factors, the encroaching societies are not always equally developed. The extreme of this is shown on the north shore where, owing to the proximity of the cliff, the talus slope dips into the lake, the fresh talus fragments fall nearly to the water and very little soil has accumulated. There is, therefore, no shelving beach at this point, the aquatic and mud flat societies are absent while the alder zone is represented only by a few forms, the Hoary Alder more conspicuously, and is largely mixed with the Mountain Ash, White and Red Pine and Wild Cherry of the talus slope. At the east end of the lake the grass and sedge zone constitutes the principal society, for, owing to the large amount of material carried by the river, the delta is built up to the level of the lake much faster than it can be raised above it by the accumulation of plant remains and flood deposits, while at the same time owing to the shelving nature of its outer margin, the aquatic zone is also extensively developed. At the west end of the lake, however, the margin is shallow, deposition is slow, and the aquatic societies are the most prominently developed.

But, notwithstanding differences in the rapidity of the process, the lake

is undoubtedly being filled up, and the present environmental and biotic conditions are being changed toward those of the river flood-plain.

Station IV. South of Carp Lake the country is covered by the biota of the deciduous forest type which is essentially the same as on the north slope. The small spring brooks which drain the region, however, bring in a different set of conditions, and may be considered as representative of the headwater conditions of the larger streams. The two studied on Sections 23 and 28, T. 51 N., R. 43 W., are shallow, cold, swift flowing streams from 6 to 15 feet wide with a bottom composed of gravel and stones. The biota is limited in variety probably owing principally to the coldness of the water. There is practically no aquatic vegetation, and the fauna consists chiefly of the snail, *Planorbis parvus*, caddis—and stone-fly larvae, and the frogs, *Rana septentrionalis, clamitans,* and *R. sylvatica cantabrigensis.* On the banks of these streams, however, the conditions are much more favorable. The deciduous trees usually overtop them entirely, so that the humus conditions along the margin are essentially the same as in the forest with the exception of a considerable increase in the moisture content. The flora that lines the creek is composed of such forms as *Caltha palustris, Equisetum sylvaticum, Cinna latifolia, Onoclea sensibilis, Scirpus cyperinus, Osmunda claytoniana,* Skunk Cabbage, *Carex crinita* and *pubescens,* and large mats of *Conecephalus conicus* and *Endocarpon miniatum.* Behind this narrow zone occur occasional clumps of alders (*Alnus incana*), and Mountain Maple.

The molluscan fauna of the creek bank is characterized principally by an increase in the abundance of the forest forms, while among very wet leaves *Physa sayii* is occasionally found.

It will be noticed that the biota of the creek bank is composed of members of the alder, sedge and forest societies of the river valley, but that the forms of the cassandra and coniferous societies are apparently lacking.

Station VII. Practically the same conditions prevail in Little Carp Lake as in Carp Lake, although its smaller size probably affects the biota to some extent. The deciduous forest forms extend down the sides of the bordering hills nearly to the waters edge. Between the forest and the water there is a narrow zone of vegetation the most conspicuous form of which is the Hoary Alder (*Alnus incana*) which is associated with the Few Flowering Cranberry, etc. The rush society in the margin of the water and on the delta (which is mostly submerged) is composed principally of *Equisetum* (*fluviatile* where examined) but for a short distance along the south shore the Canada Rush becomes prominent. As a rule, the aquatic societies are not extensive, the vegetation of the rush societies is scattered even on the delta, while the pond lily zone is only occasionally present.

The bivalve, *Anodonta marginata,* is quite commonly found about the margin of the lake, especially on the delta. The most characteristic fish, at this time of the year, are the Sucker and Horned Dace, the latter being very abundant.

Station VII. Substation 2. Above the lake, Little Carp river is a small meandering stream about 15 feet wide and 2 feet deep. It enters the lake through a narrow valley about one-fourth of a mile long which is crossed at the east end by several beaver dams. Above these dams, the valley widens out into an amphitheater about a mile long by one-fourth mile wide. In the narrow part of the valley near the lake, the space between the river and the foot of the adjacent ridges is occupied by a dense thicket of Hoary Alder, (*Alnus incana*). As the valley widens out above the dams, this alder zone, composed now of the Hoary Alder, *Betula glandulosa,* and several willows, is

separated from the mesophytic forests of the slopes by a coniferous society of Tamarack, White Spruce, White and Black Ash, and follows closely the foot of the ridge. The floor of the valley is occupied by a broad beaver meadow, covered with a luxuriant growth of grasses, sedges and other herbaceous forms, Fig. 20.

Among the conspicuous forms in this meadow may be mentioned *Carex monile, filiformis* and *viridula, Juncus effusus* and *tenuis, Agrostis hyemale, Calamagrostis canadensis, Scirpus cyperinus, Deschampsia flexusa, Panicularia canadensis, Solidago neglecta* and *erecta,* and the Marsh Bellflower, Joe Pye Weed, Swamp Milkweed and Nodding Ladies Tresses. The fauna is composed chiefly of the butterflies, *Basilarchia arthemis, Vanessa antiopa* and *Argynnis cybele;* the dragon-flies, *Sympetrum obtrusum* and *Aeschna clepsydra;* the grasshopper, *Camnula pellucida;* and the amphibians, *Hyla pickeringii* and *Rana clamitans.* This is also the habitat of the Song and Swamp Sparrows, and there was abundant evidence that it was a favorite feeding ground for deer.

Station VII. Substation 3. The dams at the west end of the beaver meadow are not now in repair, so that they influence but little the nature of the river, except as small pools, four or five feet deep, are formed behind them, where the current is deflected to one side. In these pools the characteristic fish is *Couesius plumbeus,* although the Sucker is sometimes found. The fauna of the river, in harmony with the conditions, is composed mostly of brook and creek forms, such as the Shiner, *Nototropis cornutus,* and the Dwarf Stickle Back, *Eucalia inconstans pygmaea.* There is very little aquatic vegetation.

The mud flats along the river are small and practically devoid of vegetation with the exception of scattered grasses, such as *Dulichium arundinaceum* and *Calamagrostis canadensis,* on the dryer portions. The birds that were observed here were the Solitary and Least Sandpipers and the Yellow-legs. On the submerged edges of these flats, the characteristic form is the mollusc *Sphaerium simile* with which is occasionally associated *Anodonta marginata.*

The meadow is the result of an extension of the conditions that normally prevail on the wetter parts of the flood-plain, and with this extension of the habitat there is associated an increase of the grass and sedge zones. When the dams, which are largely formed of Hoary Alder, were constructed, the flood-plain in the broad part of the valley was flooded, and this ponding of the stream resulted in the killing off of the dryer flood-plain flora. It is not probable that the pond covered the entire valley, but the low adjacent ground between the pond and the sides of the valley would be saturated and subjected to floods, making the conditions favorable for the grasses and sedges and an associated fauna, so that a small meadow analagous to the present one probably existed about its margin.

No evidence of the extent of the pond now remains, for with the trapping off of the Beaver the dams were no longer repaired and were broken through by the river. The pond was thus drained and the water resumed its former channel. This resulted in better drainage and a consequently dryer substratum in the meadow, so that the meadow forms were able to follow the water as it retreated, while the conditions are, at the present time, becoming favorable for the higher flood-plain and deciduous forest forms, that are working in about the margin. That the encroachment of the forest forms will ultimately destroy the meadow by narrowing the habitats of the grass and sedge societies, is evident from an examination of the conditions in localities where the Beaver formerly occurred. For instance, there have

been no Beaver on Carp river within the memory of several of the trappers in the region, and yet several of the bends of the river were found to be due to the remains of old dams which were once evidently of considerable size. Now a slight raising of the water level in this valley, such as would be caused by these dams if they were in repair, would cause the plain to be flooded, the trees to be killed off and either a pond or meadow would result according to the height of the dam. It thus seems probable that the present flood-plain societies of Carp river have reoccupied the flood-plain since the Beaver were killed off, which suggests that the history of the meadow on Little Carp river will be similar.

6. SUMMARY.

In order to get at the relation between the physical changes and the biota of the region as a whole, it will be necessary to summarize the present conditions, the biota, the processes that are dominant in the different habitats, and the changes which they are bringing about.

I. Beach. The beach consists of tilted strata of rock that are exposed to the forces of weathering and the action of waves. It may be divided into three parts on the basis of the processes acting upon it. The Lower Beach is exposed to the pounding of the waves, that tend to break up the rock and carry the fragments back in the undertow, building them up in a submarine terrace. The Middle Beach is exposed to the action of waves only during the winter months; during the summer months the forces of weathering predominate and tend to form a soil. This soil tends to be removed during the winter with the exception of a small amount that accumulates in the edges of the joint planes. The Upper Beach is, at present, above the reach of both summer and winter waves and is chiefly exposed to the forces of weathering, which have formed a slight residual soil.

The biota of the beach as a whole is adapted to the conditions that prevail in this habitat, and may be divided into three groups that are closely associated with the physiographic divisions. There is practically no life on the Lower Beach, owing to the pounding of the waves. The life on the Middle Beach consists for the most part of annuals that can obtain a foothold during the summer on the slight soil in the crevices, and a few associated animal forms. The flora of the Upper Beach, in response to the more favorable soil conditions and the absence of wave action, consists of a number of annuals and perennials; while the more favorable food conditions are likewise marked by an increase in the animal forms.

The changes that are taking place are due to the action of waves and weathering. The waves by cutting into the beach cause it to retreat inland, but the submarine terrace built up at the same time tends to cause this retreat to proceed more slowly in its later stages, as the growing terrace carries the breaker line off shore and tends to lessen the effect of the summer and winter waves. This is, in part, counteracted in the Porcupine Mountains by the sinking of the coast line, and the beach as a whole is moving inland. As the force of the waves is diminished, the process of weathering increases in comparative importance, the beach tends to become broken up, and the area of the habitats frequented by the crevice forms increases.

II. 1. Arbor Vitae Swamp. The narrow area back of the beach, at the foot of the north slope is not well drained, and the soil is covered by a thick layer of humus.

The forms adapted to these conditions are plants and animals found in

FIG. 13. The zone of heath plants and scattered pines, station III. 2, surrounding the bald areas, above the aspen zone, on the top of the First Range.

FIG. 14. Face of the cliff and talus slope (looking north from Carp Lake) station III. 5, showing hardwoods in the foreground on the lower part of the talus slope, the bare portion of the talus, and the belt of vegetation (pines, oaks &c.) at the foot of the cliff. The presence of the pines on the cliff show the influence of rock ledges.

swampy areas. If the undrained conditions of these areas are caused by the sinking of the coast, this habitat will tend to become destroyed by the encroachment of the beach conditions. If, on the other hand, this encroachment is relatively slow compared with other changes, the accumulation of the inwash and organic debris will tend to convert such a swamp into a dryer habitat and cause the present biota to be succeeded by a society adapted to the new conditions.

II. 2. North Slope of First Ridge. This slope on account of its relief is well exposed both to the forces of weathering and of denudation and is covered by a layer of soil that becomes thinner near the top of the ridge. Above this soil there is a layer of humus and vegetable mould that tends to conduct the water from the surface, thus greatly diminishing the effects of denudation. (It also furnishes organic constituents to the soil).

These conditions are very favorable for plant life, and the lower part of the slope is covered by a dense forest with which is associated a large number of animals. This biota is composed partly of forms whose principal distribution is in southeastern North America, and partly of those which predominate to the north of the Great Lakes and in the bogs to the south. On the thinner soil near the top of the ridge, those forms of the forest predominate that can live in the more open, poorer soil, and dryer conditions of this habitat.

The processes working on this slope tend to reduce the ridge toward base level and to increase the depth of the soil. The accumulation of humus retards the former process, while the latter proceeds more and more slowly as the soil increases in thickness. Changes are thus taking place very slowly, and the physiographic processes are evidently tending to approach an equilibrium. Near the top of the ridge, owing to thinner layers of soil and humus, the changes are more rapid but in the direction of the conditions that prevail on the lower part of the slope, and the biota adapted to these conditions is pushing up the slope.

III. Mountain Top. On the bare mountain top, the forces of weathering tend to break up the rock into a soil that is washed or blown away nearly as fast as it is formed, except along the joint planes.

The flora consists of rock inhabiting lichens and a number of crevice forms, the fauna of the types frequenting open habitats, such as the grasshoppers, etc.

The soil formed in the crevices is in part held by plant roots, and, since these soil areas are the habitats of the crevice forms of life, as they gradually spread out, the habitats of the rock inhabitating forms are restricted. At the same time, the soil washed down the slope is held at the forest margin, thus permitting the forest societies to encroach on the crevice forms which will thus in time tend to become replaced by the forest forms. This succession of forms is modified by the influence of the strong winds which tend to break down the pioneer trees on the exposed areas.

III. Cliff and Talus Slope. The cliff is constantly exposed to the forces of weathering, for as fast as the rock is broken up it is removed, exposing a fresh surface.

The fauna and flora, owing to the unstable and exposed conditions, are very poor except on the rock ledges, where a slight soil accumulates.

The talus slope at the foot of the cliff is also very unstable and is exposed to the destructive effects of falling rock fragments. Toward the bottom, beyond the limit of falling rocks, the blocks tend to become broken up into a soil.

The biota of the talus slope, on account of the unstable conditions, is also very poor. Toward the bottom of the slope the rocks become covered by a vegetation of lichens, and farther down by a slight soil and the heath and forest societies.

As the cliff is destroyed, the talus slope and the top of the ridge tend to approach. The lower part of the talus slope in time becomes broken up to form a soil, and the deciduous forest types from below tend to spread up the slope thus encroaching on the areas occupied by the cliff and talus slope forms.

IV. Carp River Valley. The sides of the valley of Carp river slope down to a low flood-plain that becomes still lower near the river, grading into mud flats along the stream. The soil is deep and contains a large amount of organic material, and there is a decrease in its moisture content from the mud flats up into the forest.

The aquatic biota is a mixture of pond and river types. The mud flats are inhabited by amphibious forms that are replaced on the dryer parts of the flood-plain by the sedge, cassandra, and alder societies, behind which usually occurs a society of Tamarack, White Spruce and White and Black Ash. On the valley slopes occurs the mesophytic forest type of biota.

The prominent forces at work in these habitats are those of denudation and deposition. The river tends to destroy the adjacent ridges and build up a part of the material derived in this way into mud flats. Deposition during high water builds these flats above the level of the water, and they come in time to form part of the flood-plain. The flood-plain is in turn built up by deposition during floods and by the accumulation of organic remains until the conditions become similar to those in the adjacent forest habitats. The effect of the processes is, therefore, to reduce the country to a level plain thus permitting the encroachment of the forest forms.

V. VII. Carp and Little Carp Lakes. These lakes on account of the similarity of conditions may be considered together. They are, for the most part, shallow throughout. At the east end of each lake, there is a broad delta formed at the mouth of the entering stream.

The aquatic biota is of the quiet water type. At the margin occur the amphibious forms that give way on the dryer ground to the flood-plain and forest forms. The deltas afford conditions similar to those on the mud flats and are occupied by a flora of grasses and sedges, and an associated fauna that is characterized by such forms as the snipes, sandpipers, etc.

The lakes are evidently being filled up, and the conditions are approaching those of the surrounding and encroaching forests.

VII. 2-3. Little Carp River. This is a small meandering stream which evidently at one time was expanded into a pond by the formation of beaver dams across it. As the Beaver were trapped off, the dams were destroyed and the pond became drained.

The biota of this stream consists of brook types. The forms on the mud flats along the stream grade into the flood-plain biota which consists principally of grasses and sedges which ordinarily inhabit the wetter parts of the flood-plain, the higher ground types being limited to a narrow zone in front of the forest.

The changes going on are evidently tending to make the flood-plain dryer, and the forest is encroaching on the meadow. The present extent of the area occupied by the meadow forms is due to the fact that they were able to push in and acquire the territory left by the receding water of the river when the dams were destroyed.

VI. Hardwood Forest. This region has been reserved to the last, for the conditions are evidently those toward which the other habitats tend to be changed under the present conditions. The conditions are similar to those on the north slope, and the whole region is covered by a similar type of biota. This society thus represents the climax society of the region. It consists of the forms that are adapted to or associated with the conditions which prevail in this region in the last stages of the mutual adjustment of all the environmental processes. As the processes become adjusted to one another, the habitat of the climax society is increased at the expense of the other habitats, and the associated biota tends to become of general geographic extent in the region.

7. INTERPRETATIONS AND CONCLUSIONS.

From the conditions of life in this region as summarized above, the following interpretations and conclusions seem justifiable.

Owing to the dependence of forms of life on their environment, biotic changes are necessarily closely related to environmental changes. These biotic changes may occur in two ways; the forms must either be able to respond to the new conditions or be supplanted by other forms. That they tend to become adjusted cannot be questioned, but in many cases at least this adjustment lags behind the changing conditions, and the forms are replaced by others from adjacent habitats which are adjusted to the conditions toward which the particular habitat is changing, thus bringing about a succession of societies.

To understand, therefore, the succession of societies in a region it is necessary to know both the environmental conditions and the processes that modify them. The environmental conditions are brought about by the association of certain environmental factors, such as the geographic, physiographic, organic, edaphic (the chemical and structural composition of the rock and the depth of the soil), time, and climatic factors. These divisions are arbitrary, for the different factors are so intimately related that they can only rarely be separated, and although certain ones may predominate in different habitats, it is impossible, owing to this interrelation, to explain the distribution of animals or plants on the basis of a single factor, for all are more or less involved in the formation of a habitat. This is one of the primary reasons for emphasizing habitat dynamics.

It will be seen by reference to Van Hise ('04, p. 40) that the environmental factors given above are the same as the geological factors in the belt of weathering. Each of these factors is the resultant of various processes (composed in turn of physical forces, heat, light, etc.) which when not in equilibrium tend to become so. The adjustment of these processes to each other brings about changes in the conditions which can only approximately cease when they approach an equilibrium, as, for example, when the topography has been reduced to a base-leveled plain covered by a layer of residual soil. The conditions in habitats where the processes are not in equilibrium are thus being constantly changed in the direction of other habitats in which they have more nearly reached an adjustment, and a succession of societies occurs that only ceases when the processes have become approximately adjusted to each other. The forms that are adapted to the adjusted conditions will constitute the climax society. It is necessary to here emphasize the importance of the organic factor; this must also become adjusted to the others for the entrance of new forms into a region may greatly change the equilibrium of its societies.

The conditions and changes that are going on in this region at the present time have been given in the discussion of the different stations, but, owing to the fact that the relation between environmental changes and the succession of societies has also prevailed in the past, the historic factor in biotic interpretation, the present conditions will not alone explain the present biotic conditions. It is therefore necessary to take into account the conditions that have prevailed in the past. This may be done by reversing the order followed in the discussion and by considering the past in the light of the action of the present processes.

The historical geology of the Lake Superior region has been worked out by Van Hise ('04), and his results are the basis of the following account. During the earliest period the oldest rocks were formed of which we have any knowledge; the crystalline schists, gneisses and granites comprising the Basement Complex (the Kewatin and Laurentian). They form in North America the broad old land area, extending, according to Wilson ('03, p. 617), from Coronation Gulf in the extreme northwest of Canada, southward around Hudson Bay, and northward through Labrador to Baffin Bay and beyond. South of Lake Superior, in Michigan and Wisconsin, there is a continuation of this area, largely buried in Michigan under later deposits but exposed in a large area in Central Wisconsin. There were at least three series of rocks formed upon the Basement Complex before the Keweenawan, but the mountains formed by the elevation and folding of these rocks were reduced to a peneplain before the Keweenawan rocks were laid down. During the period of unstable equilibrium that followed the Huronian Epoch, this peneplain was submerged, and the sediments of the Keweenawan Series were laid down. During their formation, these sediments were covered from time to time by great sheets of volcanic lavas, the products of fissure eruptions. At the close of the Keweenawan Epoch, the land was again elevated and the strata tilted to form great mountains, as is shown by the inclination of the strata in the cross section, Fig. 2. During the subsequent cycle of erosion, the entire thickness of the Keweenawan Series was greatly eroded, and the mountains together with the whole pre-Cambrian area (Wilson, '03, and Weidman, '03) were reduced nearly to sea level.

During Mesozoic times, there was a particularly well marked period of baseleveling that removed the overlying Palaeozoic sediments from the Lake Superior region and reduced the topography to a peneplain. This peneplain, the Jura-Cretaceous, extended over much of the existing land area of North America and has been recognized in Canada (Wilson, '03, p. 658), in the Ozarks (Hershey, '01, pp. 22-24), eastern (Davis, '89, p. 197) and western United States (Woodworth, '94, p. 221). At this time eastern and western North America were separated by the Cretaceous Mediterranean Sea. At the close of the Cretaceous Period, the continent was unified by an elevation of the interior which banished the Mediterranean Sea and put an end to the Jura-Cretaceous peneplain; but in the Tertiary Period that followed, another cycle of erosion occurred which, although not complete in the mountainous regions of North America, sufficed to reduce the northern part of the continent nearly to baselevel (Upham, '04). The surface of the earth in the Great Lakes region at this time probably became covered by a thick mantle of residual soil, owing to the enormous length of time during which it was subjected to disintergrating processes.

The present elevations in the Porcupine Mountain region are evidently formed by the projecting edges of the more resistant basic and acidic lava sheets, while the valleys of Carp and Union rivers are sunk by erosion into

a softer inter-bedded clastic. This contrast between the resistance offered by the sandstone and trap sheets to erosion has given rise, in a small degree, to what Marbut ('96, pp. 29-32) has called step and platform topography. The cross section, Fig. 2, shows that the first ridge is formed by the projecting end of a stratum of trap; if this sheet had been vertical, erosion would have been equal on both sides and the slope on either side would have been the same. But, owing to the fact that the sheet is inclined, the outcropping edge protects the underlying sandstone and a precipitous escarpment is formed. This section also shows that the valley of Carp river is formed by the erosion of the softer stratum of sandstone lying between the escarpment and the second ridge of trap, and that the stream runs along the strike of the rocks, so that it is difficult to believe with Dr. Wright ('05, p. 38) that the valley was formed by the submarine erosion of post-glacial lakes.

If the second sheet of trap was, like the first, underlaid by a bed of detrital material, another escarpment would have been formed. But instead of overlaying an interbedded clastic, it overlies the hard resistant quartziferous porphry that constitutes the central part of the mountainous district. This results in the topography that would prevail if the resistant stratum were vertical, i. e. equal slopes on either side. The topography, however is not of recent origin, and although the physiographic history of this part of Michigan has not been worked out by geologists, one is lead to believe from the work of Wilson in Canada ('03), Weidman in Wisconsin ('03), and Van Hise in northern Michigan ('94 and '96) that the baselevel that is represented by the truncated strata, Fig. 2, probably represents a pre-Cambrian peneplain.

Prof. C. K. Leith has suggested to me in a letter that this structure possibly represents a peneplain of later age than the Wisconsin pre-Cambrian, which it probably intersects at a low angle in a manner similar to the intersection of peneplains of different ages about the Laurentian of Canada as described by Wilson ('03, p. 651). The Porcupine Mountains would thus represent the remains of a peneplain, buried since early geological time under later deposits.

But whether the topography is of pre-Cambrian or later age, it is largely determined by the geological structure and has been comparatively little modified by the ice age. Thus Van Hise ('04, p. 35) has shown that the rocks at present exposed in this part of the Lake Superior region were buried under later deposits all through the Palaeozoic Era and had probably become approximately adjusted to those conditions. Later when they were brought to the surface by the extensive denudation of Cretaceous and Tertiary Periods, and still later when the thin layer of weathered material had been removed by the ice sheets of the Glacial Epoch, this equilibrium was disturbed, and they at once began to adjust themselves to the new conditions—a process that is not yet completed.

At the close of the Tertiary Period, the Tertiary peneplain was destroyed by an elevation of 3,000 to 5,000 feet (Upham, '04, p. 244) over northern North America. Near the culmination of this uplift, three centers of ice accumulation developed in this region and gave rise to the continental ice sheets of the Glacial Epoch.

The glaciers that were formed from these three centers covered Canada and invaded the northern part of the United States at various times, but the final invasion was the most important from the standpoint of the present biota. At this time, ice sheets fed by the different centers united into a

single sheet, the Wisconsin, that covered Canada and moved southward over northern United States, forcing the biota before it. As the ice from the Labradoran center reached the Great Lake region, it was broken up into lobes, the direction of which was determined by the lake basins. The Superior Lobe traveled southwest to the end of the lake. It then spread out laterally, united with the neighboring lobes and moved southward as a continuous sheet.

Thus during the inception of the ice age, certain forces gradually became dominant, throwing the environmental processes out of adjustment, changing the conditions so that the northern forms were able to encroach on the habitats of the more southern societies, thus resulting in a general southward movement of the biota. At the same time, the habitats of the northern forms were destroyed, and their societies were forced southward beyond the limits of glaciation. It may be inferred, from the fossils of boreal forms now found in Pleistocene deposits near the margin of the ice sheet (Adams, '05, p. 55), that the societies during the ice age became adjusted, in a general way, to the conditions beyond the ice margin. But, as the glaciers finally retreated the equilibrium of environmental processes was again disturbed. The conditions changed in favor of the more southern forms which were thus able to extend their habitats into those previously occupied by the boreal types. At the same time, the habitats of the northern forms were extended by the retreat of the ice sheet and a northward migration began (Adams, '02) In this migration the extreme northern types were probably in the lead, and the barren ground left by the retreating glacier was invaded, in all probability, by the lemmings, voles, moles, ptarmigan, etc., representative of the tundra. As the glacier continued to retreat and the conditions became more favorable, the habitats of the tundral types were probably encroached upon by the hares, porcupines, chipmunks and the Lincoln's, White-throated and White-crowned Sparrows, etc., now characteristic of the northern boreal forest of Spruce, Balsam Fir and Tamarack. This biota was in turn succeeded by the deciduous forest type that includes the dominant forms of life in Indiana, Illinois and southern Michigan today. As these southern forms moved northward, they often surrounded groups of boreal plants and animals, as illustrated by tamarack swamps or bogs. These swamps are characterized by a distinctly northern biota consisting of such forms as the Southern Varying Hare, Star-nosed Mole, Red-backed Mouse, Cassandra, Tamarack, Spruce, etc., and are really boreal islands (Bailey, '96) surrounded by the deciduous forest types in the northward migration (Adams, '02, and Transeau, '03).

When the receding edge of the glacier reached the Great Lake region, it was broken into lobes that retreated up the lake basins. As soon as the lobes had retreated beyond the southern watersheds of the Great Lakes, the water accumulated in front of each lobe as an ice dammed lake which drained through the lowest point in the divide (Taylor, '05, p. 97). The lake formed in front of the Superior Lobe drained by way of the St. Croix river through the Mississippi to the Gulf, thus forming a highway for the migrating forms into the Lake Superior region. The Porcupine Mountains, however, owing to the height of the St. Croix outlet, were entirely surrounded by the lake (Wright, '05, p. 38). As the ice retreated, an eastern outlet was opened lower than the St. Croix, and the level of the lake descended; during this descent successive beach lines were cut about the Porcupines until they were finally united with the mainland.

Meanwhile, as the continental ice sheet continued to retreat north of the

Great Lakes, it was followed by plants and animals, so that when it finally disappeared the different forms of life were left distributed in a north and south direction approximately in the order of their northward migration. The wide distribution of the boreal forms in northern North America is thus seen to be very intimately related to the character and extent of the peneplained nature of the region.

Toward the south, with the retreat of the last ice sheet, the boreal forms became restricted to local areas, as in bogs for example. but further north they tend to become of wider distribution. This is shown in the Porcupine Mountains by the general distribution of forms that about Ann Arbor, Michigan are confined to the tamarack swamps, by the presence of boreal forms in the climax forest to the exclusion of more southern forms, and by the fact that there are few forms restricted to the bog societies. That this spreading out of the conditions with which the boreal forms are associated affects the more nearly related habitats first is shown by the number of boreal forms in the flood-plain biota while on the higher ground the southern forms become more numerous. When the present biotic types reached this region, the various societies took possession of the different habitats to which they were adapted, but, owing to the fact that the processes were not in equilibrium these societies could not remain fixed. This is shown, at the present time, where the changes were taking place rapidly, as for example on the mountain top, by the fact that the conditions are being changed in the direction of those that prevail on the low land, and the biota of the cliff habitats is being supplanted by the deciduous forest types which occupy the lower levels where the processes approach an equilibrium. As the processes approach an adjustment, the changes take place more slowly, and the more resistant forms may persist for a considerable time in the succeeding society, as is shown by the presence of the isolated White Pines in the deciduous forest. The deciduous forest society thus represents the climax biota in the Porcupine Mountains, as it is associated with those conditions toward which the other habitats are tending.

From the dynamic nature of the processes that give rise to the environmental factors in the different habitats, it follows that a study of the distribution of forms in a particular region should be made from the standpoint of the processes involved, and, since the conditions in particular habitats may become of geographic extent, the same methods are applicable to general distributional problems. This leads naturally to the conclusion so well expressed by H. R. Mill ('05, p. 10) for geography in general: "Geography was defined long ago as the science of distribution; but the old idea was statical distribution, the laying down on maps of where things are; now we see that we ought to go further and discuss also how the things got there, why they remain there, whether they are in transit and if so how their path is determined. We are learning to look on distribution from its dynamical side, the earth with all its activities being viewed as a machine at work."

PART II. ISLE ROYALE.

1. GENERAL GEOGRAPHY.

Isle Royale is situated in the northwestern part of Lake Superior on the junction of the 89th degree of west longitude with the 48th degree of north latitude, Fig. 21. It lies northeast and southwest nearly parallel to the north shore of the lake. The topography is striking; several nearly parallel ridges separated by broad valleys run the length of the island, and project out into the lake at either end (more conspicuously at the north) as the walls of deep fiords. These ridges are all low, the highest not exceeding 500 feet. The geology and topography have been discussed by Lane ('98) and Irving ('83), and it is sufficient for this report, to say that the topography, as in the Porcupine Mountains, is closely dependent on the geological structure. The ridges consist of the centers of outcropping sheets of lava, while the valleys between are mostly cut in the inter-bedded clastics as in the Porcupine Mountains. The dip of the rocks, is however, toward the Michigan shore, and the escarpments are thus on the north instead of the south side of the ranges. These escarpments are not precipitous in the southern part of the island. There is abundant evidence that the entire island was overridden by the ice sheets of the glacial epoch and that after the final retreat of the glacier it was entirely submerged beneath the Pleistocene Lakes (Lane, '98, pp. 183 and 184). It has not since that time been connected with the mainland, a fact to which many of the peculiarities of its biota are probably due.

2. LOCATION OF FIELD STATIONS. (FIG. 21).

Only the southwestern end of the island was examined. Stations were established as follows:

Station I. Clearing on the Shore of Washington Harbor, Section 29, T. 64 N., R. 38 W.

Station II. Washington River, Section 29, T. 64 N., R. 38 W.

Station III. Trail along the Top of Greenstone Range, T. 64 N., R. 38 W.

Station IV. Washington Creek, Sections 28 and 32, T. 64 N., R. 38 W.

Station V. Tamarack Swamp, Section 20, T. 64 N., R. 38 W.

Station VI. North Slope of Greenstone Range, Section 32, T. 64 N., R. 38 W.

Station VII. Lake Desor, T. 64 N., R. 32 W.

Station VIII. West End of Siskowit Bay, T. 64 N., R. 32 W.

Station IX. Southwestern End of Minong Trap Range, Section 30, T. 64 N., R. 39 W.

Station X. Washington Harbor, T. 64 N., R. 38 W.

3. THE BIOTA CONSIDERED BY STATIONS.

Station I. Clearing on the Shore of Washington Harbor. This station will not be discussed as it is an artificial clearing into which cultivated species

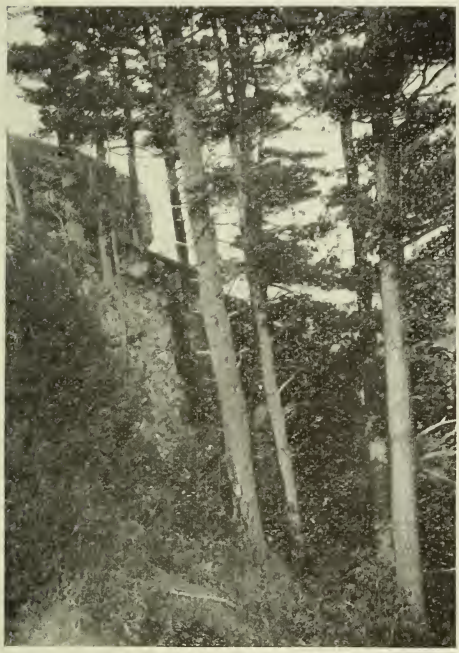

FIG. 15. Large rock ledge on the face of the cliff shown in Figure 14, illustrating the character of the vegetation on a cliff that is broken by ledges.

FIG 16. Talus slope, station III. 5, showing the nature of the talus. The influence of the unstable character of the slope upon the vegetation is indicated by the fallen pines.

have been introduced, and which is kept open, so that only in a few places can the succession of forms be observed that would occur if the clearing was left undisturbed. There is evidence, however, in several places, that the pioneer forms are the Quaking and Large-toothed Aspens, and the Paper and Yellow Birch. The animals taken here were probably all forms from adjacent habitats (see annotated lists).

Station II. Washington River. This river is a sluggish meandering stream flowing through a broad flat valley between the Greenstone and Minong Trap Ranges, and emptying into the head of Washington Harbor. The aquatic vegetation is very poor. In the quiet water near the mouth of the river, *Myriophyllum sp.* forms the principal vegetation with *Sparganium eurycarpum,* and *Phragmites communis* in the shallow water near shore. These forms are replaced on the mud flats by a zone of sedges and herbaceous forms, among the conspicuous forms of which are *Carex tribuloidea, retrorsa, intumescens* and *trisperma, Juncus effusus,* Joe Pye Weed, *Esclepias incarnata,* and *Spiraea salicifolia.* This society is not extensive but soon grades into the dense thickets of Hoary Alder (*Alnus incana*) that are characteristic of the flood plains in this region. The undergrowth in these thickets is limited to a few forms such as *Caltha palustris,* Skunk Cabbage, *Vagnera trifolia,* and several species of ferns and violets. Where the flood-plain is broad, as toward the mouth of the river, the alder thickets are followed by a society of White and Black Spruce, Tamarack, White and Yellow Birch, and Black Ash, with an undergrowth of *Taxus canadensis,* Mountain Maple, *Andromeda polyfolia, Mitella nuda,* Dwarf Dogwood, *Coptis trifolia, Chiogenes hispidula, Ledum groenlandicum, Vaccinium canadensis,* and *Viburnum opulus,* on a thick carpet of moss. As the valley narrows toward the head of the river, this zone gradually disappears.

As in the case of the flora, the aquatic fauna is limited both in individuals and species. The birds are represented by the Pied Billed Grebe, American Coot and American Merganser; the molluscs by *Planorbis exacuous* and *Physa sp.* among the leaves of aquatic plants, and *Pisidium variabile* and *Pisidium spp.* on the mud bottom. Among the alders are found the sparrows, warblers and thrushes; the toad, *Bufo americanus;* the garter snakes, *Thamnophis sirtalis sirtalis,* and *T. sirtalis parietalis,* and the molluscs, *Carychium exile, Pisidium abditum, Apecta hypnorum, Pyramidula striatella, Zonitoides arborea* and *exigua, Vitrea binneyana* and *Agriolimax campestris.* In the tamarack and spruce forest, the birds are not so numerous, and the sparrows, thrushes and warblers tend to be replaced by the Arctic Three-toed, Downy and Hairy Woodpeckers, the Crossbills and the Sharp-shinned and Sparrow Hawks. Among the molluscs, *Pisidium abditum, Apecta hypnorum* and *Carychium exile* also seem to drop out in this zone, but *Pyramidula striatella, Vitrea binneyana, Zonitoides arborea* and *exigua* were found associated with *Euconulus fulvus* and *E. chersinus polygyratus, Sphyradium edentulum, Acanthinula harpa* and *Pyramidula striatella alba.* Here also the grasshopper, *Tettix acadicus,* and the spider, *Amaurobius bennetti,* are occasionally found in the moss.

Station VI. North Slope of Greenstone Range. On account of the intermediate relation which it bears to the flood-plain of Washington river, Station II, and the top of the Greenstone Ridge, Station III, this station will be considered here. The Tamarack and Black Spruce are replaced on the sides of the valley by a forest composed principally of the Balsam Fir, White Spruce, Paper and Yellow Birch, and large isolated White Pines. The undergrowth consists principally of the Ground Hemlock associated

with the Beaked Hazel and Mountain Maple, forming dense thickets that are almost impenetrable, and in exposed situations, particularly about the shores of the island, with the Mountain Ash. Less conspicuous forms in the undergrowth are the Twin Flower, Rattle Snake Plantain, Dwarf Cornel, *Mitella nuda*, *Coptis trifolia*, *Clintonia borealis*, *Lycopodium annotinum* and *clavatum*, and *Chiogenes hispidula*. The birds are represented chiefly by the Nuthatch, Brown Creeper, and the Downy, Hairy, Arctic Three-toed and Pileated Woodpeckers; the molluscs by *Pyramidula striatella*, *Zonitoides arborea*, and *Vitrea binneyana;* the reptiles by *Storeria occipitomaculata;* the amphibians by the common toad, *Bufo americanus*, and the mammals by the Canada Lynx, Hudson Bay Red Squirrel, Canadian White-footed Mouse and Hudson Bay Varying Hare.

Station III. Top of Greenstone Range. Toward the top of the slope the White Spruce decreases in abundance and the Balsam Fir and Birches become associated on the top of the ridge with a large predominance of Sugar Maple. This forest extends as a narrow strip along the top of the ridge and contains the only Sugar Maples observed on the island. The undergrowth is essentially the same as in the Balsam Fir and Spruce forest of the slopes, and the only difference in the fauna is the greater development of molluscs; the forms collected are *Pyramidula striatella*, *P. striatella alba* and *alternata*, *Zonitoides arborea*, *exigua* and *milium*, *Vitrea binneyana*, *Euconulus fulvus* and *E. chersinus polygyratus*, and *Sphyradium edentulum* among the fallen leaves, and *Vertigo gouldii*, *Punctum pygmaeum*, *Carychium exile* and *Vitrina limpida* in the damp humus in the small ravines. Other forms that may be listed here, although they also occur in the Balsam Fir and Spruce forest, are Storer's Snake (*Storeria occipitomaculata*), the garter snakes, *Thamnophis sirtalis sirtalis* and *T. sirtalis parietalis*, and the grasshoppers, *Tettix acadicus* and *Ceuthophilus seclusus*.

Station IV. Washington Creek. The conditions represented here are similar to those which prevail on the head waters of the rivers and along the small streams. Where the valley is narrow (near the mouth, Section 32) the forms of the slope forest extend nearly to the waters edge, being separated from it by a narrow zone of Hoary Alder, *Equisetum arvense*, *Caltha palustris*, *Vagnera trifolia*, *Rhamnus alnifolia* and various grasses and sedges. Up stream, Section 28, the valley is wider, and the coniferous forest of the slope is separated from the stream by a considerable development of bog forms. The arboreal vegetation consists of the Arbor Vitae, Tamarack and Black Spruce, with an undergrowth of *Coptis trifolia*, *Chiogenes hispidula*, *Linnaea borealis*, *Lycopodium clavatum* and *obscurum*, and a thick carpet of *Sphagnum* and other mosses.

There is practically no aquatic flora, and the only aquatic animals found were *Pisidium*, too young to identify.

The molluscs collected in the bog society are *Pyramidula striatella*, *Zonitoides arborea* and *exigua*, *Vitrea binneyana*, *Acanthinula harpa*, *Vertigo gouldii*, *Agriolimax campestris* and *Pallifera hemphilli*.

Station V. Tamarack Swamp. On Section 20, T. 64 N., R. 38 W., in the valley of the small stream draining into Huginnins Cove, the bog society attains a considerable development. The Tamarack is the principal tree and is associated with the Balsam Fir, Black Spruce and Black Ash. The undergrowth consists of the Dwarf Dogwood, *Chiogenes hispidula* and *Coptis trifolia* on a thick mat of *Sphagnum* and other mosses. The molluscs found here are *Zonitoides exigua*, *Z. arborea* and *milium*, *Vitrea binneyana*, *Euconulus fulvus*, *Vertigo gouldii*, *Pyramidula striatella* and *Euconulus chersinus poly-*

gyratus. A conspicuous feature of the bogs in this region is the lack of undergrowth. As may be seen from the list of species; the forms that compose the undergrowth consist only of a few herbaceous forms, which is in striking contrast to the density of the undergrowth in the surrounding forest.

Station VII. Lake Desor. This lake lies between the Greenstone and Minong Trap Ranges. Its shores are for the most part shelving and covered with a fine silt-like deposit. The islands, however, have uniformly rocky shores. The coniferous forest of the slopes comes down to the margin of the lake where it grades into a narrow zone of Hoary Alder, *Viburnum opulus* and Arbor Vitae that lines the shores. The aquatic flora and fauna is very poor. The marginal forms consist of the plants, *Equisetum sp.*, *Phragmites communis*, *Sparganium eurycarpum*, and occasionally the White Water Lily (*Castalia odorata*); the frog, *Rana sylvatica cantabrigensis*, and the molluscs, *Planorbis bicarinatus striatus*, and *Anodonta marginata.* On the rocky shores of the islands, the vegetation consists of a scattered growth of *Isoetes sp.* and *Phragmites communis* in the water among the rocks, and *Equisetum arvense* on the rocks in exposed places. The animals collected here are the leeches, *Haemopis grandis* Verrill and *Nephelopsis obscura* Verrill, a number of caddis fly larvae, and the molluscs, *Planorbis hirsutus*, *P. exacuous* and *parvus*, and *Physa sp.*

Station VIII. Siskowit Bay. The only part of Siskowit Bay worked was the west end in T. 64 N., R. 32 W. The shore at this point consists of outcropping strata of conglomerate that dip under the bay, and are often broken up into shingle beaches. Owing to the grinding of the waves, there is practically no aquatic life, although a small *Physa* is sometimes found on the larger rocks. In the pools that occur occasionally along this beach behind the outcropping strata, the conditions are more favorable. Small mats of Algae may occur on the rocks and there is a limited fauna of which caddis fly larvae, and molluscs, *Physa sp.* and *Valvata sincera lewisii*, are the principal forms. The beach flora is also very limited, consisting chiefly of Juneberry, *Phegopteris polypodiales*, *Euthamia graminifolia*, *Campanularia rotundifolia* and *Listera convallariodes* that occur in the rock crevices and scattered over the shingle beach.

Station IX. Southwestern End of Minong Trap Range. As may be seen on the map, the Minong Trap Range on Section 30, T. 64 N., R. 39 W. projects into Lake Superior, becoming deeply submerged several hundred yards fromthe mainland. It is also sloping on the south side, owing to the dip of the strata, but on the north side it is precipitous. Near the outer end of the ridge, there are a number of rock pools in the angular spaces formed by the removal of portions of the rock between the joint planes. These are very similar in form and probably in origin to the beach pools in the Porcupine Mountains. The flora of these pools is very limited, but a number of animal forms are found such as the molluscs, *Limnaea sumassi* and *Planorbis parvus*, the water strider, *Gerris remigis*, and caddis-fly larvae. The flora on the outer end of the ridge consists of scattered patches of *Parmelia conspersa*, and a crevice vegetation of *Sibbaldiopsis tridentata* and *Dasiphora fruticosa Campanularia rotundifolia*, *Solidago sp.*, Arbor Vitae and several grasses.

Toward shore a thin soil covers the rock and supports a flora of Reindeer Lichen (*Cladonia rangiferina*), and the heaths, Bearberry, Dwarf Blueberry and New Jersey Tea that are often found growing on the remains of lichen mats. Here also are found *Empetrum nigrum*, and *Lycopodium annotinum*, *clavatum* and *complanatum.* The first tree is the Arbor Vitae

that grows nearly prostrate on the rock, associated with *Juniperus nana*, Mountain Ash, White Pine, and Quaking Aspen. Near the shore the White Spruce, Balsam Fir and Paper Birch come in, forming the forest of the region. The succession on these points is evidently represented by four stages, the lichen-moss, grass-sedge, heath, and coniferous societies. The history of the pools is somewhat different. There is evidence that these are being filled in places by *Sphagnum* and other mosses, and on this moss such bog forms as *Ledum groenlandicum*, Cassandra, Black Spruce and Tamarack are occasionally found. These forms must, however, in time be succeeded by the forms of the upland forest.

In listing the fauna of the outer end of the ridge, the Herring Gull should be mentioned as one of the most characteristic forms, for hundreds of individuals were often observed on this ridge during the summer. As in the Porcupine Mountains, a number of molluscs push out in advance of the forest on the heath mat. In the dry soil among the roots of these plants was found, *Pyramidula striatella*, *Zonitoides exigua*, *Vitrea binneyana* and *Acanthinula harpa*.

Station X. Washington Harbor. As may be seen from the map, Washington Harbor is a long narrow bay lying between the Minong Trap and Greenstone Ranges, on the southwest end of the island. It attains a depth of 6 to 9 fathoms and has a rocky bottom that rises nearly to the surface in places as reefs.

The fauna of the deeper waters, as represented by the collections, consists of the Lake and Brook Trout, Herring, Sucker, Muskallunge, Yellow Perch and *Couesius plumbeus*. Among the rocks near shore the Millers Thumb (*Cottus ictalops*) is found, and the molluscs, *Limnaea stagnalis var.*, *Limnaea summassi*, *Physa sayii*, *Physa sp.* and *Planorbis exacuous*. Of these forms the two Limnaeas were the most characteristic and were particularly abundant on the northeast end of the harbor.

4. SUMMARY AND CONCLUSIONS.

On account of the preliminary nature of the work done on Isle Royale, but few conclusions will be drawn. It will be seen at once, however, that while the biota of the Porcupine Mountains possess many southern forms, the Isle Royale societies are characteristically boreal, the bog forms are less restricted, the sedge, cassandra, shrub and coniferous societies are better represented on the river flood-plains, and many of the forms of the coniferous society occur in the climax forest. This makes the climax forest society of Isle Royale, of the northeastern North American type. The bog forms are thus boreal types having the same affinities, and their spreading out in this region from the restricted habitats which they occupy to the south may be accounted for by the fact that the environmental conditions with which they are associated, toward the north tend to become of general or of geographic extent, so that these forms ultimately come to form the climax society. Thus several forms that about Ann Arbor have been recorded only from tamarack swamps, such as the snails, *Philomycus dorsalis*, and *Pallifera hemphilli* (collected by Miss Jean Dawson), and the Varying Hare, Star-nosed Mole, and Red Backed Mouse, are all boreal species (Bailey, '96), that toward the north tend to become of general distribution.

It will be noticed in the annotated lists, however, that while most of the species have northeastern affinities, a number of forms collected on Isle

Royale are forms of western and northwestern distribution. There are conspicuous examples of this:

1. The snail listed as *Limnaea sumassi* Bd., according to Mr. Bryant Walker, although probably entitled to rank as a distinct variety or species, is very closely related to *L. summassi* Bd. a peculiarly western form originally described from British Columbia.

2. The range of the ant, *Camponotus herculeanus* L. var. *Whymperi* Forel, according to Dr. Wheeler, is not well known, but it has been previously found in the mountains of Colorado and Britsh Columbia.

3. The specimens of the Garter Snake, *Thamnophis sirtalis parietalis*, taken on the island strikingly resemble in coloration western forms from Washington and Colorado, and not those of southern Michigan, that are sometimes referred to this variety.

4. Although not found on the island, the Michigan Grayling, *Thymallus ontariensis*, may also be mentioned in this connection. According to Jordan and Evermann ('96, p. 518), this variety "represents a detached colony left from the post glacial extension of the range of *T. signifer*, of which it was a variety." The range of *T. signifer* is given as "Mackenzie River to Alaska and the Artic Ocean."

5. Another instance of the same nature was the finding of the Devils Club, *Echinopanax horridus* Decsene, by Wheeler ('01, p. 620) on the north end of the island in 1900. The range of this plant, as given by Macoun ('83, p. 189), is the north coast of America and in Alaska; being abundant west, but extremely rare east of the Rocky mountains.

The occurrence of these western and northwestern elements in the biota of Isle Royale is emphasized because, as was said before, the majority of the species are those of the northeastern North American type. Whatever may be the explanation of the occurrence of these western and northwestern forms this far to the east, an important factor is, no doubt, the peneplain nature of the country, which probably formed an extensive highway for boreal forms along the ice margin during the retreat of the last ice sheet.

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THE ECOLOGICAL DISTRIBUTION OF THE BIRDS IN THE PORCUPINE MOUNTAINS, MICHIGAN.

OTTO McCREARY.

The country in which these observations were made is largely included within a narrow area about a mile wide which runs from Lake Superior almost directly south, crossing Carp river about a quarter of a mile east of Carp Lake. Few observations were made south of the Carp river valley.

On account of differences observed in the environments of the bird life of this region, it will be discussed according to the following habitats:

I. THE LAKE SUPERIOR SLOPE OF THE FIRST MOUNTAIN RIDGE.

1. Lake Superior }
2. Lake Beach... } .....Station I.
3. Cedar Swamp.....Station II. Sub. 1.
4. Hemlock Forest.....Station II. Sub. 2.
5. Hardwood Forest.....Station II. Sub. 2.
6. Camp Clearing.....Station II. Sub. 3 and 4.
7. Mountain Top and Escarpment.....Station III. Sub. 1-6.

1. Lake Superior (Station I).

This habitat includes the open water of the lake and is only a feeding place for the birds, as it is impossible for them to nest here.

The water is very cold, the temperature being about 58° F. during the latter part of July. The shores are rocky and steep, the rocks in some places making an angle of 30° with the surface of the water, and on this account, aquatic life, with the possible exception of small algae and invertebrates, was lacking along the edge of the water, so that waterfowls feeding on these would be expected to occur here only occasionally, during the migration season.

The only birds observed, were those of fish eating habits, such as mergansers, loons and gulls. On July 21 a female American Merganser with nine or ten young in the down was seen near the shore. On my approach they swam out into the lake and were soon out of sight behind some rocks that jutted into the water. Two adult Loons were seen the same day, and two days later two Herring Gulls were observed flying over the lake. These were the only birds seen in about fifteen trips made to the lake shore from July 15 to August 13.

2. Lake Beach (Station I).

At this part of the lake shore, the beach is formed by the dipping of the bed rock below the lake, thus making a barren rocky strip, almost destitute of vegetation, between the waters edge and the trees. In addition to the mosses and lichens that grew upon the rocks, the principal plants that

occurred here were goldenrods bluebells, lobelias, etc. that grow in the crevices.

The scarcity of small invertebrates and plants suitable for bird food made this a very poor feeding ground. Indeed the scarcity of bird life here was especially noticeable, as only three birds, the Spotted, Solitary and Least Sandpipers were seen, all of which are shore birds.

Ravens, Crows and Chimney Swifts were seen flying along the shore; the last was probably searching for insects and the first two for fish. Although no dead fish were seen along the shore, no doubt they are occasionally washed up, and these birds were probably patrolling the coast in search of cast up refuse.

3. Cedar Swamp (Station II. 1).

This station extended from the lake beach to the hemlock forest, a distance varying from a quarter to a half mile at different places. The trees were mostly arbor vitae, spruce, Canada balsam and birch, the principal forms being the arbor vitae and balsam. There were several clearings in this substation, and, as the bird life was different at such places than in the woodland, I shall divide this station into two parts, the Woodland and the Clearings.

Woodland.

In some places the woodland has been partially cleared, but where no lumber has been taken out the woods are very dense. The same species of birds, with one or two exceptions, were found in the dense forest as in the open woodland, only there were fewer of them in the former forest. In the very dense forest birds of all species were few and far between. The birds found here were Mangolia Warbler, Black-throated Blue Warbler, Redstart, Winter Wren, Canadian Warbler, Olive-backed Thrush, Golden-crowned Kinglet, Myrtle Warbler, White-throated Sparrow, Brown Creeper, Oven Bird, Crow, Hairy Woodpecker, Purple Finch, Red-eyed Vireo, Cedar Waxwing, Chickadee, Wood Pewee, Ruffed Grouse, Black-throated Green Warbler, Sharp-shinned Hawk, Pileated Woodpecker, Pine Siskin, Mourning Warbler, Raven, and Red-breasted Nuthatch, and Arctic Three-toed Woodpecker. The Black-throated Blue Warbler is characteristic of the undergrowth. The Pine Siskin and Purple Finch were nearly always seen in flocks and roamed about over a large expanse of territory.

The Olive-backed Thrush, Mourning Warbler, Wood Pewee and White-throated Sparrow were found in the open woods.

Clearings in the Cedar Swamp.

There were several clearings in this vicinity, most of them being near the lake. In all of them there were plenty of small trees and brush, in which the birds found favorable conditions.

The birds seen in the clearings were, Black-throated Blue Warbler, Winter Wren, House Wren, Arctic Three-toed Woodpecker, Red-tailed Hawk, Sparrow Hawk, White-throated Sparrow, Crow, Flicker, Purple Finch, Red-eyed Vireo, Chickadee, Canadian Ruffed Grouse, Song Sparrow, Great Horned Owl, Sharp-shinned Hawk, Sparrow Hawk, Pileated Woodpecker, Pine Siskin, American Bittern, Raven, Least Fycatcher, Olive-sided Flycatcher and King Bird.

The Bittern was a straggler, observed once near the lake shore. The Red-tailed Hawk, Raven and Pine Siskins were seen flying overhead, and

the Flickers on the high dead stumps in the clearing. The Purple Finch came to the clearing to feed on the raspberries, and one was shot with part of a berry in its mouth.

Supplementary Clearing Observations.

This clearing is about two miles west of the main line of observation, and one-half mile south of Lake Superior. The conditions here were decidedly swampy, as cat-tails grew in the middle of the logging road in many places. The arbor vitae had been cleared away several years before and the second growth had become quite a factor in the conditions. This growth, together with the underbrush and tree tops, made traveling outside of the logging road very difficult. Here, among a young growth of maple about five or six feet high, was found a family of four Connecticut Warblers.

Other birds seen in this clearing are as follows: Blue-headed Vireo, Red-breasted Nuthatch, Black-throated Blue Warbler, Pileated Woodpecker and White-throated Sparrow.

4. Hemlock Forest (Station II. 2).

This habitat may be called the hemlock belt because the majority of the trees were of this species. The lower part of this station, at the edge of the cedars, was covered with a dense growth of hemlock, while farther up the side of the mountain the proportion of maples increased until finally the hemlocks were nearly all replaced by maples. In the dense hemlock forest there was very little underbrush, but where there were many maples there was always a thick underbrush of young maples and some basswood.

The birds of this Station were: Pine Siskin, Red-eyed Vireo, Cedar Waxwing, Purple Finch, Black-throated Blue Warbler, Chickadee, Hairy Woodpecker, Golden-crowned Kinglet, Brown Creeper, Blackburnian Warbler, Black-throated Green Warbler, Winter Wren, White-throated Sparrow, Oven Bird, Wilson's Thrush, Ruffed Grouse, Olive-backed Thrush, Raven, Pileated Woodpecker, Broad-winged Hawk.

Here, as in the cedars, different species of birds frequented certain places. The Pine Siskins, Purple Finches and Golden-crowned Kinglets were nearly always seen in the hemlocks. The Winter Wrens were observed mostly along streams and in damp places. The Black-throated Blue Warbler was found quite commonly in the underbrush, but where the dense shade prevented an undergrowth, none were observed. The Olive-backed Thrush and White-throated Sparrow were always found in the open woodland.

Supplementary Clearing Observations.

This was a clearing in the hemlock forest about two miles west of the main line of observation and about a quarter of a mile south of Lake Superior.

The birds seen in this clearing were the Purple Finch, Olive-sided Flycatcher, Least Flycatcher, White-throated Sparrow, Song Sparrow and Ruffed Grouse. The Olive-sided Flycatchers were seen sitting on high dead stubs making themselves conspicious by their noise.

5. Hardwood Forest (Station II. 2).

This habitat extended from the hemlock belt through the maples to the aspens about the natural clearing at the top of the cliff. This may be called the hardwood belt because the trees were mostly maple with a few scattered hemlocks, basswood, balsam, and birch. In these woods there was a very thick undergrowth composed mostly of young maples.

The birds observed in this habitat are: Black-throated Blue Warbler, Oven Bird, Black-billed Cuckoo, Cedar Waxwing, Red-tailed Hawk, Flicker, Wilson's Thrush, Red-eyed Vireo, Black-throated Green Warbler, Blackburnian Warbler, Brown Creeper, Chickadee, Pileated Woodpecker, Ruffed Grouse and Olive-backed Thrush. An Oven Bird's nest containing two eggs and one young was found along the path up the mountain on July 16. It was made of coarse grass and leaves, and was placed on the ground. The Olive-backed Thrush, Black-billed Cuckoo, and Flicker were seen near the camp, where the woods were more open.

6. Camp Clearing (Station II. 3-4).

This was the clearing around the camp. It was not more than two acres in extent and was surrounded by a zone of aspens, except on the north where the trees were mostly maple. It was situated at the crest of a low mountain pass, a little more than 750 feet above the level of Lake Superior. It was bounded on the north by Station II. 2, and on the east by II. 2, and III. 1; on the south by IV. 3, and on the west by II. 2, and III. 5; It contained many tall weeds, bushes, and several trees, principally aspen.

The birds found on this station were: Purple Finch, Mourning Warbler, Blackburnian Warbler, Red-eyed Vireo, Black-billed Cuckoo, American Crossbill, Song Sparrow, Downy Woodpecker, Pine Siskin, Sapsucker, Robin, Raven, Sparrow Hawk, Indigo Bunting, Chimney Swift and Cedar Waxwing. The Song Sparrow, Sapsucker and Indigo Bunting were probably accidental here, as only one of each was observed. The Chimney Swift was often seen flying overhead. The Purple Finches and Pine Siskins came to feed on bread crumbs and other refuse from the camp. A pair of adult Mourning Warblers and two young were taken among the bushes in the clearing, July 15.

7. Mountain Top and Escarpment (Station III. 1-6).

From the top of the mountain to the valley of Carp river, there is a precipitous descent of about 400 feet. On top of the cliff and back a few rods from the brink of the precipice, there are no trees except a few scattered pines. The chief vegetation consists of dwarf huckle and blueberries, New Jersey tea, bearberry and other heath plants. The cliff is nearly continuous, but not entirely so, being broken occasionally by gullies. Surrounding the "bald" top of the cliff is a zone of aspen which grades down into the gullies, and down the north slope into the hardwoods. At intervals, where the slope is not so steep, the pines form a narrow belt up the face of the cliff, across the top of the mountain and into the hardwoods beyond, thus surmounting the range.

It is the top of the cliff on the eastern half of Section 14 and western half of Section 13 (III.1, 2, 3) that will be described first.

The western end of the station lies in a gully in Section 14. As the top is approached the aspens become smaller and smaller and finally disappear. Toward the east end of the mountain top, on Section 13, this "bald" area is crossed by a zone of Norway and white pines, many of them being of very large size. The middle portion consists of a precipice and a narrow strip at the top. It differed from the west end in that it contained no aspens, and the pines were so far apart that they had but very little influence upon the general conditions. Probably owing to this reason the bird life on the west end and middle portion was practically identical, and I will describe them together, treating the bird life in the pines separately, as it is entirely different.

Birds were always to be found along the western slope and top (III. 1 and 2), but the small number of species was noticable. The Junco, Cedar Waxwing and Flicker were the only birds that were abundant. The Flicker was often seen on the few tall dead stumps and scattered pines that occurred here, and probably nested in these stumps, as they contained many holes. Both young and adult Juncos were found in abundance and this seemed their natural habitat. The Cedar Waxwing was attracted here by the Juneberries, upon which they were often seen feeding. Crows, Ravens, Chimney Swifts and Red-tailed Hawks were seen flying overhead. Sparrow Hawks came occasionally to feed upon the grasshoppers, but these birds seem to prefer the cliffs to the west of this location.

The birds seen in the pines (III. 3) were the Pine Warbler, Red-breasted Nuthatch, Chickadee, Chipping Sparrow and White-breasted Nuthatch. Two Pine Warblers, evidently a male and female, were seen on the tops of these pines looking for insects. Finally one caught an insect, but instead of eating it the bird perched on a limb, held the insect in its mouth, and scolded. It acted as if it had young near me and was afraid to feed them. Several Chipping Sparrows were seen on the tree tops and one was shot July 19.

The tops of the cliffs west of camp (III. 5) were similar to III. 2, except that the "bald" areas were of greater extent. The same birds that were found in III. 1 and 2 were found here and also a few additional ones.

For some reason, which I cannot explain, Robins, Bluebirds, Blue Jays and Vesper Sparrows were often found on this cliff and seldom in Station II. 1 and 2. A Bluebird's nest containing young was found in a deserted Woodpecker's hole in a Norway pine; Vesper Sparrows and a Scarlet Tanager were seen here once. The former were perhaps migrating, (August 3), while the latter was from the neighboring forest. The Ravens came here n the evening and left in the morning, when nine were counted at one time. A few could be seen about here at almost any hour of the day.

The bird life on the second cliff west of camp was somewhat different from that of the first as no Robins, Bluebirds, or Vesper Sparrows were seen here, while a Phoebe was seen here and not on the other cliffs. Two Bald Eagles were observed flying overhead.

II. CARP RIVER VALLEY.

This region extended from the foot of the talus slope south to the elevation on the other side of the river valley, a distance of about a quarter of a mile. From west to east, it extended from the outlet of Carp Lake as far up the Carp river as we could ascend in a boat, a distance of about one and a quarter miles.

Within this area are included several different varieties of conditions, and these furnish the basis for the following habitats:

1. Carp Lake.....Station V. 1, and 3.
2. Grassy Marshes.....Station V. 2, and IV. 2.
3. Alders.....Station IV. 2.
4. Damp Woodland.....Station IV. 3.
5. Tamarack Swamp.....Station IV. 4.
6. Carp River.....Station IV. 1.
7. Dry Woodland.....Station IV. 3.
   a. Western End.
   b. Eastern End.

FIG. 17. Upper portion of the talus slope, station III. 6, showing the angle of slope, and the lichens (light colored patches) on the rocks. The birches in the background are on the lower part of the slope.

FIG. 18. General view of Carp river valley, looking up stream and southeast from station III. 5. Note the alder and cassandra vegetation bordering the river, station IV. 2.

1. Carp Lake (Station V. 1 and 3).

The lake is about a mile long, a quarter of a mile wide, and comprised, in extent, about one-half of the station. The western half of the lake extended from the foot of the talus slope to the foot of the ridge on the other side, while the eastern half differed from it principally in having a narrow strip of land between the waters edge and the foot of the talus slope on the north side.

Bordering most of the lake there is just enough beach to walk on, except on the northwest shore where it is somewhat wider. On the southwest and southeast shores of the lake, there are small grassy marshes, and at such places bulrushes and sedges grow along the edge of the water.

On the south side arbor vitae, maples, alders, and other trees grow along the edge of the beach. These trees were usually not more than twenty feet high and are so close together that it was almost impossible to penetrate them. At other places there is a fringe of alders along the beach.

Very few birds were seen on the lake; a Loon, was upon the water August 10; Kingfishers were often seen flying across the lake, now and then diving for a fish; an Osprey was observed several times doing the same thing, and a Great Blue Heron was twice seen flying across the lake and once in the sedges. A Swamp Sparrow, a Solitary Sandpiper and Crows were observed on the beach.

2. Grassy Marshes (Station V. 2, IV. 2).

There were two of these grassy marshes. One at the east end of Carp Lake and another a mile and a quarter up Carp river. Both were overgrown with tough marsh grass and were too small to be of any special importance as a bird habitat.

Song Sparrows and Swamp Sparrows came out of the alders to feed but the only birds taken characteristic of grassy marshes were the Wilson's Snipe and Carolina Rail. The former was taken in the marsh, up the river, and the latter in the marsh at the east end of the lake.

3. Alders (Station IV. 2).

The alders occupied the bottom land along either side of Carp river. There are many willows, dogwoods, and cassandra bushes among the alders, and together they formed a thicket so dense, that it was impossible to see more than a few yards.

The birds of this habitat were the White-throated Sparrow, Red-eyed Vireo, Black-throated Green Warbler, Redstart, Oven Bird, Swamp Sparrow, Mourning Warbler, Olive-backed Thrush, Downy Woodpecker, Kingfisher, Sharp-shinned Hawk, Cedar Waxwing, Chestnut-sided Warbler, Chickadee, Canadian Warbler, Rose-breasted Grosbeak, Wilson's Thrush, Black-billed Cuckoo, Alder Flycatcher, Song Sparrow, American Bittern, Ruffed Grouse, Least Flycatcher, Red-winged Blackbird, Water Thrush, and Black-throated Blue Warbler.

The Canadian and Chestnut-sided Warblers and Red-winged Blackbird probably did not breed in this zone, as they were not seen here until after the first of August.

The Kingfisher, American Bittern and Sharp-shinned Hawk were seen along the edge of the river. Only one of each of the last two were seen. The Hawk was on the bank eating a grouse and the Bittern was standing

on an alder that leaned out over the river. Kingfishers were often seen flying up and down the river and would alight upon the overhanging branches to watch for fish.

A Cedar Waxwing's nest was found in an alder. This nest was made of mud and dead grass and was built in the top of the shrub. The nest was found July 28, but contained no eggs.

Almost all of the birds among the alders appeared quite tame, for as soon as I would go into the bushes some bird would begin to scold, nearly always a White-throated Sparrow, and the rest of the birds would come to see what the trouble was about. Redstarts, Mourning Warblers, Black-throated Green Warblers, Oven Birds, Red-eyed Vireos, Swamp Sparrows, Song Sparrows, Wilson's Thrushes, Winter Wrens, Water Thrushes and a Rose-breasted Grosbeak came within a few feet of me. Even the shy Olive-backed Thrush would come within a rod to scold. It was very interesting to observe the marked curiosity which they showed.

4. Damp Woodland (Station IV. 3).

This was a small strip of maple and ash between the alders, and the maple forest of the slopes. The birds seen here were: Red-eyed Vireo, White-throated Sparrow, Winter Wren, Water Thrush, Black and White Warbler, and Least Flycatcher.

The trees of this piece of woodland were not very high but were so crowded that they produced a dense shade. This was perhaps the reason why there were so few birds seen here, and why those seen were near the margin.

5. Tamarack Swamp (Station IV. 4).

About a half mile east of the lake where the river turns to the south, there is, on the west bank, a tamarack swamp. The trees of this swamp are arbor vitae, and tamarack, which about the margin of the swamp grow much thicker than in the center.

The birds observed were as follows: Purple Finch, White-throated Sparrow, Magnolia Warbler, Cedar Waxwing, Red-breasted Nuthatch, Red Crossbill, White-winged Crossbill, Olive-sided Flycatcher, Pine Siskin, Golden-crowned Kinglet and Ruffed Grouse. The two species of Crossbills were probably attracted here by the seeds of the tamarack cones, as the crops of five specimens all contained tamarack seeds. The Red-breasted Nuthatch nested here, as an adult bird was seen feeding three young. The Olive-sided Flycatchers were seen on the tops of tall dead trees.

6. Carp River (Station IV. 1).

About a mile and a quarter east of Carp Lake, the river becomes so narrow that the alders which line the banks meet above the middle of the stream and obstruct further passage with a boat. Where the alders line the bank there were few places for wading birds, but where there were grassy mud flats between the water and the shrubs Solitary Sandpipers were to be seen at almost any time. The Snipe, however, was only seen July 17 and 18. The only birds seen on the river were Hooded Mergansers.

7. Dry Woodland (Station IV. 3, North of Carp River).

This is the upper part of the strip of woodland lying between the cliff and Carp Lake, on the north side of the valley, and occupies the lower part

of the talus slope. The trees here were mostly maple, birch and aspen, with a few pines scattered among them. At the eastern end the forest was open, while the trees of the western end were so close as to make a dense shade. On account of the difference of the character of the two portions, they will be taken up separately.

Western End. Here, where the trees were thick, few birds were seen. The different species noticed were as follows: Blackburnian Warbler, Kingfisher, Sparrow Hawk, Red-eyed Vireo, Wilson's Thrush, Canadian Warbler, Blue Jay and Redstart. There was a Sparrow Hawk's nest situated high up in a dead tree, in what seemed to be a deserted Woodpecker's hole. The young of the Wilson's Thrush, still unable to fly, were found here.

Eastern End. The birds found in this end of the forest were: Black-throated Blue Warbler, Robin, Ruffed Grouse, Flicker, Downy Woodpecker, Oven Bird, Olive-backed Thrush, Red-eyed Vireo, Black-billed Cuckoo, Blackburnian Warbler and White-throated Sparrow. In the evening and morning the song of the Olive-backed Thrush could be heard almost everywhere in the tree tops, and they seemed to be quite numerous, but in the daytime this bird was seldom heard. The probable explanation of this is that they went into the alder thickets to the south.

III. HARDWOOD FOREST SOUTH OF CARP RIVER (STATION VI.).

The trees along the trail to Government Peak were mostly maple, birch and hemlock, except in low places along the small streams, where there was much arbor vitae and balsam.

Observations along the trail were made July 26 and the following birds were seen in the forest: Oven Bird, Golden-crowned Kinglet, Scarles Tanager, Red-eyed Vireo, Magnolia Warbler, Black-throated Blue Warblert Wood Pewee, Winter Wren and Olive-backed Thrush. The Magnolia, Warbler, Wood Pewee and Winter Wren were seen along a stream.

An Olive-backed Thrush's nest was found on top of a small hemlock about ten feet high beneath a larger tree. The nest was composed of leaves, rootlets, and grasses, and was lined with still smaller grasses and rootlets, and contained two bluish green eggs with cinnamon brown spots.

IV. LITTLE CARP RIVER VALLEY.

1. Little Carp Lake (Station VII. 1).

This lake is small, being about one-half mile long and a quarter of a mile wide. The only observations made upon the bird life on the lake shore were in an open spot at the east end. Only one bird was seen on the water, a Pied-billed Grebe, on August 2.

The open area was at the foot of a small hill which arose precipitously out of the lake to a height of about fifty feet. There was very little soil, which accounts for the absence of an extensive vegetation. Observations were made on August 2 and 3 and the birds seen were: Blue Jay, Junco, Humming Bird, Yellow-bellied Sapsucker, Hairy Woodpecker, White-throated Sparrow, Wood Pewee, Purple Finch, Chimney Swift, Raven, Kingfisher, Cedar Waxwing, Flicker and Song Sparrow. The Chimney Swift and Raven were seen flying overhead.

2. Beaver Meadow (Station VII. 2 and 3).

This meadow was along Little Carp river, about a quarter of a mile east of Little Carp Lake. It was about a mile long and a quarter of a mile wide, the Little Carp river running through the middle of it. The ground was quite marshy in many places and was covered with grass, there being no trees in the meadow. There were several willow and alder bushes at the east end. The surrounding trees were alder, tamarack, arbor vitae, balsam and birch.

Observations were made on August 3, and the birds seen here were: Kingfisher, Solitary Sandpiper, Cedar Waxwing, Red-eyed Vireo, Swamp Sparrow, Song Sparrow, White-throated Sparrow, Marsh Hawk, Pine Siskin, Hairy Woodpecker, Tree Swallow, White-winged Crossbill, Yellow-legs, Least Sandpiper, Red-breasted Nuthatch.

The Kingfisher, Solitary Sandpiper, Least Sandpiper, and Yellow-legs were seen along Little Carp river. The Tree Swallow, Marsh Hawk and Pine Siskin were seen flying overhead, and the Song Sparrow and Swamp Sparrow were seen feeding in the grass, while the rest were seen in the trees around the edge. The Crossbills were seen in tamarack trees at the edge of the marsh. As it was August 3 when I was at the beaver meadow, I cannot say which birds bred there and which were migrants.

V. SUMMARY.

On glancing over the list of birds found at the different stations, it will be noticed that some birds were found at only one or in a few stations, while others were found in nearly all of them. At some stations a certain species of bird would be quite numerous, while another only a short distance away, would contain none of these. From such facts we must conclude that some birds are found only in certain situations which possess definite environmental conditions. There were also a number of birds observed which were too rare to determine what kind of localities they preferred; still others were only seen flying overhead. Regarding abundance, at one extreme were the rare forms and at the other those found almost everywhere. The rare birds were: Myrtle Warbler, Great Horned Owl, Black and White Warbler, Indigo Bunting, Broad-winged Hawk, Humming Bird, Arctic Three-toed Woodpecker, Connecticut Warbler, Blue-headed Vireo, Rose-breasted Grosbeak, Scarlet Tanager, House Wren, King Bird, White-breasted Nuthatch and Phoebe. The birds only seen flying overhead were: Red-tailed Hawk, Chimney Swift, Bald Eagle, Tree Swallow and Marsh Hawk. The birds of general distribution were: Ruffed Grouse, Red-eyed Vireo, Black-throated Green Warbler, Chickadee, Purple Finch, Black-throated Blue Warbler, Sharp-shinned Hawk, Cedar Waxwing, Oven Bird and Wilson's Thrush.

In the case of birds with a restricted range, the limiting area was occasionally very sharply defined, while in other cases it was difficult to recognize these limits. Examples of the former are the water and shore birds, of the latter, the Golden-crowned Kinglet and Pine Siskin. The distribution of the water and shore birds was the most sharply defined, and, as they are the simplest to place, I will begin my summary with them. In connection with these I will also mention other birds found in association with the shores of the lakes and rivers.

1. Water Birds. Of the water birds only a few species were observed. The Herring Gull, Loon and American Merganser were found on Lake

FIG. 19. Carp river, station IV, showing zones of vegetation on the mud flats

FIG. 20. Beaver meadow, station VII. 2, showing grasses and sedges bordered by encroaching willows and alders. Tamarack and spruce in the background.

Superior. A Loon was once seen on Carp Lake and a Pied-billed Grebe was seen on Little Carp Lake. The only water bird found on the rivers was the Hooded Merganser which was taken on Carp river.

Although not an aquatic bird, I will mention the Osprey here as it was seen flying over the water. It was first seen near the mouth of Union river and afterwards over Carp Lake. It would circle around above the water until it saw a fish and then it would plunge into the water after it. As far as observed most of these efforts were successful.

2. Birds Frequenting Shores and Banks of Streams. Shore birds were most abundant along Carp and Little Carp rivers; only a few were seen on the lake beaches. The Solitary Sandpiper was the only one seen in all the places mentioned. The Lesser Yellow-legs was seen only along Little Carp river. The Least Sandpiper was seen along Little Carp river and on the Lake Superior beach. The Spotted Sandpiper was seen only on the Lake Superior beach. These birds were always seen near the waters edge except when on the wing. A Snipe was seen at the edge of the water along Carp river, in the neighborhood of a grassy marsh.

Another bird that was characteristic of the rivers and small lakes was the Kingfisher, which was nearly always seen at the edge of the water, but never on the ground. It always lit on some bush or tree, and was most frequently seen on trees overhanging the water. The Great Blue Heron was seen standing on the edge of Carp Lake once, and several times it was seen flying over.

Besides the birds characteristic of the waters edge, birds from the alders and birds of general distribution were often observed on the beach of Carp Lake and Lake Superior. This includes such birds as the Song Sparrow, Swamp Sparrow, Crow and Raven.

3. Birds Found in Grassy Marshes and in Alders. Closely associated with the birds of the water's edge were the birds of grassy marshes and alders along the streams. The birds often seen in the grassy marshes were the Wilson's Snipe, Rail, Song Sparrow, and Swamp Sparrow. The Rail was only seen once in the grassy marsh east of Carp Lake.

The Song Sparrow and Swamp Sparrow are not confined to the grassy marshes, since both were also found in the alders. The Song Sparrow was also found in the camp clearing (Station III. 3) and in one of the clearings in the arbor vitae swamp (Station II. 1), so that the Song Sparrow may be said to inhabit clearings both natural and artificial, and the Swamp Sparrow may be said to inhabit marshy clearings. In this case I have classed the alders as a natural clearing because there were no trees among the bushes.

The only bird confined to the alders was the Alder Flycatcher, but several others, of limited distribution, were found here, such as the Redstart, Swamp Sparrow, Mourning Warbler, Olive-backed Thrush, Black-billed Cuckoo, Least Flycatcher, Song Sparrow, and Water Thrush.

The Redstart was rather common here and among the cedars near the shore of Lake Superior (Station II. 1) and was also seen along Little Iron river. It seems to keep near water and near the ground, as it was very seldom seen in the high trees.

The Mourning Warbler was found here, but also in the bushes of the camp clearing, and along the path to the lake in the cedar swamp (Station II. 1). Thus it is seen that this bird is not usually found in thickly forested woodland but is more decidedly a bird of the bushes or thickets.

The Olive-backed Thrush was found on the mountain top, in the river

valley, and in the bushes around the edge of the clearings or in partially cleared woodland. In the mornings and evenings it also appeared abundant among the scattered trees at the base of the talus slope. It was never found in dense woodland.

The Black-billed Cuckoo was often seen among the alders, in the scattered trees at the foot of the talus slope, and in the aspens surrounding the camp clearing. These facts show that it was a bird of the open woodland.

The Least Flycatcher was found in the alders and in a clearing in a hemlock forest; the former a natural, and the latter an artifical clearing. It was also seen in damp woodland south of Carp river, on the edge of a clearing.

The Water Thrush was seen in two other localities, the damp woodland south of Carp river, and along the road to Ontonagon near Lake Superior.

4. Birds Frequenting Tamarack Swamps and Cedar Swamps. The lowlands have all been dealt with, with the exception of the tamarack swamps and cedar swamps. The former was not entirely true to its name, as about half of the trees were cedar. The birds of these swamps deserving mention are as follows: Magnolia Warbler, Canadian Warbler, Sparrow Hawk, and Olive-sided Flycatcher, Red-breasted Nuthatch, Red Crossbill, White-winged Crossbill, Winter Wren, White-throated Sparrow, Golden-crowned Kinglet and Pine Siskin.

The Magnolia Warbler was found only in the cedar and tamarack swamps or along small streams where the arbor vitae grew.

The Canadian Warbler was found near Lake Superior shore and near Carp Lake and always in the more or less open woods.

The Sparrow Hawk was seen in a clearing among the cedars, and had a nest just south of the cliff in a limbless tree which stood above the tops of the surrounding trees. It was also often seen on the top of the cliff and around the camp clearing.

The Olive-sided Flycatcher was found in the tamarack swamp in Carp river valley and in a hemlock clearing near Lake Superior. It was always seen on the top of a dead tree, usually on the highest perch in the neighborhood.

The Red-breasted Nuthatch was seen in the tamarack swamp, and among the pines at the top of the mountain. It can, therefore, be classed with the birds characteristic of the coniferous forests.

The Red, and White-winged Crossbills were numerous in the tamarack swamps, the White-winged Crossbill being seen only in such places. The Red Crossbill came to the camp clearing several times. The cause for their occurrence in the tamaracks is that these are the only conifers whose seeds could be obtained for food.

The Golden-crowned Kinglets and Pine Siskins were very abundant among the coniferous trees, and were seldom seen where these were lacking. The Pine Siskin occasionally came to the camp clearing.

The Winter Wren and White-throated Sparrow were found in the lowlands and about half way up the mountain side. The White-throated Sparrow frequented the open woodland and the edge of the clearings. The Winter Wren was found in the more dense parts of the forests and near streams.

5. Birds Frequenting Hemlocks and Maples. Nearly all the birds that were found in these two stations were also found in the cedar swamp to the north (II. 1) or belonged to the list of rare birds. There were a number of birds that were generally distributed in all the woodland between the Lake Superior and Carp river which, with the exception of the Blackburnian Warbler,

seemed to be more abundant in these two stations. To this class belong the following: Oven Bird, Blackburnian Warbler, Hairy Woodpecker, Brown Creeper and Pileated Woodpecker.

6. Birds Frequenting the Cliff and Mountain Top. The birds characteristic of this station were the Raven, Pine Warbler, Robin, Bluebird, Flicker, Junco and Chipping Sparrow.

The two specimens of Pine Warbler, which were observed several times, were always found among the pines that grew on the top and south slope, so it may be said to be characteristic of the pines.

The Robin and Bluebird were often observed on the bare top of the cliffs, and occasionally the Robin was seen in the camp clearing near by. The Robin and the Bluebird are early migrants and may have settled here because it was on the south side of the mountain and well exposed to the sun and protected from the north winds.

The Flicker was found here and in a clearing along the south shore of Lake Superior. The Junco was abundant here and was seen in a dry sandy clearing near Ontonagon. It was also abundant on the dry knoll at the edge of Little Carp Lake so that this bird and the Flicker may be said in this region to inhabit dry clearings. They are also examples of the tendancy of natural clearing birds to spread into the artificial clearings.

The Chipping Sparrow was found here among the pines and on the dry knoll above mentioned.

The Blue Jay was found on the south slope of the cliff from the top to the edge of Carp Lake and on the dry knoll.

I have here only attempted to give the distribution of the birds as I found them in the Porcupine Mountains. The distribution of many of these birds may be very different in other localities. This would be an interesting field for study in other regions.

I am under obligations to the University Museum for the opportunity to make these observations, and I am also much indebted to Mr. Charles C. Adams for assistance in preparing this paper for publication.

THE ECOLOGICAL RELATIONS OF THE ORTHOPTERA IN THE PORCUPINE MOUNTAINS, MICHIGAN.

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1. GENERAL REMARKS.

The Orthoptera collected by Mr. A. G. Ruthven in the Porcupine Mountains represent two families of the *Saltatoria* and comprise two species of *Locustidae* and 14 species of *Acridiidae*. The collection was made between July 13 and August 12, 1904. Though the list is far from complete, it may be said, in general, that the species obtained are representative elements of the orthopterous fauna of the Canadian and cooler parts of the Transition zones of the central portion of the continent. The commingling of species is especially interesting, and in itself would suffice to indicate, within relatively narrow limits, the locality from whence the collection was derived and the environmental conditions present.

While data in addition to those of date, locality, and general character of the station are lacking—no notes on individual captures or particular species and their relation to the environment in this instance being available—I have no doubt that the ecological relations of the species secured are essentially the same as in other quarters of the eastern section of the country. This judgment is confirmed by the careful collecting notes and discriminating observations of Mr. Morgan Hebard in reference to the Orthoptera of the Keweenaw Bay region (Rehn, Entom. News, Sept., Oct., 1904). I have elsewhere (Pub. No. 18, Carnegie Inst. of Wash., p. 15 et seq.) classified the Acridian societies of eastern North America and discussed some of their more salient features. The same classification is followed in the present paper.

The Acridians secured represent several distinct societies and habitats. These habitats, or complexes of environmental conditions, when viewed from the standpoint of locust biology, may be arranged in three major groups:

1. Bare rock and soil surfaces of the lake shore, clearing, mountain top, or talus slope, either wet or dry,—these are inhabited by campestral geophilous locusts.

2. Areas clothed with a low vegetal growth of grasses or other herbaceous plants, such as meadows, fields, clearings, etc., likewise varying greatly in moisture content of soil, and often extremely limited in size,—these are the haunts of campestral phytophilous locusts.

3. Thickets of shrubs or stunted undergrowth bordering forest edges and openings, either along the lake shore, about clearings, or on the mountain top,—here dwell the sylvan phytophilous species.

Of the Locustarians collected, one species is a bush-dwelling form, nearly related to the katydid; the other, a shield-backed grasshopper, is a typical thicket-inhabiting species.

As is evident from Mr. Ruthven's field notes on the general character of the stations, and also from a consideration of the station lists of Orthoptera, almost every station contains two or more locust societies. These societies comprise one or more characteristic species of locusts which find their preferred haunts within a relatively narrow range of physical conditions and are practically characteristic of such habitats. It should be pointed out, however, that in the heart of its range a species is usually more generally distributed, and less restricted to its special habitat, than elsewhere; furthermore, that accidental occurrences are not infrequent and can be correctly estimated as such only by careful observation or experience. "One swallow does not make a summer," and the capture of a single specimen of a locust in a given locality does not necessarily indicate either an austral or a boreal climate, a campestral or a sylvan habitat.

It is scarcely necessary to state that the abundance and extent of the area occupied by the various elements of the locust fauna will inevitably be affected by the physical and organic agencies controlling the condition of the environments they inhabit, and, other things being equal, will change as they change. On the advent of new conditions one of three things will happen: either the species will become adapted to its changed environment, will emigrate, or will die out in that particular spot—probably the latter. There is every reason to think that with increasing deforestation of the territory, the thamnophilous locusts will increase in numbers; and that, if settlements and clearings multiply, so will the campestral locusts.

The avenue of ingress of the orthopterous fanua into this territory, it is believed, was on the southwest, along the continuous land surface, following the retreat of glacial conditions. This avenue was probably the only practicable one open to the flightless thicket-dwelling forms, and was doubtless followed by most, or all, of the flying species as well.

For further information in regard to the biology of the Orthoptera herein mentioned, the following works should be consulted, in addition to those already referred to:

Blatchley, W. S.—The Orthoptera of Indiana.—27th Annual Report of the Department of Geology and Natural Resources of Indiana.

Morse, Albert P.—Notes on the Acridiidae of New England.—Psyche, vols. VII, and VIII.

The former of these contains a valuable bibliography.

2. STATION LIST.

Station I. Beach of Lake Superior. Species taken: *Chloealtis abdominalis, Camnula pellucida, Circotettix verruculatus, Melanoplus atlanis* and *Melanoplus femoratus.*

Habitats represented and characteristic species.

1. Exposed rock or soil surfaces: *Circotettix verruculatus,* (*Camnula pellucida*).
2. Grassy places—dry: *Melanoplus atlanis* and *Camnula pellucida.*
3. Grassy places—moist: *Melanoplus femoratus.*
4. Thickets—forest edge: *Chloealtis abdominalis.*

Station II. North Slope of First Range. Species taken:

Sub. 2.—Hardwood Forest.—*Tettix brunneri.*

Habitats represented and characteristic species.

The single species taken is not typical of forested environment, usually occurring on bare soil.

Sub. 3.—*Clearing in Saddle.* Species taken: *Chloealtis conspersa, Stenobothrus curtipennis, Circotettix verruculatus, Melanoplus extremus,* and *Melanoplus femoratus.*

Habitats represented and characteristic species. (No notes on conditions at this station have been submitted, but the habitats are probably the following:)

1. Exposed rock or soil surfaces: *Circotettix verruculatus.*
2. Grassy places—moist: *Stenobothrus curtipennis, Melanoplus extremus* and *Melanoplus femoratus.*
3. Thickets—edges of clearing (sometimes in dry, grassy places): *Chloealtis conspersa.*

Sub. 5.—*Aspen Zone Bordering Bare Mountain Top.* Species taken: *Melanoplus fasciatus.*

Habitats represented and characteristic species.

1. Thickets—usually xerophytic: *Melanoplus fasciatus.*

Station III. Top of First Range and Southern Escarpment. Species taken:

Sub. 1.—West Slope of Ridge (aspen zone).—*Chloealtis abdominalis, Chloealtis conspersa, Camnula pellucida, Melanoplus fasciatus, Melanoplus femoratus* and *Melanoplus luridus.*

Sub. 2.—Bare Mountain Top (heath and grass vegetation).—*Chloealtis abdominalis, Chloealtis conspersa, Circotettix verruculatus, Melanoplus fasciatus* and *Melanoplus islandicus.*

Sub. 3.—Zone of Pines crossing Mountain Top.—*Melanoplus fasciatus.*

Sub. 4.—East Slope of Ridge (aspen and scrub oak vegetation).—*Melanoplus fasciatus* and *Atlanticus pachymerus.*

Sub. 5.—Mountain Top.—*Chloealtis abdominalis, Chloealtis conspersa, Melanoplus fasciatus, Melanoplus femoratus, Circotettix verruculatus* and *Atlanticus pachymerus.*

Sub. 6.—Mountain Top.—*Melanoplus amplectens.*

Habitats represented and characteristic species.

1. Exposed rock surfaces:—*Circotettix verruculatus.*
2. Grassy places—(usually moist):—*Melanoplus femoratus.*
3. Thickets:—*Chloealtis conspersa* and *abdominalis, Melanoplus amplectens, fasciatus,* and *islandicus, Atlanticus pachymerus.*

Station IV. 2. Carp River Valley Flood-plain (characterized by cassandra thickets, grasses and sedges). Species taken: *Stenobothrus curtipennis, Podisma glacialis, Melanoplus islandicus, Atlanticus pachymerus, Scudderia pistillata.*

Habitats represented and characteristic species.

1. Grassy places—moist:—*Stenobothrus curtipennis.*
2. Thickets:—*Podisma glacialis, Melanoplus islandicus, Atlanticus pachymerus.*
3. Bushes, leafage of:—*Scudderia pistillata.*

Station VII. 2. Beaver Meadow along Little Carp River. Species taken:—*Camnula pellucida.*

Habitats represented and characteristic species.

1. Grassy places—moist. The species of locust taken here is not characteristic of such conditions, but it is a very common and widely distributed species in the boreal zones, and may occur almost anywhere, especially in grassy places. Its preferred haunts are on dry upland soils.

3. SYSTEMATIC LIST OF THE ORTHOPTERA.

Porcupine Mountains.

ACRIDIIDAE.

1.	*Tettix brunneri* Bol.	1 ♂, Station II.
2.	*Chloealtis abdominalis* Thom.	1 ♂, Station III., Substation 1.
	" "	1 ♂, III., 2.
	" "	2 ♂, 3 ♀, III., 5.
	(juv. spec. do.)	♀, juv. in the 5th stage, I.
	"	♂, juv. in the 5th stage, III., 2.
	"	2 ♀, juv. in the 5th stage, III., 2.
	"	♀, juv. in the 4th stage, III., 2.
	"	♀, juv. in the 5th stage, III., 5.
3.	*Chloealtis conspersa* Harr.	1 ♀, II., 3.
	" "	1 ♀, III., 1.
	" "	1 ♀, III., 1, long-winged.
	(juv. spec. do.)	♂, juv. in the 5th stage, III., 1.
	"	♂, juv. in the 4th stage, III., 2.
4.	*Stenobothrus curtipennis* Harr.	2 ♀, II., 3.
	" "	2 ♂, IV., 2.
	" "	1 ♀, IV., 2.
5.	*Camnula pellucida* Scudd.	1 ♀, III., 1.
	" "	1 ♂, I., beach.
	" "	1 ♀, I., beach.
	" "	2 ♀, VII., 2.
6.	*Circotettix verruculatus* Kirb.	1 ♀, II., 3.
	" "	3 ♂, III., 2.
	" "	1 ♂, III., 2.
	" "	1 ♀, III., 2.
	" "	1 ♀, III., 2.
	" "	1 ♀, III., 5.
	" "	2 ♂, I., beach.
	" "	1 ♀, I., beach.
7.	*Podisma glacialis* Scudd.	1 ♀, IV., 2.
8.	*Melanoplus amplectens* Scudd.	1 ♀, III., 6.
9.	*Melanoplus atlanis* Ril.	1 ♂, I., beach.
10.	*Melanoplus extremus* Walk.	2 ♀, II., 3.
11.	*Melanoplus fasciatus* Barnst.-Walk.	1 ♂, II., 5.
	" "	1 ♀, II., 5.
	" "	1 ♂, III., 2.
	" "	1 ♂, III., 2.
	" "	4 ♀, III., 2.
	" "	1 ♂, III., 3.
	" "	1 ♀, III., 3.
	" "	1 ♂, III., 4.
	" "	1 ♂, 4 ♀, III., 5.
12.	*Melanoplus femoratus* Burm.	4 ♂, II., 3.
	" "	8 ♀, II., 3.
	" "	1 ♀, III., 1.
	" "	1 ♂, III., 5.
	" "	2 ♀, I., beach.
	" "	1 ♂, I., beach.
	(juv. spec. do.)	2 ♀, juv. in the 5th stage, II., 3.

13.	*Melanoplus islandicus* Blatchl.	1♀, II., 5.
	" "	1♂, III., 2.
	" "	1♀, IV., 2.
14.	*Melanoplus luridus* Dodge.	1♂, III., 1.

LOCUSTIDAE.

15.	*Scudderia pistillata* Brunn.	1♀, IV., 2.
16.	*Atlanticus pachymerus* Burm.	1 juv. ♀, III., 4.
	" "	1♀, III., 4.
	" "	1♀, IV., 2.
	" "	1♂, III., 5.

Isle Royale.

The following species were identified from this locality; no field notes accompanied the specimens.

1.	*Tettix acadicus* Scudd.	1♀, III.
2.	*Camnula pellucida*, Scudd.	2♂, 2♀, II.
3.	*Ceuthophilus seclusus* Scudd.	1♂, III.
	" "	1♀, III.

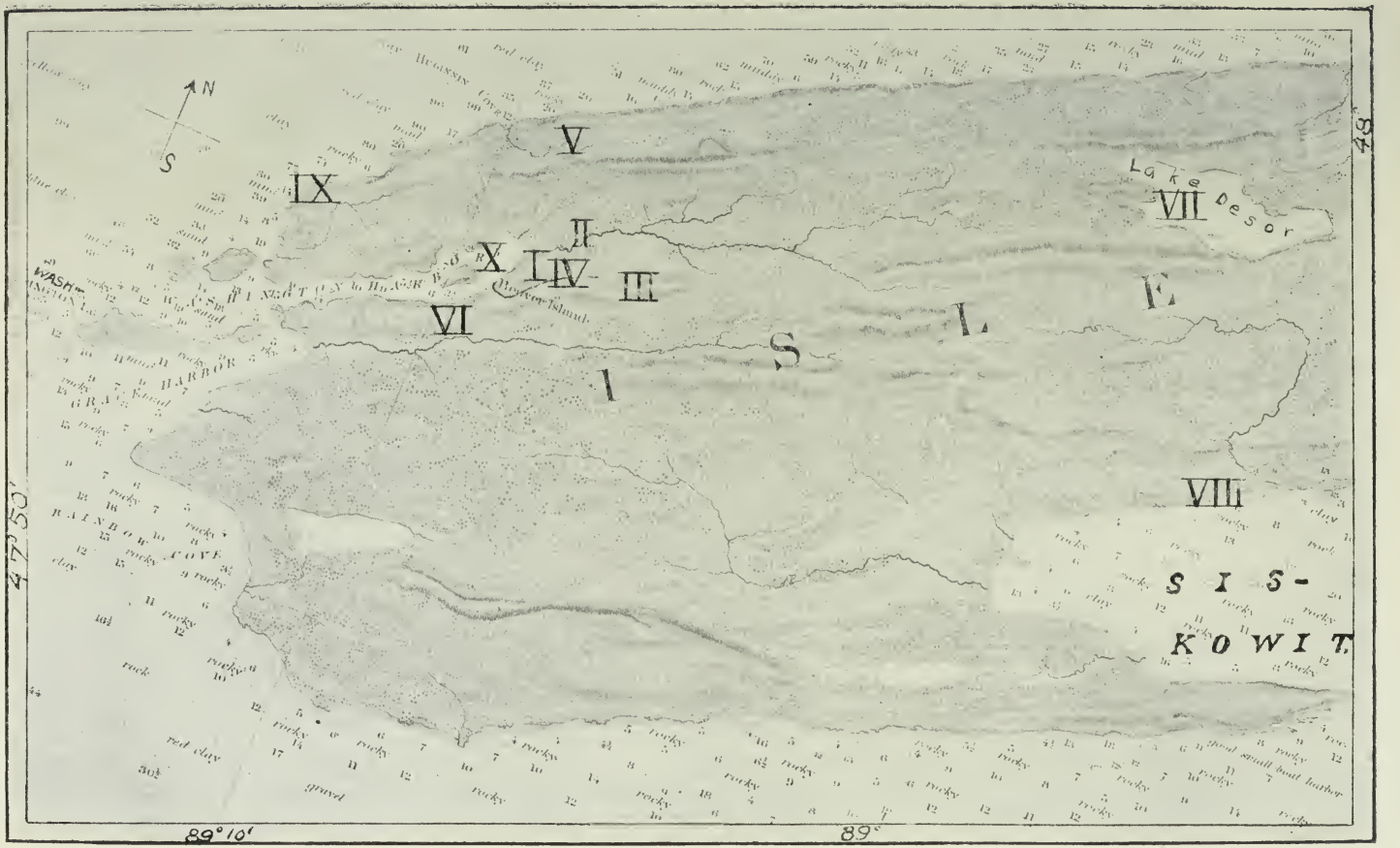

Fig. 21. Map of lower end of Isle Royale, showing the location of field stations. Scale, 2 miles to the inch. (From U. S. Lake Survey Chart).

ANNOTATED LISTS.

LIST OF STATIONS IN THE PORCUPINE MOUNTAINS.

See Fig. 3.

Station I.—Beach of Lake Superior, Secs. 11 and 12, T. 51 N., R. 43 W.

Station II.—North Slope of First Range, Secs. 11, 12, 13, 14, 15, and 16, T. 51 N., R. 43. W.

Sub. 1.—Arbor Vitae Swamp at Foot of Slope, Secs. 11 and 12.

Sub. 2.—North Slope, Secs. 11, 12, and 14.

Sub. 3.—Clearing in the Saddle, Sec. 14.

Sub. 4.—Aspen Zone about Clearing, Sec. 14.

Sub. 5.—Aspen Zone at Top of Ridge bordering the Bare Mountain Top, Secs. 13, 14, 15, 21, T. 51 N., R. 43 W.

Station III.—Top of the First Range and the Southern Escarpment, Secs. 13, 14, 15, and 21, T. 51 N., R. 43 W.

Sub. 1.—West Slope of the Ridge on Secs. 13 and 14.

Sub. 2.—Bare Mountain Top, Secs. 13 and 14.

Sub. 3.—Zone of Pines crossing the First Range, Secs. 13 and 14.

Sub. 4.—East Slope of the Ridge on Secs. 13 and 14.

Sub. 5.—Mountain Top on Sec. 14 and 15.

Sub. 6.—Mountain Top on Sec. 21.

Station IV.—Carp River Valley on Secs. 13, 14, 23, and 24, T. 51 N., R. 43 W.

Sub. 1.—Carp River, Secs. 14 and 24.

Sub. 2.—Flood-plain, Sec. 14.

Sub. 3.—Valley Slopes, Secs. 14 and 23.

Sub. 4.—Peat Bog, Sec. 14, 23 and 24.

Station V.—Carp Lake, Secs. 15, 21 and 22, T. 51 N., R. 43 W.

Sub. 1.—Beach at West End of Lake, Secs. 21 and 22.

Sub. 2.—Delta at East End of Lake, Sec. 22.

Sub. 3.—Carp Lake, Sec. 22.

Station VI.—Mountains between the Carp and Little Carp Drainage Systems, Secs. 21, 22, 23, 27, 28, and 34, T. 51 N., R. 43 W.

Station VII.—Little Carp Drainage System, Sec. 2, T. 50 N., R. 44 W., and Sec. 34, T. 51 N., R. 43 W.

Sub. 1.—Little Carp Lake, Sec. 2, T. 50 N., R. 44 W.

Sub. 2.—Beaver Meadow along Little Carp River, Sec. 34, T. 51 N., R. 43 W.

Sub. 3.—Little Carp River, Sec. 34, T. 51 N., R. 43 W.

LIST OF STATIONS ON ISLE ROYALE.

See Fig. 21.

Station I.—Clearing on the Shore of Washington Harbor, Sec. 29, T. 64 N., R. 38 W.

Station II.—Washington River, Sec. 29, T. 64 N., R. 38 W.

Station III.—Trail along the Top of Greenstone Range, T. 64 N., R. 38 W.

Station IV.—Washington Creek, Secs. 28 and 32, T. 64 N., R. 38 W.

Station V.—Tamarack Swamp, Sec. 20, T. 64 N., R. 38 W.

Station VI.—North Slope of Greenstone Range, Sec. 32, T. 64 N., R. 38 W.

Station VII.—Lake Desor, T. 64 N., R. 32 W.

Station VIII.—West End of Siskowit Bay, T. 64 N., R. 32 W.

Station IX.—Southwestern End of Minong Trap Range, Sec. 30, T. 64 N., R. 39 W.

Station X.—Washington Harbor, T. 64 N., R. 38 W.

NOTES ON THE PLANTS OF THE PORCUPINE MOUNTAINS AND ISLE ROYALE, MICHIGAN.

A. G. RUTHVEN.

This list has been prepared from the collections and field notes of Mr. N. F. Macduff, and the field notes of the writer. To Mr. Macduff, who devoted his time to collecting and listing the plants, many of the determinations and most of the annotations are due. The writer was able to add many localities to the list while locating the different stations. We are indebted to Dr. C. A. Davis and Mr. S. Alexander for the determination of the Pteridophytes and Spermatophytes in the herbarium, and to Prof. B. Fink for the determination of the Lichens. The nomenclature followed is that given in Britton's "Manual of the Flora of the Northern States and Canada," (1901). For the general habitat conditions and associations, reference should be made to the discussion of the stations on pp. 22-40, 48-52.

1. PORCUPINE MOUNTAINS.*

Lichens

1. *Amphiloma* (*Pannaria*) *languinosum* (Ach.) Koerb. Found only in shady places on the cliff face, III.
2. *Biatora lucida* (Ach.) Fr. Associated with *Amphiloma languinosum* on the cliff face, III.
3. *Cladonia alpestris* (L.) Rabenh. Occurs in mats, covering the talus blocks toward the bottom of the slopes where a slight soil has accumulated, III.
4. *Cladonia rangiferina* (L.) Hoffm. Abundant on the lower part of the talus slopes with *C. alpestris*, also on ledges of the cliff that possess a slight soil, III, and in the pine zone, III. 3.
5. *Endocarpum miniatum* (L.) Sch. Covering the rocks in very damp places on the banks of Carp creek, VI.
6. *Gyrophora* (*Umbilicaria*) *vellea* (L.) Nyl. Only found on the cliff face, III.
7. *Lecidea lactea* Flk. This species is one of the pioneer forms on rock habitats and was found associated with *Parmelia conspersa* and *Lecanora cinerea* on the mountain top, cliff face and talus slopes, III; also on the Middle Beach of Lake Superior, I.
8. *Lecanora conspersa*. With *Parmelia conspersa* and *Lecidea lactea* on ledges on the cliff, and on the talus slopes, III. Apparently a pioneer form in rock habitats.
9. *Lecanora cinerea* (L.) Sommerf. A pioneer form in rock habitats,

*A list of plants from the Porcupine Mountains was published by W. A. Burt in 1848. Jackson, 1st Sess. 31st Cong., Vol. 3, pp. 876–882.

occurring on the Middle Beach of Lake Superior, I, and on the mountain top, cliff and talus slopes, III.

10. *Parmelia conspersa* (Ehrh.) Ach. This is the most characteristic form on rock habitats in this region. It occurs abundantly on the Middle Beach of Lake Superior, I, and on the mountain top, cliff, and talus slopes, III.

11. *Peltidea* (*Peltigera*) *aphthosa* (*L.*) Ach. Found quite commonly on rocks in the pine zone, III. 3, and with the Cladonias near the bottom of the talus slopes, III.

12. *Stereocaulon coralloides* Fr. On the mountain top, cliff, and talus slopes, III.

13. *Sticta pulmonaria* (L.) Schau. Occasional on the trunks of fallen tamarack trees, IV. 4.

Ophioglossaceae Presl. Adder's-Tongue Family.

14. *Botrichium virginianum* (L.) Sw. In the climax forest, II. 2, IV. 3, VI.

Osmundaceae R. Br.

15. *Osmunda cinnamomea* L. Cinnamon Fern. Occasional in the alder thickets along Carp river, IV. 2.

16. *Osmunda claytoniana* L. Clayton's Fern. In hardwood forest, II. 2, VI, (Macduff).

Polypodiaceae R. Br. Fern Family.

17. *Polypodium vulgare* L. In exposed situations, occurring commonly on the Upper Beach of Lake Superior, I; on the bald areas on the mountain top, III. 2, 5, 6; in the aspen zone, II. 5, and III. 1, 4; in the pine zone, III. 3, and on the lower parts of the talus slope.

18. *Adiantum pedatum* L. Maiden-hair Fern. Common in the mesophytic forest, II. 2, IV. 3, VI.

19. *Pteridium aquilinum* (L.) Kuhn. Brake. In open places in the forest, II. 2, IV. 3, VI, becoming more abundant in the open woods toward the top of the ranges and on the foot of the talus slope. Especially abundant in the aspen zone bordering the mountain top, II. 5, III. 1, 4. Also in the pine zone, III. 3.

20. *Asplenium trichomanes* L. Spleenwort. In rock crevices on the mountain top, III. 2, 5, 6, and on ledges and in crannies on the cliff face, III.

21. *Polystichum lonchitis* (L.) Roth. Holly-fern. In rock crevices on the mountain top, III. 2, 5, 6; on ledges on the cliff face, and in front of the forest on the lower part of the talus slopes, III.

22. *Dryopteris spinulosa* (Retz) Kuntze. In the hardwood forest, II. 2. Common.

23. *Onoclea sensibilis* L. Sensitive Fern. In the alder thickets along Carp river, IV. 2, and on the banks of Carp creek, VI.

Equisetaceae Michx. Horsetail Family.

24. *Equisetum sylvaticum* L. In the forest in the valley of Carp river. IV. 3, and on Government Peak, VI, (Macduff).

25. *Equisetum littorale* Kuehl. On the delta of Carp river, V. 2.

26. *Equisetum fluviatile* L. On the submerged part of the delta in Carp Lake, V. 2; about the margin of Carp Lake, V. 1, and about the margin and on the delta of Little Carp Lake, VII. 1.

27. *Equisetum hyemale* L. About the shores of Carp Lake, V. 1, and on the delta, V. 2.

Lycopodiaceae Michx. Club-Moss Family.

28. *Lycopodium selago* L. Common in the aspen zone, II. 5; also found in the pine zone, III. 3.

29. *Lycopodium lucidulum* Michx. A common plant in the ground cover of the hardwood forest, II. 2; VI.

30. *Lycopodium clavatum* L. Running Pine. In the arbor vitae swamp, II. 1; in the hardwood forest, II. 2, and in the aspen zone, II. 5, III. 1, 4.

31. *Lycopodium complanatum* L. Common in the aspen zone, II. 5, III. 1, 4. Often extending out on the heath mats.

Pinaceae Lindl. Pine Family.

32. *Pinus strobus* L. White Pine. Large isolated trees occur through the hardwood forest, II. 2, IV. 3, VI. More abundant in the aspen zone, II. 5. Occurs principally as a scattered growth with *P. resinosa* on the heath mats on the mountain top, on the ledges on the cliff face, and on the talus slopes, III, forming belts of denser growth where the cliff face is broken by large ledges.

33. *Pinus resinosa* Ait. Red or Norway Pine. Associated about equally with *P. strobus* on the mountain top, cliff, and talus slopes, III. Not present in the hardwood forest.

34. *Pinus divaricata* (Ait.) Gord. Labrador or Gray Pine. Several specimens observed on the heath mat on the mountain top, III. 5.

35. *Larix laricina* (Du Roi) Koch. American Larch. Tamarack. Occasional in the cassandra and alder thickets along Carp river, IV. 2, in the broader portions of the flood-plain, and about the beaver meadow on Little Carp river, VII. 2; often forming in the last two habitats a zone with *Picea canadensis* and *Abies balsamea* between the alder thickets and the deciduous forest of the slopes. Predominates in peat bogs, forming a nearly pure stand, IV. 4.

36. *Picea canadensis* (Mill.) B. S. P. White Spruce. Occasional in the arbor vitae swamp, II. 1; in the tamarack swamp, IV. 4; in the coniferous zone behind the alder thickets in the valley of Carp river, IV, and about the beaver meadow on Little Carp river, VII. 2.

37. *Tsuga canadensis* (L.) Carr. Hemlock. This tree nearly always forms a small portion of the tree cover in the hardwood forest, II. 2, IV. 3, VI. Occasionally, as at the foot of the north slope of the first range and on the south slope of the second range, it predominates, forming dense forests with little underbrush.

38. *Abies balsamea* (L.) Mill. Balsam Fir. Widely distributed, occurring, but never predominating, in the climax forest, II. 2, IV. 3, VI. It also occurs with the Spruce and Tamarack in the coniferous society in the valley of Carp river, IV. 2; about the beaver meadow on Little Carp river, VII. 2, and in the tamarack, IV. 4, and arbor vitae swamps, II. 2; being more abundant in these coniferous societies.

39. *Thuja occidentalis* L. White Cedar. Arbor Vitae. This tree occurs in the rock crevices on the Upper Beach of Lake Superior, I; occasionally on the cliff face, III, and about the margins of Carp, V, and Little Carp Lakes, VII. It is more characteristic, however, of the swampy areas at the foot of the north slope, II. 1, and in the river valleys, IV. 2, where it forms a dense and almost impenetrable growth.

40. *Juniperus nana* Willd. Low Juniper. Characteristic of the "bald" areas of the mountain top, III. 1, 2, 4, 5, 6, spreading out from the crevices as circular mats over the rocks.

Taxaceae Lindl. Yew Family.

41. *Taxus canadensis* Marsh. Ground Hemlock. Forms, with young Sugar Maples, the principal undergrowth of the hardwood forest, II. 2, IV. 3, VI.

Naiadaceae Lindl.

42. *Potamogeton natans* L. Common Floating Pond-weed. Occasional in Carp river, IV. 1, and forms a well defined zone in shallow water about the margin of Carp Lake, V. 1.

Alismaceae DC. Water-Plantain Family.

43. *Sagittaria sp.* Arrow-head. Near the margin of the water on the mud flats, IV. 1, and delta, V. 2, of Carp river.

Vallisneriaceae Dumort. Tape-grass Family.

44. *Vallisneria spiralis* L. Tape-grass. Forms extensive mats in the shallow water at the west end of Carp Lake, V. 1, and occasionally about the margin of Little Carp Lake, VII. 1.

Gramineae Juss. Grass Family.

45. *Panicum xanthophysum* A. Gray. Slender Panicum. In the rock crevices on the mountain top, III. 2, 5, 6.

46. *Cinna latifolia* (Trev.) Griseb. Occasional in the hardwood forest, II. 2, IV. 3, and along the banks of Carp creek, VI.

47. *Agrostis hyemalis* (Walt.) B. S. P. Rough Hair-grass. On the delta of Carp river, V. 2, and in the beaver meadow on Little Carp river, VII. 2.

48. *Calamagrostis canadensis* (Michx.) Beauv. Blue Joint-grass. In the cassandra zone, on the dryer parts of the mud flats, IV. 2, and delta V. 2, of Carp river, and in the beaver meadow on Little Carp river, VII. 2.

49. *Deschampsia flexuosa* (L.) Trin. Wavy Hair-grass. In the cassandra zone, IV. 2, and on the delta, V. 2, of Carp river; also in the beaver meadow, VII. 2, on Little Carp river.

50. *Panicularia canadensis* (Michx.) Kuntze. Rattlesnake-grass. Cassandra zone, IV. 2, and delta, V. 2, of Carp river; also in the beaver meadow, VII. 2, on Little Carp river.

Cyperaceae J. St. Hil. Sedge Family.

51. *Dulichium arundinaceum* (L.) Britton. Dulichium. Near the submerged margins of the mud flats and deltas of Carp and Little Carp rivers.

52. *Scirpus cyperinus* (L.) Kunth. Wool-grass. In the cassandra zone and on the mud flats, IV. 2, and delta, V. 2, of Carp river; and on the mud flats and beaver meadow along Little Carp river, VII. 2. Also along the bank of Carp creek, VI.

53. *Carex monile* Tuckerm. A prominent sedge in the beaver meadow on Little Carp river, VII. 2.

54. *Carex riparia* Curtis. In the cassandra zone and on the mud flats,

IV. 2, and delta, V. 2, of Carp river. Also about the shore of Carp Lake, V. 1.

55. *Carex filiformis* L. In the cassandra zone, on the mud flats, IV. 2, and delta, V. 2, of Carp river; and in the beaver meadow and on the mud flats on Little Carp river, VII. 2.

56. *Carex crinita* Lam. On the banks of Carp creek, VI.

57. *Carex viridula* Michx. In the cassandra zone and on the mud flats IV. 2, and delta, V. 2, of Carp river; and in the beaver meadow and on the mud flats of Little Carp river, VII. 2.

58. *Carex pubescens* Muhl. Along the banks of Carp Creek, VI.

Araceae Neck. Arum Family.

59. *Spathyema foetida* (L.) Raf. Skunk Cabbage. Occasional in the alder thickets along Carp river, IV. 2, and along the banks of Carp Creek, VI.

Eriocaulaceae Lindl. Pipewort Family.

60. *Eriocaulon septangulare* With. Seven-angled Pipewort. Common on the shores of Carp Lake, V. 1.

Juncaceae Vent. Rush Family.

61. *Juncus effusus* L. Bog Rush. Common on the mud flats, IV. 2, and delta V. 2, of Carp river. Also abundant in the beaver meadow and on the mud flats on Little Carp river, VII. 2.

62. *Juncus tenuis* Willd. In the beaver meadow and on the mud flats of Little Carp river, VII. 2.

63. *Juncus canadensis* J. Gay. Canada Rush. In shallow water about the margin of Carp Lake, V, and Little Carp Lake, VII. 1.

Convallariaceae Link. Lily-of-the-valley Family.

64. *Clintonia borealis* (Ait.) Raf. Yellow Clintonia. A very common form in the hardwood forests, II. 2, IV. 3, VI.

65. *Vagnera racemosa* (L.) Morong. Wild Spikenard. In the hardwood forest, II. 2, IV. 3, VI.

Iridaceae Lindl. Iris Family.

66. *Iris versicolor* L. Larger Blue Flag. On the mud flats and in the cassandra and alder thickets along Carp river, IV. 2; also in the beaver meadow on Little Carp river, VII. 2, and in the arbor vitae swamps, II. 1.

Orchidaceae Orchid Family.

67. *Gyrostachys cernua* (L.) Kuntze. Nodding Ladies Tresses. On the shores of Carp Lake, V. 1; on the delta, V. 2, and occasionally in the cassandra zones on Carp river, IV. 2. Also in the beaver meadow on Little Carp river VII. 2.

68. *Peramium pubescens* (Willd.) Mac M. Downy Rattlesnake Plantain. Generally distributed through the hardwood forest, II. 2, IV. 3, VI; also occurring in the tamarack swamp, IV. 4.

Salicaceae Lindl. Willow Family.

69. *Populus grandidentata* Michx. Large-toothed Aspen. In the hardwood forest bordering the beach of Lake Superior, I, the clearing, II. 2, and

mountain top, II. 5, III. 1 and 4. Also on the lower part of the talus slope, III, and in burnings.

70. *Populus tremuloides* Michx. American or Quaking Aspen. The principal form of the forest bordering open localities; adjoins the beach of Lake Superior, I, the clearing, II. 4, and the mountain top, II. 5, III. 1 and 4. Also conspicious on the lower part of the talus slopes, III, and in burnings, VI.

71. *Salix spp.* Willow. A number of willows occur in the alder and cassandra zones along Carp river, IV. 2; in the beaver meadow on Little Carp river, VII. 2, and in the aspen zone on the mountain top, II. 5.

Myricaceae Dumort. Bayberry Family.

72. *Myrica cerifera* L. Wax-myrtle. In the cassandra zone along Carp river, IV. 2.

Betulaceae Agardh. Birch Family.

73. *Ostrya virginiana* (Mill.) Willd. Iron-wood. Occasional in the hardwood forest, II. 2, IV. 3, VI.

74. *Corylus rostrata* Ait. Beaked Hazel-nut. In the woods on the lower part of the talus slopes, IV. 3; pushing out beyond the forest with the birches and often extending well up the slope, III.

75. *Betula papyrifera* Marsh. Paper or Canoe Birch. Throughout the climax forest, II. 2, IV. 3, VI. Also a prominent form on the lower part of the talus slopes, IV. 3.

76. *Betula lutea* Michx. Yellow Birch. Occasional through the forest II. 2, IV. 3, VI. More conspicious in the hemlock forests.

77. *Betula glandulosa* Michx. Glandular or Scrub Birch. Common about the margin of the beaver meadow, VII. 2; with *Alnus incana* and several willows encroaching on the meadow.

78. *Alnus alnobetula* (Ehrh.) K. Koch. Green or Mountain Alder. A few shrubs occur in the aspen zone bordering the mountain top, III. 5.

79. *Alnus incana* (L.) Willd. Speckled or Hoary Alder. Nearly always present along streams, forming dense thickets. Along Carp river, IV. 2, between the cassandra and coniferous zones on wide parts of the flood-plain, and between the river and the forest where the flood-plain is narrow. Where a cassandra zone is present, there is nearly always a narrow strip of alders along the natural levees, separating the cassandra zone from the river. Also common about Carp Lake, V. 1; Little Carp Lake, VII. 1, and the beaver meadow, VII. 2.

Fagaceae Drude. Beech Family.

80. *Quercus rubra* L. Red Oak. A prominent form in the aspen zone, II. 5, III. 1, 4, bordering the mountain top. Also on the fine material at the top of the talus slope and on the ledges on the cliff face, III.

81. *Quercus macrocarpa* Michx. Burr Oak. In the aspen zone, II. 5, bordering the mountain top.

Nymphaeaceae DC. Water-lily Family.

82. *Nymphaea advena* Soland. Large Yellow Pond Lily. Abundant in Carp river, IV. 1, and near the margin of Carp Lake, V. 3.

83. *Castalia odorata* (Dryand.) Woodv. and Wood. Sweet-scented White

Water Lily. Several specimens were found in Carp river, IV. 1, which was the only locality in which it was observed.

Ranunculaceae Juss. Crowfoot Family.

84. *Caltha palustris* L. Marsh-marigold. In the alder thickets along Carp river, IV. 2; also common on the banks of Carp creek, VI.

85. *Coptis trifolia* (L.) Salisb. Gold-thread. Common in the hardwood forest, II. 2, IV. 3, VI, and in the tamarack swamp, IV. 4.

Sarraceniaceae LaPyl. Pitcher-Plant Family.

86. *Sarracenia purpurea* L. Pitcher-plant. Found commonly in the peat bog, IV. 4, and on a Sphagnum growth in the beaver meadow, VII. 2. Not observed elsewhere.

Rosaceae B. Juss. Rose Family.

87. *Opulaster opulifolius* (L.) Kuntze. Eastern Ninebark. Upper Beach of Lake Superior, I; in the aspen zone bordering the mountain top, II. 5, and on the rocky bluff at the east end of Little Carp Lake, VII.

88. *Spiraea salicifolia* L. American Meadow-sweet. In the cassandra zone on Carp river, IV. 2, and about the margin of the beaver meadow on Little Carp river, VII. 2.

89. *Rubus parviflorus* Nutt. White-flowering Raspberry. In the aspen zone about the clearing, II. 4, and mountain top, II. 5; in the open woods near the top of the slope, II. 2, and in burnings, VI. Very common in exposed situations. Locally known as the Thimbleberry

90. *Rubus strigosus* Michx. Wild Red Raspberry. On the Upper Beach of Lake Superior, I; in the aspen zone about the clearing, II. 4, and on the mountain top, II. 5. Also at the foot of the talus slopes, III.

91. *Rubus nigrobaccus* Bailey. High Bush Blackberry. Frequent in the cassandra zone, IV. 2, especially near the margin of the alder thickets.

92. *Rubus hispidus* L. Running Swamp Blackberry. Common in the cassandra zone on Carp river, IV. 2, and in the beaver meadow, VII. 2.

93. *Comarum palustre* L. Marsh Cinquefoil. In the cassandra zone, IV. 2, and on the delta of Carp river, V. 2, and in the beaver meadow on Little Carp river, VII. 2.

94. *Dasiphora fruticosa* (L.) Rydb. In the cassandra zone, IV. 2, and on the delta, V. 2.

94a. *Potentilla argentea* L. Silvery Cinquefoil. In rock crevices on the Middle and Upper Beaches of Lake Superior, I.

95. *Sibbaldiopsis tridentata* (Soland.) Rydb. Common in the rock crevices on the mountain top and on the cliff face, and among the rocks on talus slopes, III.

Pomaceae L. Apple Family.

96. *Sorbus americana* Marsh. American Mountain Ash. Common on the Upper Beach of Lake Superior, I, and at the foot of the talus slopes, III. Also occurs on the rocky bluff at the east end of Little Carp Lake.

97. *Aronia nigra* (Willd.) Britton. Black Chokeberry. Occasional on the lower part of the talus slopes, III.

98. *Amelanchier canadensis* (L.) Medic. Juneberry. Common on the Upper Beach of Lake Superior, I; in the aspen zone bordering the mountain

top, II. 5, III. 1, 4; on the ledges of the cliff; at the bottom and top of the talus slopes, III, and in the tamarack swamp, IV. 4.

99. *Crataegus sp.* Thorn-apple. Occasional on the cliff face and on the fine material at the top of the talus slopes, III.

Drupaceae DC. Plum Family.

100. *Prunus pumila* L. Dwarf Cherry. On the Upper Beach of Lake Superior, I, and in burnings, VI.

101. *Prunus pennsylvanica* L. f. Wild Red Cherry. Common on the lower parts of the talus slopes and on the finer material at the top, III, Also occurs on the ledges of the cliff, III, and in burnings, VI.

Papilionaceae L. Pea Family.

102. *Lathyrus maritimus* (L.) Bigel. Beach Pea. Upper and Middle Beaches of Lake Superior, I.

103. *Lathyrus ochroleucus* Hook. Cream-colored Vetchling. Upper Beach of Lake Superior, I.

Anacardiaceae Lindl. Sumac Family.

104. *Rhus glabra* L. Scarlet Sumac. In the aspen zone about the clearing, II. 4, and mountain top, II. 5. Also scattered over the talus slopes, III.

105. *Rhus microcarpa* (Michx.) Steud. Northern Poison Oak. On the talus slopes and cliff face, III.

Aceraceae St. Hil. Maple Family.

106. *Acer saccharum* Marsh. Sugar or Rock Maple. The principal forest tree of the region, forming, with a small portion of Balsam Fir, Basswood and Hemlock, the climax forest of the region, II. 2, IV. 3, VI.

107. *Acer spicatum* Lam. Mountain Maple. Occurs as a scattered undergrowth in the hardwood forest, II. 2, IV. 3, VI; becoming more abundant in the open woods toward the talus slopes, III, mountain top, II. 5, and beach of Lake Superior, I.

Rhamnaceae Dumort. Buckthorn Family.

108. *Ceanothus americanus* L. New Jersey Tea. A prominent plant in the heath society on the mountain top, III. 2, 5, 6, and at the foot of the talus slope. Also occurs on the finer material at the top of the talus slope and on ledges of the cliff.

Vitaceae Lindl. Grape Family.

109. *Parthenocissus quinquefolia* (L.) Planch. Virginia Creeper. Occasional on the talus slopes and cliff face, III.

Tiliaceae Juss. Linden Family.

110. *Tilia americana* L. Basswood. Occasional in the hardwood forest, II. 2, IV. 3, VI.

Hypericaceae Lindl. St. Johns-wort Family.

111. *Hypericum ellipticum* Hook. Pale St. Johns-wort. On the delta, V. 2, and in the cassandra zone, IV. 2, on Carp river; and in the beaver meadow on Little Carp river, VII. 2.

Violaceae DC. Violet Family.

112. *Viola spp.* A number of species of violets occur in the forest, II, 2, IV. 3, VI., and in the alder thickets, IV. 2.

Eleagnaceae Lindl. Oleaster Family.

113. *Lepargyraea canadensis* (L.) Greene. Canadian Buffalo-berry. Upper Beach of Lake Superior, I.

Onagraceae Dumort. Evening-primrose Family.

114. *Chamaenerion angustifolium* (L.) Scop. Fire-weed. In the clearing, II. 3, at the foot of the talus slopes, III, and almost universally in burnings, VI.

115. *Onagra biennis* (L.) Scop. Common Evening-primrose. In the rock crevices on the mountain top, III. 2, 5, 6. Also on ledges on the cliff face.

Haloragidaceae Kl. and Garke. Water-milfoil Family.

116. *Myriophyllum sp.* Water-milfoil. The common aquatic plant in Carp river, IV. 1, Carp Lake, V. 3, and Little Carp Lake, VII. 1.

Araliaceae Vent. Ginseng Family.

117. *Aralia nudicaulis* L. Wild Sarsaparilla. Common throughout the forest, II. 2, IV. 3, VI.

Umbelliferae B. Juss. Carrot Family.

118. *Heracleum lanatum* Michx. Cow-parsnip. Common in the clearing, II. 3.

Cornaceae Link. Dogwood Family.

119. *Cornus canadensis* L. Low or Dwarf Cornel. Generally distributed, occurring in the hardwood forest, II. 2, VI; in the aspen zone, II. 5, and extending, to some extent, on the heath mat beyond the aspen zone on the mountain top, III. 2, 3, 5, 6. Also common in the tamarack swamp, IV. 4.

120. *Cornus circinata* L'Her. Round-leaved Dogwood. Common in the aspen zone, II. 5, about the mountain top; and at the bottom and top of the talus slopes, III.

121. *Cornus stolonifera* Michx. Red-osier Dogwood. Quite common in the alder zone along Carp river, IV. 2, Carp Lake V. 1, Little Carp Lake, VII. 1, and in the beaver meadow on Little Carp river, VII. 2.

Pyrolaceae Agardth. Wintergreen Family.

122. *Chimaphila umbellata* (L.) Nutt. Pipsissewa. Prince's Pine. Occasionally in the hardwood forest, II. 2, and in the pine zone, III. 3.

Monotropaceae Lindl. Indian-pipe Family.

123. *Monotropa uniflora* L. Indian-pipe. In damp shady places in the climax forest, II. 2, IV. 3, VI.

Ericaceae DC. Heath Family.

124. *Ledum groenlandicum* OEder. Labrador Tea. Common in the tamarack swamp, IV. 4.

125. *Chamaedaphne calyculata* (L.) Moench. Dwarf Cassandra. Forming dense thickets in the wider parts of the flood-plain of Carp river, IV. 2. Also present, but not forming extensive thickets, about the beaver meadow on Little Carp river, VII. 2.

126. *Epigaea repens* L. Trailing Arbutus. Occasionally seen in the pine zone on the mountain top, III. 3.

127. *Gaultheria procumbens* L. Creeping Wintergreen. A common plant in the undergrowth of the aspen zone, II. 5, III. 1 and 4, and in the heath mats on the bald areas, III. 2, 5, 6.

128. *Arctostaphylos uva-ursi* (L.) Spreng. Red Bearberry. The principal heath plant in the aspen zone, II. 5, III. 1, 4, and in the mats on the mountain top, III. 2, 5, 6. Also occurs on ledges of the cliff, at the bottom and top of the talus slopes, III, and on the Upper Beach of Lake Superior, I.

Vacciniaceae Lindl. Huckleberry Family.

129. *Vaccinium uliginosum* L. Great Bilberry. Upper Beach of Lake Superior, I, and in the aspen zone on the mountain top, II. 5.

130. *Vaccinium canadense* Richards. Canada Blueberry. In a moist ravine through the hardwood forest in the valley of Carp river, IV. 3, and in the tamarack swamp, IV. 4.

131. *Vaccinium pennsylvanicum* Lam. Dwarf or Low-bush Blueberry. A prominent form in the undergrowth of the aspen zone surrounding the mountain top, II. 5, and in the heath mat on the bald areas, III. 2, 5, 6. Also on ledges on the cliff face, at the top and bottom of the talus slopes, III, and on the Upper Beach of Lake Superior, I.

132. *Vaccinium nigrum* (Wood) Britton. Low Black Blueberry. Associated with *V. pennsylvanicum* in the aspen zone on the mountain top, II. 5, III. 1, 4; on the bare top, III. 2, 5, 6; on ledges on the cliff face, and on the talus slopes, III.

132. *Chiogenes hispidula* (L.) T. and G. Creeping Snowberry. Common in the tamarack swamp, IV. 4.

Oleaceae Lindl.. Olive Family.

134. *Fraxinus americana* L. White Ash. Occasional in the tamarack swamp, IV. 4; with the conifers and alders in broad portions of the flood plain of Carp river, IV. 2, and about the beaver meadow, VII. 2.

135. *Fraxinus nigra* Marsh. Black Ash. Associated with *F. americana*.

Asclepiadaceae Lindl. Milkweed Family.

136. *Asclepias incarnata* L. Swamp Milkweed. Occasional in the cassandra zone, IV. 2, and on the delta, V. 2, of Carp river. Also in the beaver meadow on Little Carp river, VII. 2.

Labiatae B. Juss. Mint Family.

137. *Scutellaria sp.* Skullcap. An unidentified species of this genus occurs commonly in the alder thickets along Carp river, IV. 2, and along Carp creek, VI.

Scrophulariaceae Lindl. Figwort Family.

138. *Melampyrum lineare* Lam. Narrow-leaved Cow-wheat. In the aspen zone bordering the mountain top, II. 5, III. 1, 4.

Lentibulariaceae Lindl. Bladderwort Family.

139. *Utricularia cornuta* Michx. Horned Bladderwort. On the beach of Carp Lake, V. 1.

Rubiaceae B. Juss. Madder Family.

140. *Galium triflorum* Michx. Sweet-scented or Fragrant Bedstraw. Common in the more open woods near the top of the first ridge, II. 2.

Caprifoliaceae Vent. Honeysuckle Family.

141. *Viburnum opulus* L. High Bush-cranberry. Along the banks of Carp river, IV. 2, and about the shores of Little Carp Lake, VII. 1.

142. *Viburnum pauciflorum* Pylaie. Few-flowered Cranberry-tree. On Carp river in the cassandra zone, IV. 2, and tamarack swamp, IV. 4; also about the shores of Little Carp Lake, VII. 1.

143. *Linnaea americana* Forbes. American Twin-flower. Of general distribution throughout the hardwood forest, II. 2, IV. 3, VI; becoming more abundant toward the top of the slopes and in the aspen zone bordering the mountain top, II. 5.

144. *Symphoricarpos pauciflorus* (Robbins) Britton. Low Snowberry. In the aspen zone bordering the mountain top, II. 5, III. 1, 4.

145. *Lonicera oblongifolia* (Goldie) Hook. Swamp Fly-Honeysuckle. In the shrub zone of the tamarack swamp, IV. 4.

146. *Lonicera ciliata* Muhl. American Fly Honeysuckle. In the hardwood forest, II. 2, and VI.

147. *Diervilla diervilla* (L.) Mac M. Bush Honeysuckle. Common in the aspen zone bordering the clearing, II. 4, and mountain top, II. 5, III. 1, 4. Also occurs on the lower part of the talus slopes, III.

Campanulaceae Juss. Bell-flower Family.

148. *Campanula rotundifolia* L. Harebell. In the rock crevices of the Middle and Upper Beaches of Lake Superior, I, and mountain top, III. 2, 5, 6. Occasional on ledges of the cliff and on the talus slopes, III.

149. *Campanula aparinoides* Pursh. Marsh Bellflower. In the cassandra zone, IV. 2, and on the delta, V. 2, of Carp river; and in the beaver meadow on Little Carp river, VII. 2.

150. *Lobelia spicata* Lam. Pale Spiked Lobelia. In the rock crevices of the Middle Beach, and on the thin soil on the Upper Beach of Lake Superior, I.

Compositae Adans. Thistle Family.

151. *Eupatorium purpureum* L. Joe-pye-weed. In the cassandra zone IV. 2, and on the delta, V. 2, of Carp river; and in the beaver meadow on Little Carp river, VII. 2.

152. *Solidago bicolor* L. White Goldenrod. In the rock crevices and on the thin soil of the mountain top, III. 2, 5, 6.

153. *Solidago erecta* Pursh. Slender Goldenrod. In the crevices on the bare mountain top, III. 2, 5, 6. The specimens collected, according to Dr. C. A. Davis, are not typical but are nearest to this form.

154. *Solidago uliginosa* Nutt. Bog Goldenrod. Common in the cassandra zone, IV. 2, and on the delta, V. 2, of Carp river, and in the beaver meadow of Little Carp river, VII. 2.

155. *Solidago neglecta* T. and G. Swamp Goldenrod. Middle and Upper Beaches of Lake Superior, I, and in the beaver meadow on Little Carp river, VII. 2.

156. *Solidago juncea* Ait. Early or Sharp-toothed Goldenrod. Common in the aspen zone, II. 5, and on the bare mountain top, III. 1, 2, 4, 5, 6.

157. *Euthamia graminifolia* (L.) Nutt. Associated with *S. juncea*, II. 5, III. 1, 2, 4, 5, 6.

158. *Aster divaricatus* L. White Wood Aster. Apparently of general distribution in the hardwood forest, II. 2, IV. 3, VI.

159. *Aster macrophyllus* L. Large-leaved Aster. Occasional in damp shady woods, II. 2, IV. 3, VI.

160. *Artemisia caudata* Michx. Tall or Wild Wormwood. Occasional in the aspen zone surrounding the mountain top, II. 5, III. 1, 4.

2. ISLE ROYALE.

Polypodiaceae R. Br. Fern Family.

1. *Polypodium vulgare* L. In the rock crevices on the end of the Minong Trap Range, IX, and in the rock crevices and on the shingle beach at Siskowit Bay, VIII.

2. *Adiantum pedatum* L. Maiden-hair Fern. Occasional in the Balsam Fir and Spruce woods, VI.

3. *Pteridium aquilinum* (L.) Kuhn. Brake. In the coniferous forest on the north side of the Greenstone Range near the shore of Lake Desor. Also about the margin of the clearing, I.

4. *Phegopteris phegopteris* (L.) Underw. On the shores of Siskowit Bay, VIII.

Equisetaceae Michx. Horsetail Family.

5. *Equisetum arvense* L. On the shore of Siskowit Bay, VIII, and on the shores of the islands in Lake Desor, VII.

Lycopodiaceae Michx. Club-moss Family.

6. *Lycopodium obscurum* L. Ground Pine. In the tamarack and spruce woods in the valley of Washington river, II.

7. *Lycopodium annotinum* L. On the beach at Grace Harbor; with the heaths on the Minong Trap Range, IX, and in the coniferous forest, VI.

8. *Lycopodium clavatum* L. Running Pine. In the coniferous and deciduous forests, VI, and III; on the beach at Grace Harbor, and on the Minong Trap promontory, IX.

9. *Lycopodium complanatum* L. In the alder thickets along Washington river, II. and with the heaths on the Minong Trap promontory, IX.

Isoetaceae Underw. Quillwort Family.

10. *Isoetes sp.* Among the rocks in shallow water about the islands in Lake Desor, VII.

Pinaceae Lindl. Pine Family.

11. *Pinus strobus* L. White Pine. Large isolated trees occur scattered through the forest, III, and VI. Young trees occur on the jutting promontories on the southwestern end of the island, IX. A few trees also occur with *P. resinosa* on a small strip of rock beach on the north shore of Lake Desor, VII.

12. *Pinus resinosa* Ait. Norway or Red Pine. Large trees occur occasionally in the coniferous forest on exposed slopes, VI. A few trees were also found on the rocky promontory, IX, and with *P. strobus* on a small strip of exposed beach on the north shore of Lake Desor, VII.

13. *Larix laricina* (Du Roi) Koch. Tamarack. Occurs along the flood-plains of the streams, where the valleys are broad, II, IV. It becomes more abundant in bogs, forming a nearly pure stand, V. Also occurs occasionally in the old beach pools on the Minong Trap promontory, IX.

14. *Picea canadensis* (Mill.) B. S. P. White Spruce. Generally distributed. It occurs with the Tamarack and Black Spruce on the flood-plains, II, IV, and forms an important part of the coniferous forest of the slopes, VI, but becomes less abundant toward the top of the higher ridges, III. With the Balsam Fir and Paper Birch, it succeeds the heaths and Arbor Vitae on the rocky promontories, IX.

15. *Picea mariana* (Mill.) B. S. P. Black Spruce. This tree is associated with the Tamarack and White Spruce on the flood-plains of the streams, II, IV. It also occurs occasionally in the old pools on the Minong Trap promontory, IX.

16. *Abies balsamea* (L.) Mill. Balsam Fir. This tree is generally distributed, occurring in the river valleys, II, IV, and on the ridges, III, VI. It apparently forms, with the White and Yellow Birch and White Spruce, the principle forest of the island.

17. *Thuja occidentalis* L. White Cedar. Arbor Vitae. This tree is most abundant in the valleys along streams, IV, where it occasionally forms dense growths. It is also found, however, on the shores of Lake Desor, VII, and about Washington Harbor, X; while on the Minong Trap promontory, IX, it is the first tree to gain a foothold, and may be seen growing in the crevices, nearly prostrate on the rock.

18. *Juniperus nana* Willd. Low Juniper. Common on the rock surfaces. of the Minong Trap promontory, IX.

Taxaceae Lindl. Yew Family.

19. *Taxus canadensis* Marsh. Ground Hemlock. This is one of the most characteristic forms of the Isle Royale forest. It forms a dense and almost impenetrable undergrowth throughout the coniferous woods, VI, but it is not as abundant in the flood-plain societies, II, IV. In the bogs it may be nearly or entirely wanting, and in the deciduous forest along the top of the Greenstone Range, III, it is often replaced over small areas by *Corylus rostrata.*

Sparganiaceae Agardh. Bur-reed Family.

20. *Sparganium eurycarpum* Engelm. In the margin of Washington river near its mouth, II, and about the shores of Lake Desor, VII.

Gramineae Juss. Grass Family.

21. *Phragmites phragmites* (L.) Karst. Reed. Along the margin of Washington river near its mouth, II, and about the shores of Lake Desor, VII.

Cyperaceae J. St. Hil. Sedge Family.

22. *Carex intumescens* Rudge. Along Washington river, II.
23. *Carex retrorsa* Schwein. Along Washington river, II.
24. *Carex trisperma* Dewey. Along Washington river, II.
25. *Carex tribuloides* Wahl. Along Washington river, II.

Araceae Neck. Arum Family.

26. *Spathyema foetida* (L.) Raf. Skunk Cabbage. In alder thickets, along Washington river, II, and Washington creek, IV.

Juncaceae Vent. Rush Family.

27. *Juncus effusus* L. Soft or Bog Rush. Along the shore of Washington river, II.

Convallariaceae Link. Lily-of-the-Valley Family.

28. *Clintonia borealis* (Ait.) Raf. In the forests on the flood-plain of Washington river, II, and on the adjacent ridges, III, VI.
29. *Vagnera racemosa* (L.) Morong. Wild Spikenard. In the alder thicket near the mouth of Washington creek, IV.
30. *Vagnera trifolia* (L.) Morong. Three-leaved Solomon's Seal. Found commonly in the alder thickets along Washington river, II, and Washington creek, IV.
31. *Streptopus amplexifolius* (L.) DC. In the alder thicket along Washington creek, IV.
32. *Salomonia biflora* (Walt.) Britton. Hairy Solomon's Seal. In moist places in the coniferous forest, VI.

Iridaceae Lindl. Iris Family.

33. *Iris versicolor* L. Large Blue Flag. In low places about the shores of Lake Desor and on the smaller islands, VII.

Orchidaceae Lindl. Orchid Family.

34. *Listera convallarioides* (Sw.) Torr. On the shores of Siskowit Bay, VIII, and Grace Harbor.
35. *Peramium pubescens* (Willd.) MacM. Downy Rattlesnake Plantain. Common in the coniferous forest, VI.

Salicaceae Lindl. Willow Family.

36. *Populus grandidentata* Michx. Large-toothed Aspen. In burnings and on the margin of clearings. Found in the large clearings at Siskowit

Bay, VIII, and Washington Harbor, I; and on the cliffs along the northwest shore of the island.

37. *Populus tremuloides* Michx. American Aspen. This tree occurs in the same conditions as *P. grandidentata* but is more abundant. It was abundant in the burnings and clearings at Siskowit Bay, VIII, and Washington Harbor, I. It also occurs on the rocky promontories at the southwest end of the island, IX, on the cliffs along the northwest shore of the Isle, and on the smaller islands in Lake Desor, VII. It prefers dry open habitats and is one of the first trees to encroach on the clearings.

38. *Salix spp.* Willow. Several undetermined willows occur in the alder zone along the streams, II, IV, and about Lake Desor, VII.

Betulaceae Agardh. Birch Family.

39. *Corylus rostrata* Ait. Beaked Hazel-nut. As underbrush through the forest, III, VI, with the Ground Hemlock. Often forming in small areas a nearly pure stand.

40. *Betula papyrifera* Marsh. Paper or Canoe Birch. Of general distribution, being a prominent form in the coniferous and deciduous forests, although it predominates in neither. It is the chief deciduous tree on this part of the island, owing to its general distribution.

41. *Betula lutea* Michx. f. Yellow Birch. This birch is of general distribution in the forests of the slopes, VI, and river valleys, II, but is apparently more abundant in the former.

42. *Alnus incana* (L.) Willd. Speckled or Hoary Alder. Forms extensive thickets along the streams, II, IV, about the shores of the Isle, and on low ground around Lake Desor, VII.

Santalaceae R. Br. Sandalwood Family.

43. *Comandra livida* Richards. Recorded by Mr. Macduff as occurring in an alder thicket near the mouth of Grace creek.

Nyphaeaceae DC. Water Lily Family.

44. *Castalia odorata* (Dryand) Woodv. and Wood. Sweet-scented White Water Lily. In a small shallow bay at the west end of Lake Desor, VII. The only place observed.

Ranunculaceae Juss. Crowfoot Family.

45. *Caltha palustris* L. Marsh-marigold. This species seemed to be characteristic of the alder thickets, II, IV.

46. *Coptis trifolia* (L.) Salisb. Gold-thread. Of general distribution in the river valleys, II, IV, and V, and on the slopes, III and VI.

Saxifragaceae Dumort. Saxifrage Family.

47. *Mitella nuda* L. Occasional in the Tamarack and Spruce forests along Washington river, II, and in the Balsam and Spruce forests of the slopes, VI.

Rosaceae B. Juss. Rose Family.

48. *Opulaster opulifolius* (L.) Kuntze. Eastern Ninebark. About the shores of Siskowit Bay, VIII; on the Minong Trap promontory, IX, and about the shores of the islands in Lake Desor, VII.

49. *Spiraea salicifolia* L. Willow-leaved or American Meadow-sweet. This shrub was found along Washington river, II, between the alder and sedge zones, where the latter was well developed.

50. *Rubus parviflorus* Nutt. White-flowering Raspberry. In sunny spots in the woods, III, VI, also along the shore of Washington Harbor, X.

51. *Rubus arcticus* L. Arctic Raspberry. In the bogs, IV, and V. Apparently not common.

52. *Rubus strigosus* Michx. Wild Red Raspberry. In burnings and clearings, Siskowit Bay, VIII, and at Washington Harbor, I.

53. *Potentilla argentea* L. Silvery or Hoary Cinquefoil. On the shingle beach at Siskowit Bay, VIII.

54. *Sibbaldiopsis tridentata* (Soland.) Rydb. Three-toothed Cinquefoil. On the shingle beach and in the rock crevices at Siskowit Bay, VIII, and in the rock crevices on the Minong Trap promontory, IX.

55. *Dasiphora fruticosa* (L.) Rydb. Shrubby Cinquefoil. In the rock crevices on the Minong Trap promontory, IX.

Pomaceae L. Apple Family.

56. *Sorbus americana* Marsh. American Mountain Ash. In rocky exposed situations, especially about the shores of the island and on the islands in Lake Desor, VII.

57. *Amelanchier canadensis* (L.) Medic. June-berry. On the shore at Siskowit Bay, VIII, and Grace Harbor; also in burnings and clearings, and on the small islands in Lake Desor, VII.

Drupaceae DC. Plum Family.

58. *Prunus pumila* L. Sand Cherry. In the clearing at Siskowit Bay, VIII, and on the rocky bluffs along the northwest shore of the island.

59. *Prunus pennsylvanica* L. f. Wild Red Cherry. On the islands in Lake Desor, VII.

Papilionaceae L. Pea Family.

60. *Lathyrus maritimus* (L.) Bigel. Beach Pea. On shingle beaches in the bays on the southwest end of the island (Macduff).

61. *Lathyrus ochroleucus* Hook. Cream-colored Vetchling. As the last.

62. *Empetrum nigrum* L. Black Cranberry. With the heaths on thin soil on the Minong Trap promontory, IX.

Aceraceae St. Hil. Maple Family.

63. *Acer saccharum* Marsh. Sugar or Rock Maple. Only found on the top of the Greenstone Range, III, where it predominates in a narrow strip along the crest of the ridge. This is the only hardwood forest on the south end of the island, and it is reported by Mr. Hollinger to extend the length of the island.

64. *Acer spicatum* Lam. Mountain Maple. This shrub is generally distributed as undergrowth in the forest, III, VI, with *Taxus canadensis* and *Corylus rostrata*. Although more abundant than the latter, it does not form as large a proportion of the undergrowth as the former.

Rhamnaceae Dumort. Buckthorn Family.

65. *Rhamnus alnifolia* L'Her. In the alder thickets, II, IV.

66. *Ceanothus americanus* L. New Jersey Tea. With the heaths on the Minong Trap promontory, IX.

Violaceae DC. Violet Family.

67. *Viola spp.* Violet. A number of species of violets were observed in the woods and alder thickets, but, as they were not in bloom, they were not identified with certainty.

Haloragidaceae Kl. and Garcke. Water-milfoil Family.

68. *Myriophyllum sp.* An unidentified species was abundant in Washington river near the mouth, II.

Araliaceae Vent. Ginseng Family.

69. *Aralia nudicaulis* L. Wild Sarsaparilla. Generally distributed throughout the forests of the slope, III, VI, and river valleys, II, IV.

Cornaceae Link. Dogwood Family.

70. *Cornus canadensis* L. Dwarf Cornel. Generally distributed through the forests of the slopes, III, VI, and in the forest of the river valleys, II, IV, V. It also occurs with the heaths on the Minong Trap promontory, IX.

71. *Cornus stolonifera* Michx. Red-osier Dogwood. Occasional in the tamarack-spruce forests of the river bottoms, II, IV, V. Also about the shore of Lake Desor, VII.

Pyrolaceae Agardh. Wintergreen Family.

72. *Chimaphila umbellata* (L.) Nutt. Pipsissewa. Prince's Pine. In damp woods, III, and VI.

Monotropaceae Lindl. Indian-pipe Family.

73. *Monotropa uniflora* L. Indian-pipe. Occasional in shady situations in the forest, III, VI, and in the tamarack and spruce woods in the river valleys, II, IV and V.

Ericacae DC. Heath Family.

74. *Ledum groenlandicum* OEder. Labrador Tea. In the tamarack-spruce forest, on the flood-plain of Washington river, II, and on the Sphagnum in old pools on the Minong Trap promontory, IX.

75. *Andromeda polifolia* L. Wild Rosemary. In the tamarack and spruce woods on the flood-plain of Washington river, II.

76. *Chamaedaphne calyculata* (L.) Moench. Dwarf Cassandra. On the Sphagnum growth in old rock pools on the Minong Trap promontory, IX.

77. *Arctostaphylos uva-ursi* (L.) Spreng. Red Bearberry. On the thin soil on the outer end of the Minong Trap promontory, IX. With the other heaths, it follows the crevice grasses and sedges.

Vacciniaceae Lindl. Huckleberry Family.

78. *Vaccinium pennsylvanicum* Lam. Dwarf or Low-bush Blueberry. Distribution as the last.

79. *Chiogenes hispidula* (L.) T. and G. Creeping Snow-berry. Common in the low tamarack-spruce woods along Washington river, II, and Washington creek, IV. Also in low spots in the slope forest, VI, and tamarack swamp, V.

Oleaceae Lindl. Olive Family.

80. *Fraxinus nigra* Marsh. Black Ash. Occasional in the tamarack and spruce woods on the flood-plain of Washington river, II, and in the bog, V.

Asclepiadaceae Lindl. Milkweed Family.

81. *Asclepias incarnata* L. Swamp Milkweed. Occasional in the grass and sedge zone along Washington river near its mouth, II.

Caprifoliaceae Vent. Honeysuckle Family.

82. *Viburnum opulus* L. High Bush-cranberry. In the tamarack and spruce woods, II, and about the shores of the islands in Lake Desor, VII.

83. *Viburnum pauciflorum* Pylaie. Few-flowered Cranberry-tree. In a bog near the mouth of Grace creek (Macduff).

84. *Linnaea americana* Forbes. American Twin-flower. Of general distribution throughout the forest, II, III, VI.

85. *Lonicera oblongifolia* (Goldie) Hook. Swamp Fly-honeysuckle. In the slope forest, VI, (Macduff).

86. *Lonicera ciliata* Muhl. American Fly-honeysuckle. Occasional in the slope forests, VI, (Macduff).

87. *Diervilla diervilla* (L.) MacM. Bush Honeysuckle. In the clearings at Siskowit Bay, VIII, and Washington Harbor, I.

Campanulaceae Juss. Bell-flower Family.

88. *Campanula rotundifolia* L. Harebell. In the rock crevices on the Minong Trap promontory, IX, and in the rock crevices and on the shingle beach at Siskowit Bay, VIII.

89. *Lobelia spicata* Lam. Pale Spiked Lobelia. In the rock crevices on the Minong Trap promontory, IX.

Compositae Adans. Thistle Family.

90. *Eupatorium purpureum* L. Joe-Pye-Weed. Among the sedges along Washington river, II. Also on the Sphagnum in the abandoned rock pools, IX.

91. *Euthamia graminifolia* (L.) Nutt. Bushy or Fragrant Goldenrod. On the shores of Siskowit Bay, VIII, and in the rock crevices on the Minong Trap promontory, IX.

ANNOTATED LIST OF THE MOLLUSCS OF THE PORCUPINE MOUNTAINS AND ISLE ROYALE, MICHIGAN.

BRYANT WALKER AND A. G. RUTHVEN.

This list has been prepared from the collections and field notes made by A. G. Ruthven. The species of *Pisidium*, *Sphaerium* and *Vertigo* were identified by Dr. V. Sterki, the Slugs by Dr. H. A. Pilsbry, and the remainder of the collection by Bryant Walker.

1. PORCUPINE MOUNTAINS.

1. *Agriolimax campestris* (Binn.). This species was found among the fallen leaves in the hardwood forest, II. 2, and under a pine log in the aspen zone on the mountain top, III. 1.

2. *Pallifera hemphilli* (W. G. Binn.). As represented by the collections, this slug is quite generally distributed. It was found among the fallen leaves in the deciduous forest, II. 2; beneath a fallen pine log in the pine zone, III. 1, and under the bark of a tamarack log, IV. 4.

3. *Zonitoides arborea* (Say). III. 1. A number of specimens of this species were taken under fallen pine trees among the bearberry and huckleberry bushes in the aspen zone. IV. 4. Several specimens were found beneath the bark of decaying tamarack and cedar logs in the tamarack swamp. VI. A few specimens were taken in the moist humus about the roots of ferns on the bank of Carp creek, and among the moist decaying leaves on higher ground.

4. *Zonitoides milium* (Mse.). III. 2. Individuals of this species were collected in the dry earth about the roots of the New Jersey tea on the mountain top; in the humus about the roots of an arbor vitae in the cedar swamp, II. 1, and in the humus in the hemlock woods, II. 2.

5. *Zonitoides exigua* (Stimp.). II. 2. A number of individuals were found among the fallen leaves in the hemlock and maple woods. Several were also found in decaying cedar and tamarack logs in the tamarack swamp, IV. 4.

6. *Vitrea ferrea* (Mse.). IV. 4. A few individuals of this species were taken in a fallen tamarack log in the peat bog.

7. *Vitrea indentata* (Say). II. 2. Under dead moist leaves in the hardwood forest. III. 1. Under fallen logs and in the soil in the aspen zone on the mountain top. III. 2. In the dry earth in crevices and held by the roots of the heath plants on the bare mountain top, and among the roots of the New Jersey tea in the aspen zone, III. 4. Also found under the bark of fallen tamarack logs in the tamarack swamp, IV. 4.

8. *Vitrea multidentata* (Binn.). III. 1. Several specimens were taken under the bark of a fallen pine in the aspen zone at the top of the first range.

9. *Pyramidula alternata* (Say). II. 3. Specimens of this form were found crawling about on a log in the clearing, early in the morning while the dew was heavy.

10. *Pyramidula striatella catskillensis* Pils. This species was collected

among the damp leaves in the woods toward the bottom of the slope, II. 2, and near the top under fallen pine logs among the heath plants, III. 1. It was also found in the tamarack swamp, IV. 4, in decaying arbor vitae and tamarack logs.

11. *Pyramidula asteriscus* (Mse.). IV. 4. Two were found beneath the bark of fallen tamarack trees in the peat bog. This is the only station at which this species was taken.

12. *Helicodiscus lineatus* (Say). Among the damp fallen leaves in the hardwoods, II. 2; near the bottom of the slope, III. 1; in fallen tamarack logs in the tamarack swamp, IV. 4; in the damp humus about the roots of ferns on the banks of Carp creek, VI. This species seems to prefer a damp habitat, and the dead shells found in the crevices of the cliff face and among the talus blocks were probably blown there.

13. *Acanthinula harpa* (Say). III. 2. A number of specimens were collected in the dry soil held by the grasses and heath plants on the mountain top. This is one of the characteristic molluscs of this exceedingly dry and exposed habitat.

14. *Punctum pygmaeum* (Drap.). II. 1. A few specimens were collected in the damp humus among the roots of an arbor vitae in the swamp. II. 2. Found to occur quite abundantly among damp leaves in the hardwood forest. III. 1. A few individuals were found under fallen logs among the huckleberry bushes in the aspen zone. III. 2. Several taken in the dry earth about the roots of New Jersey tea on the mountain top. IV. 4. A few found beneath the bark of fallen tamarack trees in the peat bog.

15. *Sphyradium edentulum* (Drap.). II. 2. Among the damp leaves in the hardwood forest; also found under fallen pine trees in the aspen zone, III. 1, and in decaying tamarack and arbor vitae logs in the tamarack swamp, IV. 4.

16. *Polygyra albolabris* (Say). III. 1. Several specimens were taken beneath fallen logs in the aspen zone on the mountain top, and among the damp leaves in the hardwood forest, VI.

17. *Polygyra sp.* [young, probably *albolabris* (Say)]. III. 2. In the dry earth about the roots of the bearberry on the mountain top.

18. *Polygyra fraterna* (Say). II. 3. On a log in the clearing after a heavy dew. VI. Among the damp leaves in the forest.

19. *Strobilops virgo* (Pils.). Found in the damp leaves of the hardwood forest near the bottom of the slope, II. 2; under logs in the aspen zone near the top, III. 1; in the dry earth among the roots of the heath plants on the mountain top, III. 2, and among the roots of the blueberry in the aspen zone, III. 4. It was also found in decaying tamarack logs in the tamarack swamp, IV. 4; a few in the humus beneath a hemlock on II. 2, and in the moist loam about the roots of ferns on the banks of Carp creek, VI.

20. *Bifidaria curvidens* (Gld.). This species was taken under logs in the aspen zone on the mountain top, III. 1, and on the bald areas, III. 2, in the dry earth held by the heath plants.

20a. *Vertigo gouldii* Binn. Taken in the Porcupine Mountains, and at Limestone Mountain in the summer of 1903. These specimens have only recently been identified and with the following species constitute the forms listed in the 1903 list as *Vertigo sp.* (Sixth Report Mich. Acad. Sci. 1904, p. 190).

20b. *Vertigo ventricosa elatior* Sterki. See 20a.

21. *Cochlicopa lubrica morseana* (Doh.). This species was only found in damp leaves in the hardwood forest, II. 2, and in the moist humus on the banks of Carp creek, VI.

22. *Euconulus chersinus polygyratus* (Pils.). II. 2. Among the damp leaves in the hardwood forest. III. 1. Under fallen logs in the aspen zone about the mountain top. III. 2. In the dry soil in rock crevices and among grass roots near the brink of the precipice. VI. In the loam on the bank of Carp creek.

23. *Succinea avara* Say. III. 2. A few shells were found in crevices in the rock on the brink of the cliff. These specimens were probably blown here as the animal is said to prefer a damp habitat.

24. *Carychium exile* H. C. Lea. II. 2. Several individuals of this form were taken in a very moist place among fallen leaves in the hardwood forest. Also found in very wet humus about the roots of ferns on the banks of Carp creek, VI.

25. *Limnaea decollata* Migh. Occurs quite frequently in the rock pools of the Middle Beach, and behind projecting outcrops on the Lower Beach of Lake Superior, I, where they were protected from the full force of the waves.

26. *Limnaea desidiosa* Say. I. Occurs quite numerously in the rock pools of the Middle Beach, and has been dredged in Lake Superior at a depth of 8 to 13 fathoms (Baker).

27. *Physa sp.* (too young to identify). IV. 1. Found on the under side of lily pads in Carp river.

28. *Physa sayii?* Tapp. (young specimen). VI. Found in very damp leaves on the bank of Carp creek.

29. *Physa ancillaria* Say. *var.* I. In the rock pools of the Middle Beach of Lake Superior.

30. *Planorbis campanulatus* Say. Taken on the under side of lily pads and among the leaves of submerged water plants on Carp river, IV. 1, and on the larger stones forming the bottom near the shore of Carp Lake, V. 1.

31. *Planorbis bicarinatus striatus* Baker. V. 1. Found on the stones composing a strip of shingle beach on Carp Lake.

32. *Planorbis exacuous* Say. IV. 1. Taken on the under side of water lily leaves in Carp river.

33. *Planorbis parvus* Say. I. This species was found in several of the pools on the Middle Beach of Lake Superior, both on the bare rock and in the slight algal growth that lines the sides. It was also found among the leaves in the bottom of a pool formed by a spring in the forest, II. 2, and in considerable abundance on the under side of the larger rocks that lie loosely in the bed of Carp creek, VI. Dredged in Lake Superior at a depth of 8-13 fathoms (Baker).

34. *Planorbis deflectus?* Say. (immature). V. 1. Found on the small stones forming the bottom of Carp Lake just off shore. VII. 3. On the submerged sticks of a beaver dam on Little Carp river.

35. *Planorbis hirsutus* Gld. IV. 1. Among the leaves of a submerged aquatic plant in Carp river, about two feet below the surface of the water.

36. *Ancylus parallelus* Hald. IV. 1. On the stems and under side of lily pads in Carp river.

37. *Valvata tricarinata* (Say). V. 3. Among the leaves of submerged aquatic plants in Carp Lake.

38. *Amnicola limosa* (Say). IV. 1. Abundant on the stems and under side of lily pads, and among the leaves of submerged aquatics in Carp river. Also common on the stems and among the leaves of submerged aquatic plants in Carp Lake, V. 3.

39. *Anodonta marginata* Say. V. 1. Occurs quite numerously in Carp Lake, just off shore on a bottom of either silt or pebbles, and in considerable

numbers among the rushes on the delta of Little Carp river, VII. 1. VII. 3. One specimen was also taken on a mud flat in Little Carp river, near the lake.

40. *Sphaerium simile* (Say). V. 1. This species was found in the mud at the outlet of Carp Lake, and on the mud flats of Little Carp river, VII. 3.

41. *Sphaerium rhomboideum* (Say). V. 1. Partially buried in the fine silt covering the bottom of Carp Lake just off shore.

42. *Pisidium sp.* V. 2. Beneath a partly submerged log on the delta of Carp river.

43. *Pisidium sp.* (immature). II. 2. Among the leaves in a spring pool in the hardwood forest.

2. ISLE ROYALE.

1. *Agriolimax campestris* (Binn.). Among fallen alder leaves on a wet flat along Washington river, II, and in the humus of the cedar swamp, IV.

2. *Agriolimax?* (specimen mutilated). VIII. One specimen taken on the under side of a stone in shallow water at Siskowit Bay.

3. *Pallifera hemphilli* (W. G. Binn.). IV. A specimen of this slug was found in swamp humus on Washington creek.

4. *Vitrina limpida* Gld. VI. Several specimens were taken in decaying spruce logs in the coniferous forest. Found also in the damp fallen leaves, in the deciduous forest, III.

5. *Zonitoides arborea* (Say). II. On Washington river among the fallen leaves in an alder thicket on a wet mud flat, and among the leaves and under the bark of fallen spruce and birch trees on dryer ground. III. Found among the leaves and under the rocks in the deciduous forest. IV. A few specimens taken in the humus of a cedar swamp on Washington creek. V. Collected in the moss in the tamarack swamp. VI. Several found beneath the bark of fallen spruce trees in the coniferous forest.

6. *Zonitoides milium* (Mse.). Specimens of this form were collected among the leaves and in fallen birch logs in the deciduous forest, III; in the moss of the tamarack swamp, V, and beneath the bark of fallen spruce trees, VI.

7. *Vitrea binneyana* (Mse.). II. Taken among the fallen leaves in an alder thicket on a mud flat on Washington river, and in the moss in the coniferous forest bordering the river. Specimens were found under stones and among the fallen maple leaves in the deciduous forest, III; in the humus of the cedar swamp, IV; in the fallen spruce logs in the coniferous forest, VI, and in the moss of the tamarack swamp, V. A few specimens were also found in the moss among the bearberry bushes on the Minong Trap promontory, IX.

8. *Zonitoides exigua* (Stimp.). II. Found among the fallen leaves of an alder thicket on a very wet mud flat, and in the moss covering the ground in the coniferous forest bordering the river. Collected among the fallen leaves in the deciduous forest, III; in the moss of the arbor vitae swamp, IV, and in the moss of the tamarack swamp, V. Also found in the moss among the bearberry bushes on the Minong Trap promontory, IX.

9. *Pyramidula alternata* (Say). III. Among the damp fallen leaves, beneath the bark of fallen birch logs, and under stones in the deciduous forest.

10. *Pyramidula striatella* (Anth.). This species was collected on Washington river, II, among the fallen leaves of alders on a mud flat, and in the moss in the coniferous forest, bordering the river. It was also collected in

the deciduous forest, III, among the damp fallen leaves and under rocks; in the humus of the cedar swamp, IV; in the moss in the tamarack swamp, V, and in the moss among the heath plants on the Minong Trap promontory, IX.

11. *Pyramidula striatella alba* (Walker). II. In the moss forming the ground cover of the coniferous forest. III. Several specimens were also collected among the damp fallen leaves in the deciduous forest.

12. *Pyramidula asteriscus* (Mse.). III. Taken among the fallen leaves in a moist ravine in the deciduous forest.

13. *Acanthinula harpa* (Say). II. This species was found to occur in the moss ground cover of the coniferous forest bordering Washington river; in the humus of the arbor vitae swamp, IV, and in the moss about the roots of the heath plants on the Minong Trap promontory, IX.

14. *Punctum pygmaeum* (Drap.). III. Several specimens of this form were collected among the damp fallen leaves in the deciduous forest.

15. *Sphyradium edentulum* (Drap.). II. Beneath the bark of a fallen log in the coniferous forest along Washington river, and among the fallen leaves in the deciduous forest, III.

16. *Euconulus fulvus* (Drap.). This shell was found beneath the bark of a fallen birch tree in the coniferous forest, II; among the fallen leaves in the deciduous forest, III, and in the moss of the tamarack swamp, V. A few dead shells were also found in the sediment in the bottom of Grace creek.

17. *Euconulus chersinus polygyratus* (Pils.). Collected in the moss and decaying logs in the coniferous forest on the flood-plain of Washington river, II; among the fallen leaves in the deciduous forest, III, and beneath the bark of a decaying tamarack stump, V.

18. *Vertigo ovata?* Say. A defective specimen was found in the humus of the arbor vitae swamp, IV.

19. *Vertigo gouldii* Binn. Among the fallen leaves in the deciduous forest, III, and in the moss of the tamarack swamp, V.

20. *Vertigo sp.* In the moss about the foot of a tamarack, V.

21. *Carychium exile* H. C. Lea. This species was found among the fallen alder leaves on a very wet flat along Washington river, II, and among the fallen maple leaves in the deciduous forest, III.

22. *Limnaea stagnalis* L. *var.* This snail is very abundant about the shores of Washington Harbor, X. The specimens collected were attached to the larger rocks that are not readily moved by the action of the surf.

23. *Limnaea* n. sp.? (related to *L. sumassi* Bd., but probably undescribed). X. This form is also abundant in Washington Harbor, and with *Limnaea stagnalis* constitutes the characteristic molluscan life of this station. The specimens collected were found clinging to the rocks under the same conditions as *L. stagnalis*. It was also found to occur commonly in the rock pools on the Minong Trap promontory, IX.

24. *Physa sayii* Tapp. *var.* X. This form was found only in Washington Harbor, where it occurs on the rocks near shore.

25. *Physa sp.* (probably *sayii* Tapp.). VIII. A few specimens were found at Siskowit Bay, attached to stones in the back water pools on the beach.

26. *Physa sp.* Under this head are grouped a number of immature shells collected in Lake Desor, VII, in the fine silt near shore and attached to large rocks about the islands; among the leaves of submerged aquatic

plants in Washington river, II, and attached to the rocks about the shore of Washington Harbor, X.

27. *Aplexa hypnorum* (L.). II. Found only among the fallen alder leaves on a wet flat on Washington river.

28. *Planorbis bicarinatus striatus* Baker. VII. This species was found in the silt near shore and on the rocks off the islands of Lake Desor.

29. *Planorbis exacuous* Say. II. A number of specimens were taken among the leaves of submerged aquatic plants in Washington river. It was also found on the rocks in shallow water about the islands of Lake Desor, VII, and in Washington Harbor, X.

30. *Planorbis parvus* Say. III. Collected among the leaves in the bed of a dry creek in the deciduous forest. Also found in the rock pools on the Minong Trap promontory, IX, and clinging to the rocks in shallow water about the islands of Lake Desor, VII.

31. *Planorbis hirsutus* Gld. This species was only found in Lake Desor, VII, where it occurs on the rocks in shallow water about the islands.

32. *Valvata sincera lewisii* Curr. VIII. A few specimens of this species were found on the rocks in a back water pool at Siskowit Bay.

33. *Anodonta marginata* Say. VII. Several specimens were collected in shallow water at the west end of Lake Desor, among a scattered vegetation of equisetum and water lilies. This is the only place where mussels were found on the south end of the island, with the exception of a broken shell in Washington Harbor, X, although a careful search was made for them about the shore of the harbor and in Washington river.

34. *Pisidium abditum* Hald. *var.* II. Several specimens were collected among the wet fallen leaves in the alder thicket, on the bank of Washington river.

35. *Pisidium variabile* Pme. II. Among the leaves of a submerged aquatic plant in Washington river.

36. *Pisidium sp.* Pisidia which could not be identified were collected on water plants in Washington river, II; in the silt in the bottom of Washington creek running through the arbor vitae swamp, IV, and in the debris in the bottom of Grace creek, near its mouth.

The following general observations on the collection will call attention to the specimens of special interest and to their faunal affinities. So far as Isle Royale is concerned, the fauna is purely boreal; the land species, as far as they go, are the same (with one exception) as those of the Porcupine Mountains, Ontonagon County. The only species not found in Ontonagon County is *Pyramidula striatella* Anth. The occurrence of the typical form of *striatella* on Isle Royale while the Ontonagon County form is uniformly var. *catskillensis* Pils., is very curious. *Catskillensis* is the characteristic form of Northern Michigan. It has been traced from Beulah, Benzie County, Mich. north through the Grand Traverse region, Mackinac Island and the St. Mary's river, to Marquette, Baraga and Ontonagon Counties. At Charlevoix both forms occur, while specimens from Crooked Lake, Emmet County, are rather intermediate. On the main land of the Upper Peninsula thus far only the variety has been found.

Among the aquatic species, however, Isle Royale furnishes some interesting forms. The form of *Limnaea stagnalis* is a peculiar and well marked

one, quite different from any of the described forms. The occurrence of the *Limnaea* related to *L. sumassi* Bd. on Isle Royale is a very interesting discovery, and, whether distinct or merely a variety of that form, is new to the Michigan fauna. Originally described from British Columbia *L. sumassi* is peculiarly a western species, and its occurrence so far east, if these shells are referred to it, is quite unexpected. *Planorbis bicarinatus striatus* Baker has not before been listed in the Michigan fauna, as it was described since the last (1894) general catalogue of the Mollusca of the State was published. It is, however, a form of general distribution through the northern part of the state and occurs occasionally in the southern counties. (Raisin river, Monroe Co. and Orchard Lake, Oakland Co.). The *Pisidia* are represented by several interesting forms, some of which are probably undescribed species, but the amount of material is at present too meager to justify a decisive opinion. It is a matter of regret that this interesting group was not more largely represented in the collection. The collection from the Porcupine Mountains is necessarily largely the same as that made in 1903, and affords no occasion to vary the opinion as to the general character of the fauna already expressed in the report on these collections.*

The specimens of *Cochlicopa lubrica* from the hardwood forest, II. 2, are the elongated slender form described by Doherty as *morseana*. It has not been listed before from this State. *Acanthinula harpa* and *Zonitoides asteriscus* are boreal species, the former hitherto found only at Beulah, Benzie Co., Charlevoix and Petoskey, and the latter at Charlevoix. Their occurrence on Isle Royale and in Ontonagon County are the first records for the Upper Peninsula. *Pallifera hemphilli* W. G. Binn. is a new species for Michigan and a very interesting one. It was originally described from Mount Mitchell, N. C. and Lulu, Hall Co., Ga. Dr. Pilsbry says, "It looks as though *hemphilli* might be a Canadian form which extends down the mountains. I have seen it also from the mountains in Pennsylvania."

*Sixth Report Mich. Acad. Science, 1904, p. 192.

SPIDERS AND INSECTS FROM THE PORCUPINE MOUNTAINS AND ISLE ROYALE, MICHIGAN.

A. G. RUTHVEN.

With the exception of the Odonata and Orthoptera, no attempt was made to make extensive collections of the different groups of invertebrates, and the lists comprise only the more characteristic forms in the different habitats studied. The collections were, for the most part, made by the author with the assistance of the other members of the party, except in the case of the ants which were collected largely by Mr. Otto McCreary. We are indebted to the following persons for the determination of the collections:

Spiders.—Mr. Nathan Banks, U. S. Department of Agriculture.

Dragonflies.—Mr. E. B. Williamson, Bluffton, Ind.

Butterflies and Moths.—Prof. Arthur J. Snyder, Springfield, Idaho.

Ants.—Dr. W. M. Wheeler, American Museum of Natural History.

1. SPIDERS FROM THE PORCUPINE MOUNTAINS.

1. *Gnaphosa conspersa* Thor. III. 1. Taken under a pine log among the dwarf huckle-and blueberry bushes in the aspen zone, August. 6.

2. *Linyphia phrygiana* Koch. I. Taken on the leeward side of projecting outcrops of rock on the beach of Lake Superior, July 21. Also occurs in Europe (Banks).

3. *Epeira trifolium* Hentz. I. This spider occurs numerously along the beach of Lake Superior. It weaves its web behind projecting outcrops of rock, and when surprised runs swiftly into the rock crevices. The webs are often filled with small white moths, July 30.

4. *Epeira patagiata* Clerck. I. This species was found under the same conditions as *Epeira trifolium*. Also occurs in Europe (Banks).

5. *Lycosa gracilis* Bks. III. 1. In a shallow hole in dead grass under a fallen pine log in the aspen zone, August 6.

6. *Pardosa lapidicina* Th. I. This species was taken on the beach of Lake Superior, July 30. It was observed quite frequently running about over the rocks, and dodging into the crevices when pursued.

7. *Pardosa. sp.* (probably *lapidicina*). I. Several immature specimens were taken on the rocks of the Lake Superior beach, July 21.

8. *Dolomedes tenebrosus* Hentz. II. 1. A specimen of this spider with its egg mass was taken on a cedar stump in the arbor vitae swamp, August 25.

2. SPIDERS FROM ISLE ROYALE.

1. *Amaurobius sp.* V. One specimen was found in the Sphagnum moss in a tamarack swamp, August 22.

2. *Amaurobius bennetti* Blackw. II. One specimen was taken in the moss ground cover of the balsam and spruce forest on the flood-plain of Washington river, August 26.

3. *Lycosa pratensis* Em. IX. Several specimens were found in the moss about the roots of the dwarf blueberry bushes on the Minong Trap promontory, September 2.

4. *Xysticus sp.* IX. One specimen was taken in the same habitat as the last, September 2.

Mr. Banks remarks in a letter, concerning the collection, that these species are all fairly common throughout the northeastern United States.

3. DRAGONFLIES FROM THE PORCUPINE MOUNTAINS.

1. *Calopteryx aequabilis* Say. IV. 2. A male was taken among the alder bushes along Carp river, August 5, and a female flying up the river, IV. 1, on August 12.

2. *Lestes unguiculatus* Hagen. II. 3. A male was taken in the clearing on August 12. III. 2. Two females were taken on the "bald" crest of the first range, resting on goldenrods, July 18. IV. 2. One male was taken on a cassandra bush in the valley of Carp river, August 5.

3. *Nehalennia irene* Hagen. V. 2. A female was collected on a grass stem on the delta of Carp river, August 12.

4. *Enallagma hageni* Walsh. V. 2. Twenty-one males and one female were taken on the delta of Carp river, on August 12, and four males on July 21. This is the only station at which this form was observed. It occurs here, however, abundantly, and is the characteristic species of this marsh.

5. *Enallagma carunculatum* Morse. V. 2. A single specimen of this form, a male, was taken on the delta of Carp river, August 12.

6. *Enallagma sp.* V. 2. A male was taken on the delta of Carp river on August 12.

7. *Ischnura verticalis* Say. V. 2. A female was taken on the delta of Carp river, July 21, resting on a grass stem, and a male and female in the same locality on August 12.

8. *Hagenius brevistylus* Selys. V. 1. Only one specimen of this form was collected, a female taken on Carp Lake, on an alder branch overhanging the water, August 10.

9. *Gomphus spicatus* Hagen. A male was taken in the clearing, II. 3, on July 16, a female, flying about among the cassandra bushes on the flood-plain of Carp river, IV. 2, August 5, and five males on the delta of Carp river, V. 2, July 21. The habitat of this form seems to be the marsh and river. The specimen taken in the clearing was the only specimen observed away from water.

10. *Aeschna clepsydra* Say. I. Several individuals resembling this form were observed, flying back and forth along the beach of Lake Superior on July 30. II. 3, 4. Two males and two females were taken about dusk on July 16, flying about the clearing and in and out among the surrounding aspens. V. 2. A male and female were captured in coitu among the grasses and sedges on the delta of Carp river, on August 8. IV. 1. Individuals resembling this form were often seen in the evening, flying up and down Carp river, and along Little Carp river, VII. 3, and over the lake, VII. 1, on August 3. This species seemed to occur generally along the streams, except in the evening, when it was also observed flying back and forth in the woodland clearings. The individuals seen flying over Little Carp Lake often made sudden swerves close to the surface, and nearly every time, as they flew upward again, they were followed by the snout of a hungry dace, but in no instance observed was the fish successful.

11. *Sympetrum obtrusum* Hagen. II. 3. One female was taken on July 16; many others were seen in the clearing at various times. II. 4. Five males and one female were taken in the aspen zone that surrounds the clearing, July 15 and 16. II. 5. Two males and two females were taken on the heath undergrowth in the aspen zone bordering the north side of the bald crest of the ridge, July 15. III. 1, 2. Several individuals of the genus, thought to belong to this species, were seen at different times, flying about over the heath plants, and in the aspen zone on the mountain top. III. 3. One specimen was taken among the pines on July 19. III. 4. Two males and one female were taken on July 15 in the aspen zone that borders, on the east, the bald crest of the first range. IV. 2. Three males were taken among the cassandra bushes along Carp river on July 5. VII. 2. One taken and several seen on the beaver meadow on Little Carp river, August 3. This form seemed to occur most numerously in the cassandra zones and beaver meadows along the streams, although it was also observed to occur quite commonly in hardwood clearings and on the bald crests. It is not strictly confined to the clearings, however, but seems to occur in equal abundance in the aspen zones.

12. *Sympertum costiferum* Hagen. I. One male was taken on July 30, flying about over the beach of Lake Superior. This was the only specimen taken. Three others which resembled this form were seen resting on the beach, but they eluded capture. None were observed at any other station.

13. *Plathemis lydia* Drury. IV. 1, V. 2, VII. 2. No specimens of this form were taken, but a dragonfly was observed several times on the mudflats of Carp river, on the marsh at the east end of Carp Lake, and on the beaver meadow, that can be referred to this species with little doubt.

4. BUTTERFLIES AND MOTHS FROM THE PORCUPINE MOUNTAINS AND ISLE ROYALE.

a. Porcupine Mountains.

1. *Argynnis cybele* Fab. II. 3. One specimen of this form was taken on the flower of a cow parsnip in the clearing, July 20, and one on a goldenrod on the mountain top, III. 2, on August 10. Argynnid forms resembling this species were often seen about the clearing, "balds" and river valley, but how many of these were to be referred to the species, and to the following variety, was not determined.

The observations and collections indicate that both the variety and typical forms prefer an open sunny habitat.

2. *Argynnis cybele* Fab. *var.* (near *leto*). For a discussion of this variety see Prof. Snyder's comments on the collection at the close of the Isle Royale list. II. 3. One specimen was taken, flying about the clearing, July 21, and one on Carp river, IV. 2, flying about among the cassandra bushes on August 12.

3. *Argynnis atlantis* Edwards. Specimens of this species were collected on the beach of Lake Superior, I, August 11, in the clearing, II. 3, July 16, and in the valley of Carp river, IV. 2, August 12.

4. *Phyciodes tharos* Drury. I. Two were taken, flying over the beach of Lake Superior, July 30 and August 11, and two on a harebell on July 17. II. 3. Two specimens were also found on a cow parsnip flower in the clearing, July 16. This species like the Argynnids, seems to prefer open sunny habitats.

5. *Grapta gracilis* Grote and Robinson. I. Five specimens were taken on the rocks and flying about over the beach of Lake Superior on August 11. II. 3. One was collected in the clearing, August 7, and one on the face of the cliff, III. 6, August 11. This form is the characteristic butterfly of

the beach. The one captured in the clearing was the only one observed there. They were numerous on the face of the cliff, but, owing to the difficulty in scaling the precipice, only one could be secured. Both on the cliff face and beach, they made but short flights when disturbed, and if not pursued soon settled on the rocks again. After alighting they settled close to the rocks with their wings outspread, now and then raising them above their back, but quickly lowering them again.

6. *Grapta progne* Cramer. I. One specimen of this butterfly was taken, flying over the beach of Lake Superior, August 11.

7. *Vanessa j-album* Boisduval and Leconte. This form was taken on the beach of Lake Superior, I, on August 11. Two individuals were collected in the clearing, II. 3, on August 5, and August 7. III. 2. One specimen was also found on the talus slope, July 21.

8. *Vanessa antiopa* Linn. I. One taken on the beach of Lake Superior, August 11. This butterfly was not often seen. It was twice recognized in the clearing, II. 3, once on the shore of Carp Lake, V. 1, and once in the beaver meadow on Little Carp river, VII. 2.

9. *Basilarchia arthemis* Drury. This form was found to occur on the beach of Lake Superior, I, in the clearing and surrounding aspen zone, II. 3, 4, in the cassandra zone on Carp river, IV. 2, and in the beaver meadow. It is a very common form in this region, being apparently of general distribution in clearings

10. *Thecla edwardsii* Saunders. III. 2. One specimen was collected on a goldenrod on the mountain top, August 10.

11. *Colias philodice* Godart. I. Two specimens were taken on harebells on the beach of Lake Superior, August 30, and three flying about, August 11. II. 3. One was found on a cow parsnip in the clearing, August 7. "Yellow" butterflies were not often observed

12. *Catocala unijuga* Walker. II. 3. One specimen was found in a crevice between the logs of the camp shack in the clearing, August 5.

13. *Hypoprepia miniata* Kirby. III. 6. On a huckleberry bush on the "bald" mountain top, August 11.

14. *Actias luna* Linn. II. 2. A single specimen was taken on a hemlock, July 15.

b. Isle Royale.

Basilarchia arthemis and *Colias philodice* were both common in the clearings. One specimen of *Vanessa antiopa* was seen in a clearing, September 3.

c. Notes on the Collection of Butterflies, by Prof. A. J. Snyder.

Of all the lot the most interesting are the two varieties of the female of *Argynnis cybele*, which so closely resemble the female of *Argynnis leto* as to startle one. The same form was found in the Lake Superior region by Mr. Bates of Chicago. I believe two specimens of this form are now in the collection of Mr. John Healey of Chicago. The two specimens listed above well illustrate geographic variation.

Dr. Holland speaks of *Carpenterii*, the variety of *cybele* found in New Mexico and Colorado, and claims a similar form is found in Labrador and Canada; also on the mountains of Carolina. The largest forms of *cybele* I have seen are from Tennessee. *Argynnis leto* is a western species common in Utah and some parts of Colorado. The dark female, at its best, is a handsome specimen, and that a female of *cybele* should be found in the Superior country is enough to make one question the ancestory of *leto*. Of one thing we are

certain, altitude and latitude both tend to make smaller and darker colored specimens of a species.

5. ANTS FROM THE PORCUPINE MOUNTAINS.

1. *Formica impexa* Wheeler.* III. 6. A colony of this form was found beneath a loose stone among the huckleberry bushes on the mountain top, August 12, 1904 (not 1902 as given by Wheeler).

"*Worker.* Length 3.3—6 mm.

"With the habitus of *Formica rufa*. Mandibles 8 toothed. Clypeus broadly rounded in front, not produced in the middle, carinate its entire length. Head excluding the mandibles, distinctly longer than broad even in the largest workers. Cheeks rather long, straight, subparallel. Posterior border of head straight, posterior corners rounded. Joints 1-4 of antennal funiculus decidedly longer and more slender than the remaining joints. Thorax of the *rufa* type, but with the epinotum very low and rounded. Petiole rather thick anteroposteriorly, its anterior surface convex in profile, its posterior flattened, its edge, especially in smaller workers, very blunt. Seen from behind the node is produced upwards in the middle and is of rather variable outline, being notched in the middle in some specimens, but oftener more or less rounded.

"Mandibles lustrous, finely and sharply striated. Surface of clypeus uneven. Frontal area shining. Remainder of body opaque, distinctly but finely shagreened.

"Whole body and appendages covered with very minute white pubescence, which is rather sparse on the head and thorax, but dense and concealing the ground surface on the gaster. Body, antennal scapes, and legs covered with robust, obtuse, erect or suberect, whitish or yellowish hairs. On the gaster they are uniformly distributed and very conspicuous in certain lights. They are also very numerous and prominent on the upper surface of the thorax, clypeus, front, vertex, posterior corners and lower surface of the head. They are absent or very sparse on the cheeks, pleurae and coxae. On the legs they are prominent both on the flexor and extensor surfaces.

"Head and thorax red. Gaster black. All specimens, even the largest are more or less infuscated as follows: Mandibles, anterior border of clypeus and apical half of funiculi dark reddish brown. Ocellar triangle, upper surface of pro- and mesonotum, much of the upper portion of the petiole, legs and coxae, except their articulations, more or less blackened. In the largest workers the fore coxae are largely red. Anal region and articulations of legs yellowish. In the smallest workers the infuscation is more extensive, involving the whole of the posterior portion of the head and the epinotum.

"Described from twelve workers taken August 12, 1904 by Mr. O. McCreary from a colony nesting under a stone in the Porcupine Mountains, Ontonagon county, Michigan. Types in the American Museum of Natural History, cotypes No. 32,925 in the University Museum, University of Michigan, Ann Arbor, Mich.

"*F. impexa* is allied to *F. oreas* Wheeler and *F. microgyna* Wheeler, with which it agrees in having erect hairs on the antennal scapes. It differs from *F. oreas* in the much stiffer and less abundant erect and obtuse hairs on the head and thorax, the prominent hairs on the gaster, the longer head, more opaque surface of the head and thorax, etc. In most of these characters

*Wheeler, W. M. New Species of Formica. Bull. Amer. Mus. Nat. His., XXI, p. 273, 1905.

it also differs from the typical *microgyna*. The erect hairs on the gaster of *impexa* are much more robust and obtuse than in the latter species. The new species also resembles *F. difficilis* Emery and notably its var. *consocians* Wheeler, except in pilosity and the absence of any yellow color on the basal gastric segment.

"It is very probable that the female of *F. impexa* is aberrant, either in being very diminutive like the females of *F. difficilis* and *F. microgyna* or in having an unusual color like the female of *F. oreas*. Until this sex of *impexa* is discovered there may be some doubt as to whether the form should be regarded as a species distinct from *rufa*. That it differs very markedly in pilosity from all the hitherto described subspecies and varieties of *rufa*, there can be no doubt." W. M. Wheeler.

2. *Formica fusca* L. var. *subsericea* Say. III. 6. On the rocks at the foot of the talus slope and at the foot of the cliff, August 12. Also found in an ant hill in the clearing, II. 3, and under the loose stones on the mountain top, III, August 6.

3. *Formica fusca* L. var. *argentata* Wheeler. III. 1, 2. A number of colonies were found under the loose rocks on the mountain top, especially among the heath plants.

4. *Formica fusca* L. var. *neorufibarbis* Emery. II. 4. A colony of this species was found in a decaying aspen log, August 8.

5. *Formica lasioides* Emery. var. *picea* Emery. III. 2. Collected under the loose stones on the mountain top, August 11.

6. *Brachymyrmex heerii* Mayr. subsp. *depilis* Emery. III. 6. Under stones on the mountain top, August 12. III. 2. Taken among the heath plants on the mountain top, July 18.

7. *Tapinoma sessile* Say. (small var.). III. 1. Under the stones in the aspen zone near the top of the first range, August 11, and on III. 6, under the loose stones on the side of the mountain near the top on August 12.

8. *Camponotus herculeanus* L. var. *whymperi* Forel. III. 2. A colony was found in a dry decaying pine log on the bare mountain top, August 6. and in a decaying pine log on the mountain top, III. 6, August 12.

9. *Lasius brevicornis* Emery. III. 2. Beneath the loose rocks on the mountain top, August 11.

10. *Spenamma* (*Aphaenogaster*) *fulvum* Roger. var. *rude* Emery. III. 6. Collected beneath the stones near the top of the mountain, August 12, and under stones and fallen pine logs in the aspen zone near the top of the ridge, August 6.

6. ANTS FROM ISLE ROYALE.

1. *Formica sanguinea* Latr. subsp. *aserva* Forel. I. One colony found in the clearing, August 18.

2. *Formica fusca* L. var. *subsericea* Say. I. Several colonies were found in the clearing, August 18.

3. *Formica fusca* L. var. *neorufibarbis* Emery. I. In the humus beneath a decayed stump in the clearing, August 18. III. In a decayed log on the top of the ridge, August 20.

4. *Camponotus herculeanus* L. var. *whymperi* Forel. I. Found on sides of a log shack, August 18, and feeding on a fish head in the clearing, September 1.

5. *Leptothorax canadensis* Prov. var. I. One colony found in the clearing, August 18.

Dr. Wheeler makes the following comments on the collection: "The

collection is a very interesting one. All the forms are subboreal and characteristic of the hills or mountains of the northern states or British Columbia. The new *Formica* [*impexa*] is especially interesting. Unfortunately only workers are represented. The female is probably an aberrant form like the female of *F. oreas* or *F. ciliata*. All the other species are well known, with the exception of *F. aserva* and *Camponotus whymperi*. The latter occurs in the mountains of Colorado and British Columbia."

THE COLD-BLOODED VERTEBRATES OF THE PORCUPINE MOUNTAINS AND ISLE ROYALE, MICHIGAN.

A. G. RUTHVEN.

The list of fish in the following report is entirely the result of the work of this expedition, and we are indebted to Dr. S. E. Meek of the Field Columbian Museum, Chicago, for the identification of the specimens.

The list of amphibians and reptiles is intended to include the data at present available to the author on the occurrence of these animals in the Northern Peninsula. It is of necessity far from complete, as very little collecting has been done in this region, and the records that have been made are scattered. For the latter reason it was thought best to bring together all available information. The sources of the records are the collections made for Mr. Bryant Walker about Limestone Mountain, Baraga County, and in the Porcupine Mountains, Ontonagon County, in the summer of 1903*; the collections and field notes of the Museum Expedition in the Porcupine Mountains and on Isle Royale, during the summer of 1904; records and collections made about Marquette by Dr. E. R. Downing of the Northern State Normal School, and specimens in the University Museum collected by Dr. A. E. Foote on Isle Royale. A few notes have also been added from specimens collected during the summer of 1905, by Dr. C. A. Davis of the Michigan Geological Survey.

The amphibians, with the exception of the Marquette specimens, have been identified by Dr. Stejneger of the United States National Museum; the Marquette specimens, and the reptiles were identified by the writer, unless otherwise stated.

1. FISH FROM THE PORCUPINE MOUNTAINS.

1. *Catostomus commersonii* (Lacépede). Fine Scaled or Common Sucker. IV. 1. Ten specimens were taken in the deeper holes in Carp river near Carp Lake, July 16, on a bottom of fine mud. V. 3. Twelve specimens were collected near the center of Carp Lake on July 16. VII. 1. One was taken and several others seen off the edge of the delta of Little Carp river, August 3. VII. 3. Two specimens were collected in a pool about five feet deep behind a beaver dam on Little Carp river, August 3. This is the characteristic and common fish in the deeper waters of this region.

2. *Semotilus atromaculatus* (Mitchell). Horned Dace. IV. 1. Thirteen specimens were taken in Carp river on July 16 and 18. This fish seemed to occur only in small numbers in the deeper water near the lake, but farther up stream, where the current is more rapid, it was very abundant, although the bottom was still composed of mud and debris. No specimens were taken in Carp Lake, but it is abundant in Little Carp Lake, VII. 1, where

*Ruthven, A. G.—Notes on the Molluscs, Reptiles and Amphibians of Ontonagon County, Michigan. Sixth Annual Report Michigan Academy of Science, pp. 188–192.

thirty-four specimens were taken, August 3. In the latter, locality they were observed repeatedly about dusk to jump partly out of the water in pursuit of dragonflies.

3. *Nototropis cayuga* Meek. IV. 1. Four specimens were taken off a mud flat in Carp river on July 16, among a vegetation of water lilies.

4. *Nototropis hudsonius* (DeWitt Clinton). Spawn Eater or Shiner. IV. 1. Four specimens were taken off a mud flat in Carp river, and many others in Carp Lake, V. 3, in about six feet of water, off a gravelly shore, July 16.

5. *Nototropis cornutus* (Mitchell). Shiner; Red Fin. VII. 3. One specimen of this form was taken in Little Carp river. This fish was observed to occur much more numerously up stream, where the current was swift and the bottom composed of gravel, than in the deeper water near the lake.

6. *Couesius plumbeus* (Agassiz). VII. 3. Six specimens of this fish were collected in Little Carp river at about the middle of the beaver meadow, where the stream is shallow, current quite rapid, and the bottom composed of small stones.

7. *Salvelinus fontinalis* (Mitchell). Brook Trout. Owing to the preference of this species for clear cold streams with a swift current and gravel bottom, it is not surprising that it does not occur in Carp Lake or Carp river within the mountains. It is reported by Mr. Allie, of the Carp Lake Mine, to be abundant in Little Carp Lake during the spring and early summer, but we were unable to obtain any in August.

8. *Thymallus ontariensis* (Cuvier and Valenciennes). Grayling. This fish was not taken, but specimens were seen by the writer in the summer of 1903, which had been taken in Little Carp river, near Lake Superior.

9. *Eucalia inconstans pygmaea* (Agassiz). VII. 3. One specimen was taken in Little Carp river on August 3, where the current was quite rapid and the bottom composed of fine silt. Several others were seen in a small creek cut in the loam of the beaver meadow.

10. *Percopsis guttatus* Agassiz. Trout Perch. IV. 1. Three specimens were collected in shallow water off a mud flat in Carp river, and in the deeper waters of Carp Lake, V. 3. This genus and species were originally described by Agassiz[1] from specimens taken in the Lake Superior region. Its habitat is given by Forbes[2], as apparently deeper waters, not often found in streams, and by Jordan and Evermann,[3] as "cold or clear lakes and rivers." It, however, occurs in the Porcupine Mountains, in quite shallow water. This may be due to the fact that it is a northern form, and that in this region the conditions to which it is adapted are more widespread than toward the south.

11. *Perca flavescens* (Mitchell). Yellow Perch. IV. 1. Four specimens were collected in the deeper parts of the river near Carp Lake, and twenty-five in the lake, V. 3. These specimens were all obtained in the deeper parts of the lake and river, where there was considerable vegetation and muddy bottom.

2. FISH FROM ISLE ROYALE.

1. *Catostomus commersonii* (Lacepede). Common Sucker. X. Often seen in large schools near the shore of Washington Harbor. The conditions were: bottom rocky, and little or no vegetation.

[1]Agassiz, Louis. Fishes of Lake Superior compared with those of the other Great Canadian Lakes. p. 284. Lake Superior its Physical Character, Vegetation, and Animals. Boston, 1850.
[2]Forbes, S. A. A Catalogue of the Native Fishes of Illinois. Rep. Ill. State Fish Com., 1886, p. 96.
[3]Jordan and Evermann. The Fishes of North and Middle America. Bull. U. S. Nat. Mus., No 47, Pt. I, p. 784.

2. *Couesius plumbeus* (Agassiz). The type of this species was from Lake Superior.* It occurs abundantly in Washington Harbor, X, where eight specimens were taken, August 31, just off shore, on hooks baited with worms.

3. *Argyrosomus artedi* (LeSueur). Lake Herring. X. The Herring was observed in large schools in Washington Harbor at different times; one was taken in a gill net out in the harbor, and one near shore in about fifteen feet of water, August 31.

4. *Cristivomer namaycush* (Walbaum). Lake Trout. X. This fish was taken at various times by trolling off rocky reefs in Washington Harbor and along the north shore of the island. The weight of those taken varied from 5 to 12 pounds.

5. *Salvelinus fontinalis* (Mitchell). Brook Trout. This trout occurs abundantly in Washington river, II, and individuals were often observed in the Herring schools in Washington Harbor, just off shore, X.

6. *Lucius masquinongy* (Mitchell). Muskallunge. X. But one specimen of this fish was observed, which was speared with a cant hook near the shore of Washington Harbor on August 2. Weight 13 pounds.

7. *Perca flavescens* (Mitchell). Yellow Perch. X. Occasionally taken in Washington Harbor on hooks bated with worms.

8. *Cottus ictalops* (Rafinesque). Millers Thumb. X. Occurs among the large rocks along the shore of Washington Harbor.

3. THE AMPHIBIANS OF THE NORTHERN PENINSULA.

1. *Plethodon glutinosus* Green. Slimy Salamander. I have examined a specimen of this salamander collected by Dr. E. R. Downing at Marquette. He reports it as occurring commonly in that locality.

2. *Plethodon cinereus erythronotus* Green. Red-backed Salamander. Specimens of this form were taken in decayed logs, especially in damp places, at Limestone Mountain, Baraga County, in August, 1903, and in the Porcupine Mountains in August and September, 1903. It is also reported by Dr. Downing from Marquette.

3. *Diemyctylus viridescens* Raf. Green Triton or Newt. I have examined a specimen of this form taken by Dr. Downing from a small tributary to Dead river, near Marquette.

4. *Bufo americanus* (Lec.). Common Toad. Found commonly in the woods both at Limestone Mountain and in the Porcupine Mountains in the summer of 1903, and in the Porcupine Mountains and on Isle Royale, in the same habitat, in the summer of 1904. It is reported by Dr. Downing as common at Marquette. There are also four specimens in the University Museum collected by Dr. A. E. Foote on Isle Royale, where the notes of the Museum Expedition indicate that it is very common.

5. *Hyla pickeringii* Storer. Pickering's Tree Frog. A specimen of this little frog was taken on a fern in a damp ravine at Limestone Mountain in the summer of 1903, and another on a rush in the beaver meadow on Little Carp river, VII. 2, in the Porcupine Mountains on August 3, 1904. A specimen was also taken by Dr. C. A. Davis near Winona, Houghton County, on September 1, 1905.

6. *Hyla versicolor* Lec. Chameleon Tree Frog. Dr. Downing writes me that he has taken this species at Marquette. There is also a record in the University Museum (Museum Catalogue, Vol. 2, p. 196) of a specimen

*Agassiz, *loc. cit.*, p. 366.

(No. 7457) taken on Isle Royale by Dr. Foote, which I have been unable to verify.

7. *Rana pipiens brachycephala* Cope. Leopard Frog. The distinction between the typical form of this species and the so-called variety *brachycephala* does not seem to be a good one. If it is, the specimens recorded from the Northern Peninsula, according to Dr. Stejneger, probably belong to the variety. The specimens collected on the shores of Carp Lake in the summer of 1903, and recorded as *R. pipiens*,* belong to this form. Specimens were also taken here, V. 1, 2, during the summer of 1904, and Dr. C. A. Davis captured four specimens near Winona, Houghton County, September 1, 1905. The "Leopard Frog" is abundant about Marquette, according to Dr. Downing. Owing to the resemblance between this species and *R. palustris* Lec. several specimens from the Porcupine Mountains were listed provisionally as *palustris* in the 1903 list. These have all been identified by Dr. Stejneger as *R. pipiens brachycephala.*

8. *Rana septentrionalis* Baird. Mink Frog. This species is more aquatic than the other members of the genus found in this region, and specimens are thus more difficult to capture. A number of specimens were taken along the shores of Carp Lake, V. 1, and river, IV. 1, in the summer of 1904. It is also reported by Dr. Downing at Marquette, and there is in the University Museum a specimen taken by Dr. A. E. Foote on Isle Royale, that is labeled *R. clamitans*, but, owing to its condition, it is impossible to tell whether it is to be referred to this species or *clamitans.* As it is labeled *clamitans*, however, it should probably be listed with that species.

9. *Rana clamitans* Daud. Green Frog. This is probably the most common frog in the Northern Peninsula, at least in the western part. Several specimens were taken in Otter river near Limestone Mountain in August, 1903, and it was found to be abundant in Carp, IV. 1, and Little Carp river, VII. 3, and Lakes, V. 1, and VII. 1, in 1903 and 1904. At least one of the two specimens listed as *catesbiana* in the 1903 list belongs to this species, and perhaps also the other. They are both characterized by an obscurity of the dorso-lateral folds. In the former specimen this obscurity is more pronounced than in the latter, but Dr. Stejneger states that the slight webbing of the toes in the latter indicates that it, also, belongs to this species.

10. *Rana catesbiana* Shaw. Bull Frog. See *R. clamitans.* Dr. Downing reports this species from Marquette, but it is doubtful whether his specimens are to be referred to this species or, as the Porcupine Mountain specimens, to *clamitans.*

11. *Rana sylvatica cantabrigensis* Baird. Cambridge Frog. This variety of the Wood Frog is one of the most common amphibians in the localities where collecting has been done in the Upper Peninsula. It was found to be abundant in damp woods, especially about springs, both at Limestone Mountain and in the Porcupines, during the summers of 1903 and 1904. A single specimen was also taken on the shore of Lake Desor, Isle Royale; this was, however, the only one seen on the island. To this variety are to be referred the specimens that were listed in 1903 as *R. sylvatica.*

4. THE REPTILES OF NORTHERN MICHIGAN.

1. *Storeria occipitomaculata* (Storer). Storer's Snake. A single specimen of this snake was taken in the Porcupine Mountains in 1903, and a number of specimens collected about Marquette by Dr. Downing have been examined.

*Ruthven, *loc. cit.*, p. 191.

During the summer of 1904, eight specimens were taken on Isle Royale. These snakes, as has been stated by Smith,* appear to be somewhat nocturnal although not strictly so, and the specimens found on Isle Royale were taken, for the most part, under stones in the coniferous, VI, and deciduous forest, III. On September 3, after a heavy frost, four adult specimens, very sluggish on account of the cold, were found under a stone in the woods. These were brought to Ann Arbor alive. One of these snakes, University Museum Catalogue No. 33408, during the night of September 7 gave birth to a single young, and the next morning was found dead; the young one died the following night. The mother was examined at once, and six entire and two mutilated embryos were removed. As the mutilated specimens were nearest the opening of the oviduct, it is possible that they may have been killed by an injury to the mother in rolling over the stone under which she was found, and prevented the birth of those that lay behind them. The young snake was 45 mm. long, of a rich dark brown above, and pink below. As in the adult specimens, the pink was confined to the center of the gastrosteges, not extending to the edges. The upper occipital spot was bright yellow and well defined; the laterals smaller and less distinct, although plainly present.

Another adult, University Museum Catalogue No. 33409, died on September 10. This is also a female and possesses four nearly mature embryos in the right oviduct. The left oviduct is flattened out against the dorsal body wall and contains but one very small embryo which lies in the lower part of the oviduct; notwithstanding its small size, however, it is evidently nearly mature, as the yolk has entirely disappeared.

During the night of September 19, a third specimen, University Museum Catalogue No. 33410, gave birth to nine young, one of which was dead. The fourth specimen, University Museum Catalogue No. 33411, during the night of September 26 gave birth to seven young, one of which was dead. These records are interesting on account of the questions which they raise, as to the size of the young at the time of hibernation. On the Isle, during the first part of September, the nights were cold, and heavy frosts occurred frequently, so that the specimens found in the morning were very sluggish, and the time of hibernation was probably near at hand.

Since the above was written, the University Museum has received two specimens from Dr. C. A. Davis, which were taken on Paint River, near Crystal Falls, Iron County, on August 22, 1905.

2. *Diadophis punctatus* (L.). Ring-necked Snake. Specimens of this snake have been taken by Dr. Downing at Marquette.

3. *Thamnophis sirtalis sirtalis* (L.). Common Garter Snake. Specimens of the Common Garter Snake have been taken at Marquette by Dr. Downing, and near Limestone Mountain (1903), in the Porcupines (1903 and 1904), and on Isle Royale (1904). They are more commonly found along the streams, although they are also often found in forest clearings. The University Museum has recently received a specimen from Dr. C. A. Davis, which was taken in the woods near Bessemer, Gogebic county, August 28, 1905. There are four specimens (No. 7454) listed in the University Museum Catalogue, Vol. 2, p. 196, as taken on Isle Royale by Dr. Foote. These specimens are probably the basis for Smith's Isle Royale locality.†

4. *Thamnophis sirtalis parietalis* (Say). Pacific Garter Snake. This

*Smith, W. H. Report on the Reptiles and Amphibians of Ohio, p. 698. Geological Survey of Ohio, Vol. IV., 1882.

†Smith, loc. cit., p. 680.

snake has been listed from the Lower Peninsula,* but I have never seen a specimen from southern Michigan that could be definitely referred to this variety. *Sirtalis* forms with a varying amount of red on the skin between the lateral spots are often found about Ann Arbor, but the amount of red is so small that it is generally more satisfactory to classify the specimens with the typical form. During the past summer, however, three specimens were taken on Isle Royale, II, III, that strikingly resemble specimens from Colorado and Washington and can only be referred to the variety. The dorsal row of spots, as in typical specimens of the variety, are fused into a band along either side of the dorsal stripe, which is united below with the row of spots above the lateral stripes. Between the scales the skin is Orange Red Tint No. 1 (using Milton Bradley colors). One of these is a female containing 28 embryos not yet mature, as a large yolk body is present.

5. *Thamnophis saurita* (L.). Riband Snake. There is a record in the University Museum Catalogue, Vol. 2, p. 196, of a specimen (No. 7452) of this snake taken on Isle Royale by Dr. Foote, which I have been unable to verify.

6. *Chrysemys marginata* Agassiz. Painted Tortoise. A number of specimens were taken on Carp river, IV. 1, in the Porcupine Mountains in 1904. It is also reported from Marquette by Dr. Downing.

*Clark, H. L. Notes on the Reptiles and Batrachians of Eaton County. Fourth Annual Report Michigan Academy of Science, pp. 192–194.

ANNOTATED LIST OF THE BIRDS OF THE PORCUPINE MOUNTAINS AND ISLE ROYALE, MICHIGAN.*

N. A. WOOD, MAX M. PEET, AND O. MCCREARY.

1. PORCUPINE MOUNTAINS.

The following observations upon the birds cover a period from July 13 to August 13, 1904. For the determination of certain specimens from both the Porcupine Mountains and Isle Royale, we are indebted to Mr. Robert Ridgway and Mr. H. C. Oberholser of the Smithsonian Institution, and to Dr. C. Hart Merriam, Chief of the Biological Survey of the U. S. Department of Agriculture.

1. *Podilymbus podiceps.* Pied-billed Grebe. Station VII. Sub. 1. One seen on Little Carp Lake, August 3. VII. 3. One was seen August 7, on Little Carp river.

2. *Gavia imber.* Loon. I. One seen on Lake Superior August 5, and two July 21. V. 3. One seen on Carp Lake August 10.

3. *Larus argentatus.* Herring Gull. I. Several adults observed at various times along the lake. Common at Ontonagon, Mich., July 12, 13, and August 13 and 14.

4. *Merganser americanus.* American Merganser. I. An adult female and nine or ten young were seen July 21 on Lake Superior.

5. *Lophodytes cucullatus.* Hooded Merganser. IV. 1. Adult female and young found on Carp river, July 19 and 20; also observed July 18.

6. *Botaurus lentiginosus.* American Bittern. I. One seen in the bushes along the lake shore, August 12. IV. 1. One seen along Carp river July 18, and one shot July 19.

7. *Ardea herodias.* Great Blue Heron. IV. 1. One seen July 16. V. 2. One adult male in breeding plumage seen at Carp lake, August 6. One was seen flying across Carp Lake, July 30.

8. *Porzana carolina.* Sora. V. 2. An adult male taken on the delta at the eastern end of Carp Lake, August 5.

9. *Gallinago delicata.* Wilson Snipe. IV. 1. An adult male taken along Carp river, July 19. One observed feeding July 17. IV. 2. One seen in a grassy marsh along Carp river, July 18.

10. *Actodromas minutilla.* Least Sandpiper. I. One seen along the Lake Superior shore, July 21. VII. 2. Adult male taken and several specimens seen at the beaver meadow on August 3.

11. *Totanus flavipes.* Yellow-legs. VII. 2. Immature and adult males taken at the beaver meadow August 3.

12. *Helodromas solitarius.* Solitary Sandpiper. I. One seen on the Lake Superior beach, July 27. IV. 1. Immature males, adult male and females, taken along Carp river, July 27 and 28. Common along Carp river, July

*A preliminary note was published by N. A. Wood, Auk, XXII, pp. 175–178, 1905.

18 and August 10. VII. 2. Several were seen along Little Carp river in the beaver meadow.

13. *Actitis macularia.* Spotted Sandpiper. I. One male taken on the Lake Superior beach August 13. IV. 1. Two seen along Carp river, August 3.

14. *Bonasa umbellus togata.* Canadian Ruffed Grouse. II. 2. Several bevies of quite small young were seen July 17. Both old and young were seen several times. II. 3. Large bevies of young were seen in a clearing near camp. An adult bird was killed in the camp clearing by a Sharp-shinned Hawk. II. 5. A female with a large bevy of young was seen July 18. A large flock of young, unable to fly, and several nearly full grown were seen August 1. III. 2. Several flocks of both young and adults were seen on the mountain top during July. IV. 3. Both young and old were seen several times in the forest.

15. *Circus hudsonius.* Marsh Hawk. II. 3. An adult female was seen fighting with a Sparrow Hawk, August 8. IV. 2. A male was observed hunting, August 3. V. I. One was seen along the shore of Carp Lake August 3. VII. 2. One was seen near the beaver meadows, August 3.

16. *Accipiter velox.* Sharp-shinned Hawk. II. 1. An adult male taken July 27 and a female July 26. II. 3. One seen July 13 in the camp clearing. Several were seen below camp toward the Carp river. III. 5. They were frequently seen circling over the cliff in the morning. IV. 2. An adult female taken, August 7, near Carp river.

17. *Buteo borealis.* Red-tailed Hawk. II. 2. Two were seen flying overhead July 20. II. 3. One seen circling over the clearing August 8. III. Seen flying overhead on July 20, and at other times.

18. *Buteo lineatus.* Red-shouldered Hawk. One seen July 13 in the hemlock forest near Union Bay. The bird was on a tall dead tree, which afforded a good view of it (Wood).

19. *Buteo platypterus.* Broad-winged Hawk. II. 2. Young male, female and adult female taken August 12. The only ones seen.

20. *Haliaetus leucocephalus.* Bald Eagle. III. 5. One seen circling over the cliff, July 31, and two were observed on wing July 29. V. One was seen circling over Carp Lake July 29. Two were observed at Union Bay on July 23.

21. *Falco columbarius.* Pigeon Hawk. Several were seen at Union Bay and two were taken July 23.

22. *Falco sparverius.* American Sparrow Hawk. II. 1. Female taken in cedar swamp July 23. II. 3. One young female was taken August 4. Several were seen August 8, both young and adults. An immature male was taken July 28. These Hawks came into the camp clearing searching for grasshoppers. III. 5. Frequently observed sitting on dead stubs near the edge of the cliff in the early morning. IV. 3. A nest with young was found in an old pine stub in the hardwoods, July 16. Observed several times flying along the river. VII. 1. Seen at Little Carp Lake, August 3 and 7.

23. *Pandion haliaetus carolinensis.* Osprey. V. 3. One seen over Carp Lake July 23, and on August 10. One was also observed at Iron river, northeast of the Porcupines, July 13.

24. *Asio magellanicus occidentalis.* Great Horned Owl. II. 1. Young of the year taken and two others seen July 26. One seen among the hemlocks and maples, July 30.

25. *Coccyzus erythropthalmus.* Black-billed Cuckoo. II. 2. Was heard many times in the hardwood forest. II. 3. One was seen July 17 near the

camp. Late in the evening, about 9 p. m. of July 20, one was heard. One was seen July 15 in the aspens. An adult female was taken July 21. IV. 2. The call was heard many times in the alders. IV. 3. One was seen in the woods at the foot of the talus.

26. *Ceryle alcyon.* Belted Kingfisher. II. 3. One alighted upon the house top. IV. 2. Two birds were seen many times along Carp river. V. 3. One seen near Carp Lake July 16 and an adult female was taken July 28. VII. 1 and 2. Several were observed at Little Carp Lake and at the beaver meadows, August 2 and 3.

27. *Dryobates villosus.* Hairy Woodpecker. II. 1. One adult male was taken July 21 in the cedar swamp. II. 2. A young male was taken July 22, and adult females July 24 and 29. II. 3. An adult female was taken August 10 in the clearing. III. A male and female were seen August 10 on a dead Norway pine. III. 5. Often found on the dead stubs on top of, or overhanging the cliff. VII. 1. One seen at Little Carp Lake, August 7. VII. 2. One seen at the beaver meadow, August 3.

28. *Dryobates pubescens medianus.* Downy Woodpecker. II. 3. Young males were taken near camp August 2 and August 7, and an adult male was taken July 28. III. 3. Male and female seen near camp, August 10 on Norway pines. III. 5. Only seen once, August 12, upon a decayed pine stump. IV. 2. One seen in the tag alders, July 27. IV. 3. One was seen in the maples at the foot of the cliff, July 28. VII. One was seen August 6, at Little Carp Lake.

29. *Picoides arcticus.* Arctic Three-toed Woodpecker. II. 1. One was seen on the road to camp, July 13, and an adult male was taken July 21.

30. *Sphyrapicus varius.* Yellow-bellied Sapsucker. II. 3. A young female was taken near camp July 28. VI. One seen near Little Carp Lake, August 3, and again on August 9. One was seen at Little Iron river, east of the Porcupines, July 13.

31. *Coephloeus pileatus abieticola.* Northern Pileated Woodpecker. II. 1. A young female was taken July 27. II. 2. An adult female was taken August 1 in the hardwoods. "A young male was taken July 28 This I called to the tree nearest to me by clapping my hands, the method suggested in Chapman's Handbook. Two were called on this occasion and came within easy gun shot. After being called, they alighted and kept up a calling and drumming noise." (Peet). "In the hardwood forest I saw a dead hard maple which showed to good advantage the work of this bird. The tree contained many holes, some from 10 to 20 inches long; others 6 to 8 inches wide and deep. These birds seem to have the habit of working a tree very thoroughly." (Wood). VI. Several were seen and heard August 7 and 8, in the vicinity of Little Carp Lake. One was seen about a mile south of Carp Lake, on a hemlock. One was seen near Union Bay, east of the Porcupines, in a forest of large hemlocks with scattered white pine and a few maples, July 13.

32. *Colaptes auratus luteus.* Northern Flicker. II. 1. Several were seen in a clearing near the Lake Superior shore, August 4. II. 2. A young male was taken July 19. II. 3. One was seen July 17 flying over camp. III. 2. Several were seen and a young male was taken July 26, on the mountain top. Common, especially the young. III. 1. Several seen at different times on the stumps on the face of the cliff. IV. 3. One seen July 15, in the hardwoods near camp.

33. *Chaetura pelagica.* Chimney Swift. I. Several seen, flying overhead, along the Lake Superior shore, July 27. II. 3. Several were seen

in the evening of August 9 about camp, and an adult female was taken. IV. From the mountain top these birds were seen many times on wing over the valley of Carp river, July 19 and 20. V. Observed flying over Carp Lake on several occasions. Seen at the mouth of Carp river, July 31.

34. *Trochilus colubris.* Ruby-throated Hummingbird. VII. A female came many times to feed from flowers within about 20 feet of our breakfast camp fire, at Little Carp Lake, August 7. Another was seen at Little Carp Lake, August 9.

35. *Tyrannus tyrannus.* Kingbird. II. 1. Seen near the Lake Superior shore August 13. VI. One was seen near Little Carp Lake, August 7. On August 8 four birds, two young and two adults, were seen at a small lake two miles southwest of Little Carp Lake.

36. *Sayornis phoebe.* Phoebe. III. 5. Was seen on the south side of the cliff north of Carp Lake, July 29.

37. *Nuttallornis borealis.* Olive-sided Flycatcher. II. 1. Adult male and female were taken July 27, and an adult male was seen, and a female taken August 4, in an arbor vitae clearing near the Lake shore. IV. 4. Two birds were seen in a tamarack swamp, July 28.

38. *Contopus virens.* Wood Pewee. II. 1. An adult female was taken July 30. II. 2. Several were seen in open woodland. One nest was found July 23 in a tree, about 60 feet from the ground. VI. One was heard on the trail to Government Peak, July 26.

39. *Empidonax trailli alnorum.* Alder Flycatcher. IV. 2. Observed catching insects along the bank of Carp river. Several were seen in the alders along the river July 18. An adult male and female were taken July 22; these were among the willows when shot.

40. *Empidonax minimus.* Least Flycatcher. II. 1. Two were seen in a clearing in the arbor vitae swamp near the lake shore, and an adult male and female were taken July 27. IV. 2. Several were seen along Carp river, August 6, and two were seen in the alders along Carp river, July 18.

41. *Cyanocitta cristata.* Blue Jay. III. 5. Several seen at top of bluff July 23, and a female was taken July 17. IV. 3. Often seen along the river bank; an adult male shot July 18. VII. Several were seen at Little Carp Lake August 3, and one was seen August 7.

42. *Perisoreus canadensis.* Canada Jay. VI. One was seen near Little Carp Lake, August 7.

43. *Corvus corax principalis.* Northern Raven. I. Observed several times near Lake Superior. II. 3. One was seen flying over camp July 15, and one was heard August 12. One alighted upon the roof of the barn and was seen in the vicinity of the camp several times. III. Seen flying over the mountain top. III. 5. Often seen flying over the cliff, between July 5 and July 26. Adult males were taken, August 5 and July 30, on the cliff. Usually seen flying toward this cliff toward evening, about a dozen in a flock. IV. Was seen flying over the valley many times. V. Nine were counted flying over Carp Lake July 29. VII. One was seen at Little Carp Lake, August 2.

44. *Corvus brachyrhynchos.* American Crow. I. Common on the shore of Lake Superior. II. 3. One seen upon a dead tree near camp. III. 2. Observed flying overhead. III. 5. Common on the bluff July 15, and on July 18 several were seen on a dead pine. IV. 2 and 3. Often seen at the foot of the cliff, near the river, resting on tall tamaracks.

45. *Agelaius phoeniceus.* Red-winged Blackbird. IV. 2. Several were seen August 6, and on August 8 a young male was taken.

46. *Carpodacus purpureus.* Purple Finch. II. 1. Was often seen in the coniferous trees. An adult female was taken July 27. II. 3. "I found these very plentiful, and they did not appear to be paired. The males and females usually coming in separate flocks." (Peet). An adult male was taken July 14, and both sexes again July 15. These birds visited the camp for table refuse. IV. 2. Was seen feeding in the tamaracks August 3 and 4. VII. Observed at Little Carp Lake, August 2.

47. *Loxia curvirostra minor.* American Crossbill. II. 3. Adult male and female were taken at camp, August 5. These birds often came to camp to pick up crumbs. IV. 4. An adult male was taken August 4. A small flock was seen near the upper part of the river, August 5. Observed feeding among tamaracks, August 3 and 4.

48. *Loxia leucoptera.* White-winged Crossbill. IV. 4. Adult male and three females were taken August 5. The crops of these birds were full of tamarack seeds. VII. 2. A flock was seen at the beaver meadow, August 3.

49. *Spinus pinus.* Pine Siskin. II. 2. Common among coniferous trees July 13 and August 12. II. 3. A female came to camp and was seen to pick up some hair and fly away. Adult males were taken at camp, July 15 and 25, and August 9. The birds about camp showed little fear, and would fly within about three feet of one, to pick up crumbs. The males secured had very large testes. IV. 4. They were observed many times in the tamarack swamp August 3 and 4. VII. 2. Were seen near the beaver meadow, August 3.

50. *Pooecetes gramineus.* Vesper Sparrow. III. 2. Several were seen on the top of the mountain, August 10. III. 5. Several were seen on the top of the cliff on July 26; a large flock was also seen here August 3. They appeared to be migrating.

51. *Zonotrichia albicollis.* White-throated Sparrow. II. 2. An adult female was taken July 22 and an adult male August 5, in the hardwoods. II. 3. One was heard singing at dusk, July 18, in the clearing. IV. 2. One adult male was taken July 21 near Carp river, and an adult female was taken August 5. Often seen and heard singing towards evening along the river. IV. 4. Several were seen in a tamarack swamp July 28. VII. Several were seen at Little Carp Lake August 7. VII. 2. A number were seen at the beaver meadow, August 3. One was seen on the road from the Porcupines to Ontonagon August 14.

52. *Spizella socialis.* Chipping Sparrow. III. 2. An adult male was taken July 20. III. 5. Several were seen on the top of the cliff July 26, and a small flock on August 3. VII. Seen at Little Carp Lake August 2.

53. *Junco hyemalis.* Slate-colored Junco. III. 2. Abundant at all times on top of the cliff. Many were seen with insects, as if caring for young; they were always in the open or near the edge of a clearing (Peet). III. 5. On the top of the mountain a female was seen feeding young on July 27, and an adult female was taken July 17. VII. Observed at Little Carp Lake, August 2.

54. *Melospiza cinerea melodia.* Song Sparrow. II. 1. One was seen in a clearing near Lake Superior, July 25. II. 3. An adult female was taken, July 21, near camp. IV. 2. A young female was taken near Carp river. Adults were observed feeding fully fledged young, July 22.

55. *Melospiza georgiana.* Swamp Sparrow. IV. 2. Very common in the valley. Adult males were taken July 21 and 22, and young females July 28 and 31. The adults were observed feeding fully fledged young July 22. VII. 2. Observed at the beaver meadow, August 3.

56. *Zamelodia ludoviciana.* Rose-breasted Grosbeak. III. 5. One seen at the edge of the cliff July 23. IV. 2. One was seen in the alders July 23. A young male and female were taken in the tamaracks, August 5.

57. *Cyanospiza cyanea.* Indigo Bunting. II. 3. An adult female was taken while eating weed seeds in the clearing near camp, July 21. This was the only one seen.

58. *Piranga erythromelas.* Scarlet Tanager. III. 5. Adult male and female were seen July 15, and an adult male was seen July 26. VI. One was heard along the trail to Government Peak, July 26.

59. *Tachycineta bicolor.* Tree Swallow. VII. 2. One was seen at the beaver meadow, August 3.

60. *Ampelis cedrorum.* Cedar Waxwing. II. 1. One adult female was taken August 13; was frequently observed along the lake shore. II. 2. Seen flying overhead. II. 3. An adult male was taken July 19. These birds came repeatedly to the camp to pick up crumbs, etc. near the door of the shack. III. 2. Frequently seen on the top of the cliff and observed feeding on berries. III. 5. Several were seen July 26, along the edge of the cliff. Frequently observed at this locality, always in flocks. IV. 2. Very common along Carp river. An adult female was seen August 2 building a nest in the alders overhanging Carp river. VI. Several were seen at a small lake below Little Carp Lake on August 7.

61. *Vireo olivaceous.* Red-eyed Vireo. II. 1. Abundant at this station. II. 2. One was heard in the hardwoods July 14. An adult male was taken July 20. Several were seen with young just able to fly. II. 3. At camp an adult male was taken July 19, and young were taken July 15 and 20. These birds were common about camp, in the aspens. IV. 2. On July 22 one was seen singing in the alders. Abundant along the river. VII. 2. Seen near the beaver meadow, August 3.

62. *Vireo solitarius.* Blue-headed Vireo. II. 1. An adult male and female were taken July 27. IV. 4. Were seen in a tamarack swamp, and an adult male and female were taken August 5.

63. *Mniotilta varia.* Black and White Warbler. VI. The only one seen was on a small maple tree south of Carp river, August 5.

64. *Dendroica caerulescens.* Black-throated Blue Warbler. II. 2. A pair was found July 17, whose actions indicated a nest was near. A young bird in the down and an adult male were taken July 20. Several were seen on August 1. An abundant bird at this station, the young and adults were common in the hardwoods and usually in low brush. An adult female was taken July 16. II. 3. A female seen feeding young near the edge of a clearing July 20. II. 5. Many seen whose restless manner indicated a nest. Usually seen in young maples about four feet high. II. 2. Frequently in the low growth along the path in the hardwoods. IV. 2. Often seen in the bushes bordering Carp river. VI. Several males and females were seen in the vicinity of Little Carp Lake, August 7.

65. *Dendroica coronata.* Myrtle Warbler. I. Adults and young birds were seen in the brush near the shore of Lake Superior, July 16. III. 3. A young male was taken August 10. Several birds were seen in a flock among the tops of the Norway pines.

66. *Dendroica maculosa.* Magnolia Warbler. II. 1. A male was seen and a female taken July 21. Was always to be found among cedars near Lake Superior. Two were seen, August 1, on damp land quite thickly overgrown with bushes and tall grass. IV. 4. An adult male was taken July 21. Several were seen feeding in the tops of tamarack trees, and heard

singing July 28. On July 18 they were also observed in the tamaracks. VI. Seen near a stream on the trail to Government Peak July 26.

67. *Dendroica pensylvanica.* Chestnut-sided Warbler. IV. 2. An adult female was taken July 28, and several were seen near Carp river.

68. *Dendroica blackburniae.* Blackburnian Warbler. II. 1. A pair with two young were seen in the tops of birches, July 14. On August 1 several adults and young were seen in birches on marshy land. II. 2. Observed several times between July 13 and 30. II. 3. A female, with young in the down, were taken July 14. A young male was taken July 19. Several were seen near camp with young. II. 5. Small flocks of adults and young were seen several times feeding in the tops of young maples. IV. 3. Seen at the foot of the talus slope among the maple trees July 15.

69. *Dendroica virens.* Black-throated Green Warbler. II. 1. An adult male taken July 30, along the lake shore. II. 2. Common in the hardwoods; an immature male was taken July 20, and an adult July 18. III. 2. Several were seen feeding in the tops of Norway pines on the mountain top August 10. III. 5. Seldom seen at this station. A young male was seen here July 20. IV. 2. An immature male was taken August 5. Common among the alders along Carp river.

70. *Dendroica vigorsii.* Pine Warbler. III. 2. Seen carrying food to young in top of a Norway pine, at the edge of the cliff.

71. *Seiurus aurocapillus.* Oven-bird. II. 2. A nest containing two eggs and one young bird was found in the leaves near the path through the hardwoods, July 15. Young in nearly all stages of plumage were seen. Two were seen in the maple undergrowth, August 11, and a young male was taken July 21. II. 5. An adult male was taken in a trap set for mammals near the top of the bluff, July 15. Many young birds were seen, usually on the ground among the bushes, but sometimes running ahead in the path like quail (Peet). III. 2. Several were seen singly in the aspens bordering the bare mountain top. IV. 2. Seen several times among the alders along Carp river.

72. *Seiurus noveboracensis.* Water Thrush. IV. 2. Seen several times in the alders along Carp river, one was seen July 22. A bird was seen July 13 east of the Porcupines, on the road to Ontonagon.

73. *Geothlypis agilis.* Connecticut Warbler. II. 1. Adult females were taken July 27 and August 4. On July 27, four of these birds were seen in a marshy strip of land thickly overgrown with birch and long grass, but shaded with large hemlocks.

74. *Geothlypis philadelphia.* Mourning Warbler. II. Seen among the brush of open woodland, August 4. II. 3. A female and her young were taken July 15. An adult male was taken at the camp, July 14. Two females were seen, each with one young bird just able to flutter along in the low weeds. When the young were shot the females remained near by and kept up a sharp chirping and jerking movement of the body. Two males were taken, one of these appeared greatly excited when approached and flew from tree to tree among the young aspens, grasping the trunk of the trees so that its body was at right angle to the tree. They remained within about five feet of the ground (Peet). IV. 2. Was seen several times among the alders along Carp river and last seen August 5. VII. An adult and one young bird were seen among the brush on a bluff at Little Carp Lake, August 7.

75. *Geothlypis trichas brachidactyla.* Northern Yellow-throat. IV. 2. One was seen, scolding vigorously, in the brush near the boat landing, July

22, on Carp river. VII. 1. One was seen at Little Carp Lake, August 7 among the low brush growing on a rocky bluff over the lake.

76. *Wilsonia canadensis.* Canadian Warbler. II. 1. Seen several times among cedars along the Lake Superior shore, July 13-August 2. An adult female was taken August 2. IV. 2. An adult female was taken July 31 and again on August 2. One was seen July 15 with an insect in its bill and acted as if young were near.

77. *Setophaga ruticilla.* American Redstart. II. 1. An adult male was seen July 16, and several were observed in tall birches on July 17, near the Lake Superior shore. An adult male was taken July 17. IV. 2. An adult female was seen near Carp Lake, August 6. Many were seen in the brush along the river at various times. One was seen on the road to Ontonagon, July 14.

78. *Troglodytes aedon.* House Wren. II. 1. A young female was taken in a clearing July 25. There were several observed at this place in a dense brush pile. II. 2. A young male was taken July 24, in the hardwoods.

79. *Olbiorchilus hiemalis.* Winter Wren. II. 1. A small family was seen July 21, and a young male was taken July 23. Abundant at this station. IV. 2. An adult female and two young were taken August 10. Often seen among the alders along Carp river. VI. Several were seen near streams on the trail to Government Peak, July 26.

80. *Telmatodytes palustris.* Long-billed Marsh Wren. IV. 2. One male was taken near Carp river, July 22.

81. *Certhia familiaris americana.* Brown Creeper. II. 1. The first ones were seen July 13, but were frequently observed after that date. II. 2. A large flock of adults and young were seen among the hemlocks, July 15. An adult female and young were taken July 19.

82. *Sitta carolinensis.* White-breasted Nuthatch. III. 3. One was heard in the pines, July 20.

83. *Sitta canadensis.* Red-breasted Nuthatch. II. 1. This species was seen twice in the cedar swamps near Lake Superior, July 21 and 27. III. 3. One was seen, July 20, in the pines on the mountain top. IV. 4. An adult male and female, and two young males were taken July 27 in a tamarack swamp. Several were seen here again August 4. VI. One was seen near the beaver meadow August 3.

84. *Parus atricapillus.* Chickadee. II. 2. Adults were seen feeding fully fledged young in the aspens, along the path through the hardwoods, on July 15. Young were taken July 21. II. 3. A young bird was taken July 15, and an adult male and a young female were taken July 21. Often seen in the aspens about camp, usually with young which they were feeding. III. 5. Several were seen feeding in the Norway pines on top of the cliff, July 23. IV. 4. Several observed in a flock of Golden-crowned Kinglets in a tamarack swamp, August 11. VI. Quite common near Little Carp Lake on August 7.

85. *Regulus satrapa.* Golden-crowned Kinglet. II. 2. Young in the down taken July 2. Several seen in the hemlocks July 17. Abundant among the hemlocks, July 13 to August 12. Large flocks of young and adults seen in the tops of the tallest hemlocks on July 14. II. 3. Young birds were taken July 14 in the clearing. IV. 2. A young female was taken July 27. Several were seen with Chickadees August 11. Many were seen along the Carp river at various times. IV. 4. They were abundant in the tamarack swamps, August 4 and 5.

86. *Hylocichla ustulatus swainsonii.* Olive-backed Thrush. II. 1. An

adult female was taken July 22, with the tough thickened skin on the abdomen characteristic of a breeding bird. II. 2. Often seen in an open woodland, July 13 to August 12. III. 2. One specimen seen August 1. IV. 2. A young male taken July 29. The song was heard in the evening and morning in the woods at the foot of the cliff, but during the day the bird retired to the alders along the river valley. It stopped singing the last week in July. VI. A nest containing two eggs was found on the trail to Government Peak July 26.

87. *Hylocichla fuscescens.* Wilson Thrush. II. 3. Heard singing near camp during the evening of July 18. IV. 2. Young taken July 22 along Carp river.

88. *Merula migratoria.* American Robin. II. 3. An adult male was taken July 30, and another was seen near camp on August 10. III. 2. One was seen July 20. III. 5. An adult male was seen on the top of the bluff July 23. This is apparently a rare bird in the Porcupines.

89. *Sialia sialis.* Blue Bird. III. 2. Several seen near the edge of the cliff on August 10. III. 5. An adult female was taken July 19. "A nest was found in a Norway pine stub on the top of the cliff July 23. The old birds fed the young every 5 to 8 minutes during the half hour they were observed. The parents were quite tame as they fed the young while I stood within 15 feet" (Wood).

2. ISLE ROYALE.

The observations and records incorporated in the following notes were made at the southwestern or lower end of the Isle, in the vicinity of Washington Harbor. A few observations were also made in the vicinity of Siskowit Bay on the south coast. The time spent on the island covered the period from August 16 to September 5, 1904.

On account of the lateness of the season, but little could be determined concerning the breeding birds. The migrants were already abundant. This was evident on account of the abundance of the Chipping Sparrow, Sharp-shinned and Sparrow Hawks. Many of these migrating birds were so abundant and of such general occurrence that little could be learned of their habitat relations. Perhaps the limited extent of the island, as a feeding ground, emphasized the apparent abundance.

1. *Podilymbus podiceps.* Pied-billed Grebe. II. Two were seen on Washington river, August 17, and several more August 30. A young bird, in the first plumage, was taken August 18, and young birds were again taken August 24 and 25.

2. *Gavia imber.* Loon. VII. Two were seen on Lake Desor, August 24, and again August 30.

3. *Larus argentatus.* Herring Gull. VII. One adult was seen at Lake Desor on August 24. IX. The rocky promontories were often white with these gulls. They would swim about in the lake and then fly back to the rock. X. These birds were very abundant in the harbor, where they were seen every day. On August 19, a small island north of the mouth of Washington Harbor was almost completely covered with them. On August 31, flocks were observed feeding in the harbor.

4. *Merganser americanus.* American Merganser. II. A young female, in the down, and an adult, were taken August 31. An adult and five young were observed on Washington river, August 31. VII. A young bird, in the down, was taken August 21. X. An adult bird and several young were observed August 19.

5. *Querquedula discors.* Blue-winged Teal. II. Three were seen on Washington river August 30. X. A flock of 25 or 30 were seen in the harbor August 30.

6. *Botaurus lentiginosus.* American Bittern. II. One was seen flying along the river on August 24 and again on August 30.

7. *Ardea herodias.* Great Blue Heron. I. One was seen flying over camp, August 21. X. One was seen flying over the harbor on August 30.

8. *Porzana carolina.* Sora. II. One was seen near the margin of the river August 22. Adult males were taken on both August 24 and 25. One was again observed at the edge of the river in tall grass, August 28; also observed on August 30, near the river.

9. *Fulica americana.* American Coot. II. One was seen August 22 on the river, and an adult female was taken August 24.

10. *Gallinago delicata.* Wilson's Snipe. I. One seen August 17 and 25 near the harbor.

11. *Actodromas minutilla.* Least Sandpiper. X. One seen August 28 and September 4, along the shore of Washington Harbor.

12. *Totanus flavipes.* Yellow-legs. I. An adult female was taken August 26 from a small flock which came into the clearing at the house. X. One was seen on the dock in the harbor, August 25.

13. *Helodromas solitarius.* Solitary Sandpiper. II. An adult male was taken August 17, a female August 18, and a young bird September 3. It was common along Washington river August 17 to September 3. X. Several were seen at the edge of the harbor September 4.

14. *Actitis macularia.* Spotted Sandpiper. X. One was seen on the shore at Washington Harbor, August 28.

15. *Pediocaetes phasianellus.* Sharp-tailed Grouse. I. A resident reports that "prairie chickens" come to the clearing in the fall. VIII. Several were seen in a clearing at Siskowit Bay, August 29. This was the only species of grouse seen on the island by the party.

16. *Accipiter velox.* Sharp-shinned Hawk. I. Very abundant. Young males were taken between August 16 and 31, and young females August 21, 23 and 31. One adult female was taken August 27. Several were seen every day about the camp and in the clearings along the river. "Very abundant in clearings, showing little fear until fired upon repeatedly. They were very ferocious; one caught a Sora Rail while on the wing, and tore it to pieces within 15 feet of me. It grasped its prey from beneath by darting under it, turning over, and thrusting its claws into its victim's breast" (Peet). VII. One was seen at Lake Desor, August 24.

This was an abundant bird from August 17 until September 3, and showed a decided preference for clearings and open woodland, where it found several kinds of sparrows and warblers, in whose company it seemed to migrate.

17. *Accipiter cooperii.* Cooper's Hawk. X. One seen over the harbor. "This bird flew over the boat as I was fishing on August 19" (Wood).

18. *Buteo borealis.* Red-tailed Hawk. I. One was seen flying over camp, August 28.

19. *Buteo lineatus.* Red-shouldered Hawk. II. One was seen September 4.

20. *Haliaetus leucocephalus.* Bald Eagle. X. A fine adult was seen at Washington Harbor, August 16. An adult bird was perched upon a stump near the water's edge, at the mouth of Washington river, on August 27. On August 31, this eagle was again seen. A resident reports

that its mate was killed last year, and that the pair had lived here for many years (Wood).

21. *Falco columbarius.* Pigeon Hawk. I. An adult female was taken August 30. One was seen near the camp on August 31 and September 1. II. An adult male was taken August 23, and two were seen September 1.

22. *Falco sparverius.* American Sparrow Hawk. I and II. Adult males were taken August 16 and 23, adult females August 23 and 27. This was the most common hawk frequenting the clearing about the harbor. Observed catching grasshoppers in the clearings. Several were caught in steel traps baited with meat. Observed in abundance from August 16 to September 5.

23. *Pandion haliaetus carolinensis.* Osprey. II. An adult female was taken August 26, and one was seen August 25. X. One was seen over the harbor on August 20.

24. *Asio accipitrinus.* Short-eared Owl. I. One was seen at the edge of the clearing August 17, and one was found dead near the camp on August 16. This species was not seen after August 17. It probably migrated (Wood).

25. *Asio magellanicus occidentalis.* Great Horned Owl. II. Three were seen August 22 near the river. Near by, in a clearing, four were found about dark August 26, and three were taken.

26. *Ceryle alcyon.* Belted Kingfisher. II. One or two were seen nearly every day from August 16 to September 1, along Washington river. An adult female was taken August 26. They were occasionally seen pursued by Sharp-shinned Hawks. When the hawk was nearly upon it, the Kingfisher would throw up its bill and ward it off, in a manner similar to that stated for herons when pursued by hawks (Peet). VII. One was seen at Lake Desor on August 24. X. Occasionally seen along the harbor.

27. *Dryobates villosus leucomelas.* Northern Hairy Woodpecker. I. One was seen September 1. II. One was seen August 16 and again on 19. III. Adult females were taken August 20 and on September 1. IV. Two were heard along the creek in the cedar swamp, August 4.

28. *Dryobates pubescens medianus.* Downy Woodpecker. I. A young male was taken August 29. IV. An adult male was taken August 18. VII. Seen at Lake Desor, August 24. A common bird of general distribution.

29. *Picoides arcticus.* Arctic Three-toed Woodpecker. II. An adult female was taken, August 31. One was seen each day August 28, 29 and 30. This was a rare bird in the vicinity of Washington Harbor.

30. *Sphyrapicus varius.* Yellow-bellied Sapsucker. II. A young female was taken August 22, along Washington river, in the coniferous forest. Apparently a rare bird in this vicinity.

31. *Coephloeus pileatus abieticola.* Northern Pileated Woodpecker. II. and III. An adult male and a young female were taken August 19. An adult male was taken August 30, and five other birds were seen. Quite common in the forest and were heard or seen almost every day. "One specimen, after being shot at, was called back by continued clapping of the hands, although under other circumstances, they are very shy and difficult to approach. On rainy mornings they were very noisy" (Peet). "They were very noisy in the morning about sunrise, but on cloudy days they continued their pounding and calling for several hours" (McCreary).

32. *Colaptes auratus luteus.* Northern Flicker. II. Very abundant in the clearings along Washington river. One was shot August 16. VII. One was seen September 3 at Lake Desor.

33. *Chordeiles virginianus.* Night Hawk. I. Young females were taken August 16, and an adult male was taken August 23. A very common bird, frequently seen in the evening catching insects over the grass and water. Found roosting on the ground in clearings. None were observed after August 29.

34. *Chaetura pelagica.* Chimney Swift. I. Several were seen flying overhead on August 16, 17, 19 and 23, at the camp clearing.

35. *Trochilus colubris.* Ruby-throated Hummingbird. I. It was reported, as have been seen hovering about flower beds at the camp clearing. II. One was seen August 30 along the road through the coniferous forest.

36. *Sayornis phoebe.* Phoebe. I. An adult male was taken August 26 near camp. II. An adult female was taken August 18 and others were seen, at various times, between August 17 and 28, along the road in or near clearings.

37. *Nuttallornis borealis.* Olive-sided Flycatcher. I. Occasionally seen on dead trees in the clearings. II. An adult male was taken August 18, and was common from August 17 to August 28. IV. Seen on August 18 in a cedar swamp.

38. *Empidonax minimus.* Least Flycatcher. II. Often seen between August 19 and September 3. III. An adult male was taken August 31. Common.

39. *Cyanocitta cristata.* Blue Jay. II. An adult male was taken August 19, and a young female August 18. Very common about the deserted mining camps. Seen August 22 and 28, along the road. Adults moulting.

40. *Perisoreus canadensis.* Canada Jay. II. An adult male and female were taken August 25. Found about the deserted mining camps. Adult males were seen August 18, 22, and September 1, and females August 19 and 23. A common bird. VII. A number were seen at Lake Desor, August 24. They were very quiet and were not seen until we started to fry our bacon in front of the tent. Several then came flying from different directions and perched on the spruce boughs just above us, hopping about until we left camp, when they flew down about the ashes in search of scraps. (Ruthven).

41. *Corvus corax principalis.* Northern Raven. I. An adult female was taken August 23. II. On several mornings a flock of six was seen in a clearing. One was shot August 17. X. Eight were seen August 19, near the entrance to Washington Harbor; on August 30, three were seen flying over the Harbor. Reported to be a resident bird. The adult specimens taken were moulting.

42. *Corvus brachyrhynchos.* American Crow. I. This species was not as common about the clearing as were the Ravens, and was much more shy. Early in the morning of September 4, one came to the clearing and perched on the roof of an old log house, a few rods from camp. II. Two were seen nearly every day along the river.

43. *Agelaius phoeniceus.* Red-winged Blackbird. I. An immature female was taken August 26.

44. *Agelaius phoeniceus fortis.* Northern Red-winged Blackbird. I. Young males were taken August 18 and 26, and an adult female was taken on August 29. II. Several flocks (species uncertain) numbering about 15 or 20 specimens, were seen in the clearing. Only one male in black plumage was seen. Common. VII. An adult female was taken on August 24.

45. *Quiscalus quiscula aeneus.* Bronzed Grackle. II. An adult female

was taken August 19 in the clearing along the river. This was the only specimen seen and was found feeding in front of a deserted cabin.

46. *Loxia leucoptera.* White-winged Crossbill. II. Only small flocks were seen August 18, 26 and 30. IV. A small flock was seen on August 18.

47. *Astragalinus tristis.* American Goldfinch. II. A flock was seen August 19, and several were seen on August 17.

48. *Spinus pinus.* Pine Siskin. II. Frequently seen in flocks between August 18 and September 5.

49. *Passerculus sandwichensis savanna.* Savanna Sparrow. I. Young males were taken August 17 and 26, and adult females were taken August 30, and 31. This species was seen in flocks all over the clearing about camp, and was very tame, even coming into the houses. Very common after August 26 along roads and in the clearings. During the last week in August this species became abundant and was very tame. After September 1 it began to leave and nearly all were gone by September 5.

50. *Zonotrichia leucophrys.* White-crowned Sparrow. II. Two specimens were seen near the deserted mining camps September 1. On August 29 two were seen along Washington river. One was taken August 28.

51. *Zonotrichia albicollis.* White-throated Sparrow. I. One was seen at the edge of the clearing on August 24, and on September 1 and 4. II. An adult female and a young male were taken August 19. Young and the adults were seen almost every day along the river. VII. One was heard at Lake Desor on August 24.

52. *Spizella socialis.* Chipping Sparrow. I. Young males were taken August 17 and 27, and young females August 24 and 27. Very common in the camp clearing. II. Abundant in the clearing.

53. *Spizella pallida.* Clay-colored Sparrow. I. An adult male was taken August 25, and one was seen August 26. II. One was seen each day on August 28 and 31, in the clearing.

54. *Junco hyemalis.* Slate-colored Junco. I. An adult male was taken August 29. II. It was very common in the clearings between August 28 and September 5.

55. *Melospiza cinerea melodia.* Song Sparrow. I. One was seen August 24. II. Common from August 17 to 28, among brush in the clearings.

56. *Melospiza lincolnii.* Lincoln's Sparrow. II. An adult male was taken September 1, in the undergrowth of a white cedar swamp.

57. *Ampelis cedrorum.* Cedar Waxwing. I. A young male was taken and a flock was seen August 18. II. Several were frequently seen along Washington river. Several nests were found August 28 in alders about six to ten feet from the ground. These nests had recently been used (Wood). An old bird was seen feeding four young that had just left the nest, September 1. An abundant species.

58. *Vireo olivaceus.* Red-eyed Vireo. II. Adult males were taken August 23 and September 5.

59. *Vireo philadelphia.* Philadelphia Vireo. II. One was seen September 1, along the road through the coniferous forest.

60. *Mniotilta varia.* Black and White Warbler. II. One was seen August 24 (Wood).

61. *Helminthophila rubricapilla.* Nashville Warbler. II. One was seen August 28. IV. A young male was taken August 18.

62. *Helminthophila peregrina.* Tennessee Warbler. I. An adult male was taken August 22 and a young male September 4. II and III. Three birds were seen August 24. Very common in woodland. Not seen before

August 22, after that date they were quite common until September 4. Evidently a migrant.

63. *Dendroica caerulescens.* Black-throated Blue Warbler. II and III. An adult male was taken August 17. A male and female were seen August 25 and one was seen August 24. Common, a few seen nearly every day from August 17 to September 4.

64. *Dendroica coronata.* Myrtle Warbler. I. A young male was taken August 29. II and III. An adult female was taken September 3. A few seen nearly every day from August 20 to September 3. Apparently migrating. Common.

65. *Dendroica maculosa.* Magnolia Warbler. II. An adult male was taken August 30, and an adult female September 3.

66. *Dendroica striata.* Black-poll Warbler. I. A young male was taken August 26, and two were seen September 4, near the camp. II. Young males were taken August 26 and 30.

67. *Dendroica virens.* Black-throated Green Warbler. II and III. One seen on August 24, and three on August 25. Seen every few days between August 18 and September 3. An adult male was taken September 1. Of general occurrence. Common.

68. *Dendroica palmarum.* Palm Warbler. I. An adult male was taken August 26 and September 4, and a young male was taken August 29. Many were seen at camp September 4, and were quite tame. These birds were abundant in the clearing about camp and even came close to the house, September 1. Generally found in bushes along clearings. During the night of September 3, a wave of this species occurred, and in the morning of September 4, large numbers of these birds were observed in the brush in the clearing, some specimens even coming about the camp.

69. *Seiurus aurocapillus.* Oven Bird. II. One was seen August 24. VII. An adult female was taken August 24.

70. *Seiurus noveboracensis notabilis.* Grinnell's Water Thrush. I. An adult male was taken August 26. II and III. One was seen on each of the following dates, August 18, 22, 24, 28 and 31. An adult female was taken August 24. IV. On September 1, one was heard singing a low sweet song in a cedar swamp. (Wood).

71. *Wilsonia pusilla.* Wilson's Warbler. II. An adult male was taken August 30, in alder bushes near a small stream. Evidently a migrant.

72. *Setophaga ruticilla.* American Redstart. I. Several were seen August 24, 27 and September 4. II. A young male was taken August 17. A few were seen every few days from August 17 to September 4.

73. *Olbiorchilus hiemalis.* Winter Wren. II and III. Individuals were seen August 20, 25, 30 and September 1, 3, and 4. A young male was taken August 31. IV. "An adult female was taken September 1 in a dense cedar swamp. I awakened her curiosity so much by making a chirping sound that she hopped upon a bush in full view thus allowing a chance to secure her." (Wood).

74. *Certhia familiaris americana.* Brown Creeper. II. One was killed August 19 and one seen August 20, and 22.

75. *Sitta carolinensis.* White-breasted Nuthatch. VII. An adult male taken August 24 among birch trees on the hillside.

76. *Sitta canadensis.* Red-breasted Nuthatch. II, III and IV. Adult females were taken August 17, 18 and 25. Many were seen almost every day between August 16 and September 5. VII. Abundant August 24. A very abundant bird of general distribution in the forest.

77. *Parus atricapillus.* Chickadee. II, III and IV. An adult male was taken August 17. Many were seen almost every day between August 16 and September 5. VII. Abundant August 24. Very abundant, of general distribution in forests.

78. *Regulus satrapa.* Golden-crowned Kinglet. II, III and VI. It was often seen feeding in spruce and balsam trees in company with the Chickadee and Red-breasted Nuthatch. Many were seen almost every day between August 16 and September 5. VII. Abundant at Lake Desor, August 24. Abundant and of general distribution in the forest.

79. *Regulus calendula.* Ruby-crowned Kinglet. II. An adult female was taken August 28, and one or two were seen on each of the following days, August 29, 30, and September 3 and 5.

80. *Hylocichla ustulatus swainsonii.* Olive-backed Thrush. II and III. An adult male was taken September 1, and a young male on August 24. Some were seen every few days in underbrush, they were very shy.

81. *Merula migratoria.* Robin. I. One was seen on August 16. II. One was also seen along the river on August 23.

NOTES ON THE MAMMALS OF THE PORCUPINE MOUNTAINS AND ISLE ROYALE, MICHIGAN.

CHAS. C. ADAMS.

The specimens obtained by the expedition were largely collected and prepared by Max Minor Peet assisted by N. A. Wood. Mr. Wood secured the series of notes from Mr. Haring, a former fur dealer, concerning early mammal records. Other members of the party, A. G. Ruthven, O. McCreary and W. A. Maclean, also contributed notes, specimens or both.

I take pleasure in expressing our obligations to Dr. C. Hart Merriam, Chief of the Biological Survey of the U. S. Department of Agriculture, for kindly determining a representative series of specimens, and for the determinations made by Mr. W. H. Osgood of the same Survey; also to Dr. Glover M. Allen of the Boston Society of Natural History, for valuable suggestions and for the determination of the deer and bats. The other specimens collected have been named by a careful comparison with the determined series.

1. PORCUPINE MOUNTAINS.

1. *Odocoileus virginianus borealis* (Miller). Northern Virginia Deer. Near Station II. 2, but on Section 15, an adult male was taken in the hardwood forest, August 1, and a fawn, August 14, on Section 18. V. 2. "After sundown a deer came down into the marsh at the east end of Carp Lake, also a young buck about a year old, and later on a doe with a small fawn" (Maclean). VII. 1. "After sundown, August 3, nine deer were seen about the margins of Little Carp Lake, where they were feeding on the grasses and sedges. During September, 1903, deer were often surprised during the night, standing in the water at the margin of Carp Lake. Trappers reported that the flies were especially abundant this year" (Ruthven). During the past season this habit was not observed. Trappers reported that flies were not abundant owing to late spring frosts, and attributed the absence of the deer from the lake, during the night, to this cause.

2. *Sciurus hudsonicus loquax* Bangs. Southeastern Red Squirrel. II. 1. Two adult females were taken. August 21 and 28, in the cedar swamp. IV. An adult male was taken July 29.

3. *Tamias striatus lysteri* (Rich.). Northeastern Chipmunk. II. 2. An adult female was taken August 10. III. 4. A male was taken July 20. II. 3. On July 20, an adult male was taken at the camp clearing. IV. 3. August 2, an immature male was taken in the hardwood forest of the river valley.

4. *Eutamias quadrivittatus neglectus* (Allen). Lake Superior Chipmunk. II. 1. Seven specimens, young and adults of both sexes, were taken between July 21 and August 12, at the edge of a cedar swamp and along the Lake Superior shore. VII. 1. An adult female was taken, August 11, on a rocky bluff on Little Carp Lake.

5. *Marmota monax* (Linn.). Woodchuck. II. 2. An adult female

was taken July 28 (No. 32139). This is a very dark specimen when compared with the normal form found at Ann Arbor, Mich. The long over hair, especially on the top of the head, the rear of the back and the tail, is very dark brown or black. The pale under fur is also darker than in normal specimens. The hair on the lower parts of the body is much more rufous and darker than in the normal form. II. 3. In the camp clearing, an adult and one young of the normal color were seen.

6. *Sciuropterus sabrinus* (Shaw). Northern Flying Squirrel. II. 2. Two adult females were taken in the hardwood forest, August 3 and 4. III. 5. In the aspen zone near the mountain top, an adult female was taken July 29.

7. *Castor canadensis* Kuhl. American Beaver. IV. 1. Old beaver dams were observed on Carp river, and relatively fresh ones on Little Carp river, VII. 3, by Ruthven. Mr. David Allie, of the Carp Lake Mine, reported that the last beaver taken on Carp river was about 1898. VII. 3. No fresh signs of beaver were observed on Little Carp river. Allie reported them to occur on the river below Little Carp Lake. Beaver cuttings were secured from the dams on Carp and Little Carp rivers.

8. *Peromyscus canadensis* (Miller). Canadian White-footed Mouse. II. 2. Four males taken August 3, 11, and 13, were referred to *canadensis* by the U. S. Biological Survey. Two males taken August 8 (No. 32193) and August 6 (No. 32197), and an immature male taken July 24 (No. 32198), apparently belong here. This was one of the most common mammals in the mountains.

9. *Evotomys gapperi* (Vigors). Common Red-backed Mouse. II. 2. Two males were taken in the hardwood forest, August 3 and 13. III. 5. Two pair of adults were taken in the aspen zone bordering the mountain top between July 22 and 30. IV. 4. Two adult females were taken August 6 and 7, in the tamarack swamp.

In the Porcupines this mouse is thus seen to frequent a variety of habitats, the hardwood forest, the aspen zone, and the tamarack swamp. Farther south it is more closely restricted to cool swamps.

10. *Fiber zibethicus* (Linn.). Muskrat. IV. A few specimens were seen along Carp river, July 16, by Maclean and McCreary. VII. 1. One specimen was shot at Little Carp Lake, August 7, by Peet.

11. *Zapus hudsonius* (Zimm.). Northern Jumping Mouse. II. 2. An immature male was taken, July 30, in the hardwood forest. VII. 1. An immature male was taken on a rocky bluff along Little Carp river, August 11.

12. *Napœozapus insignis* (Miller). Woodland Jumping Mouse. II. 2. Three adult males were taken in the hardwoods, between August 4 and 13.

13. *Erethizon dorsatum* (Linn.). Canadian Porcupine. II. 2. An adult female and a pair of young were taken in the hardwood forest between July 23 and August 8. An adult male was shot, July 13, in the hardwood forest near the base of the mountain slope. II. 3. Three females were taken, during July, in the camp clearing. IV. 1, and V. 1. Porcupines were frequently seen, by Ruthven, in the river and lake both during the day and night, eating leaves of the yellow water lily. (This habit is shown in Fig. 19).

This interesting animal was very abundant and of general distribution in the forest.

14. *Lepus americanus virginianus* (Harlan). Southern Varying Hare. II. 3. An adult female was taken, August 9, in the camp clearing. It had evidently been suckling young and was in full summer pelage. The yellowish rufous pelage is much more marked than in the Hares from Isle Royale

(var. *americanus*). The white outer ear margin is only feebly developed. IV. 2. A young female was taken, Aug. 21, in the alders along Carp river. In this specimen the rufous tints are very pronounced on the upper side of the legs and on the pectoral region. The outer margin of the ear is of a distinctly yellowish white color.

15. *Lynx ruffus* (Gueld.). Bay Lynx; Wild Cat. IV. 2. A weathered skull was found in the alder bushes along Carp river, by Ruthven. Trappers reported this species common.

16. *Canis occidentalis* Richardson. Gray Wolf. The trappers reported them common. Near the Porcupines, during the winter of 1902-'03, a trapper was reported to have been treed by a pack. Wolves are reported to have killed many deer near the Porcupines, during the past winter of 1904-'05.

17. *Taxidea taxus* (Schreber). Badger. Trappers reported that occasionally specimens were found.

18. *Mephitis hudsonica* (Rich.). Northern Plains Skunk. II. 3. Young and three adults of both sexes were secured between July 15 and July 30, in the clearing about camp. They were very abundant. A large adult male was taken, July 30, which weighed eight pounds. II. 2. Two specimens were seen by Ruthven along the road through the hardwood forest in September, 1903. On the morning of July 15, Wood found a young skunk in a trap, held fast by the foot. Another of about the same size was observed running about the captive, making frequent attempts to liberate it by biting the trap and pulling with its fore feet.

The skunks found in the traps were not at all violent in their attempts to escape and could easily be approached and killed with a noose.

This is a northern plains and Rocky Mountain species. These northwestern affinities suggest an origin from that direction, by way of Minnesota.

19. *Putorius cicognani* (Bonap.). Small Brown Weasel. Near II. 2. An adult female was taken along a corduroy road through the hardwoods on Section 17. Dr. Merriam wrote in 1896, "It probably also occurs in Northern Michigan and Wisconsin." (N. A. Fauna No. 11, p. 11).

20. *Ursus americanus* Pallas. Black Bear. III. Fresh signs were observed several times on the mountain top, where Allie reports that they often came to feed upon the dwarf and low black blueberries. A cub was observed here, August 5, by Allie.

Trappers reported them quite common in the mountains. An adult bear was killed, July 11, 1904, at Iron river, near the Porcupine Mountains.

21. *Sorex hoyi* Baird. Hoy's Shrew. III. 5. A pair of adult specimens were found in the aspen zone on the mountain on July 29, and August 2. IV. 4. One specimen was taken, August 12, in the tamarack swamp.

This is said to be the smallest North American mammal, and is without doubt the smallest one in Michigan.

22. *Blarina brevicauda* (Say). Large Bob-tailed Shrew. II. 2. Adult shrews of both sexes were taken in the hardwoods during August. II. 3. Three adult females were taken in the clearing. III. 5. Adults of both sexes were taken in the aspen zone surrounding the mountain top.

This shrew and the White-footed Mouse were the most common small mammals in the mountains.

23. *Condylura cristata* (Linn.). Star-nosed Mole. II. 2. A pair of moles was taken, September 2, 1903, by Ruthven, in the hardwood forest, on the mountain slope above the camp. This was about 800 feet above lake level. The line of their tunnel was intersected by a cutting, at the base

of which was an old ore bucket into which they had apparently fallen and drowned. Farther south these animals are closely confined to swamp land.

24. *Myotis subulatus* (Say). Say's Bat. II. 3. Three adult males were taken in camp, August 13, by Peet.

Supplementary Notes.

The following notes were secured by Mr. Wood from Mr. C. E. Haring of Ontonagon, Michigan. Mr. Haring and his brother bought furs from the Indians and trappers between 1860 and 1875. Unless otherwise specified these records refer to Ontonagon County.

Caribou. He had no authentic record of this species.

Moose (Alce). A moose was taken at Union Bay in 1864, and one at Gogebic Lake, Gogebic County in 1863.

Deer. Are more abundant now than formerly.

Beaver. Was yet common in 1860.

Canada Lynx. Was twice as abundant as the Wild Cat. At the present time this species is rare.

Wild Cat. Common.

Panther. Had no experience with them but had heard authentic reports of their occurrence before 1860.

Wolf. Was very common and killed many deer.

Red Fox. Was common; cross fox rare, and silver gray fox very rare.

Otter. Several skins were secured each year about 1860.

Wolverine. At Rockland, five were bought by his brother, J. M. Haring, between 1865 and 1875. This is the only Michigan (?) locality known to the writer. Of course the animals may not have been killed near Rockland, but may have come from a distance. Hon. Peter White, of Marquette, informs me, that, although he has made inquiry for many years, he has been unable to obtain authentic records of the Wolverine in Michigan.

Fisher. Common in 1860; a few skins secured each year.

Martin. Very common in 1860. A few have been taken in recent years.

Mink. Common.

Racoon. A very few have been taken.

2. ISLE ROYALE.

1. *Rangifer caribou* (Gmelin). Woodland Caribou. An Indian trapper reported that fresh tracks were seen during July, 1904, in a clearing near Siskowit Bay.

2. *Sciurus hudsonicus* Erx. Hudson Bay Red Squirrel. II. Nine specimens were taken in the coniferous forests, both young and adults. The resin on the hair about the mouth shows that both young and adults feed upon the coniferous seeds. Two of the specimens are old females which have reared young, as shown by the scanty hair on the belly; in both, four nipples had been functional. III. A young and adult male were taken in the deciduous forest along the Lake Desor trail.

There is considerable variation in the color of the upper side of the tail in the Isle Royale specimens. The median rufous band is quite pronounced in two specimens.

A winter skin, taken by a trapper, lacks the distinct lateral black line, found in the summer specimens and has a faint rufous stripe extending from the ears to the subterminal black bar on the tail. The shorter tails, with

much less rufous, and the gray color contrast these squirrels with those from the Porcupine Mountains (var. *loquax*).

Mr. Wood frequently saw squirrels feeding upon seeds taken from the cones by first cutting away the lower scales.

3. *Peromyscus canadensis* (Miller). Canadian White-footed Mouse. I and III. Two specimens, both adult females, one from the camp clearing and the other from the Lake Desor trail were determined by the U. S. Biological Survey as of this species. Two immature males, from II, were doubtfully referred to this species, also a male from III. Four specimens, of both sexes, taken at II, are provisionally referred to this species.

4. *Fiber zibethicus* (Linn.). Muskrat. II. A pair of muskrats were taken along the creek through a cedar swamp, other specimens were seen but not taken.

No. 32117. August 29. l. 465., t. 216., h. f. 66. M. M. Peet,
No. 32118. August 24. l. 436., t. 250., h. f. 64. collector.

5. *Lepus americanus* Erx. Hudson Bay Varying Hare. II. Six specimens were taken among the conifers between August 18 and 22. The pelage of three of the specimens is long and loose, the tips of the long hairs on the back are white or very pale yellow; the white hairs give the head a frosted appearence. These are young specimens. The pelage of the other three is more compact, and black hairs are more conspicuous, the upper part of the head is a pale yellowish brown. An adult female, No. 32131, is the largest specimen, and also the darkest; a black mid-dorsal band is fairly distinct. The white outer margin of the ears is very wide and distinct. The upper part of the hind legs is mottled with white and yellow hairs; long, scattered white tipped hairs occur on the end of the body above the tail.

The distinctness of the outer white ear margin varies in this series. The large female, mentioned above, has very long white hair; the three specimens first mentioned, have quite white hair, while in two others the hair is yellowish white.

It is interesting to note that these are a different variety from that found in the Porcupine Mountains, on the south shore (var. *virginianus*). This, like several other members of the biota, shows the close affinities of the Isle Royale types to the adjacent mainland rather than to the remainder of Michigan.

6. *Lynx canadensis* (Kerr). Canada Lynx. Mr. Wood made the following note on lynx skins which he saw at the Washington Club House, at Washington Harbor. "I saw two Lynx skins taken by Chas. Preulx during the winter of 1903 and 1904. Preulx says that this is the only species he has seen on the Island."

7. *Mustela americana* Turton. Eastern Martin. "Mr. Preulx had several martin skins which were taken during the winter of 1903-'04, on the maple ridge, not far from Washington Harbor. These skins were very dark brown with a few scattered white hairs, especially on the under side." (Wood).

8. *Putorius vison* (Schreber). Mink. II. Mr. Wood found a dead specimen in a barrel sunk at a spring. Preulx reported it quite common about the Harbor and along the streams.

9. *Putorius cicognani* (Bonap.). Small Brown Weasel. Mr. Wood reports that Preulx had about 10 skins, and said they were quite common.

10. *Putorius noveboracensis* Emmons. New York Weasel. Preulx had a number of large weasel skins which probably belonged to this species.

11. *Myotis lucifugus* (LeConte). Little Brown Bat. I. One specimen was taken, September 1, by Peet. Wood reports seeing a bat on wing August 22. These were the only bats seen on the island.

No specimens of the Red-backed Mouse, (*Evotomys gapperi*), were taken although they have been reported from Isle Royale by Coues (Mong. N. American Rodentia, p. 145). Of special interest to the student of the Isle Royale fauna is Miller's "Notes on the Mammals of Ontario," (Pro. Bost. Soc. Nat. His., 1897, Vol. 28, pp. 1-44).

This collection from Isle Royale, although a small one, is of interest in several respects. The Isle, it should be remembered, is 45 miles long with a maximum width of 8½ miles, and is about 15 miles from the Canadian shore. As might be anticipated, the affinities of the mammal fauna are with those of the north shore of Lake Superior rather than with those of the south shore. This is shown by the occurrence of the Caribou, Red Squirrel, Varying Hare and, perhaps, the White-footed Mouse.

It should also be borne in mind the relatively recent or postglacial origin of this island fauna. Since the advent of the present fauna we have no reason to believe that this island has ever been connected with the mainland. In other words, the fauna and flora must have reached their present location through the agency of winds, waves, lake currents, over the ice, and, possibly, in the case of some forms, through the influence of man.

THE MOLLUSCAN FAUNA OF TOMAHAWK LAKE, WISCONSIN.

FRANK COLLINS BAKER.

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THE MOLLUSCAN FAUNA OF TOMAHAWK LAKE, WISCONSIN.

With Special Reference to its Ecology.

BY FRANK COLLINS BAKER.

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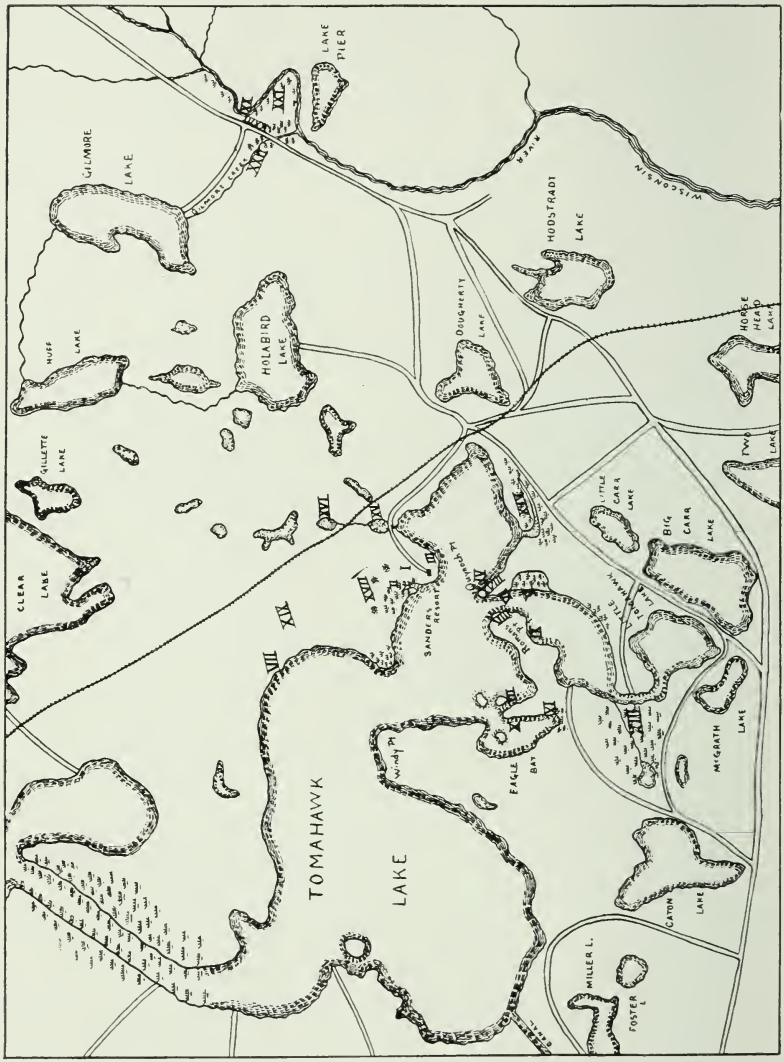
Of the states of the northern part of the Mississippi Valley, the Wisconsin molluscan fauna is the least known, although that of Minnesota is known but imperfectly. With this fact in mind, the writer planned his summer vacation of 1908 so that it included a three weeks' visit to Tomahawk Lake, in northeastern Wisconsin. But little systematic molluscan work has been done in Wisconsin, that of Mr. Chadwick ('02) being the most complete. Such work as that which Ruthven ('06), and Walker ('06, '09) have accomplished in the study of the Mollusca of Michigan is totally lacking.

The methods now in use for studying faunal areas are quite different from those in vogue a decade or more ago, the time honored annotated list being largely replaced by a discussion of the environment factors under which the organisms live. This ecological view point is of great value if properly interpreted, and when a large number of accurate papers based on studies of this kind have been published it will be possible to make many generalizations concerning the laws which govern the changes and formations of various habitats. The laws of succession are very interesting and very important and the study of these laws will help us not a little to understand the extinction of old species and the appearance of new ones in certain localities.


TOMAHAWK
LAKE
CLEAR LAKE
GILLETTE LAKE
HUFF LAKE
GILMORE LAKE
LAKE PIER
HOLABIRD LAKE
DOUGHERTY LAKE
HODSTRADI LAKE
WISCONSIN RIVER
HORSE HEAD LAKE
LITTLE CARR LAKE
BIG CARR LAKE
McGRATH LAKE
CATON LAKE
EAGLE BAY
MILLER L.
FOSTER L.

An ecological study of the Mollusca entails not only a consideration of the mollusks themselves, but also of those animals and plants intimately associated with them, and the ecological study of any one group naturally includes, if exhaustively carried on, a fairly complete discussion of the biota of the area under consideration. Time and means, however, did not permit of an exhaustive study of the entire biota, and only a few animals, as well as some typical plants, were collected and noted.

My thanks are due the following persons: Mrs. Frank C. Baker, of Chicago; Mrs. Harry L. Burke, of Kansas City; Mr. Don Blanchard, of Chicago, and Mr. Claude Sanders, of Tomahawk Lake, for assistance in collecting; Mr. Bryant Walker, of Detroit, Michigan, and Dr. V. Sterki, of New Philadelphia, Ohio, for assistance in the determination of certain mollusks.

GENERAL TOPOGRAPHY.

Tomahawk Lake (plate XI) is situated on the line between Oneida and Villas counties. The drainage is into the Little Tomahawk River via Lake Kawaguesaga, a tributary of the Wisconsin River; the waters of this region, hence, belong to the Mississippi River drainage area. Tomahawk Lake is one of the numberous chains of lakes which dot this portion of the United States. It has been well said that no single area in the world includes so many lakes as does the country bordering the line between Canada and the United States, and Wisconsin may almost be said to lead in the number of its lakes, large and small.

The lake under discussion is situated in the area covered by the late Wisconsin ice sheet and the multitude of ponds and lakes is due to the agency of this huge glacier. The lake is over four miles long and about two miles wide at its widest point; its many bays and coves give it a shore line of over eighty miles. It occupies a depression of some thirty to about one hundred feet below the surrounding country, the banks in many places rising quite abruptly. The country surrounding the lake was originally covered with a heavy coniferous forest, but all that now remains is the area on the south side which has been set

aside as a state forest reservation. The lumbered portions to the north, east and west, are now covered with a second growth of deciduous woods, such as oak, maple and birch. (Fig. 1.)

Some years ago, a dam was constructed in an arm of Lake Kawaguesaga, west of the town of Minocqua, which raised the level of this lake and Tomahawk Lake three to four feet. This dam was built for the purpose of giving uniform flow to the Tomahawk River, and also to the Wisconsin River, for the transportation of lumber rafts. The result of raising the lake has been to submerge many low, flat tracts and convert them into swamps. One looks aghast at the wholesale manner in which fine trees have been killed by the rising of the water level, and the question it at once suggested as to why these trees were not cut and used before the dam was built; any competent engineer could have easily indicated the lands which would be submerged, and many thousands of feet of fine lumber might have been saved. These noble trees now stand in the shallow water, veritable skeletons whose bleached and outstretched arms proclaim man's short-sighted and wasteful use of nature's bountiful gifts.

The rising of the water and the consequent flooding of all points and low areas about the lake has produced a number of interesting habitats, besides providing several typical examples of molluscan succession. The time at the writer's disposal was too short to make a survey of the many lakes in the vicinity, large and small, or even to make more than a cursory reconnoisance of the western part of Tomahawk Lake. The large lake north of the thoroughfare, Lake Kawaguesaga, was not studied, although a comparison between this lake and Tomahawk Lake would doubtless produce some interesting results.

One day was spent in a study of the Wisconsin River at a point about four miles northeast of Tomahawk Lake. The river was high and swift and little work could be done on the Unionidæ. Gilmore Creek, a small tributary of the Wisconsin River, however, produced some interesting naiads. It is to be regretted that time was not available for a detailed examination of some of the larger lakes in the vicinity, which would doubt-

FIGURE 1

FIGURE 2

less reveal many interesting species not hitherto reported from Wisconsin.

Headquarters were established at Sanders' Resort on the north shore of the eastern arm of the lake and from this base all field operations were conducted. The Wisconsin River stations are mostly on land owned by Mr. Charles Sanders.

DISCUSSION OF BIOTA BY STATIONS

Station I. (Figure 2.)

Well-wooded area on high bluff above Sanders' Resort. The timber is second growth, following the cutting of the original coniferous forest, and consists principally of birch, maple, poplar and oak. The ground beneath this forest growth is thickly covered with rotting logs and bark, dead leaves and a thick carpet of vegetable mold. The hill slopes at a sharp angle, providing excellent drainage. Although there had been a prolonged drought the ground was moist under the leaves and large logs, showing that a well wooded tract of country holds the moisture, allowing it to seep through the soil and provide more or less permanent springs. These incipient forests were always dark and damp.

The small mollusks, as well as a number of beetles, were very abundant in this section, hiding under started bark, in crevices, under rotting logs and in any other place of concealment.

MOLLUSCA COLLECTED.

Zonitoides arboreus, very common.
Euconulus fulvus, rare.
Pyramidula cronkhitei catskillensis, common.
Pyramidula alternata, rare.
Helicodiscus parallelus, common.
Polygyra albolabris, very rare.
Strobilops virgo, common.

Station II. (Figure 3.)

Substation I.

A small bay, or bayou, west of Sanders' Resort. The water is from a foot to five or six feet in depth, and is filled with logs, which have been brought for use in Sanders' saw mill. Mollusks are abundant on the logs or in the shallow water near the shore.

MOLLUSCA COLLECTED.

Lymnæa emarginata wisconsinensis.
Planorbis binneyi.
Planorbis bicarinatus striatus.
Planorbis campanulatus rudentis.
Physa ancillaria warreniana.
Campeloma decisum.

Substation 2.

The swampy shores of substation I, caused by the raising of the water level of the lake. The water is shallow (a few inches to a foot in depth), the bottom is composed of soft, sticky mud of clayey character and is filled with algæ. Near the shore there is an area of *Typha latifolia,* which extends westward for a considerable distance. Above the Typha society there is the same second growth of forest as that mentioned under StationI.

MOLLUSCA COLLECTED.

Lymnæa columella.
Lymnæa lanceata.
Lymnæa obrussa.
Planorbis hirsutus.
Segmentina armigera.
Succinea retusa.
Musculium securis.
Pisidium abditum.

FIGURE 3

FIGURE 4

Station III. (Figure 4.)

Exposed north shore of Tomahawk Lake, near Sanders' Resort. The bottom is sandy and gradually deepens to ten or fifteen feet when it becomes very deep, at one place being reported as dropping suddenly to a depth of sixty feet. It is very shallow for a distance of fifteen or twenty feet, and especially so on a long point extending southeasterly into the lake for a distance of some thirty feet the water being scarcely a foot deep on the bar but falling suddenly to sixty feet just off the end of the point.

The sandy shore, thought in a most exposed situation, and subject to heavy surf action during northwesterly storms forms a well tenanted habitat for *Lymnæa emarginata, Campeloma decisum, Planorbis bicarinatus striatus* and *Physa ancillaria warreniana.* In the deep water many naiads abound. During heavy wind or storms the water is thrown over the ridge of sand forming the beach and collects in little pools which are inhabited by *Lymnæa* and *Physa,* with an occasional *Campeloma* washed in by the waves. These small pools were also good habitats for the Leopard Frog *(Rana pipiens).*

MOLLUSCA COLLECTED.

In Deep Water.

Anodonta grandis footiana.
Anodonta marginata.
Lampsilis luteola.

In Shallow Water.

Sphærium simile.
Amnicola cincinnatiensis.
Campeloma decisum.
Physa ancillaria warreniana.
Planorbis bicarinatus striatus.
Planorbis campanulatus.
Planorbis campanulatus rudentis.
Lymnæa emarginata wisconsinensis.

Of the above, *Amnicola* was represented only by dead shells, washed from some other habitat.

Station IV. (Figure 5.)

Substation 1.

South shore of Tomahawk Lake near Quynock Point, opposite Sanders' Resort. A small embayment affords a typical habitat for several mollusks. The bottom is of firm sand; the water near the shore is from ten to twenty inches in depth, rapidly deepening to ten, fifteen, twenty or more feet toward the lake. *Lymnæa emarginata wisconsinensis* is plentifully scattered over the sandy bottom, *Lymnæa stagnalis lillianæ* and *Planorbis binneyi* are abundant on the sandy bottom and on floating logs, and several species of naiads live in five to ten feet of water. Evidences of the muskrats' presence were seen in the shape of little piles of dead shells along the shore.

MOLLUSCA COLLECTED.

In Deep Water.

Lampsilis luteola.
Anodonta grandis footiana.
Anodonta marginata.

In Shallow Water.

Lymnæa stagnalis lillianæ.
Lymnæa emarginata wisconsinensis.
Planorbis binneyi.
Planorbis campanulatus.
Planorbis campanulatus rudentis.
Physa ancillaria warreniana.

Substation 2.

The shore of Substation 1 is swampy with a heavy growth of *Typha latifolia* and back of this plant society the ground rises and is heavily wooded with a coniferous forest. *Planorbis* and *Lymnæa* occur in fair number in this habitat, which is in great contrast with that of Substation 1.

FIGURE 5

FIGURE 6

FIGURE 7

MOLLUSCA COLLECTED.

Planorbis trivolvis.
Lymnæa lanceata.

Station V.

A large bay south of Quynock Point, formed by the raising of the level of the lake. A heavy sand bar, formed by wave action, encloses the bay. The water on the bar is from a foot to eighteen inches in depth; in the bay it increases to four and five feet and outside of the bar on the lake side, it deepens rapidly. The entrance to the bay is further closed by a large number of logs which form a tangled mass on the sand bar. The rising of the water has killed all of the trees formerly occupying the low area and the trunks of these dead trees stand in the water.

The enclosed bay affords an excellent habitat for a plant society consisting of pondweed *(Potamogeton),* white pond lily *(Castalia odorata)* and yellow pond lily *(Nymphœa advena).* Near the shore a *Typha latifolia* society is developing. Back of the shore the land rises abruptly and is thickly wooded, birch, spruce, pine and hemlock being the predominating trees.

The pond-lily society affords a habitat for *Planorbis binneyi, Physa ancillaria, Lymnœa lanceata, Amnicola cincinnatiensis* and *Ancylus parallelus.* The under side of the lily leaf is usually chosen as a resting place, and is doubtless used as a feeding ground also. *Musculium securis* and *Planorbis* are plentiful in algæ, the bay being filed with this plant near the shore. The logs are tenanted by *Planorbis binneyi, Physa ancillaria warreniana* and *Lymnœa lanceata.*

MOLLUSCA COLLECTED.

Musculium securis.
Planorbis hirsutus.
Planorbis binneyi.
Lymnœa lanceata.
Ancylus parallelus.
Physa ancillaria warreniana.
Amnicola cincinnatiensis.

Station VI.

Sand Bar and Exposed Lake Shore North of Station V.

This habitat is occupied principally by *Lymnæa emarginata wisconsinensis* which thickly covers the sand and the rocks of the shore.

MOLLUSCA COLLECTED.

Lymnæa emarginata wisconsinensis.
Planorbis campanulatus.
Planorbis campanulatus rudentis.
Physa ancillaria warreniana.

Station VII. (Figure 6.)

Exposed shore north side of lake, three miles west of Sanders' Resort (old logging camp No. 7). The beach is sandy, shallow and slopes gradually into deep water. The land back of the beach is elevated three feet or more above the beach and forms a flat plain for a considerable distance. Several species of mollusks live on this exposed beach, their dead shells with other debris forming a distinct line at high water mark. *Lymnæa emarginata wisconsinensis* is here the most abundant mollusk, and its shell shows all degrees of variation between elongated and globose. *Lymnæa stagnalis lillianæ* also shows much variation in the form of the shell. *Amnicola* consisted only of dead, bleached shells which had doubtless been washed from a nearby habitat.

MOLLUSCA COLLECTED.

Campeloma decisum (living and dead).
Amnicola cincinnatiensis (dead).
Physa ancillaria warreniana (dead).
Planorbis campanulatus (living and dead).
Planorbis campanulatus rudentis (living and dead).
Planorbis bicarinatus striatus (living and dead).
Lymnæa stagnalis lillianæ (living and dead).
Lymnæa emarginata wisconsinensis (living and dead).

Station VIII.

Point of land opposite (west of) Quynock Point. The beach is shallow and sandy; it is exposed to the full force of the waves on the north and west side, but on the south and southwest side it is more or less protected, and in this situation the majority of the mollusks live. A few hardy individuals of *Lymnæa emarginata wisconsinensis* brave the roughness of the west side.

MOLLUSCA COLLECTED.

Lymnæa emarginata wisconsinensis.
Planorbis bicarinatus striatus.
Physa ancillaria warreniana.
Campeloma decisum.

Station IX.

Protected bay-like area on east side of long point opposite Quynock Point. The water is shallow (5 to 18 inches in depth) and the botton is sandy. Back of this is a swampy area. Several species of *Lymnæa, Planorbis* and *Physa* inhabit the sandy beach in shallow water. A few individuals prefer the logs which are scattered about.

MOLLUSCA COLLECTED.

Lymnæa stagnalis lillianæ.
Lymnæa lanceata.
Planorbis binneyi.
Planorbis campanulatus.
Planorbis campanulatus rudentis.
Physa ancillaria warreniana.

Station X.

Eagle Bay, a small enclosed bay on the south side of Tomahawk Lake, about three-quarters of a mile long and less than a quarter of a mile wide. The shores are sandy and rapidly fall away into deep water. On the sandy shores several mollusks live in considerable number.

MOLLUSKS COLLECTED.

Lymnœa stagnalis lillianæ.
Planorbis campanulatus.
Planorbis campanulatus rudentis.
Physa ancillaria warreniana.
Anodonta marginata.
Lampsilis luteola.

Station XI.

The southern end of Eagle Bay is very swampy, a condition due in large measure to the rising of the lake. The swamp is bordered by a *Typha latifolia* society. The water is shallow and is filled with floating logs, while stumps and trunks of dead trees are standing in profusion. The bottom is of carbonaceous mud and the open spaces are occupied by a plant society consisting of *Castalia odorata* and *Nymphœa advena.* The pondweed *(Potamageton)* is also present. *Lymnœa columella* lives on the under side of pond-lily leaves while *Lymnœa lanceata* prefers the sandy, or muddy, shore in shallow water.

MOLLUSCA COLLECTED.

Lymnœa columella.
Lymnœa lanceata.

Station XII.

An island, situated at the mouth of Eagle Bay. The shores are sandy and the water quite shallow. On the southeastern side of the island, where there is protection from the westerly storms, considerable driftwood has collected, which is inhabited by several mollusks.

MOLLUSCA COLLECTED.

Planorbis campanulatus rudentis.
Planorbis bicarinatus striatus.
Physa ancillaria warreniana.

FIGURE 8

FIGURE 9

Station XIII. (Figures 7, 8, 9.)

Swamp at head of thoroughfare between Tomahawk and Little Tomahawk Lake. The swamp is of large size (Figure 7) extending in a westerly direction well into the wooded portion of the country. A deep creek meanders through the swamp, but outside of this the water is very shallow in many places, scarcely covering the boggy bottom, which in places extends above the water, forming miniature islands of soft, starchy consistency.

The deep water of the thoroughfare is inhabited by a pond-lily society consisting of *Castalia odorata, Nymphæa advena* and *Potamogeton natans.* The swampy portion is thickly covered with a *Typha latifolia* society with a few *Scirpus lacustris.* The shores rise abruptly from the swamp and are thickly clothed with a spruce, hemlock, cedar and birch forest. As in all of the bays of Tomahawk Lake, this swamp is filled, near the shore, with the dead trunks of trees killed by the rising of the water.

This station was one of the best for molluscan life, the eight species tabulated, living here in large numbers.

Substation 1.

Shore, Floating Logs or Boggy Islands Near the Shore.

Planorbis binneyi.
Lymnæa lanceata.
Lymnæa megasoma.
Lymnæa stagnalis appressa.

Bulimnea megasoma was found on the boggy islands and on logs near the shore, one or two specimens only being seen in one place, the species not being gregarious, apparently.

Substation 2.

Castalia-Nymphæa Plant Society.

Amnicola cincinnatiensis.
Physa ancillaria warreniana.
Planorbis campanulatus.
Lymnæa columella.

Station XIV.

Creek at east end of Lake, near town of Tomahawk Lake. The creek is on the south side and extends well into the shore where a wide area of swamp has been formed by the rising of the water level. The creek is quite deep, but the swamp is barely covered with water in many places, though spots occur where the water is several feet deep; the bottom is covered with soft mud. A *Castalia odorata* and *Nymphæa advena* society occupies the creek while a heavy *Typha latifolia* society with *Pontederia cordata* occupies the swampy portion

Substation I.

The following mollusks were common on the under side of the lily pads:

Lymnæa columella.
Ancylus parallelus.
Physa ancillaria warreniana (young).
Planorbis parvus.
Amnicola cincinnatiensis.

Substation 2.

On logs and on the shore in the shallow water of the flooded area, where the habitat is protected from the rough water of the mouth of the creek.

MOLLUSCA COLLECTED.

Lymnæa lanceata.
Planorbis bicarinatus unicarinatus.
Planorbis trivolvis.

Substation 3..

Entrance to creek, which is deep, the shores sandy and the water shallow for some ten or twelve feet where it becomes quite deep. The snails were observed on sticks and logs and on the sandy bottom. The naiads were plentiful on the sandy beach in water from ten to thirty inches in depth.

FIGURE 10

FIGURE 11

MOLLUSCA COLLECTED.

Anodonta grandis footiana.
Anodonta marginata.
Planorbis binneyi.
Planorbis campanulatus.
Lymnæa stagnalis lillianæ.

Station XV. (Figure 10.)

Swampy pond at Sanders' "minnow-box," north side of lake, near Sanders' Resort. This station has been artificially produced by damming a little creek which flows from a small lake north of the Northwestern Railroad embankment. This barrier has caused the formantion of a shallow, stagnant pond, from six inches to about four feet in depth. The bottom is now very muddy, although originally hard and firm, showing the rapid decay and acumulation of plant humus. The water is thickly filled with *Chara* and the surface with *Spirogyra.* A large amount of duckweed *(Spirodela)* is scattered over the surface, as well as a species of *Lemna.* The trees surrounding this pond are nearly all second growth and embrace birch, oak, elm and poplar. The photograph shows a number of dead bushes, killed by the rising of the water.

Mollusks were common either swimming near the surface or crawling over the bottom. The vegetation on the surface of the pond was so thick that it was necessary to clear a patch of water before the mollusks could be seen. *Planorbis* was more frequently seen on the bottom, while *Lymnæa* seemed to prefer sticks or old logs in the water, or the vegetation. *Physa* was observed on the bottom or on logs, while *Musculium* was found only in the vegetation. *Segmentina* was seen only on logs and sticks.

MOLLUSCA COLLECTED.

Lymnæa lanceata.
Planorbis bicarinatus unicarinatus.
Planorbis trivolvis.
Segmentina armigera.
Physa ancillaria warreniana.
Musculium securis.

Station XVI.

Bass Lake one mile north of Sanders' Resort. A small lake, with soft, mucky bottom, occupying a deep hollow or kettle hole. A stream flows from the lake into the artificial pond at Station XV. The only mollusk observed was *Physa ancillaria warreniania.*

Station XVII.

Small pools in swales (kettle holes) west of Sanders' Resort. The whole country is rolling, and every depression contains a small pond or swampy pool. The ground is very marshy, the vegetation consisting of *Iris* and *Typha,* besides a kind of swamp grass. The plants in this vicinity were literally swarming with aphids. *Pisidium* was the principal mollusk observed, though a few *Ancylus* and *Planorbis* were secured from the surface of sticks.

MOLLUSCA COLLECTED.

Ancylus parallelus.
Planorbis parvus.
Pisidium abditum.
Pisidium roperi.
Musculium rosaceum.

FIGURE 12

FIGURE 13

Station XVIII. (Figures 11, 12.)

Woods on Quynock Point. This piece of woodland is a part of the Wisconsin forest reservation and is nearly all virgin forest, with the vast accumulation of debris characteristic of such a region. Among the forest trees are white pine, spruce, hemlock, white cedar, birch and poplar. The curious ground pine *(Lycopodium obscurum)* is also common. The ground is covered with moss and the trees with lichens. Rotten logs are scattered over the ground in endless profusion affording excellent concealment for the smaller helices. Curiously enough, no shells were found in birch logs, but were plentiful in pine and poplar logs. Mollusks were numerous in individuals but few in species.

MOLLUSCA COLLECTED.

Zonitoides arboreus.
Pyramidula cronkhitei catskillensis.
Strobilops virgo.

Station XIX. (Figure 13.)

Virgin woods near logging camp No. 7, known locally as the cyclone woods. The character of this habitat is the same as that of the Quynock Point station. The trees are also the same, with the addition of oak, maple and balsam fir.

MOLLUSCA COLLECTED.

Zonitoides arboreus.
Strobilops virgo.
Pyramidula cronkhitei catskillensis.
Helicodiscus parallelus.

Station XX.

Wisconsin River, four miles northeast of Sanders' Resort. The river meanders here considerably, the curves being long and sweeping. The river bottom is sandy mud. The flood plain

varies in extent from a few feet to a quarter of a mile in width, in the latter case a marsh being formed. The banks of the river are lined with heavy thickets with here and there a forest growth of maple, birch, etc., extending to the water. Several species of swamp grass occupy the flood plain, and *Iris* and *Typha* societies are scattered over the area, in the vicinity of pools.

The river has a very swift current, forming an ideal environment for naiads, a number of species of which live in this habitat. The larger and heavier mussels live in deep water, but *Lampsilis luteola,* together with *Sphærium* and *Campeloma,* seem to prefer the shallows near the shore. *Campeloma* was also plentifully distributed over the surface of floating logs. *Lymnæa humilis modicella* was observed to cover the exposed mud flats along the edge of the water.

Station I.

Deep Water of Wisconsin River.

Lampsilis ligamentina.
Lampsilis recta.
Lampsilis ventricosa.
Quadrula undulata.

Substation 2.

Shallow Water Along Shore of River.

Lampsilis luteola.
Sphærium striatinum.
Pisidium virginicum.
Campeloma decisum.

Substation 3.

Muddy Flats Above High Water.

Lymnæa humilis modicella.
Succinea retusa.

Station XXI.

Swampy tracts along margin of river, separated from the latter by a high ridge. These depressions vary in extent from a few feet to several hundred feet in diameter, and also vary in depth. The vegetation consists of swamp grass, *Iris* and *Typha*.

MOLLUSCA COLLECTED.

Sphærium occidentale.
Musculium partumeium.
Pisidium subrotundum.
Physa gyrina.
Aplexa hypnorum.
Planorbis hirsutus.
Segmentina armigera.
Vitrea hammonis.

It is noteworthy that the mollusk fauna of this station is similar to that noted in some of the summer dry ponds of the Skokie Marsh area in Illinois.

Station XXII.

Gilmore Creek, a small tributary of the Wisconsin River, emptying into the latter four miles northeast of Sanders' Resort. The water is shallow, from a few inches to two or three feet in depth, and the bottom consists of clean, firm sand. The current is swift and the water clear. Naiads are abundant buried in the sand in company with *Campeloma*. Muskrat heaps are a common sight, showing that this animal resorts frequently to this region for its food supply. The preponderance of pelecypods at this station is notable.

MOLLUSCA COLLECTED.

Lampsilis luteola.
Lampsilis ventricosa.
Lampsilis ligamentina.
Strophitus edentulus.
Anodonta grandis footiana.
Anodonta marginata.
Anodonta implicata.
Symphynota costata.
Symphynota compressa.
Campeloma decisum.

Station XXIII.

Mucky slough in marsh near mouth of Gilmore Creek. The water is shallow (eight inches to a foot or more) and the muddy bottom, which is composed of soft, impalpable, black mud formed from vegetable decomposition, is from two to six feet in depth. The pool is bordered by *Iris, Typha* and swamp grass and is partly filled with old logs.

This slough is the best habitat for *Bulimnea megasoma* which has come under the writer's observation, the specimens being numerous as well as large and of fine color. The individuals were observed attached to logs and other floating debris, as well as on the soft mucky bottom. *Planorbis binneyi* and *Bulimnea* were the only mollusks present.

COMPARISON OF THE FRESH-WATER MOLLUSCAN LIFE OF THE DIFFERENT STATIONS.

(See Table.)

The twenty-three stations and twelve substations previously considered contain a variety of molluscan life. Upon analyzing this life, a division is at once apparent, based on the kind of habitat. This analysis is tabulated below.

Species living on sandy shore subject more or less to rough water.

Lampsilis luteola.
Anodonta marginata.
Anodonta grandis footiana.
Sphærium simile.
Campeloma decisum.
Physa ancillaria warreniana.
Planorbis campanulatus.
Planorbis campanulatus rudentis.
Planorbis bicarinatus striatus.
Planorbis binneyi.
Lymnæa stagnalis lillianæ.
Lymnæa stagnalis wisconsinensis.

Species living in enclosed or sheltered bays which are connected with the open lake and in which the water never becomes stagnant.

Anodonta grandis footiana.
Anodonta marginata.
Physa ancillaria warreniana.
Planorbis campanulatus.
Planorbis campanulatus rudentis.
Planorbis bicarinatus striatus.
Planorbis binneyi.
Lymnæa stagnalis lillianæ.
Lymnæa lanceata.

Species living on *Castalia-Nymphœa* society is clear water of creek or in enclosed bay.

Amnicola cincinnatiensis.
Physa ancillaria warreniana.
Ancylus parallelus.
Planorbis parvus.
Planorbis hirsutus.
Planorbis campanulatus.
Planorbis campanulatus rudentis.
Lymnæa columella.

Species living in swampy ponds or in Typha plant societies where the water is more or less stagnant.

Sphærium occidentale.
Musculium partumeium.
Musculium securis.
Pisidium subrotundum.
Pisidium abditum.
Physa gyrina.
Aplexa hypnorum.
Ancylus parallelus.
Segmentina armigera.
Planorbis hirsutus.
Planorbis bicarinatus unicarinatus.
Planorbis trivolvis.
Planorbis binneyi.
Lymnæa stagnalis appressa.
Lymnæa columella.
Lymnæa megasoma.
Lymnæa lanceata.
Lymnæa obrussa.

Species living in swales.

Musculium rosaceum.
Pisidium abditum.
Pisidium roperi.
Ancylus parallelus.
Planorbis parvus.

Species living in river with swift current.

Lampsilis ventricosa.
Lampsilis luteola.
Lampsilis ligamentina.
Lampsilis recta.
Quadrula undulata.
Sphærium striatinum.
Pisidium virginicum.
Campeloma decisum.

Species living in creek with sandy bottom and clear, cold water; current swift.

Lampsilis ventricosa.
Lampsilis luteola.
Lampsilis ligamentina.
Strophitus edentulus.
Anodonta marginata.
Anodonta implicata.
Anodonta grandis footiana.
Symphynota costata.
Symphynota compressa.
Campeloma decisum.

These tables may be further analyzed as follows:

	Total number.	Peculiar to this habitat.
1. Open shore	12	4
2. Enclosed or sheltered bays	9	..
3. Castalia—Nymphæa society	8	..
4. Swampy ponds	18	15
5. Swales	5	2
6. Swift current of river	7	4
7. Swift current of creek	10	4

It will be seen that number four (swampy ponds) produces the greatest number of species (18) as well as the greatest number of peculiar forms (15). The open shore produces twelve species with but four peculiar. A number of species also live in several of the habitats.

Anodonta marginata in 1, 2, 7.
Anodonta grandis footiana in 1, 2, 7.

Lampsilis luteola in 1, 6, 7.
Lampsilis ventricosa in 6, 7.
Lampsilis ligamentina in 6, 7.
Campeloma decisum in 1, 6, 7.
Physa ancillaria warreniana in 1, 2, 3.
Planorbis campanulatus rudentis in 1, 2, 3.
Planorbis bicarinatus striatus in 1, 2.
Planorbis binneyi in 1 2, 4.
Planorbis parvus in 3, 5.
Ancylus parallelus in 3, 4, 5.
Lymnœa stagnalis lillianæ in 1, 2.
Lymnœa lanceata in 2, 4.
Lymnœa columella in 3, 4.

The largest number of species was produced by Stations III and XXII, each having ten. These stations are respectively the open shore and the cold, clear creek. 6, 7 and 8 species were common in several stations. It is of interest to note that though fifty-three species were secured from the entire area, yet the largest number of species from any one area was ten, a few produced six and seven, and while the majority were less than five, the average for the twenty-three stations was about six. This low average is indicative of a wide range of habitat variation, a condition which has already been seen to exist in this area.

MOLLUSCAN SUCCESSION.

Tomahawk Lake presents a unique example of molluscan succession, a condition due to the raising of the water for storage purposes. So markedly has this change of level altered the shore in many places that a complete revolution has taken place in the biota. Originally, the lake was encircled by sandy shores with but few swampy areas. The elevation of the lake level has changed this condition in many places, and at the present time swamps are abundant along the shore. All of the low flats have been submerged, the points extending under water for a considerable distance as sandy beaches and the low flats forming swamps or bays, the dead trees standing in three or four feet of water.

Succession here has been in reverse order from that usually seen, i. e., the encroaching of one plant and animal society upon another, causing in the case of a pond, its gradual filling up and destruction. It has here been a change from dry land to swamps. However, it will be studied from the usual point and its artificial origin will be ignored in the present discussion. Stations V, XI and XIV, are the best examples of succession.

Primal Condition, the Open Lake Shore.

(Figures 4, 5.)

In this primal stage, the shore is bordered by a shelving, shallow, sandy beach, which is subject to wave action to a greater or less degree. Such mollusks as the following occupy this habitat:

Lampsilis luteola.
Anodonta marginata.
Anodonta grandis footiana.
Sphærium simile.
Compeloma decisum.
Physa ancillaria warreniana.

Planorbis campanulatus.
Planorbis campanulatus rudentis.
Planorbis bicarinatus striatus.
Planorbis binneyi.
Lymnœa stagnalis lillianæ.
Lymnœa emarginata wisconsinensis.

Enclosed Bay Succession.

(Figure 9.)

The rise of the water overflows the lower portions of the shore, producing enclosed bays, which soon become filled with such plants as pondweed *(Potamogeton),* white pond-lily *(Castalia odorata)* and yellow pond-lily *(Nymphœa advena).* The mollusks of such a habitat are:

Anodonta grandis footiana.
Anodonta marginata.
Amnicola cincinnatiensis.
Physa ancillaria warreniana.
Ancylus parallelus.
Planorbis hirsutus.
Planorbis campanulatus.
Planorbis campanulatus rudentis.
Planorbis bicarinatus striatus.
Planorbis binneyi.
Lymaœa stagnalis lillianæ.
Lymnœa columella.
Lymnœa lanceata.

It will be noted that four species *(Lampsilis, Sphœrium, Campeloma* and *Lymnœa emarginata wisconsinensis)* have disappeared, while five species *(Amnicola, Ancylus, Planorbis hirsutus, Lymnœa columella* and *Lymnaea lanceata)* have been added. This change of species well illustrates the influence of a changing environment.

Swamp Succession. (Figure 3).

The water rises still higher and overflows meadow-like areas producing large open swamps (as at station XIII) or, small-ponded areas. The water is shallow, the bottom is usually muddy or boggy and the vegetation consists chiefly of *Typha latifolia* and several species of sedge. A considerable change is noted in the character of the mollusks.

Musculium securis.
Pisidium abditum.
Pisidium subrotundum.
Ancylus parallelus.
Segmentina armigera.
Planorbis hirsutus.
Planorbis bicarinatus unicarinatus.
Planorbis trivolvis.
Planorbis binneyi.
Lymnæa stagnalis appressa.
Lymnæa megasoma.
Lymnæa lanceata.
Succinea retusa.

It will be noted that the Pelecypods are represented only by the small *Musculium* and *Pisidium* and the Gastropods all belong to the fresh-water Pulmonates (excepting *Succinea.)* Only four species are the same as those in the previous succession (*Ancylus, Planorbis hirsutus, Planorbis binneyi, Lymnæa lanceata),* nine species or about 66 per cent. being new to the environment. Only one species, *Planorbis binneyi,* persists throughout the last three successions.

Swale Succession.

Should the level of the water fall a foot or more, a fourth succession would develop in certain places, in which small swampy pools or swales would be developed. Such a habitat

would contain (as several stations in this area have been found to).

Musculium rosaceum.
Pisidium roperi.
Ancylus parallelus.
Planorbis parvus.

The fresh-water species have here been reduced to five species.

Land Shell Succession.

Figure 13.

Should this area become dry it would soon be covered with such trees as birch, white spruce, tamarack, etc., and the following land mollusks would completely replace the fresh-water pulmonates.

Helicodiscus parallelus.
Pyramidula cronkhitei catskillensis.
Zonitoides arboreus.
Vitrea hammonis.
Strobilops virgo.

Though not observed continuously in one place, the above five successions have been seen within a radius of one mile; the first three, however, have occurred in one small area, during the few years which have passed since the water was raised.

TAXONOMY.

An analysis of the fifty-three species of mollusks recorded in the systematic catalog reveals several interesting facts. It is at once seen that the Gastropods (32) exceed the Pelecypods (21) almost three to two. The Gastropods divide naturally into three groups as follows:

Prosobranchiates	2
Land pulmonates	9
Fresh-water pulmonates	21

The large preponderance of the fresh-water pulmonates is noteworthy. A large portion of this excess is divided between Planorbis and Lymna, each with seven and eight species* respectively. This is to be expected, however, as these genera are typically northern in distribution, the number of species increasing largely in the boreal zone. Of the naiads, the Wisconsin River and its tributaries produced nine species while the lake produced but three, which is in accord with the well known fact that this family is typically an inhabitant of rivers.

The mollusk fauna of this region includes two elements; first, the species which are widely distributed throughout the greater portion of North America, and, second, those species which are purely boreal in distribution. These two elements may be compared in the subjoined tables.

Widely Distributed Species.

Lampsilis luteola.	*Anodonta marginata.*
ventricosa.	*implicata.*
ligamentina.	*grandis footiana.*
recta.	*Symphynota costata.*
Strophitus edentulus.	*compressa.*

* In this analysis varieties are treated as species for convenience.

Quadrula undulata.
Sphærium simile.
striatinum.
occidentale.
Musculium partumeium.
securis.
rosaceum.
Pisidium abditum.
roperi.
virginicum.
subrotundum
Campeloma decisum.
Amnicola cincinnatiensis.
Physa gyrina.
Aplexa hypnorum.
Ancylus parallelus.
Segementia armigera.
Planorbis parvus.
hirsutus.
trivolvis.
bicarinatus unicariatus.
bicarinatus striatus.
campanulatus.
Lymnæa stagnalis appressa.
columella.
humilis modicella.
obrussa.
Succinea retusa.
Strobilops virgo.
Helicodiscus parallelus.
Pyramidula alternata.
Vitrea hammonis.
Euconulus fulvus.
Zonitoides arboreus.
Polygyra albolabris.

Boreal Species.

Planorbis campanulatus rudentis.
Planorbis binneyi.
Physa ancillaria warreniana.
Lymnæa stagnalis lillianæ.
Lymnæa megasoma.
Lymnæa lanceata.
Lymnæa emarginata wisconsinensis.
Pyamidula cronkhitei catskillensis.

The very great preponderance of the widely distributed (45) over the boreal (8) species is brought out strikingly in the tables. The land shells secured from this region are of no special interest, being of general distribution throughout a large portion of the United States and Canada. The same may be said of the Pelecypods.

Among the fresh-water pulmonates, however, there are several species of unusual interest. Two new forms of Lymnæa

were discovered, besides a recently described variety of Planorbis not before recorded from the state. Comparing the catalog with Chadwick's published list, it is found that a number of species have not been previously recorded from the state. These additions (13) to the Wisconsin fauna are as follows:

Strobilops virgo.
Lymnæa stagnalis lillianæ.
Lymnæa lanceata.
Lymnæa emarginata wisconsinensis[1].
Planorbis binneyi[2].
Planorbis bicarinatus unicarinatus.
Planorbis campanulatus rudentis.
Anodonta marginata.
Musculium securis.
Musculium rosaceum.
Pisidium abditum.
Pisidium roperi.
Pisidium subrotundum.

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1 Bull. Wis. Nat. Hist. Soc., IV, pp. 67–99.
1 The species reported on p. 80 of Chadwick's list as *decollata* is *emarginata angulata* Sowb.
2 No. 51a of Chadwick's list is this species.

SYSTEMATIC CATALOG OF SPECIES.

(See Table.)

Class **PELECYPODA.**

ORDER PRIONODESMACEA.

Superfamily NAIADACEA.

Family UNIONIDAE.

Genus **Lampsilis** Rafinesque.

1. *Lampsilis ventricosa* (Barnes).

   Station XX[1], XXII. Apparently not common as only three specimens were found.

2. *Lampsilis luteola* (Lamarck).

   Stations III, IV[1], X, XX[2],XXII. The luteolas inhabiting Tomahawk Lake and vicinity are apparently closely related to Marsh's *superiorensis,* which is undoubtedly a variety or race of *luteola*[1]. Some specimens answer well to the original description and figures. The shape of the shell, however, is rather of the *luteola* type than of the *superiorensis* type. The specimens are all small (60 to 70 mill.) and vary from unicolored to distinctly rayed. The surface varies from smooth and shining to rough and scabrous. The hinge teeth are thin, especially the cardinal teeth, which are rather weak. All of the stations in which this species was found were of the rough water type.

3. *Lampsilis ligamentina* (Lamarck).

   Station XX[1], XXII. Specimens of this species from the Wisconsin River are quite normal, though small, and distinctly rayed. The Gilmore Creek examples are more quadrangular in outline and less distinctly rayed. Both inhabit swiftly running water.

4. *Lampsilis recta* (Lamarck).

   Station XX[1].

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[1] Nautilus, x, p. 103, pl. 1, figs. 1, 2, 5, 1897.

Genus **Strophitus** Rafinesque.

5. *Strophitus edentulus* (Say).

Station XXII. The examples of this species are rather small and the shells are thinner than in individuals from farther south.

Genus **Anodonta** (Bruguiére) Lamarck.

6. *Anodonta marginata* (Say).

Stations III, IV[1], X, XIV[3], XXII. The individuals of this Anodonta are usually very uniform. At Station X the specimens vary from the usual cylindrical shape to one approaching Anthony's *irisans,* with a marked postero-dorsal ridge. All inhabit rough or running water. This is a common species in Wisconsin, though not mentioned in Chadwick's list.

7. *Anodonta implicata* (Say).

Station XXII. Apparently typical.

8. *Anodonta grandis footiana* (Lea).

Stations III, IV[1], XIV[3], XXII. This race is quite typical and shows little variation. The stations are all in rough or running water, which accounts, in some measure, for the small size and uniformity of the individuals. At Station III, the open lake shore, *footiana* forms a large bed, associated with *Lampsilis luteola.* which the muskrats have made good use of. A hollow tree trunk on the shore of this lake was found filled with the empty shells of *Anodonta* and *Lampsilis,* evidently representing the "dining hall"of a muskrat.

Genus **Symphynota** Lea.

9. *Symphynota costata* (Barnes).

Station XXII. Common and typical.

10. *Symphynota compressa* (Lea).

Station XXII. One specimen of *compressa* was found in a lot of *costata.* It is evidently rare at this station.

Genus **Quadrula** (Rafinesque) Agassiz.

11. *Quadrula undulata* (Barnes).
    Station XX[1]. Only one specimen found.

Order TELEODESMACEA.

Superfamily Cyrenacea.

Family Sphaeriidae.

Genus **Sphaerium** Scopoli.

12. *Sphærium striatinum* (Lamarck).
    Station XX[2]. Common on sandy bottom, near high-water line.
13. *Sphærium simile.* (Say).
    Station III. A single valve of this species was found on the lake share.
14. *Sphærium occidentale.* Prime.
    Station XXI. Common and typical in swamps bordering the Wisconsin River.

Genus **Musculium** Link.

15. *Musculium partumeium* (Say).
    Station XXI. All the specimens secured were immature.
16. *Musculium securis* (Prime).
    Stations II[2], V, XV. The specimens secured are all rather small, none exceeding seven mill. in length. All were collected in swampy bays or ponds. Not mentioned in Chadwick's list.
17. *Musculium rosaceum.* (Prime).
    Station XVII. A frequent species in the small pools which occupy most of the kettle holes in this region.

Genus **Pisidium** Pfeiffer, 1824.

18. *Pisidium abditum* Hald.
    Station II[2], XVII. Common and variable.
19. *Pisidium roperi* Sterki.
    Station XVII. Common associated with the last species.

20. *Pisidium subrotundum* Sterki.

Station XXI. Fairly abundant in swampy places along the Wisconsin River.

21. *Pisidium virginicum* Gmelin.

Station XX^2. Common in the sandy shore of the Wisconsin River, in shallow water associated with *Sphærium striatinum, Campeloma* and *Lampsilis luteola.*

Numbers 17, 18 and 19 are not in Chadwick's list.

Class **GASTROPODA.**

Order PROSOBRANCHIATA.

Family Viviparidae.

Genus **Campeloma** Rafinesque.

22. *Campeloma decisum* (Say).

Stations II^1, III, VII, VIII, XX^2, XXII. *Campeloma decisum* is abundant in this region on sandy shores in rough or rapidly moving water. The Wisconsin River habitat was the best and furnished the largest and finest specimens. The current here is very swift and the Campelomas bury themselves completely in the sand or rest on the lee side of anchored logs. Some specimens approach *Campeloma milesi,* but lack the peculiar rounded whorls so characteristic of the Michigan species.

Family Amnicolidae.

Genus **Amnicola** Gould and Haldeman.

23. *Amnicola cincinnatiensis* (Lea).

At Stations V, XII^2 and XIV^1 this species lives in abundance, its habitat being the under side of lily leaves. At stations III and VII the dead shells were found in shore debris, evidently washed from the sheltered bays.

Sub-Class EUTHYNEURA.

Order PULMONATA.

Sub-Order BASOMMATOPHORA.

Family PHYSIDAE.

Genus **Physa** Draparnaud.

24. *Physa ancillaria warreniana* Lea.

Stations II[1], III, IV[1], V, VI, VII, VIII, IX, X, XII, XIII[2], XIV[1], XV, XVI.

This *Physa* lives in either a protected bay or on an exposed shore; the protected bays, however, are frequently subject to rough conditions when the winds are from the unprotected side, which is often the case. Stations VIII andXII, both protected bays, produced the finest specimens. The normal habitat appears to be a sandy shore, but logs and other submerged objects are resorted to.

Warreniana appears to be a race of *ancillaria* rather than of *sayii*. Specimens in Tomahawk Lake vary toward this species *(ancillaria)* in the wide aperature, low spire, and shouldered body whorl. The specimens secured were mostly of small size and were very solid.

25. *Physa gyrina* Say.

Station XXI. Swamp bordering the Wisconsin River. All of the specimens secured are immature.

Genus **Aplexa** Fleming.

26. *Aplexa hypnorum* (Linné).

Station XXI. Typical, but not common.

Family ANCYLIDAE.

Genus **Ancylus** Geoffroy.

27. *Ancylus parallelus* Haldeman.

Stations V, XIV[1], XVII. This species occupied two habitats. At stations V and XIV it was found on the

under side of lily pads and the shell is rather flat and broad, while at station XVII it was found on old sticks in bogy swales and the shell is higher and more compressed than are the specimens from the two previous habitats. The effect of environment is quite clearly marked on the shells of these two diverse habitats. The ancyli were very abundant at all three stations.

Family Planorbidae.

Genus **Segmentina** Fleming.

28. *Segmentina armigera* (Say).
Stations II^2, XV, XXI. All specimens were collected in swampy ponds. At Stations II_2, they were found abundantly in the upper marshy portions of the bay.

Genus **Planorbis** Müller.

Subgenus **Gyraulus** *Agassiz.*

29. *Planorbis parvus* Say.
Stations XIV^1, XVII. Rather rare on lily pads (Station XIV^1,) and dead sticks in swales (Station XVII).

30. *Planorbis hirsutus* Gould.
Stations II^2, V, XXI. All stations were quiet water habitats, and the species was fairly common in each.

The relation of *hirsutus* to *deflectus, albus* and *draparnaldi* is not quite clear, and perfect specimens of all these species are not at hand to make satisfactory comparisons. *Deflectus* is frequently spiraly striated and hirsute and any considerable lot of *hirsutus* contains specimens with a subcarniate periphery. In a large series of *hirsutus* all gradations may be found between the two forms, as these are usually understood. The deflection of the aperture occurs in all the smaller planorbes and cannot be taken as a specific character. An examination of the types of *deflectus* and *hirsutus* in addition to a study of lots of shells from many localities would doubtless straighten out the matter.

Subgenus **Helisoma** Swainson.

31. *Planorbis campanulatus* Say.

Stations III, IV[1], VI, VII, IX, X, XIII[2], XIV[3].

This *Planorbis* apparently prefers a habitat where wave action is marked. It is the commonest *Planorbis* in this region, living on the sandy, or pebbly shore in a few inches of water.

32. *Planorbis campanulatus rudentis* Dall.

Stations II[1] III, IV[1], VI, VII, IX, X, XII.

A large number of the *campanulatus* in Tomahawk Lake appear to be referable to Dall's *rudentis* (Alaska Moll. p. 90) characterized by a large shell and particularly by the elevation of the apical whorls above the body whorl, much as in *Planorbis multivolvis* Case. The apical whorls are flat as in typical *campanulatus,* the deflected body whorl beginning at about one-third of the last whorl. In typical *campanulatus* the whorls are usually coiled in the same plane, the apical whorls being a little below the dorsal margin of the body whorl. The specimens mentioned by Walker, from Siskowit Lake, Isle Royale, are probably also this variety (An. Rep. Mich. Geol. Surv. p. 293). The Tomahawk Lake *campanulatus* are more variable than specimens from New York and Illinois.

33. *Planorbis bicarinatus striatus* Baker.

Stations II[1] III, VII, VIII, XII. Very common on logs and on sand and pebbles in a few inches of water. Prefers open shores.

All of the *bicarinatus* living in Tomahawk Lake seem referable to this race. The spiral striation is very conspicuous and is well marked on the majority of the specimens secured. In typical *bicarinatus* from New York state (near Owasco Lake) the spiral sculpture is faint or lacking.

34. *Planorbis bicarinatus unicarinatus* Haldeman.

Stations XIV[2], XV. This distinct race was seen only in a swampy bay and the quiet waters of a small creek,

habitats quite different from those occupied by *Planorbis bicarinatus striatus*. *Unicarinatus* is spiraly striated much as is variety *striatus*, though not to so marked a degree. The habitat of this species is the muddy bottom of a pond or on sticks and other debris at the mouth of the creek.

35. *Planorbis binneyi* Tryon.

Stations II[1], IV[1], V, IX, XIII[1], XIV[3], XXIII. *Binneyi*, inhabits several diverse habitats. Stations II[1], IX, XIII[1], XIV[3], were more or less sheltered bays where there was little wave action; the shells live for the most part on logs and floating debris, but a few prefer the sandy bottom in about a foot of water. Station IV[1] was an exposed bay, open to the full force of the waves and this Planorbis lived here in considerable number. Station V was an enclosed bay occupied by a pond-lily society; this habitat is equivalent to the sheltered bay as the lake waters have free access to it. *Binneyi* occupied the logs in this bay. Station XIII was a mucky slough in a marsh, and the Planorbis were seen clinging to logs or crawling over the muddy bottom in eight to twelve inches of water. The specimens from this habitat are not horn colored, as is the case with those from the other habitats but of a reddish tinge, due probably to the iron in the water. The difference between this habitat and those of Tomahawk Lake is marked, yet there is no difference in the form of the shells.

Planorbis binneyi is a common species of the northern tier of states and has been seen by the writer from western Massachusetts to Oregon. Chadwick's reference (Wisconsin Moll. p. 83) to *Planorbis trivolvis* Say, large form, probably refers to this species.

Dall's statement (Alaska Moll. p. 88) that *binneyi* "is not known east of the Rocky Mountains" is erroneous, as it is a common *Planorbis* in the northeastern part of the United States. It is apparently a species which ranges from Oregon to Massachusetts, and from southern Wisconsin and New York northward. It has been identified as *corpulentus* Say, but that is quite a different species.

(See Walker, Nautilus, XIII, p. 133; Baker, Nautilus, XXII, p. 41). *Binneyi* is related to *Palnorbis ammon* Gould, but is apparently distinct.

36. *Planorbis trivolvis* Say.

Stations IV[2], XIV[2], XV. This species inhabits only quiet bodies of water which are more or less swampy. In such a habitat it is always abundant. The *trivolvis* of Tomahawk Lake are very large and the fully mature examples suggest such names as *megasoma* DeKay and *macrostomus* Whiteaves which are probably to be considered but different phases of development.

Family Lymnaeidae.

Genus **Lymnaea** Lamarck.

37. *Lymnœa stagnalis appressa* Say.

Station XIII[1]. *Stagnalis appressa* lives only in the more open part of a swamp-bordered thoroughfare. The shells are here quite uniform and closely resemble the typical form. At Station XIII[1] the habitat was a protected, lake-like bay at the head of a wide thoroughfare and the shells were found on floating logs or on the sandy bottom in shallow water.

38. *Lymnœa stagnalis lillianœ* Baker.

Station IV[1], VII, IX, X, XIV[3]. All of these stations were on more or less exposed shores, subject to the force of the waves. *Lillianœ* is typically an inhabitant of sandy shores, in shallow water, where it is subject to heavy wave action. When any number of specimens were found, the habitat was invariably an exposed beach. Individuals were observed crawling over the sandy beach or attached to water soaked logs or other shore debris. The animal of this race exhibits two color modifications, one bright yellow and the other black or grayish-black. No cause for this color dimorphism was apparent. It is not protective, as both forms occupy the same area of white sandy beach.

Specimens living in protected bays have a longer spire and more closely resembles *appressa,* clearly showing that *lillianæ* is a modification of this race.

Genus **Pseudosuccinea** Baker.

39. *Pseudosuccinea columella* (Say).

Stations II[2], XI, XIII[2], XIV[1]. *Columella* always occupies a still water or swampy habitat, its situs being usually the under side of lily leaves or on floating debris.

Genus **Bulimnea** Haldeman.

40. *Bulimnea megasoma* (Say).

Stations XIII,[1] XXIII. This large, fine Lymnæa lives in swamps where the water is quiet. The bottom of such a habitat is boggy and the water is so shallow that frequently little boggy islands are formed, and on these *megasoma* may be found, one or two specimens on each island. In other parts of this habitat they may be found near the shore, clinging to logs and other debris. A small swampy slough, lying between the Wisconsin River and Gilmore Creek, afford the best habitat for *megasoma,* where it lived in considerable number. This slough is about a quarter of a mile long and two or three hundred feet wide. The water is (in summer) but a few inches in depth, but the mud which is about the consistency of mush, is six or more feet in depth. *Megasoma* lives on the surface of the mud and on old logs which the lumbermen have left in the swamp. It would seem that the characteristic habitat of this species is a swamp or marshy pond or bay.

The individuals of this species are very large and fine, a length of 47 mill. being frequently attained. The epidermis is olive green or greenish chestnut, and the surface of the last whorl is either heavily malleated or shows more or less equidistant riblets parallel with the growth lines. The spire varies from elevated to depressed.

Genus **Galba** Schrank.

41. *Galba humilis modicella* (Say).

Station XX^3. Common just above the water line on the muddy flats bordering the Wisconsin River.

42. *Galba obrussa* (Say).

Station II^2. This species was seen only on debris above the water on the shore of a sheltered bay.

43. *Galba lanceata* (Gould).

Stations II^2, IV^2, V, IX, XI, $XIII^1$, XIV^2, XV. This species normally lives only in large swampy bays protected from rough water. It is most abundant in quiet bodies of water where there is little wave action, where it lives on logs, on the stems of Typa or on floating vegetation. Though quoted as a synonym of both *reflexa* and *exilis,* this species is unquestionably recognizable as a species; it is one of the most abundant species in Tomahawk Lake. Not in Chadwick's list.

44. *Galba emarginata wisconsinensis* (Baker).

Stations II^1, III, IV^1, VI, VII, VIII. This recently distinguished race of *emarginata* is characteristic of the exposed, wave-beaten shores of the large lake. It lives on the sandy or pebbly shores, in water from a few inches to several feet in depth. By wading along the sandy beach thousands may be collected in water but a few inches in depth. The habitats in this lake are all on exposed points or in curved bays where the shore receives the full force of the waves. No specimens were found in sheltered places, where the water was at all stagnant. The individuals were irregularly scattered over the surface, crawling over the sand where a distinct tract was left, or lying half buried in the sand. Two different color varieties of the animal were observed, one almost black and the other yellowish or even orange.

Emarginata wisconsinensis is by far the most abundant shell in Tomahawk Lake, where in many places it forms windrows of dead shells on the shore after a northwesterly

storm. There is great variation in the length of the spire which may be elevated or greatly depressed. All specimens agree, however, in having a pronouncedly globose body whorl. The reference to *Lymaœa decollata* Mighels, from Madison, by Chadwick (p. 81) is founded on specimens of *Galbra emarginata angulata* Sowb., which is plentiful in the lakes near Madison.

Sub-Order STYLOMMATOPHORA

Family Succineidae.

Genus **Succinea** Draparnaud.

45. *Succinea retusa* Lea.

Station II, XX^3. In wet places, on debris or water plants. Apparently not common.

Family Pupillidae.

Genus **Strobilops** Pilsbry.

46. *Strobilops virgo Pilsbry.*

Stations I, XVIII, XIX. Common in damp places under logs, in started bark and crevices and on mouldy and decaying leaves. Station I is a young deciduous forest while XVIII and XIX are virgin woods of pine, spruce, cedar, birch, etc. In these two habitats the shells were found on rotting birch logs, but not on pine logs. *Strobilops virgo* is very abundant in the forested area about Tomahawk Lake.

Family Endodontidae.

Genus **Helicodiscus** Morse.

47. *Helicodiscus parallelus* (Say).

Stations I, XIX. Associated with *Strobilops virgo,* common.

Genus **Pyramidula** Fitzinger.

Subgenus **Patula** Held.

48. *Pyramidula cronkhitei catskillensis* (Pilsbry).

Stations I, XVIII, XIX. Common associated with the two above mentioned species. None of the typical form were seem, all being good examples of *catskillensis.*

49. *Pyramidula alternata* (Say).

Station I. A few specimens of this common land snail were collected in the young deciduous forest near Sanders' Resort. They were found on the under side of decaying logs.

Family Zonitidae.

Genus **Vitrea** Fitzinger.

50. *Vitrea hammonis* (Ström).

Station XXI. A single specimen was found on the edge of a muddy pool.

Genus **Euconulus** Reinhardt.

51. *Euconulus fulvus* (Müller).

Station I. Common, associated with *Strobilops* and *Helicodiscus.*

Genus **Zonitoides** Lehmann.

52. *Zonitoides arboreus* (Say).

Stations I, XVIII, XIX. This is by far the commonest land snail in this region and is associated with *Strobilops, Pyramidula cronkhitei catskillensis, Euconulus* and *Helicodiscus.*

Family Helicidae.

Genus **Polygyra** (Say) Pilsbry.

53. *Polygyra albolabris* (Say).

Station I. Three dead specimens of this large land snail were found on the hillside above Sanders' Resort. It is apparently rare in this area.

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Name of Species.	I	II		III	IV		V	VI	VII	VIII	IX	X	XI	XII	XIII		XIV			XV	XVI	XVII	XVIII	XIX	XX			XXI	XXII	XXIII
	Wooded bluff (deciduous.	1. Sheltered bay.	2. Swamp. Typha society.	Exposed shore of lake.	1. Exposed shore of lake.	2. Swamp, Typha society.	Pond-like bay, enclosed	Exposed shore of lake.	Exposed shore of lake.	Exposed shore of lake.	Sheltered bay, Typha society.	Exposed shore of bay.	Swamp, Typha society.	Sheltered shore of lake.	1. Shore of swamp.	2. Castalia-Nymphaea society.	1. Castalia-Nymphaea society.	2. Shore of swamp.	3. Sheltered mouth of creek.	Swampy pond.	Clear pond.	Swales.	Coniferous forest.	Coniferous-deciduous forest.	1. Deep water of river current swift.	2. Shallow water of river current swift.	3. Mud flats above water.	Swamps along river.	Creek with swift current.	Boggy swamp.
Lampsilis ventricosa																														
luteola		x			x																									
ligamentina												x												x						
recta																														
Strophitus edentulus																														
Anodonta marginata					x							x							x											
implicata																														
grandis footiana				x		x																								
Symphynota costata																														
compressa																														
Quadrula undulata																														
Spherium simile				x																										
striatinum																														
occidentale																														
Musculium partumeium																														
securis			x				x													x									
rosaceum																														
Pisidium abditum										x																				
roperi		x					x																							
subrotundum																														
virginicum																											x			
Campeloma decisum										x																				
Amnicola cincinnatiensis			x	x			x																					x		
Physa ancillaria warreniana																														

Physa gyrina	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	x	....	....
Aplexa hypnorum	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	x	....	....
Ancylus parallelus	....	....	....	....	....	....	x	....	....	....	....	....	....	....	....	....	x	....	....	....	x	....	....	....	....	....	....	....	....
Segmentina armigera	....	....	x	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	x	....	....	....	....	....	....	x	....	....
Planorbis parvus	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	x	....	....	....	x	....	....	....	....	....	....	....	....
hirsutus	....	....	x	....	....	....	x	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	x	....	....
campanulatus	....	....	....	x	x	....	....	x	x	....	x	x	....	....	....	x	....	....	x	....	....	....	....	..	....	....	....	....	....
campanulatus rudentis	....	x	....	x	x	....	....	x	x	....	x	x	....	x	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
bicarinatus striatus	....	x	....	x	....	....	....	....	x	x	....	....	....	x	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
bicarinatus unicarinatus	....	....	...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	x	....	x	....	....	....	....	....	....	....	....	....
binneyi	....	x	....	....	x	....	x	....	....	....	x	....	....	....	x	....	....	....	x	....	....	....	....	....	....	....	....	....	x	....
trivolvis	....	....	....	....	....	x	....	....	....	....	....	....	....	..	....	....	....	x	....	x	....	....	....	....	....	....	....	....	....
Lymnæa stagnalis appressa	....	....	....	....	....	....	....	....	....	....	....	....	....	....	x	....	....	....	....	....	....	....	....	....	....	....	....	....	....
stagnalis lilliana	....	....	....	....	x	....	....	....	x	....	x	x	...	....	....	....	....	....	x	....	....	....	....	....	....	....	....	....	....
columella	....	....	x	....	....	....	....	....	....	....	....	....	x	....	....	x	x	....	....	....	....	....	....	....	....	....	....	....	....
megasoma	....	....	....	....	....	....	....	....	....	....	....	....	....	....	x	....	....	....	....	....	....	....	....	....	....	....	....	....	x
humilis modicella	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	x	....	....	....
obrussa	....	....	x	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
lanceata	....	....	x	....	....	x	x	....	....	....	x	....	x	....	x	....	....	x	....	x	....	....	....	....	....	....	....	....	....
emarginata wisconsinensis	....	x	....	x	x	....	....	x	x	x	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Succinea retusa	....	....	x	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	x	....	....	....	....
Strobilops virgo	x	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	x	x	....	....	....	....	....	....	....
Helicodiscus parallelus	x	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	x	....	....	....	....	....	....	....
Pyramidula cronkhitei catskillensis	x	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	x	x	....	....	....	....	....	....	....
alternata	x	....	...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	x	....	....
Vitrea hammonis	...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Euconulus fulvus	x	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Zonitoides arboreus	x	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	x	x	....	....	....	....	....	....	....
Polygyra albolabris	x	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	7	6	8	10	9	2	7	4	7	4	6	6	2	3	4	4	5	3	5	6	1	5	3	4	4	4	2	8	10	2

EXPLANATION OF PLATES.

Plate XI. Sketch map of Tomahawk Lake and Vicinity, showing location of stations.

Fig. 1. The north shore of Tomahawk Lake, showing aspect of the country after lumbering operations have ceased.

Fig. 2. Station I. Wooded area near Sanders' Resort. Second growth of timber—birch, oak and maple.

Fig. 3. Station II. Small bay west of Sanders' Resort. Note Typha latifolia plant society bordering bay.

Fig. 4. Station III. Exposed north shore of lake near Sanders' Resort. Note the bare shore.

Fig. 5. Station IV. Embayment near Quynock Point, south side of lake.

Fig. 6. Station VII. Exposed lake shore near Camp No. 7. North shore of lake.

Fig. 7. Station XIII. Thoroughfare between Tomahawk and Little Tomahawk lakes. Swamp in background in upper left hand corner.

Fig. 8. Station XIII. Thoroughfare between Tomahawk and Little Tomahawk Lake.

Fig. 9. Station XIII. Bay-like area near Little Tomahawk Lake. Note Nymphæa plant society covering surface of water. Dead trees caused by rising of lake level.

Fig. 10. Station XV. Sanders' Minnow-box pond. Formed artificially by daming a small creek. The trees and shrubs were killed by the rising of the water.

Fig. 11. Station XVIII. Woods on Quynock Point from Sanders' Resort. View taken across lake.

Fig. 12. Station XVIII. Virgin woods n Quynock Point. Part of the Wisconsin state forest reservation on south shore of lake.

Fig. 13. Station XIX. Virgin woods near Camp No. 7. Known locally as the cyclone woods.

3

THE CALIFORNIAN LAND SHELLS OF THE EPIPHRAGMOPHORA TRASKII GROUP

BY

PAUL BARTSCH

Curator, Division of Marine Invertebrates, United States National Museum

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No. 2170.—From the Proceedings of the United States National Museum, Vol. 51, pages 609–619, with Plates 114–117

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THE CALIFORNIAN LAND SHELLS OF THE EPIPHRAGMOPHORA TRASKII GROUP.

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INTRODUCTION.

Some material recently received by the United States National Museum has made it necessary to subject this group to an examination, which has yielded some rather interesting results. Foremost among these may be mentioned the assigning of a final resting place to *Helix carpenteri* Newcomb, a name that has been applied erroneously to at least three different forms since it was established. It was therefore quite a satisfaction to find a shell in the type locality that satisfies all requirements of Doctor Newcomb's diagnosis and will fix, it is to be hoped, this name forever.

In this study I have been greatly aided by having had at my disposal the entire series of the group contained in the collection of the Philadelphia Academy of Natural Sciences, which was kindly loaned to me by Dr. H. A. Pilsbry. I am also indebted to Prof. G. D. Harris, of Cornell University, for the loan of Newcomb's four cotypes of *Epiphragmophora traskii*, and to Dr. S. S. Berry, of Redlands, California, for the loan of two paratypes of his *Epiphragmophora petricola*.

The figures accompanying the sketch are after photographs retouched by Mrs. E. B. Decker.

GROUP CHARACTERS.

The group of *Epiphragmophora traskii* is characterized by having the nucleus, which usually forms one and one-half to two turns, very finely axially wrinkled and provided with a scanty number of rather distantly spaced, slightly elongated papillae, that form obliquely, protractively slanting curved lines. The sculpture of the succeeding turns may be papillose or spirally striate or both. The postnuclear whorls may be all, or in part, marked by incised spiral striations, which vary in strength in the different races, from microscopic to strongly incised. The last whorl is never malleated, as in the group of *Epiphragmophora tudiculata*, which has the nuclear sculpture like that of the present group.

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SPECIFIC CHARACTERS.

The material examined readily breaks up into two subgroups, which we shall consider species.

The southern species, *Epiphragmophora cuyamacensis*, has the last whorl uniform papillose above and below, while in the northern, *Epiphragmophora traskii*, the last whorl lacks the uniform papillations.

KEY TO SUBSPECIES.

a^1, Shell papillose above and below on all the whorls.....*E. cuyamacensis*, p. 610.
  b^1, Umbilicus half closed by the reflected inner lip; greater diameter 25 mm., *c. avus*, p. 610.
  b^2. Umbilicus not half closed by the reflected inner lip; greater diameter less than 21 mm.
    c^1, Papillations uniform over entire base.....*c. venturensis*, p. 611.
    c^2, Papillations not uniform over entire base.
      d^1, Papillations obsolete on the rounded portion of base a little behind the aperture.....*c. cuyamacensis*, p. 611.
a^1, Shell not papillose above and below on all the whorls.....*E. traskii*, p. 610.
  b^1, Obliquely protractively slanting lines of papillae on the nucleus, very faint.
    c^1, Shell subglobose.....*t. tularica*, p. 615.
    c^2, Shell decidedly depressed.
      d^1, Shell large, diameter of type 31 mm.....*t. zechae*, p. 615.
      d^2, Shell smaller, diameter of type, 20 mm .....*t. proles*, p. 616.
  b^1, Obliquely protractively slanting lines of papillae on the nucleus, well developed.
    c^1, Surface of shell with clothlike sculpture.....*t. coronadoensis*, p. 617.
    c^2, Surface of shell not with clothlike sculpture.
      d^1, Umbilicus narrow, more than half covered by the reflected inner lip.
        e^1, Shell decidedly inflated.....*t. coelata*, p. 617.
        e^2, Shell not inflated.....*t. carpenteri*, p. 617.
      d^2, Umbilicus wide, less than half covered by the reflected inner lip.
        e^1, Papillation on whorls succeeding the nuclear turns stronger than those on the nucleus.....*t. phlyctaena*, p. 618.
        e^2, Papillation on whorls succeeding the nuclear turns not stronger than those on the nucleus .....*t. traskii*, p. 612.

EPIPHRAGMOPHORA CUYAMACENSIS AVUS, new subspecies.

Plate 116, figs. 16–18.

This is a giant race resembling the large form of typical *Epiphragmophora traskii*. It has the inner lip reflected over half of the rather narrow umbilicus. The entire upper surface and the inside of the umbilicus are strongly papillose, while the rounded basal portion is almost smooth, the lines of growth being the most conspicuous feature. The spiral sculpture is obsolete.

The type (Cat. No. 120588, U.S.N.M.) comes from Los Angeles County, California. It has 5.5 whorls and measures—greater diameter, 25 mm.; altitude, 14.6 mm.

EPIPHRAGMOPHORA CUYAMACENSIS VENTURENSIS, new species.

Plate 116, figs. 13–15; plate 117, fig. 7.

Shell very much like *Epiphragmophora cuyamacensis cuyamacensis*, but with coarser papillation, which does not become obsolete behind the aperture on the rounded portion of the base, but is as strongly developed here as on the rest of the shell.

The type (Cat. No. 39642*a*, U.S.N.M.) was collected by L. Yates in Ventura County, California. It has 5.6 whorls and measures—greater diameter, 20.3 mm.; altitude, 12 mm. Another specimen without specific locality (Cat. No. 60611, U.S.N.M.) has 5.7 whorls and measures—greater diameter, 20.1 mm.; altitude, 12 mm.

EPIPHRAGMOPHORA CUYAMACENSIS CUYAMACENSIS, new species.

Plate 116, figs. 10–12; plate 117, fig. 8.

Epiphragmophora traskii cuyamacensis (Hemphill) PILSBRY, Man. Conch., vol. 9, 1894, p. 199, *nomen nudum*.

Epiphragmophora traskii cuyamacensis (Hemphill) PILSBRY, Clas. Cat. with Loc. Land Shells of Amer. North Mex., 1907, p. 5, *nomen nudum*.

Shell openly umbilicated; inner lip only slightly reflected over the umbilicus. Surface evenly papillated above and below, excepting a small portion on the rounded part of the base a little behind the aperture, which may be almost smooth.

Cat. No. 62381, Philadelphia Academy Collection, contains the type, three adult and nine immature specimens, which were collected by Mr. Henry Hemphill at the Cuyamaca Mountains in San Diego County, California. These are the specimens referred to by Doctor Pilsbry in the citations given above. The type has 5.9 whorls and measures—greater diameter, 20.1 mm.; altitude, 11.7 mm.

We have seen the following adult specimens, all collected by Mr. Hemphill:

Collection.	Catalogue number.	Number of whorls.	Greater diameter.	Altitude.	Locality.
P.A.N.S.	62387	5.9	20.1	11.7	San Diego County, California.
Do.	62387	5.9	19.2	11.7	Do.
Do.	62387	5.6	17.0	10.4	Do.
Do.	62387	5.6	16.0	10.2	Do.
U.S.N.M.	39646	5.6	20.1	12.5	San Diego mines.
Do.	39646	5.3	19.3	12.0	Do.
Do.	30520	5.4	20.2	11.0	San Diego County, California.

Two young specimens in Mr. F. W. Kelsey's collection from Paloma Mountains, San Diego County, California, were examined.

EPIPHRAGMOPHORA TRASKII TRASKII (Newcomb).

Plate 114, figs. 1–18; plate 117, figs. 1–3.

Helix traskii NEWCOMB, Proc. Cal. Acad. Nat. Sci., vol. 2, 1861, pp. 91–92.
Aglaja traskii TRYON, Amer. Journ. Conch., vol. 2, 1866, p. 314, pl. 5, fig. 16.
Arionta traskii W. G. BINNEY, Terr. Moll., vol. 5, 1878, p. 369.
Helix franki J. G. COOPER, err. typ.; teste J. G. C., in letters.
Epiphragmophora traskii PILSBRY, Tryon's Man. Conch., vol. 9, 1894, p. 199.
Epiphragmophora traskii major HEMPHILL, *nomen nudum.*
Epiphragmophora traskii verna HEMPHILL, *nomen nudum.*
Epiphragmophora traskii saucius HEMPHILL, *nomen nudum.*
Epiphragmophora petricola BERRY, Univ. Cal. Pub. Zool.,vol. 16, No. 9, Jan. 1916, pp. 107–9.

In this subspecies the fine papillation of the nuclear whorls scarcely extends beyond the third turn and is never stronger on the turns that succeed the nucleus than on the nucleus.

I have seen Dr. Newcomb's cotypes, four specimens, which are in the collection of Cornell University, No. 27832, and I have figured one of these on plate 116, as figures 7–9. These four specimens which come from Los Angeles, California, yield the following measurements:

Number of whorls.	Greater diameter.	Altitude.
5. 6	22. 6	13. 7
5. 8	22. 1	12. 6
5. 9	22. 3	13. 3
5. 6	23. 2	13. 9

To this subspecies I must refer Hemphill's *Epiphragmophora traskii major, E. t. verna,* and *E. t. saucius.* The first of these simply represents the largest shells of the group, while the green tinge of *E. t. verna* Hemphill, which is fugitive, is characteristic of all fresh specimens. The somewhat smaller average in size of the series of shells, which Hemphill named *verna,* is due to a partially diseased condition of the whorls.

Epiphragmophora traskii saucius Hemphill, as selected by the author of that name, represents pathologic specimens. It is *E. t. verna* carried a little further, pathologically speaking.

I have seen two paratypes of Mr. Berry's *Epiphragmophora petricola,* and I give figures of one of these on plate 117, figures 1–3. These specimens must be assigned to typical *Epiphragmophora traskii traskii.* Mr. Berry's ecologic data given in the paper referred to above are rather interesting since they throw considerable light on the habits of these animals. I therefore quote from his paper:

Type.—Cat. No. 3480 of the writer's collection; paratypes in the collections of the University of California and the private collection of Mr. Allyn G. Smith.

Type-locality.—A rocky talus slope on the southeast wall of Mill Creek Canyon, San Bernardino Mountains, California, near the old road, about 1-1/2 miles from the canyon

mouth, altitude about 3,250 feet; 10 dead shells, A. G. Smith and S. S. Berry, January 7, 1914; three living specimens, A. G. Smith, May 12, 1914; one living specimen, S. S. Berry, April 8, 1915.

Remarks.—This fine helicoid, one of the largest of the southern fauna, is distinguished by the aforementioned characters from all others known to me. It perhaps resembles a very large and extremely flattened form of *E. traskii* more than any of the other Californian species, and I believe the two species to be rather nearly allied, though the situations in which they are respectively to be found are very dissimilar. *E. petricola* was first discovered while quarrying through a rocky slide in the possible hope of obtaining *Micrarionta* or *Sonorella*, genera as yet unknown from the San Bernardino Range. The species does not seem to be an abundant one, and several hours' arduous labor in turning over large blocks of stone and clearing out the detritus, repeated on several occasions, have yielded to date only a single adult living specimen, all the remainder being immature or merely dead shells. While probably occurring all through Mill Creek Canyon, and perhaps neighboring parts of the range in favorable situations, only the one slide of the few so far examined has yielded specimens. A find by Mr. Smith of several shells on or near the surface leads to the belief that the species is not always, if ever, of strictly subterranean habit, at least not in the same sense as *Sonorella*.

The two paratypes sent to us by Mr. Berry give the following measurements:

Number of whorls.	Greater diameter.	Altitude.
5.9	28.3	17.0
6.0	28.7	15.4

The following additional adult specimens have been examined. No measurements were taken of pathologic and injured material; hence, most of the specimens called *verna* by Hemphill and all of his *saucius* drop out.

Measurements of Epiphragmophora traskii traskii.

Collection.	Catalogue number.	Number of whorls.	Greater diameter.	Altitude.	Locality.
U.S.N.M.	58553	6.2	26.3	17.4	San Luis Obispo County.
Do.	58553	6.3	27.6	17.3	Do.
Do.	39643	5.8	26.2	15.5	Santa Barbara.
Do.	39643	5.7	24.0	15.0	Do.
Do.	39643	5.8	24.4	13.9	Do.
Do.	39643	5.8	23.9	14.8	Do.
Do.	181313	6.2	28.8	17.4	Little Pine Canyon, Santa Barbara County.
Do.	12336	6.3	30.2	19.0	Santa Barbara.
P.A.N.S.	10700	6.0	21.7	12.5	Do.
U.S.N.M.	58523	6.0	20.3	11.7	Fort Tejon.
P.A.N.S.	10698	6.0	23.0	13.1	Do.
U.S.N.M.	39640a	6.0	26.0	15.4	Hills of Ventura County.
Do.	39640a	5.5	21.9	14.2	Do.
Do.	39640a	5.8	23.7	15.5	Do.
Do.	39640a	5.2	21.2	12.5	Do.

Measurements of Epiphragmophora traskii traskii—Continued.

Collection.	Catalogue number.	Number of whorls.	Greater diameter.	Altitude.	Locality.
U.S.N.M.	39642	6.0	25.0	14.8	Ventura County.
Do.	58559	6.0	21.5	14.3	Near Los Angeles.
Do.	58559	5.7	21.9	12.2	Do.
Do.	58559	5.8	21.6	14.9	Do.
Do.	58559	5.8	21.0	14.3	Do.
Do.	174117	5.5	20.5	13.3	Los Angeles County.
Do.	174117	5.5	22.3	14.1	Do.
Do.	174118	6.2	26.5	17.5	Do.
Do.	174118	6.2	26.1	17.4	Do.
Do.	174119	6.0	28.9	18.6	Do.
Do.	174119	6.2	28.5	17.7	Do.
Do.	174120	5.7	24.4	15.0	Do.
Do.	174120	6.0	24.3	15.8	Do.
Do.	174121	5.7	22.7	15.3	Do.
Do.	174121	5.8	22.0	15.5	Do.
Do.	174122	5.5	21.3	14.0	Do.
Do.	174122	5.7	21.4	14.1	Do.
Do.	174123	5.4	20.0	13.1	Do.
Do.	174123	5.7	19.1	13.0	Do.
Do.	174125	5.5	21.8	13.0	Do.
Do.	174125	5.8	20.9	13.0	Do.
Do.	174126	5.7	24.4	14.5	Do.
Do.	174126	5.5	24.5	14.0	Do.
Do.	174127	5.8	26.1	14.6	Do.
Do.	174127	5.8	25.3	14.5	Do.
Do.	174128	5.8	28.7	16.0	Do.
Do.	174128	6.0	26.5	15.5	Do.
Do.	201207	6.7	28.4	19.8	Artesia, Los Angeles County.
Do.	201207	6.5	29.4	18.6	Do.
Do.	201207	6.5	28.7	18.8	Do.
P.A.N.S.	10685	6.0	23.4	14.8	Los Angeles
Do.	10685	5.8	22.7	14.5	Do.
Do.	10685	5.3	22.9	15.0	Do.
Do.	10685	5.7	23.0	14.3	Do.
Do.	10685	6.0	21.4	14.2	Do.
Do.	10685	5.7	22.2	13.1	Do.
Do.	10685	6.0	22.3	13.2	Do.
Do.	86873	5.7	25.5	16.1	Do.
Do.	86873	6.2	26.7	18.1	Do.
Do.	86874	6.0	26.4	16.8	Do.
Do.	86874	6.0	25.0	16.9	Do.
Do.	86875	6.0	24.0	15.6	Do.
Do.	86875	6.0	24.1	17.2	Do.
Do.	86876	5.7	20.6	13.6	Do.
Do.	86879	5.5	20.5	12.4	Do.
Do.	86879	5.5	22.4	13.5	Do.
Do.	86880	6.0	24.0	14.0	Do.
Do.	86880	5.7	22.0	13.3	Do.
Do.	86881	5.7	25.2	14.8	Do.
Do.	86881	5.8	25.5	14.6	Do.
U.S.N.M.	182627	6.4	26.4	18.0	San Diego.
Average		5.88	24.07	15.09	
Greatest		6.7	30.02	19.8	
Least		5.2	19.1	12.2	

EPIPHRAGMOPHORA TRASKII TULARICA, new subspecies.

Plate 116, figs. 1–3.

Epiphragmophora traskii tularensis (Hemphill) PILSBRY, Man. Conch., 1894, p. 199, *nomen nudum.*

Epiphragmophora traskii tularensis PILSBRY, Clas. Cat. with Loc. Land Shells of Amer. North Mex., 1907, p. 5, *nomen nudum.*

Shell subglobose, very dark colored, with the chestnut band very broad. The axial wrinkling of the nuclear sculpture is very strongly developed, the individual wrinkles being finely granulated. The larger papillations, which form the obliquely protractively slanting lines on the nucleus, are not nearly as strongly developed here as on the other races and require search to be seen. This sculpture does not appear to extend beyond the nuclear turns, but is replaced by the incised spiral sculpture which consists of closely spaced microscopic spiral striations and deeper, distantly, irregularly distributed, stronger lines.

The type and another specimen (Cat. No. 60009, Philadelphia Academy of Natural Sciences Collection) come from Frasers Mills, Tulare County, California. The type has 5.6 whorls and measures, greater diameter, 21 mm.; altitude, 17.4 mm. The other specimen has 5.5 whorls and measures, greater diameter, 21 mm.; altitude, 15.6 mm.

EPIPHRAGMOPHORA TRASKII ZECHAE Pilsbry.

Plate 117, figs. 4–6.

Epiphragmophora traskii zechae PILSBRY, Nautilus, vol. 29, No. 9, pp. 104–5, pl. 3, lower figures (3), Jan., 1916.

Shell very large, decidedly flattened, widely, openly umbilicated, thin. "The whorls of the spire and as far as the front of the last whorl are dilute cinnamon, then changing to ecru-olive or dark olive-buff; there is a chestnut-brown band at the shoulder (about 2 mm. wide), bordered with inconspicuous, hardly noticeable bands paler than the ground color." The characteristic distantly spaced, obliquely protractively arranged papillation is almost obsolete in the nuclear whorls, as well as on the rest of the shell, appearing only as distantly scattered pustules, usually best expressed near the suture, excepting immediately behind the aperture where they are strongly developed on the upper surface and a little less so on the lower. In addition to the papillation the whorls are marked by rather strong incremental lines which are equally developed on the upper and lower surface. No spiral striations are present. Aperture broadly lunate, decidedly wider than high; lip thin, the upper margin scarcely expanded, the outer slightly expanded, the basal very narrowly reflected; columellar margin broadly dilated.

The type (Cat. No. 113426, Philadelphia Academy of Natural Sciences) measures: altitude, 15.2 mm.; diameter, 31 mm.; aperture: altitude, 14.3 mm.; width, 17.8 mm.

Habitat.—San Antonio Canyon, in the San Gabriel Mountains, western edge of San Bernardino County, California, at about 5,000 feet elevation (Miss Lilian Zech).

Miss Zech gives the following account of the locality:

The specimen was found in a narrow, winding canyon branching from the main San Antonio canyon at 4,700 feet, and at this point, some 200 or 300 feet higher, as near as I can guess, only wide enough for the creek bed, then full of rushing water, and the trail. It is a cool, moist, deep canyon, with columbine, lilies, and ferns, and on the slopes much bay laurel. The trees were incense cedar and big cone spruce. The snail lay on a pile of rock artificially heaped up at the creek's mouth and contained the dead animal when found.

EPIPHRAGMOPHORA TRASKII PROLES, new subspecies.

Plate 116, figs. 4–6.

Epiphragmophora traskii proles (Hemphill) PILSBRY, Man. Conch., 1894, p. 199, *nomen nudum.*

Epiphragmophora traskii proles (Hemphill) PILSBRY, Clas. Cat. with Loc. Land Shells of Amer. North Mex., 1907, p. 4, *nomen nudum.*

Shell decidedly flattened, widely, openly umbilicated, thin. The characteristic distantly spaced, obliquely protractively arranged, papillation is almost obsolete in the nuclear whorls as well as in the rest of the shell in the present race. Traces of this sculpture can only be seen on absolutely perfect specimens. Only one individual of all the material examined showed this character, the nuclear whorls in all the rest being slightly worn. The incremental lines of the post-nuclear turns are not strong and the spiral sculpture which consists of exceedingly fine, faintly incised lines, which are best seen on the penultimate whorl, becomes lost on the last turn, both above and on the base.

I have selected one of the three specimens collected by Mr. Henry Hemphill at Frasers Mills, Tulare County, California, which are listed as Cat. No. 62270, Philadelphia Academy of Sciences collection, as type. This has 5. 1 whorls and measures—greater diameter, 20.1 mm.; altitude, 11.1 mm.

I have seen the following additional adult specimens:

Measurements of Epiphragmophora traskii proles.

Collection.	Catalogue number.	Number of whorls.	Greater diameter.	Altitude.	Locality.
P.A.N.S	62270	5. 2	21. 5	11. 4	Frasers Mills, Tulare County, California.
Do	62270	5. 0	19. 4	10. 2	Do.
Do	10702	5. 0	20. 3	11. 0	Clarks, California.
Do	10702	5. 0	18. 7	10. 5	Do.
Do	10702	4. 7	18. 0	10. 4	Do.
U.S.N.M	39644	4. 8	18. 5	10. 3	Mariposa County, California.
Do	39644	4. 6	18. 0	10. 4	Do.
Do	39644	4. 7	17. 7	10. 2	Do.
Do	106779	5. 0	19. 3	10. 6	Clarks Ranch, Mariposa County, California, 65 feet, altitude.
Do	[1] 58538	.....	.....	.....	

[1] Two not quite matured from the same place.

EPIPHRAGMOPHORA TRASKII CORONADOENSIS, new subspecies.

Plate 115, figs. 10–12; plate 117, fig. 9.

Epiphragmophora carpenteri PILSBRY (part), Clas. Cat. with Loc. Land Shells of Amer. North Mex., 1907, p. 5.

In this island subspecies the incremental lines are much stronger and the spirally incised lines are much wider and more deeply cut than in the other races. The combination of these sculptural elements give a clothlike texture to the entire surface of the shell.

I have examined the following adult specimens:

Collection.	Catalogue number.	Number of whorls.	Greater diameter.	Altitude.	Locality.
U.S.N.M.	39649	5.3	20.7	12.4	Coronado Island.
Do.	30539	5.7	21.9	13.7	Do.
Do.	58526	5.7	23.6	15.2	Do.
Do.	58526	6.0	22.4	14.4	Do.
Do.	58526	5.5	20.6	13.0	Do.
Do.	58526	6.0	21.7	14.1	Do.
Do.	58526	5.8	21.5	14.4	Do.

EPIPHRAGMOPHORA TRASKII COELATA, new subspecies.

Plate 115, figs. 7–9; plate 117, fig. 10.

This is a small decidedly inflated race having the inner lip reflected over the very narrow umbilicus covering this half or more than half. All the whorls excepting the last turn are papillose. The spirally incised sculpture is feeble on the upper side of the last one and one-half whorls, and scarcely indicated on the base of the last turn.

The type and another specimen, (Cat. No. 124747, U.S.N.M.) come from the Mesa, at Pacific Beach, California. The type has five and one-third whorls, and measures—greater diameter, 20.8 mm.; altitude, 13.7 mm. The other specimen has four and one-half whorls and measures—greater diameter, 21.8 mm.; altitude, 13.5 mm.

EPIPHRAGMOPHORA TRASKII CARPENTERI Newcomb.

Plate 115, figs. 4–6.

Helix carpenteri NEWCOMB, Proc. California Acad. Sci., vol. 2, 1861, p. 103.
Aglaja carpenteri TRYON, Amer. Journ. Conch., vol. 2, 1866, p. 313.
Arionta carpenteri, W. G. BINNEY, Terr. Moll., vol. 5, 1878, p. 366.
Epiphragmophora carpenteri PILSBRY, Tryon's Man. Conch., vol. 9, 1894, p. 199.

This race was described by Newcomb in the following terms:

Shell umbilicate, roundly conical; apex obtuse, obscurely marked with one brown band; well striated; under the lens numerous very minute spiral striations; whorls five and one-half rounded; suture well marked; aperture circular, with margins approximating; lip moderately expanded, at the columella broadly so, but not adherent. Diameter, 23 mm.; altitude, 16½ mm. Habitat "Tulare Valley." Mus. Cal. Acad. Nat. Sci. My cabinet.

Remarks.—This shell, about the size of *H. ramentosa*, (Gould) can scarcely be confounded with any known species. It belongs to the Cyclostomoid group of Helices, and has the aspect of a desert species. Dedicated to Philip P. Carpenter, L. L. D., of Warrington, England.

The name *Epiphragmophora carpenteri* has been applied to a number of shells to which it did not belong. I believe that the three specimens which Mr. L. J. Goldman of the Biological Survey collected at Maricopa and McKittrick, on the east slope of the Coast Range, belong here and will fix this fleeting name.

The shells are characterized by a very narrow umbilicus, narrower than in any of the other races, except *Epiphragmophora traskii coelata*. The incremental lines are rather coarse, while the wavy spirally incised lines are fine and rather closely spaced.

The two adult specimens measure:

Collection.	Catalogue Number.	Number of whorls.	Greater Diameter.	Altitude.	Locality.
U.S.N.M.	272943	5.4	19.5	12.5	McKittrick, California.
Do	272942	5.5	21.0	13.7	Maricopa, California.

EPIPHRAGMOPHORA TRASKII PHLYCTAENA, new subspecies.

Plate 115, figs. 1–3; 13–15.

This is a rather large race in which the two whorls following the nuclear turns are strongly papillose, the papillae being much more numerous and much stronger than they are on the nuclear turns.

Cat. No. 12363, U.S.N.M., contains two specimens, cotypes, collected by W. G. Blunt, 40 miles north of Santa Barbara, California. One of these, an adult specimen, has six whorls, and measures—greater diameter, 28.2 mm.; altitude, 17.1 mm. The other, not quite matured, has only five turns, but in this the spiral sculpture is better preserved and has furnished the illustration of that feature.

The following specimens have been examined:

Measurements of Epiphragmophora traskii phlyctaena.

Collection.	Catalogue Number.	Number of whorls.	Greater Diameter.	Altitude.	Locality.
U.S.N.M.	12363	6.0	28.2	17.1	40 miles north of Santa Barbara.
Do	58516	6.0	23.3	15.0	Santa Barbara.
Do	58516	6.0	22.8	14.4	Do.
Do	58516	5.5	18.7	12.8	Do.
Do	58516	5.7	20.3	12.9	Do.
Do	39645	5.3	18.7	11.1	Do.
Do	39645	5.5	18.9	11.8	Do.
Do	39645	5.3	18.6	11.2	Do.
P.A.N.S.	10699	6.0	25.0	15.3	Do.
Do	94979	5.8	21.8	14.2	Near Bardsdale, Ventura County.

EPIPHRAGMOPHORA TRASKII ———, subspecies?

The collection of the United States National Museum contains an immature specimen (Cat. No. 106779*a*, U.S.N.M., from Mariposa County, California, which appears to belong to a race differing from those noted above. The papillations disappear shortly beyond the nuclear whorls. The spiral lines on the last whorl are strong and deeply incised on the upper surface and feeble on the lower.

EXPLANATION OF PLATES.

PLATE 114.

All figures on this plate are of *Epiphragmophora traskii traskii* Newcomb.

FIGS. 1–3. Top profile and bottom of the largest specimen, Cat. No. 12336, U.S.N.M.
4–6. Top profile and bottom of the smallest specimen, Cat. No. 174123, U.S.N.M.
7–9. Top profile and bottom of the *norm.*, i. e., the average specimen, Cat. No. 39643, U.S.N.M.
10–12. (The pathologic form called *Epiphragmophora traskii*, var. *saucius* by Hemphill), Cat. No. 174140 U.S.N.M.
13–15. (The pathologic form called *Epiphragmophora traskii*, var. *verna* by Hemphill), Cat. No. 174129, U.S.N.M.
16–18. The tallest specimen, Cat No. 201207, U.S.N.M.

PLATE 115.

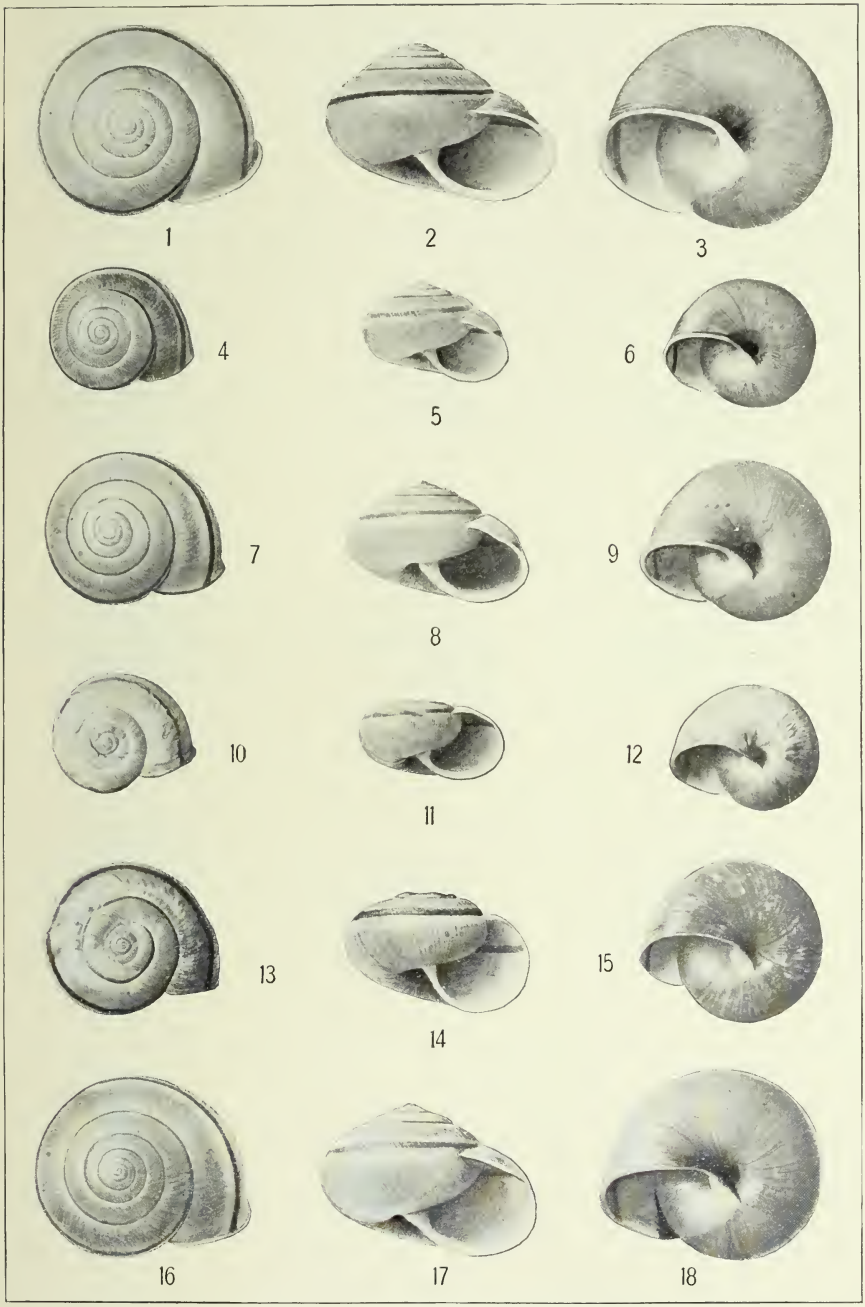
FIGS. 1–3. *Epiphragmophora traskii phlyctaena* Bartsch, type.
4–6. *Epiphragmophora traskii carpenteri* Newcomb.
7–9. *Epiphragmophora traskii coelata* Bartsch, type.
10–12. *Epiphragmophora traskii coronadoensis* Bartsch, type.
13–15. *Epiphragmophora traskii phlyctaena* Bartsch, type.

PLATE 116.

FIGS. 1–3. *Epiphragmophora traskii tularica* Bartsch, type.
4–6. *Epiphragmophora traskii proles* Bartsch, type.
7–9. *Epiphragmophora traskii traskii* Newcomb, cotype.
10–12. *Epiphragmophora cuyamacensis cuyamacensis* Bartsch, type.
13–15. *Epiphragmophora cuyamacensis venturensis* Bartsch, type.
16–18. *Epiphragmophora cuyamacensis avus* Bartsch, type.

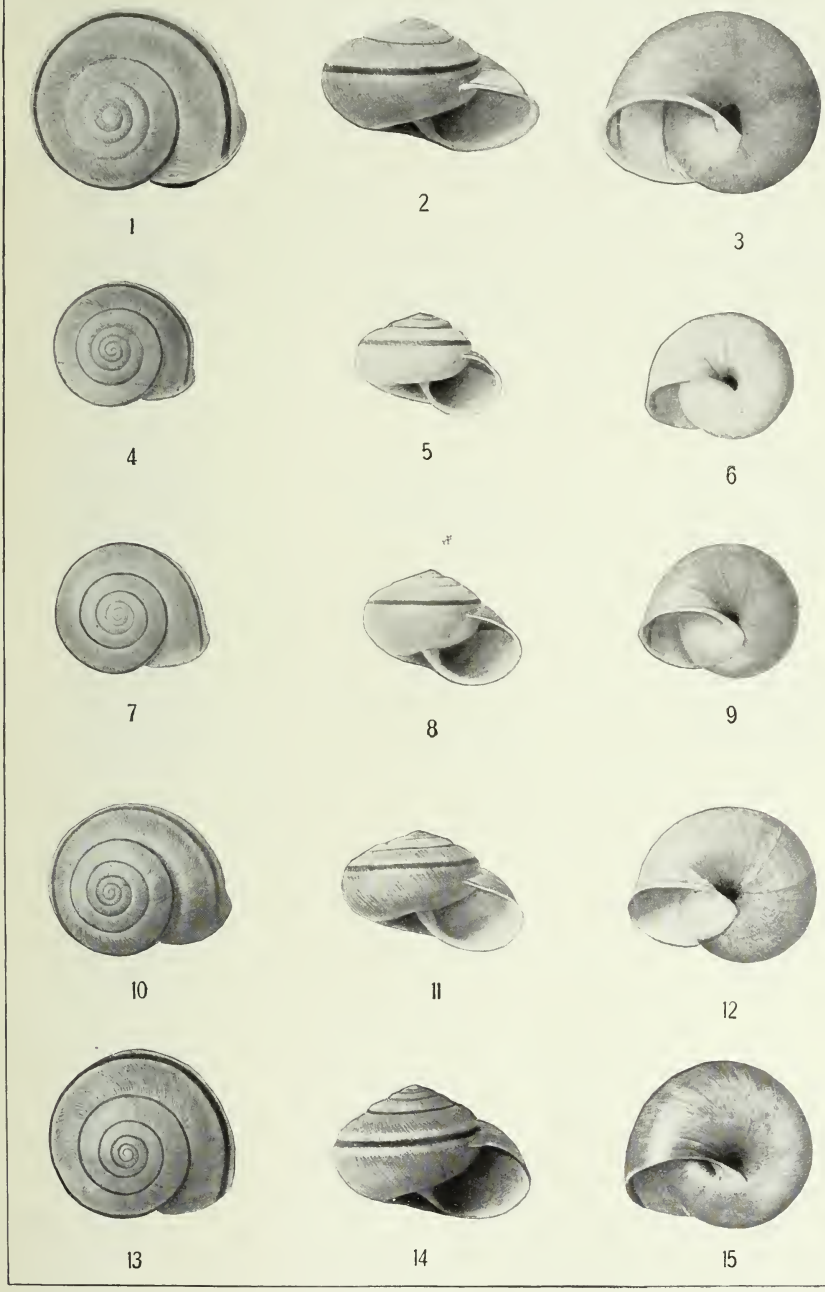
PLATE 117.

FIGS. 1–3. *Epiphragmophora petricola* Berry, paratype=*Epiphragmophora traskii traskii* Newcomb.
4–6. *Epiphragmophora traskii zechae* Pilsbry, type.
7. *Epiphragmophora cuyamacensis venturensis* Bartsch, type. A portion of the base a little behind the aperture, magnified about 25 diameters to show the strong papillations.
8. *Epiphragmophora cuyamacensis cuyamacensis* Bartsch, type. A portion of the base a little behind the aperture magnified about 25 diameters to show the obsolete papillations.
9. *Epiphragmophora traskii coronadoensis* Bartsch, type. A portion of the upper surface of the last whorl magnified about 25 diameters to show the clothlike texture.
10. *Epiphragmophora traskii coelata* Bartsch, type. A portion of the upper surface of the last whorl magnified about 25 diameters to show the absence of clothlike texture.



NEW CALIFORNIAN LAND SHELLS.

FOR DESCRIPTION OF PLATE SEE PAGE 619.



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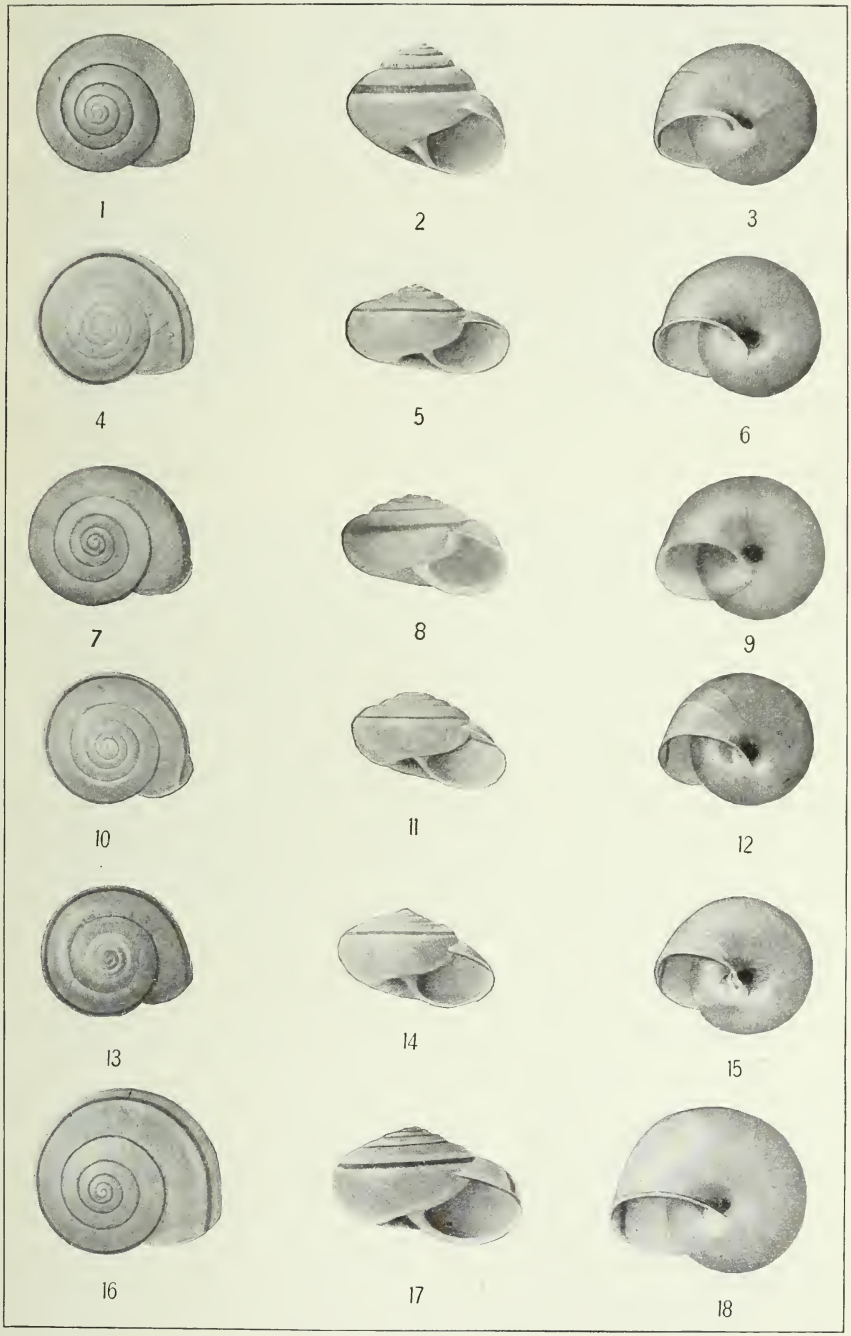

NEW CALIFORNIAN LAND SHELLS.

FOR DESCRIPTION OF PLATE SEE PAGE 619.

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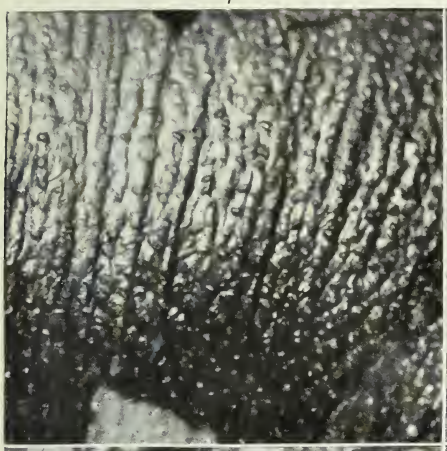

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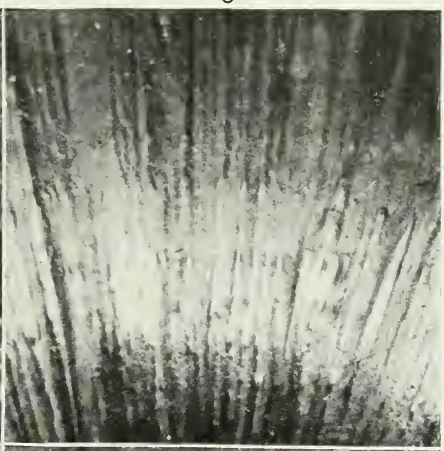

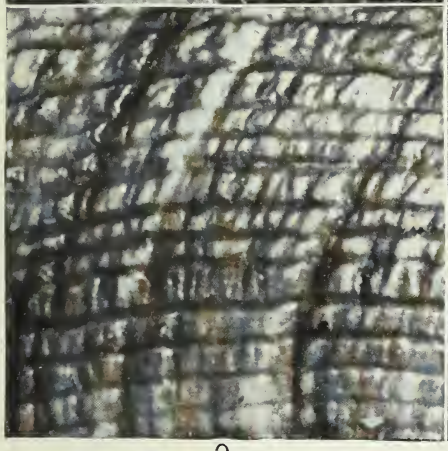

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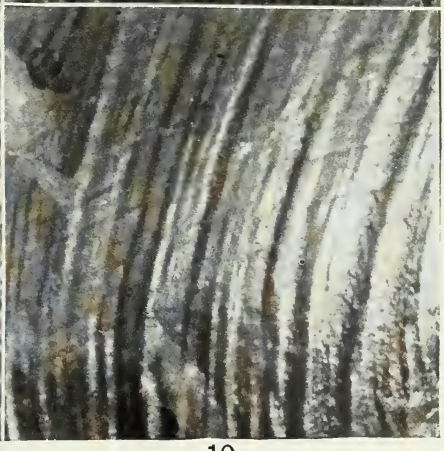

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NEW CALIFORNIAN LAND SHELLS.

FOR DESCRIPTION OF PLATE SEE PAGE 619.

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DESCRIPTIONS OF NEW WEST AMERICAN MARINE MOLLUSKS AND NOTES ON PREVIOUSLY DESCRIBED FORMS

BY

PAUL BARTSCH

Curator, Division of Marine Invertebrates, United States National Museum

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No. 2193.—From the Proceedings of the United States National Museum, Vol. 52, pages 637–681, with Plates 42–47

Published May 29, 1917

Washington
Government Printing Office
1917

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By Paul Bartsch,

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The present paper describes and figures new species of West American mollusks belonging to groups which I have previously monographed. It represents material that has come to hand since the monographs were issued. By far the larger portion of the specimens were discovered by the U. S. Bureau of Fisheries steamer *Albatross*, but many were contributed by private West American collectors, whose zeal and efforts continue to materially increase our knowledge of marine life from year to year. In addition to the descriptions of new forms, references to species (chiefly fossil) described by other authors since the monographs were published have been added, and wherever new information on nuclear characters was available it is stated.

I had hoped to be able to present with this a new classification of the Rissoidae, but the slowness attending the acquiring of certain material necessary to a complete understanding of the group has decided me not to withhold the manuscript longer, but to publish the data pertaining to members of that family under the old familiar designation, reserving the necessary changes for the final revision.

I wish to express my thanks to all the students who have contributed material to this study, acknowledgment for which is made under the various species. Credit is due to the photographic division of the United States National Museum for the splendid enlarged photographs of the species described, and to Mrs. E. B. Decker for the careful and painstaking work of perfecting these illustrations by retouching.

PYRAMIDELLIDA (LONGCHAEUS) COOPERI Anderson and Martin.

Plate 42, fig. 3.

Pyramidella cooperi Anderson and Martin, Proc. Cala. Acad. Sci., ser. 4, vol. 4, 1914, p. 66, pl. 7, figs. 18*a* 18*b*.

Shell elongate conic, stout, grayish white. All the early whorls decollated, the three remaining strongly channeled at the summit, flattened between the summit and the peripheral sulcus, angulated

posterior to the sulcus. The space between the peripheral angle and the channeled summit forms a decided groove that separates the whorls. Base short, well rounded. The entire surface of the shell is marked by fine incremental lines and well-marked spiral striations. Aperture moderately large, oval; posterior angle acute; outer lip evenly curved; inner lip strong, straight, revolute, provided with three folds, of which the posterior is very strong, lamellar and parallelly disposed to the peripheral sulcus; the other two folds are less strong and much more oblique.

The specimen described and figured, Cat. No. 194405, U.S.N.M., was collected by Mr. George H. Eldridge in the lower Miocene bluffs of Kern River, 1 mile below the power developing station, on the north side of the river at Bakersfield, California; it consists of the last three whorls, and measures—length 6 mm., diameter 3.6 mm.

PYRAMIDELLA (LONGCHAEUS?) PACKI Dickerson.

Odostomia packi DICKERSON, Bull. Dept. Geol. Univ. Cala., vol. 9, No. 17, 1916, p. 498, pl. 37, fig. 2.

The type, an incomplete specimen of 12 whorls, measures—length 10 mm., diameter 3.5 mm. It was collected in the Eocene, Tejon formation, at University of California locality 2226, Rose Canyon, San Diego County, California.

Of this the author states that the inner lip is marked by two plaits "which is characteristic of this genus." *Odostomia never* has more than *one plait*. The figure shows a *Pyramidella* with basal portion of the aperture lost, which is probably responsible for the absence of the third fold characterizing the subgenus *Longchaeus*, to which I believe the shell belongs.

PYRAMIDELLA (PHARCIDELLA) MAGDALENENSIS, new species.

Plate 42, fig. 1.

Shell elongate conic, very pale horn yellow; nuclear whorls two, well rounded, forming a depressed helicoid spire, the axis of which is at right angles to that of the succeeding turns, in the first of which it is about one-third immersed. Post-nuclear whorls flattened, narrowly shouldered at the summit with a deep spiral groove at the periphery which shows in the suture of all the turns and gives this the appearance of being deeply channeled. Summit of whorls strongly crenulated, the weak depressions on the sides of the crenulation passing down the sides of whorls for a short distance below the summit; the rest of the surface being marked by fine lines of growth and exceedingly fine spiral striations. The deep peripheral sulcus is crossed by slender axial riblets, which are more slender and more numerous

than the crenulations at the summit of the whorls. Base moderately long, well rounded, provided with a strong fasciole at the anterior end and marked by rather strong incremental lines and very fine spiral striations. Aperture oval, posterior angle acute, outer lip thin, showing four denticles within, of which the median two are the strongest; inner lip thick, almost straight, provided with three folds, of which the first is lamellar and almost transversely disposed; it covers the posterior portion of the basal fasciole; the other two folds are much weaker and much more obliquely placed and extend to the anterior portion of the columella; parietal wall glazed with a thin callus.

The type, Cat. No. 268628, U.S.N.M., was dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5628, off Redondo Point, Magdalena Bay, Lower California, in 13½ fathoms, on broken shell bottom. It has 9 postnuclear whorls and measures—length, 5.8 mm.; diameter, 2.1 mm.

This species is nearest related to *Pyramidella* (*Longchaeus*) *mazatlanica* Dall and Bartsch, but can readily be distinguished from it by the fact that the whorls are not overhanging.

EULIMELLA GABBIANA Anderson and Martin.

Eulimella gabbiana ANDERSON and MARTIN, Proc. Cal. Acad. Sci., ser. 4, vol. 4, 1914, p. 68, pl. 7, fig. 20.

This is a typical *Melanella* (*Eulimella*) and does not belong to the Pyramidellidae, but to the related family, Melanellidae. The name will therefore have to be changed to *Melanella gabbiana* Anderson and Martin. The type No. 143 California Academy of Sciences comes from the Lower Miocene, in the bottom of a small canyon about 1¼ miles due north of Barker's ranch house, Kern River, Kern County, California.

PYRAMIDELLA (SYRNOLA) OCHSNERI Anderson and Martin.

Eulimella ochsneri ANDERSON and MARTIN, Proc. Cal. Acad. Sci., vol. 4, 1914, p. 66, pl. 7, figs. 23*a* and 23*b*.

Anderson and Martin described this species which they collected in the Lower Miocene in the bottom of a small canyon about 1¼ miles due north of Barker's ranch house, Kern County, California, locality 64. They give a rather incomplete description and state that the type, which has a broken apex, is 8 mm. long and 3 mm. in diameter.

From the brief description and the figure I am inclined to believe that it is not a *Eulimella*, but belongs to the subgenus *Syrnola*. A comparative statement in the same publication (p. 67) under *Eulimella dilleri* strengthens this belief. The type, No. 138, and cotype, No. 139, are in the California Academy of Sciences.

PYRAMIDELLA (SYRNOLA) DILLERI Anderson and Martin.

Eulimella dilleri ANDERSON and MARTIN, Proc. Cal. Acad. Sci., vol. 4, 1914, p. 67, pl. 7, fig. 24.

Anderson and Martin found this species in the sea cliff (Miocene), one-quarter mile north of the lighthouse at Cape Foulweather, 4 miles north of Yaquina Bay, locality 37. The type, No. 140, California Academy of Sciences, consists of the last eight whorls and measures 9.5 mm. long and 3.5 mm. wide.

TURBONILLA (STRIOTURBONILLA) CANADENSIS, new species.

Plate 44, fig. 11.

Shell elongate conic, slender, yellowish white. Nuclear whorls small, two and one-half, depressed helicoid, having their axis at right angles to that of the succeeding turns, in the first of which they are about one-fourth immersed. Postnuclear whorls almost flattened, rather high between the sutures, appressed at the summit, marked by quite regular, slightly curved, protractive, axial ribs, of which 14 occur upon the first, 16 upon the second and third, 18 upon the fourth to seventh, 20 upon the eighth, and 22 upon the ninth and the penultimate turn. Intercostal spaces not quite as wide as the ribs, deeply impressed, terminating at the periphery, which is decidedly angulated. There is a smooth space between the periphery and the succeeding whorl, which falls at some little distance anterior to the periphery of the preceding turn. This gives the whorls a somewhat overhanging appearance. Suture well constricted. Base short, well rounded, entire surface marked by microscopic striations. Aperture subquadrate, posterior angle obtuse; outer lip thin; inner lip slightly curved and somewhat revolute.

The type, Cat. No. 273964, U.S.N.M., was collected by G. Willett, at Forrester Island, Alaska. It is a complete specimen of 11 postnuclear whorls, and measures—length, 6.3 mm.; diameter, 1.5 mm. Two additional specimens of this species are in Mr. Willett's collection.

TURBONILLA (STRIOTURBONILLA) MONTEZUMA, new species.

Plate 44, fig. 1.

Shell broadly elongate conic, yellowish-white, nuclear whorls two and one-fourth, well rounded, forming a very depressed helicoid spire, having its axis at a right angle to that of the succeeding turns in the first of which it is about one-fourth immersed. Postnuclear whorls well rounded, appressed at the summit, ornamented with very strong, narrow, well rounded, slightly protractive axial ribs of which 18 occur upon the first, 16 upon the second, 14 upon the third to

seventh, and 18 upon the penultimate turn. These ribs become somewhat enfeebled and slightly expanded toward the summit. Intercostal spaces about 3½ times as wide as the ribs marked by a double series of incised pits, of which one is midway between the summit and the periphery while the other is at the periphery. The space between the summit and the median pit is marked by 13 slender incised striations of varying strength, while that between the median and peripheral pit is crossed by 9 incised lines. Suture moderately constricted. Periphery of the last whorl angulated, marking the termination of the axial ribs and intercostal spaces. Base very short, well rounded, marked by 14 subequal and subequally spaced feebly incised wavy spiral striations and slender incremental lines. Aperture very short, decidedly subquadrate, the angles at the junction of the outer and basal lip and the basal and inner lips being almost right angles; posterior angle obtuse; outer lip thin, showing the external sculpture within; inner lip very slightly oblique, and slightly revolute; parietal wall glazed by a thin callus.

The type, Cat. No. 268232 U.S.N.M., was dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678, off Redondo Point, Magdalena Bay, Lower California, in 13½ fathoms, on broken shell bottom. It has 9 postnuclear whorls and measures—length, 4.7 mm.; diameter, 1.5 mm.

TURBONILLA (STRIOTURBONILLA) BARKLEYENSIS, new species.

Plate 42, fig. 8; plate 44, fig. 9.

Shell large, slender, elongate conic, bluish white. Nuclear whorls small, a little more than two and a quarter, depressed helicoid, having their axis at right angles to that of the succeeding turn, in the first of which they are slightly immersed. Postnuclear whorls well rounded, appressed at the summit, marked by slender, curved, moderately regular, slightly protractive, axial ribs, of which 16 occur upon the first to fifth, 18 upon the sixth, 22 upon the seventh and eighth, 24 upon the ninth and tenth, and 26 upon the penultimate turn. Intercostal spaces moderately impressed, terminating a little posterior to the periphery of the whorls. The summit of the succeeding turns falls a little anterior to the termination of the intercostal pits and leaves a smooth band in the suture. Suture moderately constricted. Periphery of the last whorl obtusely angulated. Base moderately long, weakly rounded. The entire surface of the shell is marked by microscopic striations. Aperture large, broad, subquadrate, somewhat effuse at the junction of the basal and the outer lip, posterior angle obtuse; outer lip very thin, showing the external sculpture within; inner lip decidedly oblique, slightly curved and somewhat revolute; parietal wall covered by a thin callus.

The type and 25 specimens of this species were collected by the Geological Survey of Canada, at low tide to deep water, in Barclay Sound, Vancouver Island. Fourteen of these are in the collection of the National Museum, the others are in the Geological Survey of Canada collection.

The type, Cat. No. 211568 U.S.N.M., has lost the nucleus and a part of the first postnuclear turn, the 12 turns remaining measure—length, 9.2 mm.; diameter, 2 mm. The nuclear characters were described from another specimen, bearing the same entry number.

This species was reported in former publications under the name of *Turbonilla* (*Strioturbonilla*) *serrae* Dall and Bartsch, from which it is readily distinguished by its appressed whorls, the summits of *Turbonilla* (*Strioturbonilla*) *serrae* being decidedly shouldered.

TURBONILLA (STRIOTURBONILLA) SANTAMARIANA, new species.

Plate 44, fig. 2.

Shell slender, regularly elongate conic, milk white. Nuclear whorls two and one half, large, well rounded, forming a decidedly elevated spire, the axis of which is at right angles to that of the succeeding turns, in the first of which it is about one-fifth immersed. Postnuclear whorls very high between the sutures, feebly shouldered at the summit, marked by very regular, almost straight, well rounded axial ribs which become slightly enfeebled toward the summit and terminate at the periphery. Of these ribs 14 occur upon the first and second, 16 upon the third to sixth, 18 upon the ninth, and 20 upon the penultimate turn. Intercostal spaces a little wider than the ribs, terminating abruptly, a little posterior to the suture, thus leaving a narrow, smooth, spiral band at the moderately constricted suture. Periphery of the last whorl well rounded. Base moderately long, strongly rounded, marked by incremental lines, and the fine very regularly and closely spaced wavy spiral striations. Aperture elongate oval; posterior angle acute; outer lip thin; inner lip slender, oblique, slightly revolute, without visible fold; parietal wall glazed with a thin callus.

The type, Cat. No. 267744*c* U.S.N.M., was dredged in shallow water in Santa Maria Bay, Lower California. It has 11 postnuclear whorls and measures—length, 4.7 mm.; diameter, 1 mm.

TURBONILLA (STRIOTURBONILLA) DOREDONA, new species.

Plate 44, fig. 3.

Shell very regularly, broadly elongate conic, yellowish white. Nuclear whorls $2\frac{3}{4}$, strongly rounded, smooth, forming a strongly elevated spire having its axis at right angles to that of the succeeding turns,

in the first of which the side of the last volution is about one-fifth immersed. Postnuclear whorl well rounded, slightly curved at the appressed summit, marked by rather distantly spaced, slender, narrow, well-rounded axial ribs, which become somewhat flattened and enfeebled toward the summit. Of these ribs 18 occur upon the first, 16 upon the second to fourth, and 18 upon the remaining turns. Intercostal spaces about two and one-half times as wide as the ribs, terminating at little posterior to the suture, thus leaving a very narrow plain band between their termination and the summit of the succeeding turn. Suture moderately constricted. Periphery of the last whorl well rounded. Base short, strongly rounded, marked by the feeble continuations of the axial ribs, which become evanescent before reaching the middle of the base. Entire surface of the shell crossed by rather marked, subequally strong and subequally spaced deeply incised spiral striations. Aperture subquadrate; posterior angle obtuse (outer lip partly fractured); inner lip thick, almost straight, and somewhat revolute, provided with an obsolete oblique fold a little anterior to its insertion; parietal wall glazed by a fine callus.

The type, Cat. No. 268719, U.S.N.M., was dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678, off Redondo Point, Magdalena Bay, Lower California, in 13½ fathoms, on broken shell bottom. It has 8 postnuclear whorls and measures—length, 4.2 mm.; diameter, 1.3 mm. The unique type is an adolescent shell, and it is quite possible that when adult specimens are obtained it will be found that the axial ribs terminate at the periphery instead of continuing feebly upon the base.

TURBONILLA (STRIOTURBONILLA) REDONDOENSIS, new species.

Plate 42, fig. 4.

Shell large, broadly elongate conic, yellowish white. Nuclear whorls decollated. Postnuclear whorls strongly rounded, with a strong sloping shoulder which extends over the posterior two-fifths of the whorls. Surface marked by strong, distantly spaced, well-rounded, regular, lamellose, slightly curved, protractively slanting axial ribs, of which 14 occur upon the first three whorls and 16 upon the rest except the last, which has 18. These ribs become somewhat enfeebled and flattened toward the summit and terminate at the periphery. Intercostal spaces about double the width of the ribs, shallow, terminating a very little posterior to the suture, thus leaving a very narrow smooth band immediately posterior to the summit of the succeeding turn. Suture quite strongly constricted. Periphery of the last turn obscurely angulated. Base short, almost flattened, marked by fine incremental lines and fine, rather regularly

and somewhat distantly spaced spiral striations. Aperture subquadrate; posterior angle obtuse; outer lip thin, showing the external sculpture within; inner lip moderately stout, almost vertical, slightly revolute, apparently without fold; parietal wall glazed by a thin callus.

The type, Cat. 268718, U.S.N.M., was dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678, off Redondo Point, Magdalena Bay, Lower California, in 13½ fathoms, on broken shell bottom. It has lost the nuclear turns and probably a half of the first postnuclear whorl; the 13 remaining measure—length, 7.4 mm.; diameter, 1.9 mm.

The present species is nearest related to *Turbonilla* (*Strioturbonilla*) *humerosa* Bartsch, but differs from this by having fewer, stronger, and more distantly spaced axial ribs.

TURBONILLA (STRIOTURBONILLA) SCHMITTI, new species.

Plate 43, fig. 8.

Shell elongate conic, rather stout, bluish white. Nuclear whorls small, strongly rounded, forming a decidedly elevated spire, the axis of which is at right angles to that of the succeeding turns, in the first of which it is about one-fourth immersed. Postnuclear whorls almost flattened, somewhat excurved below the strongly tabulately shouldered summit, marked by somewhat sinuous, decidedly protractively slanting, strong, regular, well-rounded axial ribs, of which 20 occur upon the first and second, 22 upon the third, and 24 upon the remaining turns. These ribs extend strongly from the summit of the whorls, where they appear as slender cusps, to the periphery, where they terminate. Intercostal spaces a little wider than the ribs, terminating also at the periphery. Suture rendered strongly channeled by the shouldered summit. Periphery of the last whorl well rounded. Base moderately long, well rounded, marked by strong incremental lines and the exceedingly fine, closely spaced spiral striations which cover the entire surface of the shell. Aperture oval; posterior angle narrowly squarely truncated by the flattened summit; outer lip thin, showing the external sculpture within; inner lip slender, slightly oblique, and weakly revolute, provided with a very feeble oblique internal fold at its insertion which is scarcely noticeable when the aperture is viewed squarely.

The type and two specimens of this species, Cat. No. 265739, U.S.N.M., were obtained in shallow water at Point Abreojos, Lower California. The type has 10 postnuclear whorls and measures—length, 6.3 mm.; diameter, 2 mm. One of the other specimens has 11 postnuclear whorls and measures—length, 7.3 mm.; diameter, 2.1 mm.

This species is quite unlike any of the other known west American forms. It recalls somewhat *Turbonilla* (*Strioturbonilla*) *panamensis* C. B. Adams, from Panama, in the very regular and oblique disposition of its axial ribs.

TURBONILLA (PYRGOLAMPROS) HANNIBALI, new species.

Plate 43, fig. 7.

Shell elongate conic, yellowish white. Nuclear whorls decollated. Postnuclear whorls almost flattened, narrowly shouldered at the summit, marked by ill-defined indications of axial ribs, which are entirely too poorly developed to permit counting. The spiral sculpture consists of slender, closely spaced striations. Sutures strongly impressed. Periphery of the last whorl obtusely angulated. Base moderately long, well rounded, marked like the spire. Aperture broadly oval; posterior angle acute; inner lip almost vertical, somewhat sinuous, and slightly reflected.

The type and two additional specimens, Cat. No. 252428, U.S.N.M., were collected by Mr. Harold Hannibal in the Upper Pliocene "Elk River beds," at the mouth of Elk River at Port Orford, Oregon. The type has nine postnuclear whorls and measures—length, 9 mm.; diameter, 2.5 mm.

The present species recalls *Turbonilla* (*Pyrgolampros*) *oregonensis* Bartsch, but is larger in every way than that species and has the summit of the whorls appressed, not tabulated; the spiral sculpture also is much more strongly developed. *Turbonilla* (*Pyrgolampros*) *hannibali* differs from *Turbonilla* (*Pyrgolampros*) *lituyana* Dall and Bartsch in being smaller and in having the ribs much less strongly indicated than in that species.

TURBONILLA (PYRGOLAMPROS) FRANCISCANA, new species.

Plate 42, fig. 2.

Shell elongate conic, flesh colored, excepting a broad chestnut band which covers the median third of the last whorl. This dark band really consists of two chestnut-colored zones, the anterior of which embraces half of the band while the posterior is equal to one-fourth of the width of the dark area, the two being separated by a zone of a little lighter shade which is as wide as the posterior zone. Nuclear whorls decollated in all the specimens seen. Postnuclear whorl rather high between the sutures, feebly shouldered at the summit, and slightly constricted at the periphery. Early postnuclear whorls marked by low, rounded, broad, almost vertical axial ribs which are wider than the shallow impressed spaces that separate them. On the later whorls the axial ribs become quite obsolete. On the first of the postnuclear whorls there are eighteen of these ribs;

on the second to fourth, twenty; on the fifth they become decidedly feeble; and on the remainder they are not at all differentiated. In addition to the axial sculpture the surface of the shell is marked by very fine, wavy, closely spaced spiral striations. Periphery of the last whorl well rounded. Base moderately long, well rounded, marked by lines of growth and spiral striations comparable to those on the spire. Aperture broadly oval; outer lip thin, showing the color markings within. Columella curved, somewhat twisted, and slightly revolute; parietal wall glazed with a thin callus.

The type and 17 specimens, Cat. No. 214435, U.S.N.M., was dredged by the U. S. steamer *Albatross* at station 5743, in 10–15½ fathoms, on very fine sand and mud bottom, San Francisco Bay, California. The type has lost the nucleus and probably the first of the postnuclear turns. The eight remaining measure—length, 6.8 mm.; diameter, 2 mm.

There are three additional lots of specimens in the collection of the United States National Museum, likewise dredged by the U. S. Bureau of Fisheries steamer *Albatross* in San Francisco Bay. These are: Cat. No. 214433, 3 specimens, from station 5729, in 4¾ fathoms, on mud bottom; Cat. No. 214434, 16 specimens, from station 5744, in 5¼ fathoms, on sandy mud bottom; Cat. No. 214436, 4 specimens, from station 5703, in 8½ fathoms, on mud bottom.

This species belongs to the obsoletely sculptured group of *Pyrgolampros*, embracing *halistrepta*, *pesa*, *rinella*, *lituyana*, and *oregonensis*.

TURBONILLA (PYRGOLAMPROS) HEMPHILLI, new species.

Plate 44, fig. 8.

Shell elongate conic. Nuclear whorls moderately large, one and one-half planorboid, having their axis at right angles to that of the succeeding turns, in the first of which they are scarcely at all immersed. The sides of the nuclear whorls project slightly beyond the outline of the spire. Postnuclear turns feebly rounded, appressed at the summit, marked by moderately strong, low, almost vertical axial ribs, which are very feeble on the first two turns, on the third and fourth there are 16, on the fifth to seventh there are 18, while on the last turn they become decidedly enfeebled and too irregular to permit counting. Intercostal spaces shallow, about as wide as the ribs. Suture moderately constricted. The summit of the whorls falls a little anterior to the periphery and gives to the whorls a slightly over-hanging appearance. Periphery inflated, well rounded. Base moderately long, well rounded, marked by the feeble continuations of the axial ribs, which extend to the umbilical chink. Entire surface marked by fine, closely spaced, spiral striations. Aperture broadly oval, posterior angle acute; outer lip thin; inner lip strongly

curved and slightly revolute; parietal wall covered with a thin callus.

The type and 21 specimens, Cat. No. 135053, U.S.N.M., were collected by Henry Hemphill in the Pliocene of a well boring, 140 feet below the surface, at San Diego, California. The type has lost the nucleus and probably half of the first postnuclear turn. The nine remaining whorls measure—length, 6.7 mm.; diameter, 1.9 mm. The nuclear whorls were described from one of the other specimens, which may be considered a paratype.

TURBONILLA (PYRGOLAMPROS) PUGETENSIS, new species.

Plate 44, fig. 4.

Shell small, elongate conic, wax yellow with a broad band of pale brown which extends posterior from the periphery, gradually fading into the general lighter color. Nuclear whorls and early postnuclear turns decollated in all our specimens; those remaining feebly shouldered at the summit, flattened in the middle, becoming considerably contracted and rounded toward the suture, marked by broad, well rounded slightly protractive axial ribs which become somewhat enfeebled and expanded toward the summit. Of these ribs 16 occur upon all of the turns remaining excepting the last which has 18. Intercostal spaces shallow, about as wide as the ribs. Suture moderately contracted. Periphery of the last whorl well rounded. Base somewhat inflated, well rounded, marked by the feeble continuations of the axial ribs which become evanescent before reaching the middle of the base and numerous very fine spiral striations which are also present on the spire. Aperture broadly oval; posterior angle acute; outer lip thin showing the external sculpture within; inner lip decidedly oblique, slender and somewhat revolute; parietal wall glazed with a very thin callus.

The type and 7 specimens, Cat. No. 268754 U.S.N.M.,were obtained by the U. S. Bureau of Fisheries at Northwest Point, Elliott Bay, Seattle, Washington. The type consists of the last 5 postnuclear whorls and measures—length, 4 mm.; diameter, 1.5 mm.

TURBONILLA (PYRGOLAMPROS) TREMPERI, new species.

Plate 44, fig. 7.

Shell short, elongate conic, pale brown. Nuclear whorls a little more than two, decidedly depressed helicoid, having their axis at right angles to that of the succeeding turns, in the first of which they are about one-fifth immersed. Postnuclear whorls flattened in the middle, sloping toward the suture and the almost appressed summit, marked by strong lamellar, decidedly retractively slanting, axial ribs, of which 12 occur upon the first, 14 upon the second to fourth, 16

upon the fifth, 18 upon the sixth, and 16 upon the penultimate turn. These ribs extend prominently to the summit. Intercostal spaces strongly impressed, about 2½ times as wide as the ribs. Suture moderately constricted. Periphery of the last whorl feebly angulated. Base short, well rounded, marked by the very feeble continuations of the axial ribs, which become evanescent before reaching the umbilical chink. Entire surface of the shell marked with fine, closely spaced, spiral striations. Aperture oval, posterior angle obtuse; outer lip thick; inner lip thick, almost straight, and slightly revolute; parietal wall covered by a thin callus.

The type, Cat. No. 250629, U.S.N.M., was collected by Mr. Gripp on kelp, in 15 fathoms, outside of San Diego Bay. It measures—length, 4.7 mm.; diameter, 1.2 mm.

TURBONILLA (PYRGISCULUS) GUILLENI, new species.

Plate 44, fig. 5.

Shell conic, milk white. Nuclear whorls 2½, well rounded, forming a depressed helicoid spire, the axis of which is at right angles to that of the succeeding turns, in the first of which it is about one-third immersed. Postnuclear whorls somewhat inflated, well rounded, almost appressed at the summit, marked on each whorl by 18 narrow, well developed, rounded, almost vertical axial ribs. Some of these ribs are developed into varices and these are distributed at irregular intervals. Intercostal spaces about 2½ times as wide as the ribs, crossed by three spiral series of strong pits, of which one is at the periphery, the second a little anterior to the middle and the third about two-fifths of the space between this and the summit posterior to the median pit. In addition to these pits the intercostal spaces are crossed by many almost equally strong incised spiral lines of which 12 occur between the summit and the first pit, 7 between the first and median pit, and 8 between the median and peripheral pit. Suture quite strongly constricted. Periphery of the last whorl well rounded. Base moderately long, attenuated, marked by the feeble continuations of the axial ribs and numerous incised spiral lines of a little wider spacing than the fine sculpture on the spire. Aperture rissoid, oval; posterior angle obtuse; outer lip thick; inner lip short, curved, reflected over and appressed to the base; parietal wall covered with a thick callus.

The type, Cat. No. 267736, U.S.N.M., was dredged in shallow water in Santa Maria Bay, Lower California. It has five postnuclear whorls and measures—length, 3 mm.; diameter, 1 mm.

TURBONILLA (PYRGISCUS) DORA, new species.

Plate 42, fig. 10.

Shell very large, elongate conic, uniformly pale brown. Nuclear whorls decollated. Postnuclear whorls well rounded, strongly appressed at the summit, marked on the early whorls by rather strong, almost vertical, axial ribs, which become evanescent on the later turns. Of these ribs 18 occur upon the first to fourth, 20 upon the fifth, 22 upon the sixth, 24 upon the seventh, 26 upon the eighth, 32 upon the ninth, and 34 upon the tenth, while upon the penultimate whorl they become too enfeebled to be counted. The spiral sculpture consists of broad pits and feebly incised lines, the posterior fifth between the sutures being marked by six very fine, subequally spaced, spiral striations. These are followed by two stronger lines, which are succeeded by two strongly impressed pits, these are followed by a pit about half as wide as the last two, then by one a little stronger and finer, then by the widest pit of all, which is succeeded by one not quite as broad. These incised spiral lines pass up on and even cross the summit of the enfeebled ribs. Suture moderately constricted. Periphery of the last whorl decidedly inflated. Base moderately long, somewhat inflated, well rounded, marked by about 25, somewhat wavy, more or less regular, spiral grooves of somewhat varying width, which inclose spaces between them of a width about equal to the grooves, the space between the first of these and the last on the spire is a rather wide band, devoid of sculpture, excepting the fine spiral striations, which cover the entire surface of the shell, in addition to the coarser sculpture already described. Aperture small, subquadrate, posterior angle obtuse; outer lip moderately strong; inner lip oblique, straight and slightly reflected; parietal wall covered by a thick callus.

The type, Cat. No. 250626, U.S.N.M., was collected by Mr. Gripp on kelp, in 15 fathoms, off San Diego Bay. It is minus the nucleus. The 13 remaining whorls measure—length, 13.8 mm.; diameter, 3.2 mm.

TURBONILLA (PYRGISCUS) INA, new species.

Plate 44, fig. 10.

Shell broadly, elongate-conic, bright brown, excepting the nucleus, which is white. Nuclear whorls, two and one-half, planorboid, having their axis almost at right angles to that of the succeeding turns, in the first of which they are about one-third immersed. Postnuclear whorls feebly rounded, appressed at the summit, marked by rather feeble, almost vertical, axial ribs, of which 18 occur upon the second and third, 20 upon the fourth and fifth, and 22 upon the remaining whorls. Intercostal spaces feebly impressed, about as

wide as the ribs, crossed by eleven incised spiral lines between the sutures, of these the fifth is the widest, being fully twice as wide as the third and sixth, which are of equal strength, the remaining are much more slender and also of equal strength. In spacing the first is about as far anterior to the summit as the second is distant from the third, or the fourth from the fifth, or the fifth from the sixth, while the space between the first and second, and those between the sixth and the seventh, are about equal, the spiral markings pass up on the sides of the ribs and the stronger ones tend to cross their summit. Suture moderately constricted. Periphery of the last whorl decidedly angulated. Base short, slightly rounded, marked by the very feeble continuations of the axial ribs, which become evanescent before reaching the middle of the whorls, and thirteen incised spiral lines, which are about equally spaced, the first one below the periphery being a little nearer to its neighbor than the spacing between the rest, the space between the seventh line of the spire and the first incised spiral basal line is a broad, smooth band. Aperture subquadrate, posterior angle obtuse; outer lip thin, showing the external sculpture within; inner lip almost straight and slightly revolute; parietal wall covered with a thin callus.

The type, Cat. No. 250625, U.S.N.M., was collected by Mr. Gripp on kelp, in 15 fathoms, off San Diego Bay. It has eight and one-half postnuclear whorls, and measures—length, 6.1 mm.; diameter 1.9 mm.

TURBONILLA (PYRGISCUS) ISTA, new species.

Plate 42, fig. 6.

Shell rather large, elongate conic, light brown. Early whorls light yellow. Nuclear whorls decollated. Postnuclear whorls appressed at the summit, which is slightly excurved, marked by rather poorly developed, almost vertical, axial ribs, which become obsolete on the later whorls. Of these ribs, 18 occur upon the second and third, 20 upon the fourth, 22 upon the fifth, 24 upon the sixth, 26 upon the seventh, 28 upon the eighth, 30 upon the ninth, and 32 upon the tenth, while upon the penultimate they are too irregular to be counted. Intercostal spaces very feebly impressed, about as wide as the ribs. The spiral sculpture consists of strong and weak incised lines, the strong lines pass strongly upon the sides of the ribs and even cross the summit; the first of these strong lines is about one-fifth of the distance between the summit and the suture anterior to the summit, while the spaces between the first and second, the third and fourth, the fourth and fifth, and the fifth and sixth are almost equal and about two-thirds as wide as that between the second and third; of the finely incised spiral lines eight occur between the summit and the first strong line and three between the first and second,

the anterior member of these three being much stronger than the other two; there are also three between the second and third, the last two of these being closer spaced than the first two; no fine lines are apparent between the other strong lines. Suture slightly constricted. Periphery of the last whorl strongly inflated. Base short, well rounded, marked by the feeble continuations of the axial ribs and 22 wavy incised lines, which are of varying width and spacing. Aperture moderately large, subquadrate, posterior angle obtuse; outer lip thin, showing the external sculpture within; inner lip oblique, straight, slightly revolute; parietal wall glazed with a moderately thick callus.

The type, Cat. No. 250627, U.S.N.M., was dredged by Mr. Gripp, in 15 fathoms, on kelp off San Diego Bay. It has lost the nucleus. The 11½ whorls remaining measure—length, 12.5 mm.; diameter, 2.8 mm.

TURBONILLA (PYRGISCUS) EVA, new species.

Plate 44, fig. 6.

Shell small, elongate conic, of pale brown ground color, with the incised spiral lines red. Nuclear whorls decollated. Postnuclear whorls gently rounded, on the posterior three-quarters of the shell sloping more abruptly toward the suture, marked by moderately strong, well-rounded, almost vertical axial ribs, of which 22 occur upon the third and fourth, 24 upon the fifth, and 26 upon the penultimate turn. Intercostal spaces a little narrower than the ribs, crossed by 11 strongly incised spiral grooves, which are of varying width. Of these the fourth, seventh, and eleventh are of equal strength and much wider than any of the rest; the remaining, with the exception of the sixth, which is a mere incised line, are of almost equal strength. In spacing the first is about as far below the summit as that is distant from the second, and these two spaces are a little wider than the spaces between the third and fourth, the fifth and sixth, and the seventh and eighth, which are equal and follow next in strength, the remaining spaces are subequal and a little narrower. Suture quite strongly constricted. Periphery of the last whorl inflated, well rounded. Base moderately long, well rounded, marked by the feeble continuations of the axial ribs, which become evanescent before reaching the middle of the base, and 13 subequally spaced incised spiral lines, of which the first three below the periphery are interrupted by the ribs. Aperture oval, posterior angle obtuse; outer lip very thin; inner lip slightly curved, reflected over and appressed to the base; parietal wall covered with a thin callus.

The type, Cat. No. 250630, U.S.N.M., was dredged by Mr. Gripp, on kelp, in 15 fathoms, off San Diego Bay. It has lost the nucleus. The seven whorls remaining measure—length, 4.3 mm.; diameter, 1.2 mm.

TURBONILLA (PYRGISCUS) ALMEJASENSIS, new species.

Plate 45, fig. 10.

Shell slender, elongate conic, milk white. Nuclear whorls decollated in the type (see end of description for this character). The early postnuclear whorls are flattened, the later ones well rounded; all have the summit feebly shouldered. The whorls are ornamented by very regular well rounded axial ribs which become somewhat enfeebled toward the summit. These ribs have a decided protractive slant on the early whorls, while on the middle turns they are vertical, and on the later volutions they have a decidedly retractive slant; here, too, they are a little less strong and less regular and much more closely spaced. Of these ribs 18 occur upon the first four of the remaining turns, 20 upon the fifth, 22 upon the sixth, 24 upon the seventh, 28 upon the eighth, 34 upon the ninth, 36 upon the tenth, and about 52 upon the last turn. Intercostal spaces a little narrower than the ribs, marked by 15 fairly equal and equally spaced spiral series of pits, which are about as wide as the spaces that separate them. Of these pits the first is about one-twelfth the distance between the first basal line and the peripheral series of pits anterior to the summit. On the last whorl, where the axial ribs become decidedly enfeebled, the combination of the axial and raised spiral sculpture gives to the surface a thimble pitted appearance. Suture of the early whorls slightly and of the later strongly constricted. Periphery of the last whorl well rounded. Base attenuated, marked by the very feeble continuations of the axial ribs, and 12 incised spiral lines, which are of irregular strength and spacing. Aperture broadly oval; posterior angle acute; outer lip thin; inner lip slightly curved, decidedly oblique, revolute, and appressed to the attenuated base for almost its entire length, provided with a strong very oblique fold at its insertion; parietal wall covered by a very thick callus.

The type, Cat. No. 266535, U.S.N.M., was dredged in shallow water in Almejas Bay, which is really the southern arm of Magdalena Bay, Lower California. The type had lost the nucleus and probably the first postnuclear turn, the 12 whorls remaining measure—length, 8 mm.; diameter, 1.1 mm. Cat. No. 267747 contains two additional specimens dredged in shallow water in Santa Maria Bay, Lower California. From these we are able to add a description of the nucleus. Nuclear whorls $2\frac{1}{2}$, well rounded, forming a moderately elevated spire, the axis of which is at right angles to that of the succeeding turns, in the first of which the tilted spire is one-fifth immersed.

TURBONILLA (PYRGISCUS) BARTOLOMENSIS, new species.

Plate 45, fig. 5.

Shell conic, yellow. Nuclear whorls decollated. Postnuclear whorls appressed at the summit, flattened in the middle, except the last, which is inflated and strongly rounded. The whorls are marked by rather strong, well-rounded axial ribs, which are slightly retractively slanting on the early turns and decidedly so on the later volutions. Intercostal spaces about as wide as the ribs marked by 12 deeply incised spiral pits. Of these the fifth is a mere line, while the first four, the sixth, ninth, and tenth are about twice as wide, and the eighth and ninth and eleventh and twelfth form deep broad pits fully three times the width of the last. Suture moderately constricted. Periphery of the last whorl strongly inflated, well rounded. Base short, inflated, well rounded, marked by the continuations of the axial ribs, which extend strongly to the umbilical area, between which poorly defined spiral striations may be seen. Aperture short, broadly oval, posterior angle obtuse; outer lip thin, showing the external sculpture within; inner lip short, partly reflected, free, provided with an obsolete oblique internal fold at its insertion; parietal wall covered by a very thick callus, which renders the peristome complete.

The type, Cat. No. 268729, U.S.N.M., was dredged in shallow water in San Bartolome Bay, Lower California. It has lost the nucleus, the nine postnuclear whorls measure—length, 5.6 mm.; diameter, 1.6 mm.

This special resembles *Turbonilla (Pyrgiscus) auricoma* Dall and Bartsch in having the inflated last whorl and the reddish incised spiral lines, but differs markedly from it in shape and sculpture.

TURBONILLA (PYRGISCUS) LAMNA, new species.

Plate 43, fig. 1.

Shell regularly, broadly elongate conic, yellowish white. Nuclear whorls 2½ smooth, forming a decidedly depressed helicoid spire, the axis of which is at right angles to that of the succeeding turns in the first of which about one-fourth of the side of the spire is immersed. Postnuclear whorls well rounded, appressed at the summit, ornamented by weak, distantly spaced, somewhat protractive axial ribs, which become flattened and decidedly enfeebled near the summit. Of these ribs 20 occur upon the first and 18 upon the remaining turns. Intercostal spaces about three times as wide as the ribs, shallow, crossed by 13 slender incised spiral lines of somewhat varying width. Of these lines the first to fifth, seventh and twelfth are mere incised lines, while the sixth, eighth, tenth, and

eleventh are about twice as wide as these, and the ninth and thirteenth are double the width of the last. The space between the summit and the first is as wide as the space between the eighth and ninth, which is doubly as wide as that separating the first five lines, which are subequally spaced. The spaces between the eighth and ninth, ninth and tenth, tenth and eleventh, and eleventh and twelfth increase steadily in width, the space between the first of this series being about one-half as wide as that separating the last. Suture moderately constricted. Periphery of the last whorl angulated. Base short, well rounded, marked by the feeble continuations of the axial ribs, which become evanescent before reaching the middle of the base, and 12 feebly incised, slender, wavy, spiral striations, which become successively weaker and closer spaced from the periphery toward the umbilical area. Aperture subquadrate; posterior angle obtuse; outer lip thin; inner lip slender, slightly twisted, provided with a very oblique fold a little anterior to its insertion; parietal wall glazed with a thin callus.

The type and an additional specimen, Cat. No. 268625 U.S.N.M. was dredged along the shore of Santa Maria Bay, Lower California. It has 8¼ postnuclear whorls and measures—length, 5.2 mm.; diameter, 1.6 mm.

TURBONILLA (PYRGISCUS) MARIANA, new species.

Plate 45, fig. 9.

Shell very slender, elongate conic, light horn yellow with the anterior half of the base and a narrow band about one-fifth of the width of the space between the sutures pale brown. The band is situated about its own width posterior to the periphery. Nuclear whorls decollated. Postnuclear whorls flattened very high between the sutures, narrowly shouldered at the summit, marked by closely crowded, quite regular, well rounded, almost straight, slightly protractive axial ribs of which 18 occur upon the first four of the remaining turns; 20 upon the fifth to seventh; 22 upon the eighth, and 26 upon the penultimate whorl. Intercostal spaces a little narrower than the ribs, marked by 13 strongly incised, subequal and subequally spaced pits. Suture moderately constricted. Periphery of the last whorl well rounded. Base attenuated, well rounded, marked by the feeble continuation of the ribs which reach to the umbilical chink and five equal and equally spaced, moderately broad, shallow, incised lines of a rust brown color. Aperture elongate oval; posterior angle acute; outer lip thin, showing the external sculpture within; inner lip slender, moderately curved, reflected over and adnate to the attenuated base for two-thirds of its length and provided with a strong oblique fold at its insertion; parietal wall covered by a thick callus.

The type, Cat. No. 267722, U.S.N.M., was dredged in shallow water in Santa Maria Bay, Lower California. It has lost the nucleus and probably the first two postnuclear turns; the nine and a half remaining whorls measure—length, 5.9 mm.; diameter, 1 mm.

TURBONILLA (PYRGISCUS) LAZAROENSIS, new species.

Plate 45, fig. 11.

Shell extremely slender, elongate conic, milk-white. Nuclear whorls decollated. Postnuclear whorls flattened, very high between the sutures, slightly excurved immediately below the feebly shouldered summit, and marked by very regular and regularly spaced well rounded, slightly protractive axial ribs of which 20 occur upon all the remaining turns excepting the last two. Of these the penultimate has 24 and the last 32. Intercostal spaces a little narrower than the ribs, marked by 17 spiral series of pits of which the first 16 are subequal and subequally spaced. The last, the peripheral pit is a little wider than the rest and separated from the sixteenth by a space about five times as wide as those separating the other pits. The first pit is about as far anterior to the summit as the sixteenth is distant from the seventeenth. Suture slightly contracted. Periphery of the last whorl well rounded. Base attenuated marked by the very feeble continuation of the axial ribs and eight wavy incised spiral lines which are of about the same strength but not of equal spacing. A broad band separates the peripheral line of pits from the first basal line; the next three lines are closely and equally spaced, while the fourth is a little farther from the third than that is from the second and the distance between the fourth and fifth is in equal proportions greater than that between the third and fourth. The rest are again narrowly and about equally spaced. Aperture elongate oval; posterior angle acute; outer lip thin showing the external sculpture within by transmitted light: inner lip slightly curved reflected and appressed to the attenuated base for almost its entire length, provided with a very oblique, strong fold at its insertion; parietal wall glazed by a thin callus.

The type, Cat. No. 267742 U.S.N.M., was dredged in shallow water off Lazaro Point, Santa Maria Bay, Lower California. It has lost the nucleus and probably the first 3 postnuclear turns, the 9¼ remaining measure—length, 5.8 mm.; diameter, 0.85 mm.

This species is nearest related to *Turbonilla* (*Pyrgiscus*) *mariana* Bartsch from which it differs by its much more slender form and spiral sculpture.

TURBONILLA (PYRGISCUS) CORTEZI, new species.

Plate 45, fig. 12; plate 42, fig. 7.

Shell rather large, elongate conic, pale yellowish brown. Nuclear whorls 2½, well rounded, forming a decidedly depressed helicoid spire, the axis of which is at right angles to that of the succeeding turns in the first of which the tilted edge is about one-fifth immersed. Early postnuclear whorls well rounded, the later ones almost flattened, all appressed at the summit and marked by slender, well-rounded, low, decidedly retractive axial ribs, of which 24 occur upon the first four turns, 22 upon the fifth and sixth, 26 upon the penultimate, and 30 upon the last turn. These ribs become somewhat enfeebled and expanded toward the summit. Intercostal spaces about two times as wide as the ribs, crossed by seven spiral series of pits, of which the second, third, sixth, and seventh are equal and stronger than the rest; the other three being about half as wide and equal. In addition to the above sculpture the entire spire is marked by fine incremental lines and equally fine spiral striations, the combinations of which give to the surface a clothlike texture. Suture feebly impressed. Periphery of the last whorl well rounded. Base moderately long, strongly rounded, marked by incremental lines and 8 rather broad, somewhat wavy, subequal, and subequally spaced spiral lines. The white color of these and the incised stronger lines on the spire stand out in marked contrast to the ground color. Aperture elongate oval; slightly effuse anteriorly; posterior angle acute; outer lip thin, showing the external sculpture within; inner lip almost straight, slightly revolute; parietal wall glazed with a thin callus.

The type and two additional specimens, Cat. No. 267722, U.S.N.M., were dredged in shallow water in Santa Maria Bay, Lower California. The type is an adolescent specimen and has 8¾ postnuclear turns, and measures—length, 6.5 mm.; diameter, 1.9 mm.

One of the other specimens is adult, but has lost the nucleus and probably the first three postnuclear turns. The eight remaining measure—length, 8.3 mm.; diameter, 2.5 mm. This specimen also enables us to say that the last whorl is inflated and that the axial ribs become obsolete on this turn.

TURBONILLA (PYRGISCUS) TECALCO, new species.

Plate 45, fig. 4.

Shell broadly elongate conic, milk white. Nuclear whorls 2½, well rounded, forming a decidedly depressed helicoid spire, having its axis at right angles to that of the succeeding turns, in the first of which it is about one-fourth immersed. Postnuclear whorls flattened in the middle, weakly rounded at the summit, marked by very regular,

well-rounded, narrow, almost straight, slightly protractive axial ribs, of which 18 occur upon all the turns. Intercostal spaces about 2½ times as wide as the ribs, crossed by 9 incised spiral lines, of which the third and ninth are equal, and fully doubly as wide as the second, fourth, and eighth, which are also equal, the rest being well-incised, slender striations. In spacing the first is about as far anterior to the summit as it is distant from the second, and the second is an equal distance from the third; the third, fourth, eighth, and ninth have about the same spacing, while the space between the fourth and fifth and seventh and eighth is only about one-half as wide, the combined spaces between the fifth and seventh are about equal to one of the spaces of the last-mentioned group, the sixth spiral giving a little wider spacing to the area between the fifth and sixth than the sixth and seventh. Suture moderately constricted. Periphery of the last whorl obtusely angulated. Base short, well rounded, marked by the feeble continuations of the axial ribs, which become evanescent on its middle, and nine very slender and almost equally spaced, incised lines. Aperture subquadrate. Posterior angle obtuse (outer lip badly fractured); inner lip very thick and provided with a strong oblique fold a little anterior to its insertion; parietal wall glazed with a thin callus.

The type, an adolescent specimen, Cat. No. 268731, U.S.N.M., was dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678 off Redondo Point, Magdalena Bay, Lower California, in 13½ fathoms, on broken-shell bottom. It has 7½ postnuclear whorls and measures—length, 3.9 mm.; diameter, 1.25 mm. Cat. No. 267743, U.S.N.M., contains an adult specimen dredged in shallow water in Santa Maria Bay, Lower California, which has lost the nucleus and probably the first three postnuclear turns, the 7½ remaining measure—length, 5.3 mm.; diameter, 1.8 mm.

TURBONILLA (PYRGISCUS) CORSOENSIS, new species.

Plate 45, fig. 8.

Shell elongate conic, pale yellowish brown. Nuclear whorls 2½, well rounded, forming a very depressed helicoid spire, the axis of which is at right angles to that of the succeeding turns in the first of which it is about one-fourth immersed. Postnuclear whorls flattened in the middle, slightly shouldered at the summit, marked by rather low, narrow, well-rounded, slightly retractively slanting axial ribs, of which 18 occur upon the first, 16 upon the second to fourth, and 18 upon the remaining turns. The ribs become slightly flattened and enfeebled toward the summit. Intercostal spaces about 2½ times as wide as the ribs crossed by nine almost equally spaced incised spiral grooves, the first of which is about as far anterior to the summit as that is

distant from the second. Of these lines the first and second are the weakest, while the fourth and ninth are the strongest, the rest being intermediate. In addition to this sculpture there are many fine incremental lines and equally fine spiral striations on the spire which give the surface a fine clothlike texture. Suture well impressed. Periphery of the last whorl well rounded. Base short, strongly rounded, marked by the feeble continuations of the axial ribs, which become evanescent before reaching its middle, and eight almost equal and equally spaced incised spiral lines. Aperture broadly oval; posterior angle acute; outer lip thin, showing the external sculpture within; inner lip almost straight, oblique, somewhat revolute, and provided with a strong fold a little anterior to its insertion; parietal wall covered with a thick callus.

The type and four additional specimens, Cat. No. 267722*a*, U.S.N.M., were dredged in shallow water in Santa Maria Bay, Lower California. The type has 9½ postnuclear whorls and measures—length, 6.1 mm.; diameter, 1.7 mm. Cat. No. 268730, U.S.N.M., contains another specimen dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678 off Redondo Point, Magdalena Bay, Lower California.

TURBONILLA (PYRGISCUS) BAEGERTI, new species.

Plate 45, fig. 2.

Shell elongate conic, light yellow horn colored. Nuclear whorls 2½, well rounded, forming a decidedly depressed helicoid spire, the axis of which is at right angles to that of the succeeding whorls, in the first of which the tilted edge of the nucleus is about one-fifth immersed. Postnuclear whorls flattened, slopingly shouldred toward the summit, marked by distinctly spaced, well-rounded, very regular, slightly retractively slanting axial ribs of which 18 occur upon the first five and 20 upon the remaining turns. These ribs become decidedly enfeebled and somewhat flattened toward the summit. Intercostal spaces about twice as wide as the ribs crossed by 12 incised spiral lines of which the first to fourth, and the sixth, ninth, and tenth are mere striations while the fifth, seventh, eighth, eleventh, and twelfth are subequal and much stronger. The widest space is between the tenth and eleventh line, the rest of the spacing is subequal, excepting the first four lines below the summit, which are a little more closely crowded. Suture strongly constricted. Periphery of the last whorl well rounded. Base short, well rounded, marked by the feeble continuation of the axial ribs which become evanescent before reaching the middle of the base and 16 rather closely crowded finely incised spiral lines, the first of which is considerably anterior to the first series of supraperipheral pits. Aperture large, broadly

oval; posterior angle obtuse; outer lip thin, showing the external sculpture within; inner lip stout, slightly curved and somewhat revolute, provided with a moderately strong oblique fold a little anterior to its insertion. Parietal wall covered with a thin callus.

The type, Cat. No. 267744*a*, U.S.N.M., was collected in shallow water in Santa Maria Bay, Lower California. It has nine postnuclear whorls and measures—length, 4.8 mm.; diameter, 1.4 mm.

TURBONILLA (PYRGISCUS) ULLOA, new species.

Plate 43, fig. 4.

Shell elongate conic, yellowish white. Nuclear whorls and all but the last 5½ postnuclear turns decollated. The whorls remaining are flattened, almost appressed at the summit, marked by 18 quite regular, slightly protractively slanting, well-rounded axial ribs. Intercostal spaces shallow, about two times as wide as the ribs, crossed by eight incised spiral grooves, of which the second, third, seventh, and eighth are of equal width and much stronger than the rest; the remaining four are also of equal width, but only about one-fourth as wide as the rest. The spaces between the first and second and second and third are equal and almost doubly as wide as those between the summit and the first, the third and fourth, and sixth and seventh; the space between the seventh and eighth is a trifle narrower than the last mentioned, and those between the fourth and fifth and fifth and sixth are a little less wide than this. Suture moderately constricted. Periphery of the last whorl well rounded. Base moderately long, well rounded, marked by the feeble continuations of the axial ribs, which become evanescent before reaching the middle of the base, and 11 strongly incised subequally spaced lines. These is a broad smooth band below the periphery equal to the space between the first and second incised line on the spire of the last whorl. Aperture broadly oval, posterior angle acute; outer lip thin, showing the external sculpture within; inner lip slender, very oblique, and decidedly revolute, provided with a moderately strong fold immediately below the insertion; parietal wall covered by a thick callus.

The type, Cat. No. 267744*e*, U.S.N.M., was dredged in shallow water in Santa Maria Bay, Lower California. It consists of a little more than the last five whorls and measures—length, 4 mm.; diameter, 1.2 mm.

TURBONILLA (PYRGISCUS) CABRILLOI, new species.

Plate 45, fig. 3.

Shell broadly elongate conic, pale yellow horn colored. Nuclear whorls 2½, well rounded, forming a decidedly depressed helicoid spire having its axis at right angles to that of the succeeding whorls, in the first of which the tilted edge is about one-fourth immersed.

Postnuclear whorls strongly roundly shouldered at the summit, flattened in the middle, crossed by strong sublamellar, slightly protractively slanting axial ribs, of which 16 occur upon the first and second and 18 upon the remaining turns, excepting the last, which has 20. Intercostal spaces about one and one-half times as wide as the ribs, crossed by 11 incised spiral lines, of which the first three are mere striations, while the fourth and the peripheral are wider than the rest, which are about half their width. Suture rather strongly constricted. Periphery of the last whorl well rounded. Base short, narrowly umbilicated, marked by the feeble continuations of the axial ribs, which become evanescent before reaching the middle of the base and seven equal incised spiral lines, of which the first three occupy about as much space as that separating the third from the fourth; the rest become successively closer spaced anteriorly. The space between the first basal line and the peripheral pit is a very broad smooth band. Aperture very broadly oval; posterior angle acute; outer lip thin, showing the external sculpture within; inner lip thin, slightly curved and somewhat revolute, provided with a weak oblique fold at its insertion; parietal wall covered with a thick callus.

The type, Cat. No. 268733 U.S.N.M., was dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678 off Redondo Point, Magdalena Bay, Lower California, in 13½ fathoms, on broken-shell bottom. It has 9¼ postnuclear whorls and measures—length, 5.5 mm.; diameter, 1.6 mm.

TURBONILLA (CINGULINA) URDENETA, new species.

Plate 45, fig. 1.

Shell elongate-conic, yellowish white, semi-translucent. Nuclear whorls deeply obliquely immersed in the first of the succeeeding turns above which only the tilted edge of the last volution projects. Postnuclear whorls well rounded, the first smooth, the second with 2, and the next three with 3 spiral keels, while the rest have 4 between the summit and the suture. The summits of the whorls are feebly shouldered; the first spiral keels fall on the anterior termination of the posterior third of the whorls between the summit and the suture, the space between the summit and this keel being concave. The second and third keels are as strong as the first and are separated from each other by a space a little more than half the width of that between the first and the summit, while the fourth keel is separated from the third by only half that space. The entire surface of the spire, excepting the summit of the keels is crossed by numerous closely spaced very slender axial threads and microscopic spiral striations. Suture strongly constricted. Periphery well rounded.

Base moderately long, well rounded, marked by the fine axial incremental threads, and closely spaced, fine, wavy, spiral striations. Aperture broadly oval, somewhat effuse anteriorly; posterior angle acute; outer lip thin showing the external sculpture within and rendered sinuous at the edge by the strong markings; inner lip very slender, strongly curved, reflected over, and appressed to the base for half its length; parietal wall covered by a thin callus.

The type, and 42 specimens, Cat. No. 267740, were dredged in shallow water in Santa Maria Bay, Lower California. The type has 8½ postnuclear whorls and measures—length, 5.7 mm.; diameter, 1.5 mm. Cat. No. 266536 U.S.N.M. contains another specimen dredged in shallow water in Magdalena Bay, Lower California, and Cat. No. 268640 U.S.N.M. contains three dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678, off Redondo Point, Magdalena Bay, Lower California, in 13½ fathoms on broken shell bottom.

TURBONILLA (MORMULA) SEBASTIANI, new species.

Plate 42, fig. 9.

Shell large, elongate-conic, pale brown. Nuclear whorls 2½, decidedly depressed helicoid, having their axis at right angles to that of the succeeding turns, in the first of which the tilted edge is about one-fourth immersed. Postnuclear whorls well rounded, almost appressed at the summit, crossed by well-rounded, sublamellar, slightly protractively slanting axial ribs, of which 18 occur upon the first, 16 upon the second to seventh, 18 upon the eighth to tenth, and 20 upon the remaining turns. In addition to the axial ribs the whorls are marked at irregular intervals by rather ill-defined varices. Intercostal spaces about three times as wide as the ribs crossed by 14 incised spiral lines, of which the fourth, sixth, and fourteenth are equal and much stronger than the rest. These are followed by the second, eighth, eleventh, and thirteenth, which are also of equal width but only about half as wide. The rest are also subequal and about half as strong as the last named series. Suture moderately constricted. Periphery obscurely angulated. Base short, well-rounded, marked only by incremental lines and eight strong, incised, spiral lines which decrease successively in spacing from the periphery anteriorly. Aperture small, subquadrate; posterior angle obtuse; outer lip very thick, reenforced within by three spiral lamellae of which the posterior two are very strong while the anterior one is feeble. The median fold is about opposite the periphery of the last whorl, while the posterior divides the space between this and the posterior angle of the aperture in two equal parts. The anterior is a trifle farther from the median than that is from the posterior fold. Inner

lip very thick, almost straight, provided with an obscure, very oblique fold a little anterior to its insertion; parietal wall glazed by a thin callus.

The type Cat. No. 268634 U.S.N.M. was dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678, off Redondo Point, Magdalena Bay, Lower California. It has 14 postnuclear whorls and measures—length, 10 mm.; diameter, 2 mm.

UGARTEA, new subgenus.

Turbonillas with a fold on the parietal wall.
Type.—Turbonilla (*Ugartea*) *juani* Bartsch.

TURBONILLA (UGARTEA) JUANI, new species.

Plate 43, fig. 5.

Shell broadly elongate conic, bluish white. Nuclear whorls at least 2, planorboid, having their axis almost at right angles to that of the succeeding turns, in the first of which they are about half immersed. Postnuclear whorls appressed at the summit with a strong sloping shoulder, which extends over the posterior fourth of the space between the summit and the suture, the rest flattened; marked by strong, rounded, distantly spaced, almost vertical, axial ribs of which 14 occur upon the first and 12 upon all the remaining, excepting the last, which has 14. The ribs form cusps at the anterior angle of the shoulder, anterior to which they become enfeebled. Intercostal spaces shallow, about 2½ times as wide as the ribs, marked by closely spaced miscroscopic spiral striations only. Immediately behind the aperture on the last turn the ribs become obsolete. Suture moderately impressed. Periphery of the last whorl rounded. Base prolonged, marked by the continuation of the axial ribs, which become evanescent before reaching the middle. Aperture narrowly oval; posterior angle acute; outer lip thick within, provided with three lamellar denticles on the inner surface; inner lip short, strong decidedly revolute continuing posteriorly into the very strong parietal callus, which becomes disjunct from the preceding whorl at the outer edge, which renders the peritreme complete. The inner lip is provided with a strong oblique fold at its insertion, while the parietal wall bears a short fold about halfway between this and the posterior angle of the aperture.

The type and another specimen, Cat. No. 268638, U.S.N.M., were collected by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678, off Redondo Point, Magdalena Bay, Lower California in 13⅓ fathoms on broken shell bottom. The type has seven postnuclear whorls and measures—length, 4.2 mm.; diameter, 1.3 mm.

TURBONILLA (MORMULA) VISCAINOI, new species.

Plate 43, fig. 3.

Shell elongate-conic, yellowish-white. Nuclear whorls two, well rounded, forming a moderately elevated helicoid spire, the axis of which is at right angles to that of the succeeding turns, in the first of which the tilted edge is about one-third immersed. Postnuclear whorls well rounded, almost appressed at the summit, crossed by strong, low, well-rounded, distantly spaced, protractive axial ribs, of which 14 occur upon the first and second, 16 upon the third to sixth, and 18 upon the remaining turns. In addition to the ribs the whorls are marked at irregular intervals by rather strong varices. Intercostal spaces about three times as wide as the ribs, crossed by five spiral pits, which, if the second were a little more anterior, would divide the space between the summit and the fifth pit, which is at the periphery, into five equal spaces. The spaces between these slender pits are crossed by many very fine spiral striations, of which there are about 13 between the summit and the first pit, 5 between the first and second, 9 between the second and third, 11 between the third and fourth, and 6 between the fourth and peripheral pit. Suture moderately constricted. Periphery of the last whorl well rounded, base short, well rounded, marked by the feeble continuations of the axial ribs, which become evanescent before reaching the middle of the base and many fine wavy spiral striations which agree with those on the spire in strength and spacing. Aperture short, subquadrate, posterior angle obtuse; outer lip thin, showing the external sculpture within, reenforced within by four slender spiral lamellæ, two of which are anterior and two posterior to the periphery; inner lip slightly flexuose, almost straight, and somewhat revolute; parietal wall glazed with a very thin callus.

The type Cat. No. 268734 U.S.N.M. was dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678, off Redondo Point, Magdalena Bay, Lower California, in 13½ fathoms on broken shell bottom. The type has nine postnuclear whorls and measures—length, 4.3 mm.; diameter, 1.2 mm.

ODOSTOMIA (CHRYSALLIDA) TARAVALI, new species.

Plate 46, fig. 3.

Shell elongate-conic, semitransparent, bluish white. Nuclear whorls, at least 2, well rounded, forming a planorboid spire, the axis of which is almost at right angles to that of the succeeding turns, in the first of which the nuclear spire is about half obliquely immersed. Postnuclear whorls flattened, narrowly, tabulatedly shouldered at the summit, marked by strong, well-rounded, retractive axial ribs, of

which 18 occur upon the first and 16 upon the remaining whorls, except the last, which has 20. These ribs pass prominently from the shoulder to the peripheral sulcus. In addition to the axial sculpture the first 4 turns are crossed by 4 equal and equally spaced, flattened spiral cords, which are about as wide as the spaces that separate them. On the rest of the turns the subperipheral cord comes into the suture and on the penultimate whorl forms a well-developed 5-spiral cord on the spire. The spaces enclosed by the axial ribs and spiral cords are deeply impressed oblong pits, while the junction of the ribs and spiral cords form well-rounded tubercles. Suture of the early turns, where the fifth spiral is still below the summit of the succeeding turn, deeply channeled, less so on the later whorls. Periphery of the last turn strongly rounded. Base short, inflated, strongly rounded, marked by nine strong, rounded, spiral cords which are almost equal and as wide as the spaces that separate them. The grooves between these spiral cords are crossed by numerous slender axial riblets. Aperture oval; posterior angle obtuse; outer lip thin rendered sinuous by the external sculpture; inner lip slender, thin, somewhat revolute, provided with a strong oblique fold at its insertion. Parietal wall covered by a thin callus.

The type, Cat. No. 267743*a* U.S.N.M. was dredged in shallow water in Santa Maria Bay, Lower California. It has seven postnuclear whorls and measures—length, 3.8 mm.; diameter, 1.3 mm.

Another specimen, Cat. No. 268635 U.S.N.M. was dredged by the U. S. Bureau of Fisheries steamer *Albatross* at station 5678, off Redondo Point, Magdalena Bay, Lower California, in 13½ fathoms, on broken shell bottom.

ODOSTOMIA (CHRYSALLIDA) SANTAMARIENSIS, new species.

Plate 46, fig. 1.

Shell stout, oval, yellowish white. Nuclear whorls decollated, the pit left in the apex of the type shows that it must have been strongly immersed in the first of the postnuclear turns. Postnuclear whorls strongly rounded, feebly shouldered at the summit, marked by rather slender axial ribs, of which 20 occur upon all the turns. In addition to the axial ribs the whorls are marked by 5 spiral cords, which are a little stronger than the ribs. The cords are about as wide as the spaces that separate them, their junctions with the ribs form rounded tubercles, while the spaces inclosed between them are strongly impressed concaved pits. Suture not channeled. Base rather long, somewhat inflated, well rounded, marked by 10 strong spiral cords, which decrease in size gradually and regularly from the periphery to the umbilical chink. The grooves between these spiral cords, which are about equal to the cords in width, are armed by

numerous slender axial riblets. Aperture oval, decidedly effuse anteriorly; posterior angle acute; outer lip thin, rendered wavy at the edge by the external sculpture; inner lip long, oblique, curved, somewhat revolute, provided with a strong oblique fold at its insertion; parietal wall covered by a moderately thick callus.

The type, Cat. No. 266180, U.S.N.M., was dredged in shallow water in Santa Maria Bay, lower California. It has 4½ postnuclear whorls and measures, length, 3.5 mm.; diameter, 1.9 mm.

ODOSTOMIA (EVALEA) VALEROI, new species.

Plate 46, fig. 7.

Shell ovate, narrowly umbilicated, thin, bluish white. Nuclear whorls small, completely, deeply, obliquely immersed in the first of the succeeding turns. Postnuclear whorls inflated, strongly rounded, appressed at the summit, crossed by numerous very fine, closely spaced spiral striations. Suture moderately constricted. Periphery of the last whorl inflated, well rounded. Base short, inflated, strongly rounded, narrowly umbilicated. Aperture broadly oval; posterior angle obtuse; outer lip thin, protracted between the summit and periphery to form a claw-like element; inner lip decidedly curved, slender, and somewhat revolute, provided with a strong oblique fold at its insertion; parietal wall glazed with a thin callus.

The type and another specimen, Cat. No. 266545, U.S.N.M., were dredged in shallow water in Magdalena Bay, lower California. The type has five postnuclear whorls and measures, length, 3 mm; diameter, 1.7 mm. Six additional specimens, Cat. No. 267754, U.S.N.M., were dredged in shallow water in Santa Maria Bay, lower California.

ODOSTOMIA (EVALEA) FRANCISCANA, new species.

Plate 45, fig. 7.

Shell thin, broadly elongate conic, yellowish white. Nuclear whorls small, deeply embedded in the first of the succeeding turns, above which the tilted edge of the last volution only projects. Postnuclear whorls inflated, well rounded, feebly shouldered at the summit, marked by almost vertical, very feeble, incremental lines and exceedingly fine, closely spaced, spiral striations. Suture moderately constricted. Periphery of the last whorl very feebly angulated. Base short, inflated, well rounded, with a very narrow umbilical chink. Aperture large; posterior angle acute; outer lip thin; inner lip strongly curved, somewhat reflected and provided with a strong, oblique fold at its insertion; parietal wall glazed with a thin callus.

The type and three specimens, Cat. No. 214431, U.S.N.M., were collected at United States Bureau of Fisheries Station 5729, in San

Francisco Bay, on sticky, nearly black, mud in 4¾ fathoms. Cat. No. 214432, U.S.N.M., contains four additional specimens, also from San Francisco Bay, dredged at U. S. Bureau of Fisheries Station 5781, on coarse sand, pebbly and shell bottom, in 9¾ to 16 fathoms.

ODOSTOMIA (EVALEA) WILLETTI, new species.

Plate 43, fig. 6.

Shell large, elongate conic, bluish white. Nuclear whorls obliquely immersed in the first of the succeeding turns, above which the tilted edge of the last volution only projects. Postnuclear whorls moderately rounded, appressed at the summit, the early ones marked by a moderate number of strongly incised lines, while on the later whorls the incised spiral lines are finer and much more numerous, in addition to the spiral sculpture the whorls are marked by decidedly retractively slanting, incremental lines. Suture moderately constricted. Periphery of the last whorl inflated, feebly angulated. Base attenuated, moderately rounded. Aperture oval, somewhat effuse anteriorly; posterior angle acute; outer lip thin; inner lip very oblique, stout, slightly curved, reflected over and appressed to the base, provided with a strong oblique fold at its insertion; parietal wall covered with a thick callus.

The type, Cat. No. 274007, U.S.N.M., was dredged by Mr. G. Willett, at Waterfall Cannery, west side of Prince of Wales Island, Alaska. It has almost seven postnuclear whorls and measures—length, 5.8 mm.; diameter, 2.4 mm. Another specimen from the same locality is in Mr. Willett's collection.

ODOSTOMIA (EVALEA) PLEIOREGONA, new species.

Plate 42, fig. 5; plate 45, fig. 6.

Shell broadly conic, white. Nuclear whorls deeply immersed in the first of the succeeding turns, above which the tilted edge of the last volution only projects. Postnuclear whorls flattened, appressed at the summit, all of them marked by very fine, closely spaced, spiral striations and decidedly retractively slanting, fine incremental lines. Suture moderately impressed. Periphery of the last whorl inflated, obtusely angulated. Base short, well rounded. Aperture large, slightly effused anteriorly; posterior angle acute; outer lip thin; inner lip oblique, slightly revolute, and appressed to the base for its posterior half and provided with a strong, oblique fold at its insertion; parietal wall covered with a thick callus.

The two cotypes, Cat. No. 252430, U.S.N.M., were collected by Harold Hannibal in the upper Pliocene, Elk River beds, at the mouth of Elk River, near Port Orford, Oregon. One of these is a young

specimen, having five postnuclear whorls, which measures—length, 3.6 mm.; diameter, 2.1 mm. The other is an adult, having three and one-fifth postnuclear whorls, and measures—length, 4.8 mm.; diameter, 2.8 mm.

I confused this species previously with *Odostomia* (*Evalea*) *stephensi* Dall and Bartsch, which is a recent form, but additional material of *O. stephensi* makes it necessary to change my opinion and requires that this be described as new.

ODOSTOMIA (EVALEA) ORFORDENSIS, new species.

Plate 43, fig. 2.

Shell small, oval. Nuclear whorls decollated. Postnuclear whorls appressed at the summit, well rounded, marked by slightly retractively slanting, incremental lines and exceedingly fine spiral striations. Suture moderately constricted. Periphery of the last whorl well rounded. Base moderately long, well rounded. Aperture oval; posterior angle acute; inner lip curved and appressed to the base; parietal wall covered with a thick callus.

The type, Cat. No. 252431, U.S.N.M., was collected by Harold Hannibal in the upper Pliocene, Elk River bed, at the mouth of Elk River, at Port Orford, Oregon. It consists of the last three and one-half postnuclear whorls and measures—length, 3 mm.; diameter, 1.6 mm.

This form I had previously identified as *Odostomia* (*Evalea*) *valensi* Dall and Bartsch, which is a recent form, but additional material cies makes it possible to determine the limits of variation of it and also requires that this shell be given a distinct name.

ODOSTOMIA (EVALEA) ANDERSONI, new name.

Eulimella californica ANDERSON and MARTIN, Proc. Cal. Acad. Sci., 1914, p. 67, pl. 7, figs. 19*a*, 19*b*, and 19*c*, not *Odostomia* (*Evalea*) *california* Dall and Bartsch, Bull. 68, U. S. Nat. Mus., 1909, pp. 20–25.

This is an *Odostomia* belonging to the subgenus (*Evalea*); the name *californica* being preoccupied makes the new name necessary. The specimens were collected in the Lower Miocene in the bottom of a small canyon, about 1¼ miles due north of Barker's ranch house, Kern County, California.

The type No. 141 and cotype No. 142 are in the California Academy of Sciences. The type measures—length, 4.5 mm.; diameter, 2 mm.

ODOSTOMIA (ODOSTOMIA) ORCUTTI, new species.

Plate 46, fig. 8.

Shell minute, pupoid, pale brown, marked by retractively slanting, incremental lines only. Nuclear whorls deeply immersed in the first

of the succeeding turns. Postnuclear whorls slightly rounded and appressed at the summit, the summit of the last one dropping some little distance below the periphery of the preceding whorl gives to the penultimate whorl an overhanging aspect. Suture moderately impressed. Periphery of the last whorl slightly inflated. Base moderately long, strongly rounded, with a narrow umbilical chink. Aperture oval; outer lip thin; inner lip slightly curved, strongly reflected, and provided with a very strong, oblique fold a little anterior to its insertion; parietal wall covered with a moderately thin callus.

The type, Cat. No. 274006, U.S.N.M., was dredged by C. R. Orcutt near the foot of Broadway in San Diego Bay, California. It has four and one-fifth postnuclear whorls and measures—length, 1.5 mm.; diameter, 0.8 mm.

The minute size and pupoid shape distinguish the shell at once from any of the Western American *Odostomias.*

CERITHIOPSIS (CERITHIOPSIS) CHARLOTTENSIS, new species.

Plate 46, figs. 9, 11.

Shell elongate conic, pale brown. Nuclear whorls strongly rounded, three, forming a slender very elevated spire, smooth. Postnuclear whorls well rounded, appressed at the summit, marked by rather strong, almost vertical axial ribs of which 14 occur upon the first four turns, 16 upon the fifth, 18 upon the sixth, and 20 upon the penultimate whorl. Intercostal spaces a little wider than the ribs. The spiral sculpture consists of three strong cords, of which the one at the summit is a little less strong than the other two. The junction of the spiral cords and the axial ribs form strong tubercles, those on the cord at the summit are well rounded, while those of the median cord are truncated anteriorly and posteriorly. The tubercles of the third cord are truncated posteriorly and sloped gently anteriorly. The spaces inclosed between the spiral cords and the axial ribs are well-rounded pits. Suture moderately constricted. Periphery of the last whorl marked by a spiral groove, which equals in strength and width the groove that separates the median from the third cord on the spire. Base short, well rounded, smooth, excepting the exceedingly fine incremental lines and microscopic spiral striations which are also present on the spire and a very slender basal fasciole which surrounds the insertion of the inner lip. Aperture decidedly channeled anteriorly; posterior angle obtuse; outer lip thin, showing the external sculpture within, decidedly sinuous at the edge; inner lip rendered decidedly flexuose; parietal wall covered by a thin callus.

The type and three paratypes, Cat. No. 225185, U.S.N.M., were collected by the U. S. Bureau of Fisheries steamer *Albatross*, at station 4205, in 60 fathoms, on mud bottom; bottom temperature 47.6° in Queen Charlotte Sound, British Columbia. The type, which has lost the first 2 nuclear whorls, has 7½ postnuclear turns and measures—length, 5 mm.; diameter, 1.7 mm. The nuclear whorls were described from one of the paratypes.

CERITHIOPSIS (CERITHIOPSIS) GRIPPI, new species.

Plate 46, fig. 12.

Shell of medium size, chestnut brown. Nuclear whorls 4½, smooth, well rounded, forming a moderately elevated apex, which is transparent. Postnuclear whorls narrowly shouldered at the summit, moderately rounded in the middle, decidedly contracted from the last spiral cord to the suture, marked by slender, slightly retractive axial ribs, of which 14 occur on the first, 16 upon the second and third, 18 upon the fourth and fifth, and 20 upon the remaining turns. Intercostal spaces about half as wide as the ribs. In addition to this axial sculpture, the whorls are marked by three strong spiral cords, of which the one at the summit is a trifle weaker than the other two. The junction of the axial ribs and the spiral cords form very prominent, well rounded tubercles, of which those on the first and median cords are well rounded, while those on the third cord are truncated posteriorly and sloped gently anteriorly. The spaces inclosed between the cords and the axial ribs are well-rounded, well-impressed pits. Suture almost channeled. Periphery of the last whorl marked by a broad groove, which is a little wider than the groove between the median and the third cord. The axial ribs extend across this groove, but stop at its anterior limit. Base short, well rounded, marked by 2 strong spiral grooves, of which one is on the median part, while the other encircles the insertion of the inner lip. The entire surface of the spire and the base is marked by very fine incremental lines and much finer spiral striations. Aperture of irregular shape, decidedly channeled anteriorly; posterior angle very obtuse; outer lip somewhat effuse, rendered decidedly sinuous at the edge by the external sculpture; columella very strong; inner lip reflected and appressed to the columella. Parietal wall covered by a thin callus.

The type and another specimen, Cat. No. 250632, U.S.N.M., were collected by Mr. Gripp, in 15 fathoms, outside of kelp, off San Diego Bay, California. The type has 8½ postnuclear whorls and measures—length, 4.7 mm.; diameter, 1.2 mm. Two additional specimens in Mr. Gripp's collection were examined.

CERITHIOPSIS (CERITHIOPSIS) BAKERI, new species.

Plate 46, fig. 10.

Shell of medium size, chestnut brown. Nuclear whorls 3½, well rounded, smooth, forming a styliform apex. Postnuclear whorls well rounded, narrowly, tabulatedly shouldered at the summit, and decidedly contracted anterior to the third keel, marked by rather slender axial ribs, of which 18 occur upon the first to fourth, 20 upon the fifth, 22 upon the sixth, and 24 upon the last turn. Intercostal spaces about 1½ times as wide as the ribs. In addition to the axial sculpture the whorls are marked by three strong spiral keels of which the first, which is considerably weaker than the rest, is at the summit. These keels are about as wide as the spaces that separate them and are much stronger than the axial ribs. The junctions of the axial ribs and the spiral keels form tubercles. The tubercles on the first keel are well rounded, while those on the second and third are truncated posteriorly and slope gently anteriorly. Periphery of the last whorl marked by a deep spiral groove which is as wide as that separating the median from the third keel. This groove is crossed by the continuations of the axial ribs which stop at the anterior termination of the groove. Suture strongly channeled. Base moderately long, slightly concave, marked by a very strong spiral keel immediately anterior to the peripheral groove. The anterior border of this keel is limited by a slender incised line. A second low, weakly developed spiral cord encircles the middle of the base between the basal fasciole, which is a mere slender thread at the insertion of the columella, and the keel immediately anterior to the periphery. Aperture of irregular shape, decidedly channeled anteriorly; posterior angle obtuse; outer lip thin, rendered sinuous at the edge by the strong external sculpture; inner lip decidedly flexuose, reflected over and adnate to the base; parietal wall covered with a moderately thick callus.

The type, Cat. No. 223049, U.S.N.M., was collected by Dr. Fred Baker in 7–10 fathoms, south of Coronado Island, California. It has 7½ postnuclear whorls and measures—length, 4.2 mm.; diameter, 1.5 mm.

CERITHIOPSIS (CERITHIOPSIS) HELENA, new species.

Plate 46, fig. 2.

Shell very small. Nuclear whorls 4½, light yellow, slightly rounded, separated by a moderately constricted suture forming an acicular apex. Postnuclear whorls chestnut brown, excepting the first keel which is white on all the whorls, tabulatedly shouldered at the summit, moderately rounded and strongly constricted below the

third spiral keel, marked by rather feeble axial ribs, which are slightly retractive. Of these ribs, 16 occur upon the first and second, 18 upon the third, 20 upon the fourth, and 24 upon the penultimate whorl. The spiral sculpture consists of three strong keels which are a little wider than the spaces that separate them and considerably wider than the axial ribs. The first of these is at the summit, the second one midway between the first and third, while the third is a little posterior to the suture. The junction of the axial ribs and spiral keels renders the spiral keels tubercular. The tubercles on the first cord are oval with their long axis corresponding to the axial sculpture. The tubercles on the median cord are truncated both anteriorly and posteriorly, but sloped a little more gently anteriorly, while the tubercles on the third cord are truncated abruptly posteriorly and gently anteriorly. Suture narrowly channeled. Periphery of the last whorl marked by a deep spiral sulcus, which is as wide as that separating the third from the median cord on the spire. This groove is crossed by the continuations of the axial rib which terminate at its anterior margin. Base moderately long, marked by a strong spiral keel immediately anterior to the peripheral sulcus, and another a little less strong in the middle of the space between the insertion of the columella and this keel. This middle keel is bordered on each side by a deep sulcus. In addition to this, the entire spire and base also bear exceedingly fine spiral striations and incremental lines. Aperture of irregular outline, decidedly channeled anteriorly; posterior angle obtuse; outer lip thick within, thin at the edge where it is rendered sinuous by the external sculpture; columella very stout, almost vertical; inner lip moderately strong, reflected over and adnate to the base; parietal wall covered with a thick callus which renders the peritreme complete.

The type, Cat. No. 204128, U.S.N.M., was collected by the U. S. Bureau of Fisheries steamer *Albatross*, on the shores of Panama Bay. It has six postnuclear whorls and measures—length, 2.9 mm.; diameter 1.0 mm.

CERITHIOPSIS OROVILLENSIS Dickerson.

Cerithiopsis orovillensis DICKERSON, Bull. Dept. Geol. Univ. Cal., vol. 9, No. 17, 1916, p. 489, pl. 39, fig. 7.

The type comes from the Eocene Tejon formation at the University of California locality 2225, south side of Oroville, South Table Mountain. It has nine whorls and measures—length, 6 mm.; diameter, 2 mm.

CERITHIOPSIS (CERITHIOPSIS) DUMBLEI Dickerson.

Cerithiopsis dumblei DICKERSON, Bull. Dept. Geol. Univ. of Cal., vol. 9, No. 17, 1916, p. 489, pl. 38, fig. 12.

The figured type has nine whorls; the specimen measures, length, 9.5 mm.

It was collected in the Eocene Tejon formation at the University of California locality 672, SE. ¼ of NW. ¼ sec. 24, Parson's Peak, in Tejon white sandstone, 0 to 10 feet below white shale.

CERITHIOPSIS OREGONENSIS Dickerson.

Cerithiopsis oregonensis DICKERSON, Proc. Cal. Acad. Sci., ser. 4, vol. 4, 1914, p. 121, pl. 11, figs. 5, 5*a*.

The type of this species, No. 246, California Academy of Sciences, comes from the Eocene, locality 25, Roseburg Quadrangle, Oregon, near the center of sec. 19, T. 26 S., R. 3 W., on the east bank of Little River at its confluence with the Umpqua, underneath the bridge at that point. It measures—length, 20 mm.; diameter, 4.5 mm.

CERITHIOPSIS BOLINGERENSIS Clark.

Cerithiopsis bolingerensis CLARK, Bull. Dept. Geol. Univ. Cal., vol. 8, 1915, pp. 490, 491, pl. 65, fig. 25.

This species comes from the Miocene Upper San Pablo of Las Trampas Ridge, University of California locality 1182. It is said to have seven or eight whorls and measures about 8 mm. in length.

CERITHIOPSIS TURNERI Clark.

Cerithiopsis turneri CLARK, Bull. Dept. Geol. Univ. Cal., vol. 8, 1915, p. 490, pl. 65, figs. 1, 2.

This specimen comes from the Miocene, in the Lower San Pablo group at Kirker Pass, University of California locality 100.

The type is said to have 10 to 11 whorls and measures—length, about 15 mm.; diameter, 4 mm.

BITTIUM BARTOLOMENSIS, new species.

Plate 47, fig. 5.

Shell stout, very broadly conic, with deeply channeled suture, the posterior half between the summit and suture of each whorl and the posterior half of the base brown, the rest white. Nuclear whorls decollated. Postnuclear turns marked by broad, rounded axial ribs, of which 16 occur upon the second to fifth, 18 upon the sixth, and 20 upon the last turn. These ribs extend strongly from the rather prominent shoulder at the summit to the suture. The spiral sculpture consists of four equally strong and equally spaced cords, which are about as wide as the spaces that separate them. On the last two turns a slender intercalated spiral thread appears between the second and third and the third and fourth cords. The junction of the axial ribs and spiral cords form quite strong well-rounded tubercles, while the spaces inclosed by them are rather deep concave pits except where they are divided by the intercalated threads. Suture strongly

constricted, channeled. Periphery of the last whorl rendered angulated by a cord, the groove between which and the fourth cord of the spire is crossed by two slender spiral threads. Base short, concave in the middle, marked by seven subequal and subequally spaced low rounded spiral cords, which are about as wide as the spaces that separate them, and numerous very fine axial threads which are best shown in the grooves. Aperture oval, slightly protracted and weakly channeled anteriorly; posterior angle obtuse; outer lip thin, rendered sinuous by the external sculpture; inner lip oblique, slightly curved, reflected over and appressed to the base; parietal wall covered by a thin callus.

The type, Cat. No. 266937, U.S.N.M., was dredged in shallow water in San Bartolome Bay, Lower California. It has 7½ postnuclear whorls and measures—length, 6.6 mm.; diameter, 2.6 mm.

BITTIUM CHALLISAE, new species.

Plate 47, figs. 2, 6.

Shell very large, white. Nucleus and early postnuclear turns decollated, those remaining slightly shouldered at the summit, weakly rounded in the middle and decidedly contracted immediately above the suture, marked by rather strong, low, well-rounded axial ribs of which 14 occur upon the second and third, 16 upon the fourth to sixth, 18 upon the seventh, and 20 upon the last turn. The spiral sculpture consists of four cords on the early whorls, of which the first, at the summit, is a little weaker than the rest. These primary cords are truncated posteriorly and slope gently anteriorly. Beginning with the fourth whorl an intercalated thread makes its appearance between all the cords and between the summit and the first cord. Suture strongly constricted. Periphery of the last whorl rendered angulated by a cord. Base short, slightly concave, marked by five low, broad, well rounded, obsolete cords which are subequal and subequally spaced. Aperture broadly oval, rather strongly channeled anteriorly; posterior angle obtuse; outer lip thin rendered sinuous at the edge by the external sculpture, showing the external markings within; inner lip somewhat sinuous, rather stout, reflected over and appressed to the base; parietal wall covered by a moderately thick callus.

The type and another specimen, Cat. No. 272376, U.S.N.M., were collected by Miss Bertha Challis at San Juan Island, Gulf of Georgia, British Columbia. The type has nine whorls remaining and measures—length, 13 mm.; diameter, 4.2 mm.

BITTIUM SANTAMARIENSIS, new species.

Plate 47, fig. 3.

Shell elongate conic, pale brown. Nuclear whorls decollated. Postnuclear whorls well rounded, narrowly tabulatedly shouldered at the summit, becoming decidedly contracted between the fourth spiral cord and the suture, marked by narrow, well-rounded, almost vertical axial ribs of which 14 occur upon the first and second, 16 upon the third and fourth, 18 upon the fifth, and 20 upon the last turn. In addition to the axial sculpture, the whorls are marked by four strong spiral cords which are equal and equally spaced, the space between them being as wide as the cords. The first of these cords is at the summit. The junction of these cords and the axial ribs form elongated, well-rounded tubercles, while the spaces between them form rectangular pits, the long axis of which coincides with the spiral sculpture. On the last whorl a slender spiral thread is present in each groove between the raised keels. Periphery marked by a rather strong spiral cord. The space between this and the fourth cord on the spire bears a slender spiral thread. Base moderately long, concave, marked by 8 slender spiral threads which are not quite as broad as the spaces that separate them. Aperture broadly oval, moderately channeled anteriorly; posterior angle obtuse; outer lip thin, rendered sinuous by the spiral sculpture; inner lip oblique, somewhat concave, reflected over and appressed to the base; parietal wall covered by a thin callus.

The type, Cat. No. 268623, U.S.N.M., was collected in shallow water in Santa Maria Bay, Lower California. It has 6½ postnuclear whorls and measures—length, 4.9 m.; diameter, 2 mm.

BITTIUM SANJUANENSIS, new species.

Plate 47, fig. 4.

Shell very large, rather thin, bluish white. Nuclear whorls decollated. Postnuclear whorls almost appressed at the summit, well rounded, decidedly contracted immediately posterior to the suture, marked by strong, broad, heavy, slightly protractive axial ribs which become enfeebled toward the summit and slightly widened there. Of these ribs, 12 occur upon the second and third, 14 upon the fourth and fifth, and 16 upon the last whorl. Intercostal spaces not quite as broad as the ribs. The spiral sculpture consists of five cords, of which the first, which is at the summit, is very slender. The two succeeding this are successively a trifle stronger, while the fourth and fifth are very strong, the last being the heaviest of all. The junction of the axial ribs and the spiral cords form well-rounded, elongated nodules which have their long axis parallel with the spiral

sculpture; the spaces inclosed between them are very shallow, rectangular pits. In addition to the above sculpture the entire surface of the spire and base is marked by many very slender lines of growth and exceedingly fine microscopic spiral striations, the combination of which gives the surface a somewhat cloth-like texture. Suture strongly constricted; it would be channeled were it not for the fact that the peripheral keel makes its appearance above the summit of the whorl, hence removes the strongly channeled element. Periphery of the last whorl marked by strong spiral cord, which is about as far anterior to the fifth cord of the spire as that is separated from the fourth. Base very short, decidedly concave, marked by three slender spiral cords, of which the first is about as far anterior to the periphery as that is distant from the fifth cord on the spire. The other two cords are very slender, the first being at the base of the columella, while the next is a little distance posterior to it. Aperture subquadrate; quite strongly channeled anteriorly; the junction of the outer and basal lip forming almost a right angle; posterior angle obtuse; outer lip very thin, showing the external sculpture within and rendered sinuous by the external sculpture at the edge; inner lip decidedly oblique, slightly curved, slender, reflected and appressed to the base; parietal wall covered by a thin callus.

The type, Cat. No. 168753, U.S.N.M., was collected by Miss Challis off San Juan Island, Gulf of Georgia, British Columbia. It has lost the nuclear turns; 7½ postnuclear whorls remaining measure—length, 11 mm.; diameter, 3.8 mm.

BITTIUM SERRA, new species.

Plate 47, fig. 1.

Shell stout, broadly conic, grayish white. Nuclear whorls decollated. Postnuclear whorls appressed at the summit, strongly rounded, marked by slender, rounded, somewhat retractive axial ribs, of which 18 occur upon the first and second, 20 upon the third, 22 upon the fourth, and 24 upon the remaining turns. In addition to the axial sculpture, the whorls are marked by four spiral cords, of which the first, which is at the summit, is a little weaker than the rest. The junction of these cords with the axial ribs form prominent, strongly rounded tubercles, while the spaces inclosed between them are rounded pits. Suture moderately constricted but not channeled. Periphery of the last whorl rendered angulated by a spiral cord. Base short, slightly concave, marked by four very low, broad, almost equal, spiral cords, which are separated by mere impressed lines. Aperture oval, narrowly, twistedly channeled anteriorly; posterior angle obtuse; outer lip rendered wavy by the external sculpture; inner lip decidedly curved, somewhat revolute, reflected over and appressed to the base; parietal wall covered with a thin callus.

The type, Cat. No. 271076, U.S.N.M., was dredged by the U. S. Bureau of Fisheries steamer *Albatross*, at station 4310, off Point Loma Light, California, in 71 to 75 fathoms, on green mud and fine sand bottom. The type has lost the nucleus and probably the first postnuclear turn; the 6½ remaining measure—length, 6.5 mm.; diameter, 2.6 mm. Cat. No. 268745, U.S.N.M., contains another specimen from San Bartolome Bay, Lower California.

BITTIUM TRAMPASENSIS Clark.

Bittium trampasensis CLARK, Bull. Dept. Geol. Univ. Cal., vol. 8, 1915, pp. 489, 490, pl. 65, figs. 3. 5.

This species occurs in the Miocene, Upper San Pablo group, at University of California locality 118. Two specimens are figured, both incomplete; the measurement given is 8 mm. for the height.

BITTIUM ? PABLOENSIS Clark.

Bittium pabloensis CLARK, Bull. Dept. Geol. Univ. Cal., vol. 8, No. 22, 1915, p. 489, pl. 65, fig. 10.

The unique type came from the Miocene of the San Pablo group of San Pablo Bay. From the description and figure I would unhesitatingly say that this is not a *Bittium*, but I am unwilling to refer it to another group without more evidence. The type is said to have six or seven whorls and to measure—length, about 16 mm.; diameter, 8 mm.

BITTIUM LONGISSIMUM Cooper.

Bittim longissimum COOPER, Bull. 4, Cala. State Min. Bur., 1894, p. 43, pl. 2, fig. 30.

I overlooked this specimen in my paper on The Recent and Fossil Mollusks of the Genus Bittium from the West Coast of America.[1]

It is a slender specimen of 16 whorls, measuring—length, 12.25 mm.; diameter, 1.55 mm. It was collected by Mr. Watts in the weir at Marysville Buttes. The figure above cited is a wretched one, absolutely unrecognizable. A specimen from the type locality is nicely figured by Dickerson.[2]

BITTIUM WASHINGTONIANA Dickerson.

Triforis washingtoniana DICKERSON, Cala. Acad. Sci., vol. 5, 1915, p. 63, pl. 6, fig. 13.

This is not a *Triphoris*, but a *Bittium*. The No. 362 Cala. Acad. Sci. type has 9 whorls and measures—length, 20 mm.; diameter, 4.5 mm. It comes from the Eocene-Tejon formation locality 183 on the west bank of the Cowlitz River, about one and three-fourths miles southeast of Vadar (Little Falls), Washington.

[1] Proc. U. S. Nat. Mus., vol. 40, 1911, pp. 383–414, pls. 51–58.
[2] Bull. Dept. Geol. Univ. California, vol. 9, No. 17, 1916, pl. 40, fig. 11.

ALVANIA BARTOLOMENSIS, new species.

Plate 46, fig. 4.

Shell very elongate ovate, pale yellow, slightly mottled and streaked with rust brown. Nuclear whorls 2½, smooth, well rounded. Postnuclear whorls well rounded, appressed at the summit, marked by incised spiral lines which are of somewhat irregular strength and spacing. Of these lines 17 occur between the summit and the periphery of the last whorl. The axial sculpture is reduced to mere lines of growth. Suture moderately constricted, periphery of the last whorl well rounded. Base moderately long, well rounded, marked by incised spiral lines which are of equal strength and spacing. Aperture irregular, decidedly effuse at the junction of the outer and basal lip; slightly channeled anteriorly; posterior angle acute; outer lip thin at the edge, thick within. Inner lip short, thick, slightly curved, reflected over and appressed to the somewhat attenuated base; parietal wall covered with a thick callus, which renders the peritreme complete.

The type, Cat. 268742, U.S.N.M., was collected by the United States Bureau of Fisheries steamer *Albatross*, in shallow water in San Bartolome Bay, Lower California. It has 4½ postnuclear whorls and measures—length, 4.2 mm.; diameter, 1.9 mm.

ALVANIA KYSKAENSIS, new species.

Plate 46, fig. 6.

Shell elongate ovate, pale brownish yellow. Nuclear whorls one and one-half, well rounded, marked by very slender spiral striations and exceedingly fine incremental lines. Postnuclear whorls strongly rounded, weakly shouldered at the summit, marked by slender axial riblets which are somewhat sinuous and slightly retractively slanting. Of these ribs 24 occur upon the first, 26 upon the second, and 40 upon the penultimate turn; these are about one-third as wide as the spaces that separate them. In addition to the axial sculpture, the whorls are marked by four spiral cords, of which the first, which is about as far from the summit as it is distant from the second, is very weak on the first two whorls, but on the last assumes almost the strength of the other three cords. The other three cords are of equal strength and spacing. The junction of the axial ribs and the spiral cords, which are a little stronger than the ribs, form weak nodules, while the spaces inclosed between them appear as well impressed, squarish pits. In addition to this sculpture, the entire surface is marked by very fine incremental lines and numerous miscroscopic spiral striations, the two lending it a cloth-like texture. Suture strongly constricted. On the last whorl the first basal keel makes its appearance above the summit of the succeeding turn. Periphery of the last whorl marked by a spiral sulcus about as wide as those separating the cords on the spire. Base well rounded, marked by seven equal

and equally spaced low, well-rounded spiral cords, which are a little wider than the spaces that separate them. Aperture subcircular; posterior angle obtuse; outer lip strongly curved, rendered somewhat sinuous by the external sculpture; inner lip strongly curved; parietal wall covered by a thick callus which renders the peritreme almost complete.

The type and three specimens of this species, Cat. No. 271407, U.S.N.M., were collected by Dr. William H. Dall in shallow water at Kyska Harbor, Aleutian Islands, Alaska. The type has 3½ postnuclear whorls and measures—length, 2.5 mm.; diameter, 1.2 mm.

ALVANIA DINORA, new species.

Plate 46, fig. 5.

Shell small, elongate ovate, yellowish white. Nuclear whorls two, strongly rounded, smooth. Postnuclear whorls strongly rounded, almost appressed at the summit and moderately constricted at the suture, marked by 7 very low, flattened spiral cords between the sutures, which are separated by a shallow impressed line. The axial sculpture consists of numerous very slender threads which are almost vertical. Suture strongly constricted. Periphery of the last whorl somewhat inflated, well rounded, base moderately long, slightly attenuated anteriorly, marked by 6 low, ill-defined rounded spiral cords, which, like those on the spire, are separated by mere impressed lines. The axial ribs also continue over the base. Aperture broadly oval, decidedly effuse at the junction of the basal and the outer lip; posterior angle obtuse; outer lip thick within, thin at the edge, evenly curved from the posterior angle to its junction with the inner lip; inner lip decidedly curved, somewhat reflected and appressed to the base; parietal wall covered by a thick callus, which practically renders the peritreme complete.

The type, Cat. No. 268730, U.S.N.M., and three additional specimens of this species, were collected by Mr. Willis at Forrester Island, Alaska. The type has a little more than 3 postnuclear whorls and measures—length, 2 mm.; diameter, 1 mm.

This is a very small species with very feeble sculpture.

In addition to these new species of *Alvania*, we have seen the additional specimens listed under the species mentioned below since the publication of my little monograph on The Recent and Fossil Mollusks of the Genus Alvania from the West Coast of America.[1]

It may be well to mention here that recent studies in the classification of the group will make it necessary to redistribute the members which we have brought together under the genus *Alvania* among several groups. I refrain from doing this at this time, because I wish first to examine the type-species of all the supraspecific groups before giving a final opinion.

[1] Proc. U. S. Nat. Mus., vol. 41, pp. 333–362, pls. 29–32.

ALVANIA COSMIA Bartsch.

Five specimens, Cat. No. 271497, U.S.N.M., from Todos Santos Bay, California.

ALVANIA ACUTILIRATA Carpenter.

Five specimens, Cat. No. 268741, U.S.N.M., from San Diego, California.

ALVANIA AEQUISCULPTA Keep.

Eleven speciments, Cat. No. 253089, U.S.N.M., from Pacific Beach, California.

ALVANIA COMPACTA Carpenter.

Two specimens, Cat. No. 271002, U.S.N.M., from Netarts Bay, Oregon. Fifteen specimens, Cat. No. 268743, U.S.N.M., from Yakutat Bay, Alaska.

Of *Rissoina* we have seen additional specimens of the following five species:

RISSOINA KELSEYI Dall and Bartsch.

One specimen, Cat. No. 271651, U.S.N.M., from San Diego, California.

RISSOINA HISTIA Bartsch.

One specimen, Cat. No. 211678, U.S.N.M., from La Paz, Gulf of California.

RISSOINA DALLI Bartsch.

One specimen, Cat. No. 268737, U.S.N.M., from San Pedro, California.

RISSOINA NEREINA Bartsch.

One specimen, Cat. No. 268643, U.S.N.M., from San Bartolome Bay, Lower California.

One specimen, Cat. No. 267735, U.S.N.M., from Santa Maria Bay, Lower California.

EXPLANATION OF PLATES.

PLATE 42.

FIG. 1. *Pyramidella* (*Pharcidella*) *magdalenensis*, new species.
2. *Turbonilla* (*Pyrgolampros*) *franciscana*, new species.
3. *Pyramidellida* (*Longchaeus*) *cooperi* Anderson and Martin.
4. *Turbonilla* (*Strioturbonilla*) *redondoensis*, new species.
5. *Odostomia* (*Evalea*) *pleioregona*, new species.
6. *Turbonilla* (*Pyrgiscus*) *ista*, new species
7. *Turbonilla* (*Pyrgiscus*) *cortezi*, new species.
8. *Turbonilla* (*Strioturbonilla*) *barkleyensis*, new species.
9. *Turbonilla* (*Mormula*) *sebastiani*, new species.
10. *Turbonilla* (*Pyrgiscus*) *dora*, new species.

PLATE 43.

FIG. 1. *Turbonilla* (*Pyrgiscus*) *lamna*, new species.
2. *Odostomia* (*Evalea*) *orfordensis*, new species.
3. *Turbonilla* (*Mormula*) *viscainoi*, new species.
4. *Turbonilla* (*Pyrgiscus*) *ulloa*, new species.
5. *Turbonilla* (*Ugartea*) *juani*, new species.
6. *Odostomia* (*Evalea*) *willetti*, new species.
7. *Turbonilla* (*Pyrgolampros*) *hannibali*, new species.
8. *Turbonilla* (*Strioturbonilla*) *schmitti*, new species.

PLATE 44.

FIG. 1. *Turbonilla* (*Strioturbonilla*) *montezuma*, new species.
2. *Turbonilla* (*Strioturbonilla*) *santamariana*, new species.
3. *Turbonilla* (*Strioturbonilla*) *doredona*, new species.
4. *Turbonilla* (*Pyrgolampros*) *pugetensis*, new species.
5. *Turbonilla* (*Pyrgisculus*) *guillcni*, new species.
6. *Turbonilla* (*Pyrgiscus*) *eva*, new species.
7. *Turbonilla* (*Pyrgolampros*) *tremperi*, new species.
8. *Turbonilla* (*Pyrgolampros*) *hemphilli*, new species.
9. *Turbonilla* (*Strioturbonilla*) *barkleyensis*, new species.
10. *Turbonilla* (*Pyrgiscus*) *ina*, new species.
11. *Turbonilla* (*Strioturbonilla*) *canadensis*, new species.

PLATE 45.

FIG. 1. *Turbonilla* (*Cingulina*) *urdencta*, new species.
2. *Turbonilla* (*Pyrgiscus*) *baegerti*, new species.
3. *Turbonilla* (*Pyrgiscus*) *cabrilloi*, new species.
4. *Turbonilla* (*Pyrgiscus*) *tccalco*, new species.
5. *Turbonilla* (*Pyrgiscus*) *bartolomensis*, new species.
6. *Odostomia* (*Evalea*) *pleioregona*, new species.
7. *Odostomia* (*Evalea*) *franciscana*, new species.
8. *Turbonilla* (*Pyrgiscus*) *corsoensis*, new species.
9. *Turbonilla* (*Pyrgiscus*) *mariana*, new species.
10. *Turbonilla* (*Pyrgiscus*) *almejasensis*, new species.
11. *Turbonilla* (*Pyrgiscus*) *lazaroensis*, new species.
12. *Turbonilla* (*Pyrgiscus*) *cortezi*, new species.

PLATE 46.

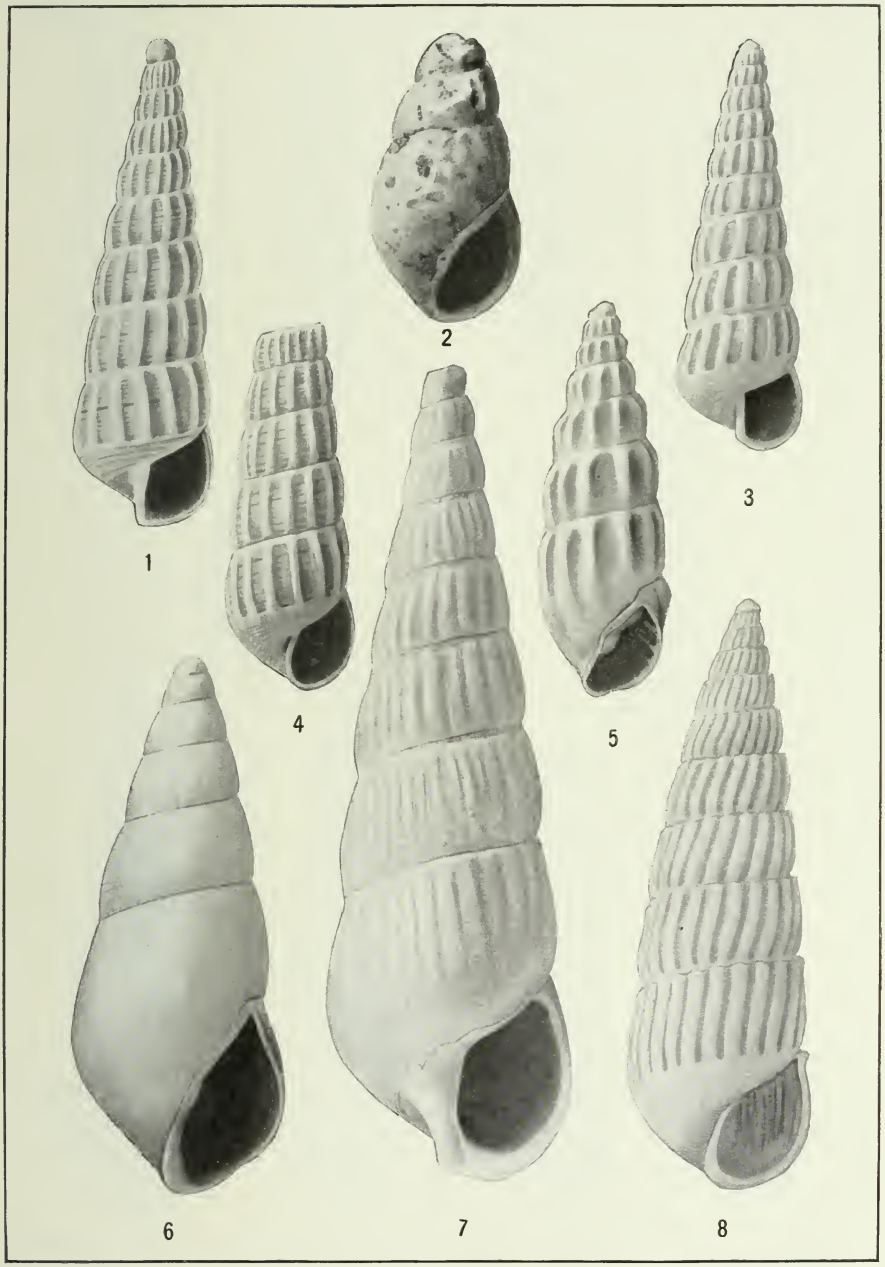
FIG. 1. *Odostomia* (*Chrysallida*) *santamariensis*, new species.
2. *Cerithiopsis* (*Cerithiopsis*) *helena*, new species.
3. *Odostomia* (*Chrysallida*) *taravali*, new species.
4. *Alvania bartolomensis*, new species.
5. *Alvania dinora*, new species.
6. *Alvania kyskaensis*, new species.
7. *Odostomia* (*Evalea*) *valeroi*, new species.
8. *Odostomia* (*Odostomia*) *orcutti*, new species.
9. *Cerithiopsis* (*Cerithiopsis*) *charlottensis*, new species.
10. *Cerithiopsis* (*Cerithiopsis*) *bakeri*, new species.
11. *Cerithiopsis* (*Cerithiopsis*) *charlottensis*, new species.
12. *Cerithiopsis* (*Cerithiopsis*) *grippi*, new species.

PLATE 47.

FIG. 1. *Bittium serra*, new species.
2. *Bittium challisae*, new species.
3. *Bittium santamariensis*, new species.
4. *Bittium sanjuanensis*, new species.
5. *Bittium bartolomensis*, new species.
6. *Bittium challisae*, new species.

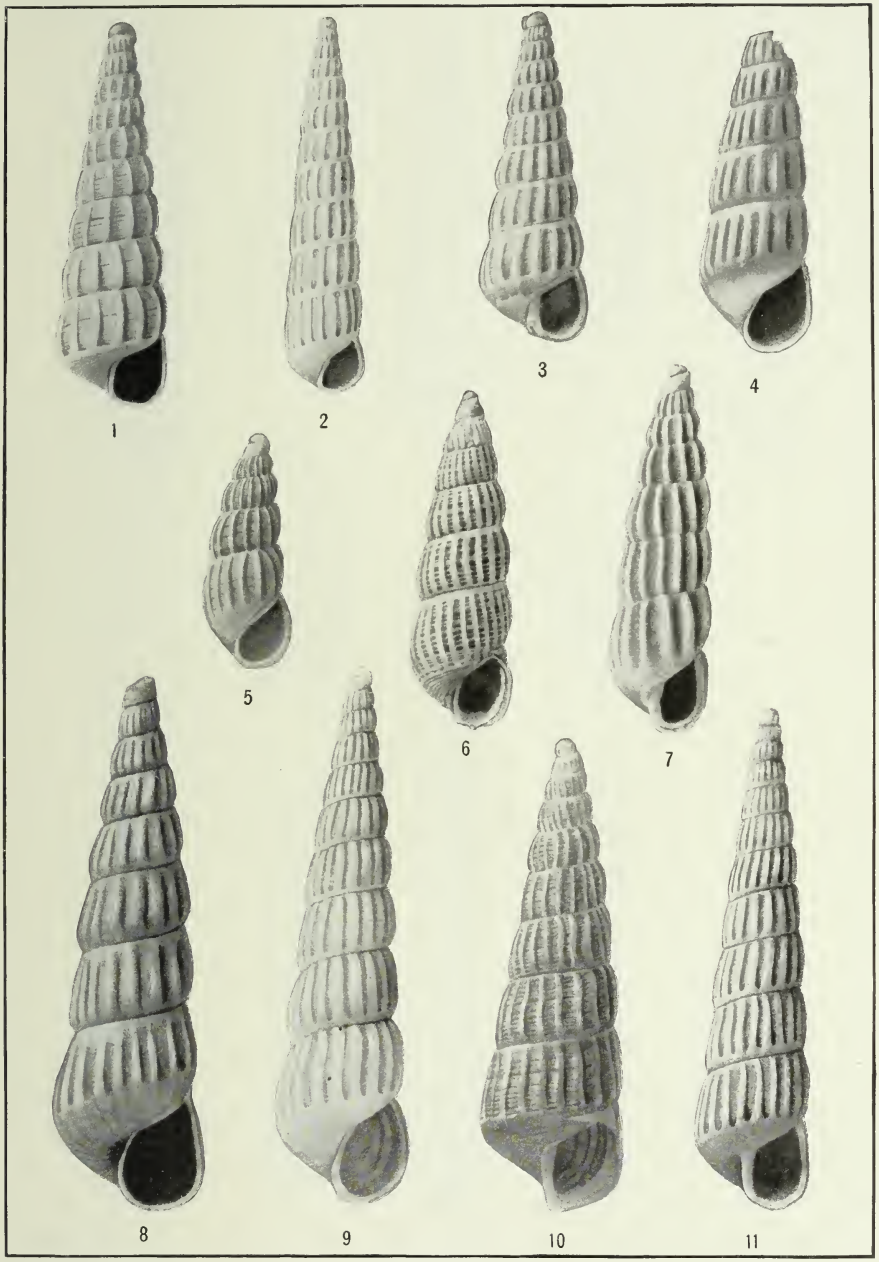
WEST AMERICAN MARINE MOLLUSKS.

FOR EXPLANATION OF PLATE SEE PAGE 680.



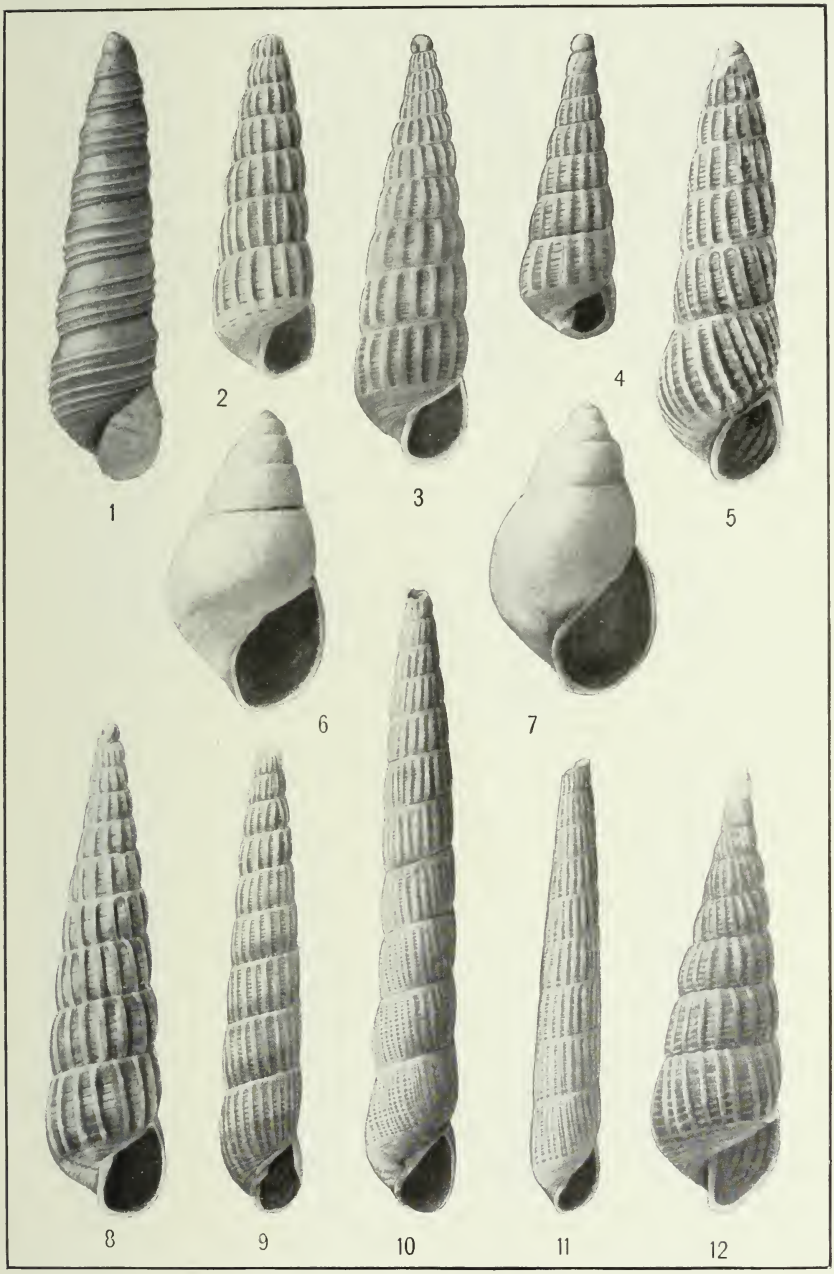
WEST AMERICAN MARINE MOLLUSKS.

FOR EXPLANATION OF PLATE SEE PAGE 680.



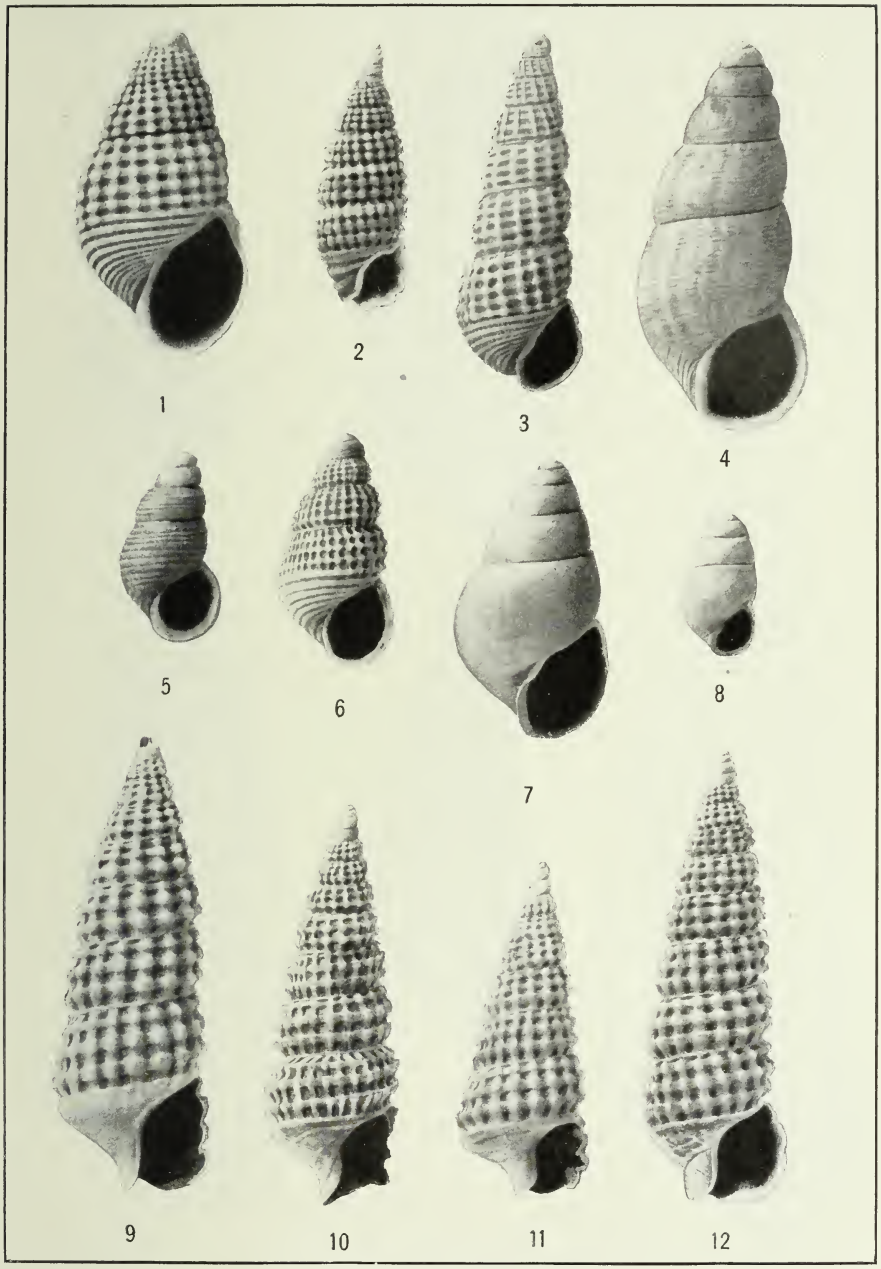
WEST AMERICAN MARINE MOLLUSKS.

FOR EXPLANATION OF PLATE SEE PAGE 680.



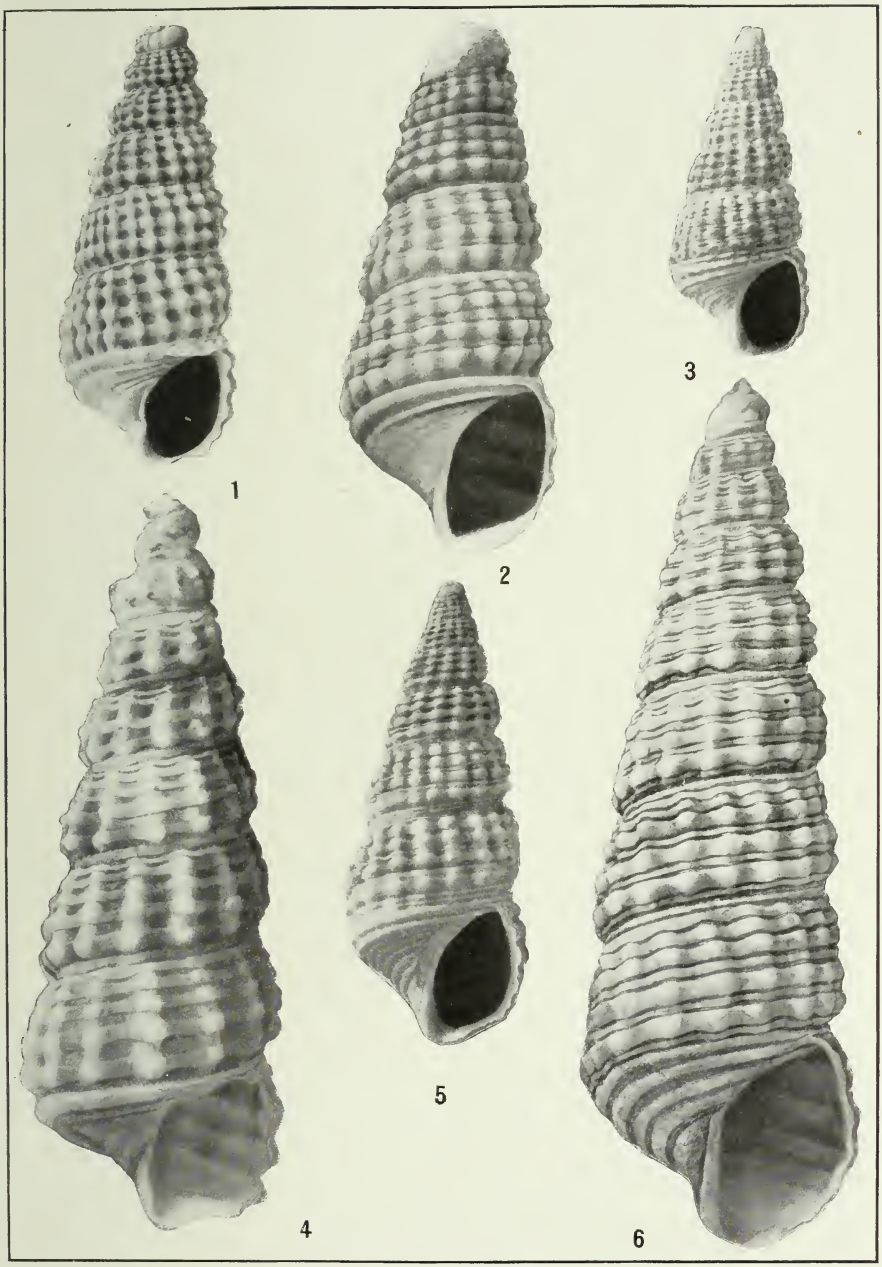
WEST AMERICAN MARINE MOLLUSKS.

FOR EXPLANATION OF PLATE SEE PAGE 680.



WEST AMERICAN MARINE MOLLUSKS.

FOR EXPLANATION OF PLATE SEE PAGE 681.



WEST AMERICAN MARINE MOLLUSKS.

FOR EXPLANATION OF PLATE SEE PAGE 681.

5

DESCRIPTIONS OF TWO NEW NAIADS

BY

PAUL BARTSCH

Assistant Curator, Division of Mollusks

No. 1454.—From the Proceedings of the United States National Museum, Vol. XXX, pages 393–396, with Plates XXVII–XXIX

Washington
Government Printing Office
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DESCRIPTIONS OF TWO NEW NAIADS.

By Paul Bartsch,
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Among the Unionidæ received by the United States National Museum in the past two years are two undescribed species, which are here diagnosed.

NEPHRONAIAS FLUCKI, new species.

Plates XXVII–XXIX.

Description.—Shell elliptical, moderately inflated, attenuated posterio-ventrally; sloping gently and evenly dorsally from a line extending from the umbones to the posterior ventral angle. Dorsal line evenly arcuate, curving a little more abruptly anteriorly than at the posterior end; ventral margin almost straight or slightly concave. In some, presumably the females, the shell is somewhat drawn out ventrally at the posterior margin, and in such the ventral outline necessarily appears more concave. Surface marked by numerous very strong concentric lines of growth and crinkly radiating rays which are most pronounced on the anterior end and gradually fade out from the middle of the shell posteriorly. Periostracum shining, dark brown at the umbones, fading gradually to greenish yellow at the edge. Umbonal cavity moderately deep. Pseudocardinal of the right valve strong, triangular, deeply notched (almost bifid by the deep vertical ∧-shaped notch in old specimens), with numerous fine secondary notchings. Pseudocardinals of the right valve rather slender, finely notched, inclosing a ∧-shaped cusp between them, which corresponds to the ∧-shaped notch in the other valve. Laterals narrow, slightly arcuate and obliquely ridged. Dorsal muscle scars feeble. Nacre bluish white at the margin, shading to livid olive dorsally.

There are four specimens of this species before me, all with more or less eroded umbones. They measure:

Length.	Height.	Diameter.
mm.	*mm.*	*mm.*
53.7	32.7	22.5
51.2	32	21.7
[a]64	26.7	17.6
40	23.7	13.6

[a] Type.

N. flucki can be readily separated from the other *Nephronaias* of the region by its rugose sculpture, in which respect it resembles *N. dysoni* Lea, from Costa Rica, and by its wavy radiating lines and the dark nacre.

Type.—Cat. No. 106121 U.S.N.M. The specimens were collected by the Rev. W. H. Fluck at Wounta River, northwest of Kukallaya, Nicaragua.

DIPLODON HUAPENSIS, new species.

Plates XXVII–XXIX.

Description.—Shell thin, elongate, elliptical, drawn out posterio-ventrally into a blunt beak, compressed dorsally, from a line extending from the umbones to the posterio-dorsal margin of the beak and somewhat pinched in its subcentral ventral half. Dorsal margin slightly curved, its posterior third sloping regularly obliquely downward. Anterior margin abruptly curved, falling off a little more gradually toward the ventral than the dorsal edge. Posterior extremity evenly rounded. Ventral margin somewhat concave in the middle. Periostracum brown on the posterior dorsal portions of the shell, grading to wax yellow streaked with brown on the anterior ventral parts. Surface marked by numerous lines of growth, the stronger ones of which are usually darker colored than the general surface, and numerous fine, crinkly, radiating lines, which are best developed on the anterior half, and gradually diminished in prominence posteriorly. Beak cavities shallow. Pseudocardinals in the right valve two, narrow, weak, sublamellar, and very oblique, the dorsal one decidedly notched and stronger than the ventral, which is rugose. Left pseudocardinal narrow, slender, slight, notched, and cut into many fine tubercles. Right lateral only moderately curved, very slender, slightly roughened, more so on the inner than the outer edge. Left laterals thin, and lamellar, inner one larger and better developed than the dorsal, both with roughened edges. Nacre bluish, with many spots of livid olive, which are more numerous and extensive in the dorsal part of the shell than ventrally. Posterior part iridescent.

There are two specimens of this species in the U. S. National Museum, No. 186117. The shells measure: Type, length, 55 mm.; height, 25.9 mm.; diameter, 14.5 mm.; the other—length, 57 mm.; height, 27.3 mm.; diameter, 16 mm.

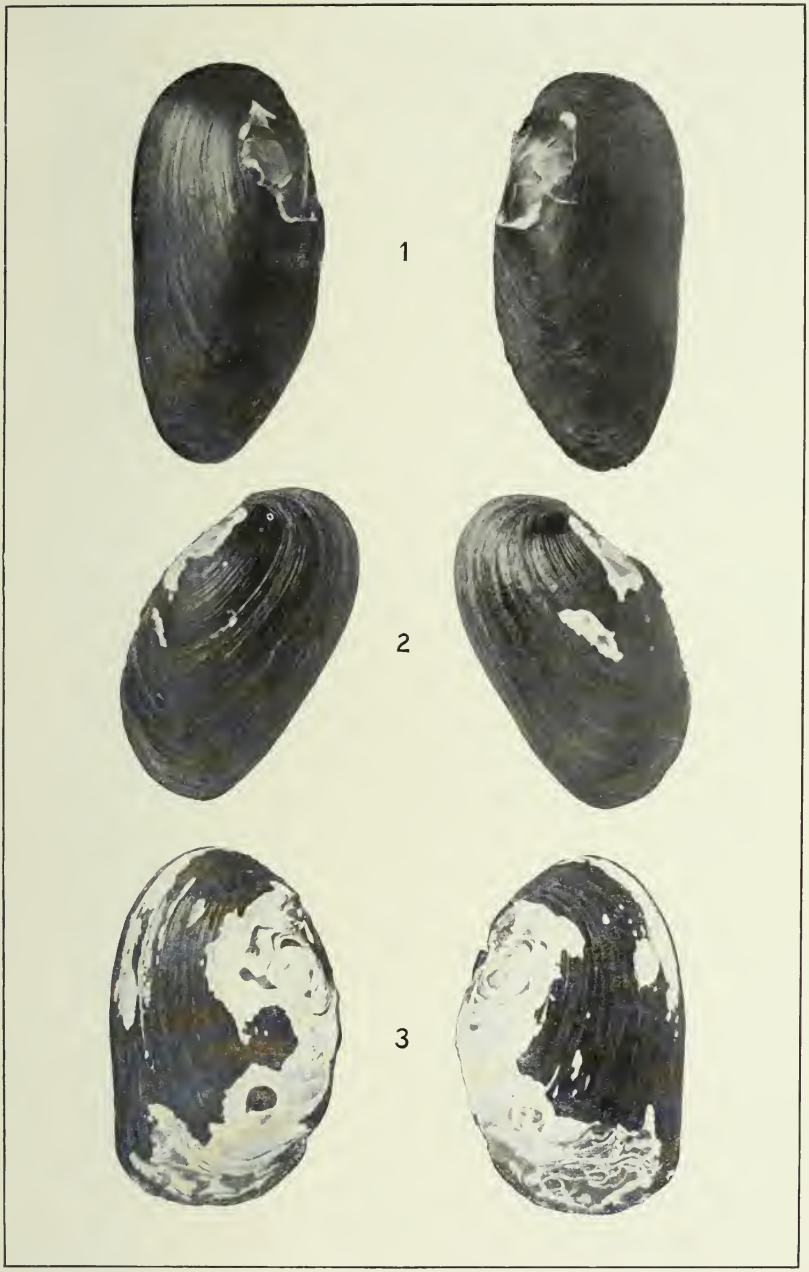
Description of soft parts.—Animal pale flesh colored. Mantle thickened near the edge all the way around from the anterior to the posterior end; this thickening is cord-like and becomes decidedly strengthened in the syphonal regions. The mantle slopes from the cord to a thin edge, which is more or less marked by longitudinal, parallel ridges. The space between the cord and the edge is dark colored on the inside. Syphons completely separated, the space between them being about 2 mm. wide. Ventral syphon 7 mm. long, thick

walled, and beset with several rows of long, thick, conical papillæ. Dorsal syphon 6 mm. long, moderately thick walled, and not papillose. Outer gills much smaller than inner, terminating somewhat posterior to the basal attachment of the inner gills; roughly they represent an isosceles triangle, the base of which constitutes the line of attachment; the anterior edge is a little less regular, not quite as straight as the posterior side, and falls off just a trifle more abruptly. The inner gills correspond at the posterior end with the outer gills in size, shape, and slope, but they extend forward in a slightly curved line, almost undiminished in width to the labial palpi, where they are suddenly deflected dorsally, their anterior margin being very short. Labial palpi small, with the free edge somewhat sinuous, agreeing with each other in shape and size, but the outer one is attached to the mantle in such a way that it probably presents only half the free surface on its outside that the inner presents on its inside. The space between them is equal. Foot and body of the animal small, the entire length of the body at the base of the gills being only 29 mm., while the entire length of the animal from the anterior mantle edge to the posterior mantle edge is 52.5 mm. The posterior half of the mantle is ash colored, deepest at the posterior edge, fading gradually anteriorly.

The shell in a general way recalls *Diplodon casæblancæ* Philippi and *Diplodon frenzellii* Ihering, but can readily be distinguished from them by its narrower outline.

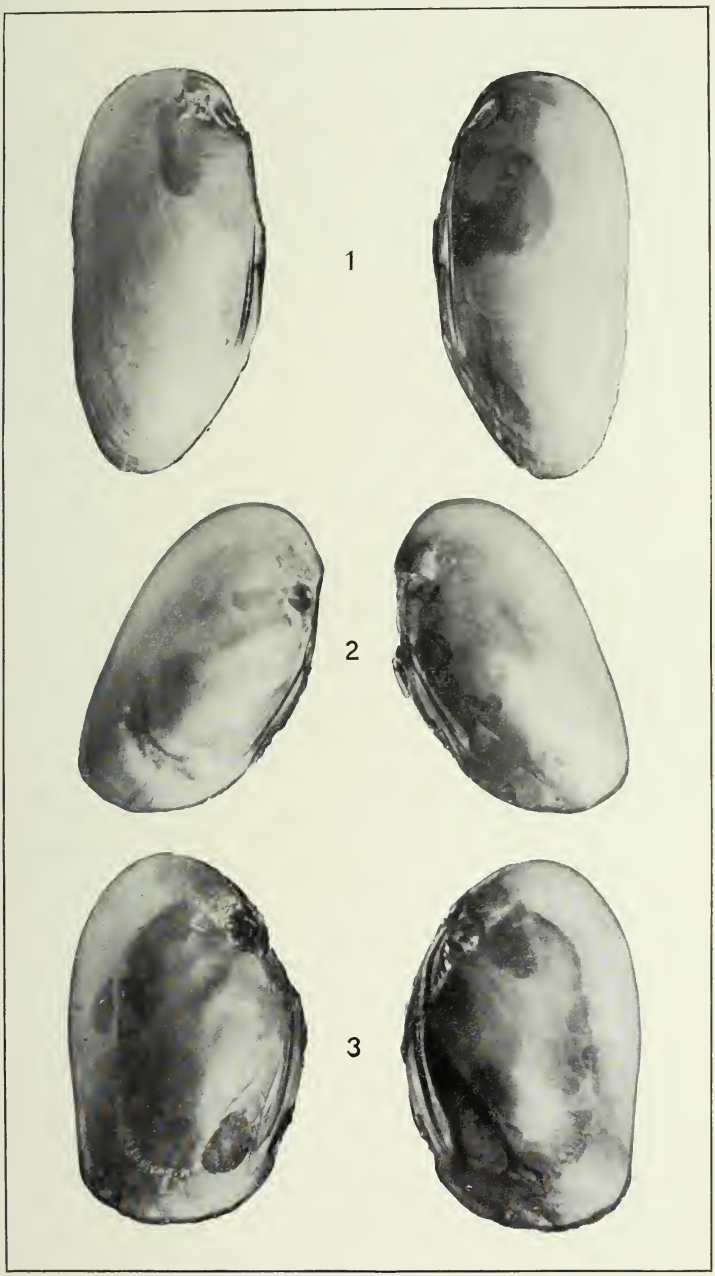
This species is reported to be very abundant in a small lake on Victoria Island, in Lake Nahuel Huapé, Argentina, where the natives are said to roast and eat them.

One of the specimens has four lateral teeth, two in the right valve, instead of one; the ventral one of these, the extra one, is almost as strong as the dorsal member.



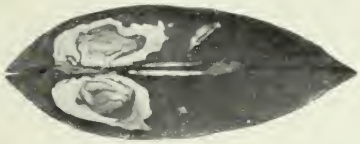
PEARLY FRESH-WATER MUSSELS.

FOR EXPLANATION OF PLATE SEE PAGES 393, 394.



PEARLY FRESH-WATER MUSSELS.

FOR EXPLANATION OF PLATE SEE PAGES 393, 394.



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PEARLY FRESH-WATER MUSSELS.

FOR EXPLANATION OF PLATE SEE PAGES 393, 394.

THE GIANT SPECIES OF THE MOLLUSCAN GENUS LIMA OBTAINED IN PHILIPPINE AND ADJACENT WATERS

[SCIENTIFIC RESULTS OF THE PHILIPPINE CRUISE OF THE FISHERIES STEAMER "ALBATROSS," 1907–1910.—No. 26]

BY

PAUL BARTSCH

Assistant Curator, Division of Mollusks, United States National Museum

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No. 1978.—From the Proceedings of the United States National Museum, Vol. 45, pages 235–240, with Plates 12–20

Published June 13, 1913

Washington
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By Paul Bartsch,

Assistant Curator, Division of Mollusks, United States National Museum.

During the cruise of the United States Fisheries steamer *Albatross* in Philippine and adjacent waters a number of Giant Limas were obtained. Here, as elsewhere, they occurred only in deep water, the least depth at which they were found being 161 fathoms, the greatest 559, with an average of 313.6. They were by no means abundant or universally distributed, for of the 369 dredgings made in more than 100 fathoms, only 18 yielded these mollusks, and 205 of these stations were made in depths between the two extremes in which Giant Limas were obtained. To these 205, eleven stations might be added, which differ only a couple of fathoms in depth from the above. Some of the new species here described are remarkable for their great size, being of much greater dimensions than any Giant Lima heretofore known.

The three large species obtained in the Sulu Sea and its ramifications among the islands, differ from those heretofore known by having a shallow, broad, and oval resilium, which follows the outer border of the hinge for a much greater distance than in typical *Acesta*, characterized by *Lima excavata* Fabricius, the type of *Acesta*, in which we have the resilium assuming the form of a deep curved wedge. The characters of the two groups are well shown in our figures of *L. rathbuni* and *L. celebensis*. These characters, taken in conjunction with the much less strongly developed sculpture in the three large Philippine species, is deemed sufficient to merit at least a sectional recognition for which I propose the name *Callolima*, with *Lima* (*Callolima*) *rathbuni* as type.

In the adjoining table I quote measurements and data of previously described species from the papers by Mr. E. A. Smith [1] and Dr. W. H. Dall.[2] To these are added similar data from the present material to render the table complete.

[1] Ann. Mag. Nat. Hist., ser. 7, vol. 4, 1899, p. 251.

[2] The Nautilus, vol. 16, No. 2, June, 1902, pp. 15–17

Distribution and measurements of known species of Giant Limas.

Name.	Locality.	Depth in fathoms.	Measurements in mm.		
			Alt.	Lat.	Diam.
(*Acesta*) *excavata* Fabricius, 1779	Norway	150–300	170	125	55
(*Acesta*) *goliath* Sowerby, 1883	Japan	775	150	110	36
(*Acesta*) *indica* Smith, 1899	Arabian Sea	430	75	61	34
(*Acesta*) *patagonica* Dall, 1902	Patagonia	245–481	100	72	31
(*Acesta*) *agassizi* Dall, 1902	Panama	322	97	78	30
(*Acesta*) *verdensis*	Philippines	394	48	40.4	21.5
(*Acesta*) *celebensis*	Buton Strait	519	159	(?)	(?)
(*Acesta*) *butonensis*	do	559	26.8	22	11
(*Callolima*) *smithi*	Philippines	281–508	175	118	48
(*Callolima*) *rathbuni*	do	161–226	208	156	59
(*Callolima*) *philippinensis*	do	190	177	111	37
(*Callolima*) *borneensis*	Borneo	305	39.2	33	16

The photographs of the accompanying illustration were made by the Photographer of the United States National Museum, and were retouched by Mrs. E. Bennett Decker.

LIMA (CALLOLIMA) SMITHI, new species.

Plates 12 and 13.

Shell large, slightly gaping for the greater part of both the anterior and posterior lateral margin. Pale lemon yellow, which is more intensified at the border than at the center of the disk, and also appears more emphasized on a series of rings which probably mark resting stages. Outline very oblique; the anterior lateral margin being much less curved than the posterior, which is very strongly arched. Hinge slightly curved, with a general upward slant posteriorly; scarcely produced beyond the beaks anteriorly. Lunule slight, outer surface marked with strongly impressed, quite regular and fairly evenly distributed somewhat zig-zag radiating lines which are less expressed on the early part of the shell and are almost obsolete on a narrow line radiating from the beak ventrally. The radiating lines are strongest on the lunule. Interior bluish white with the intensified yellow portion shining through the substance of the shell. Resilium large, with the posterior margin evenly curved and the ventral sigmoid.

The type, Cat. No. 256977, U.S.N.M., was dredged at station 5533, off Baliscasag Island, in 432 fathoms, on green mud and sand bottom, bottom temperature 53°.3. The type, which is the largest specimen, measures: alt. 175 mm., lat. 118 mm.; diameter 48 mm. The smallest specimen was obtained at station 5283. The ventral portion of this is broken, which prevents giving the height; but the breadth is 14.5 mm.

Lima (*Callolima*) *smithi* seems to prefer a finely sandy mud bottom. It was dredged at depths varying from 281 to 508, or at an average of 401 fathoms.

This species is named for Dr. Hugh M. Smith, Commissioner of Fish and Fisheries and director of the Philippine Expedition.

Specimens were obtained at the following stations:

Station 5124, north of Point Origon, Mindoro (lat. 12° 52′ N.; long 121° 48′ 30″ E.), in 281 fathoms, on soft green mud bottom. Cat. No. 256978, U.S.N.M.

Station 5283, off Malavatuan Island (lat. 13° 48′ 30″ N.; long. 120° 28′ 40″ E.), in 280 fathoms, on dark gray sand bottom; bottom temperature, 46°.8; density of water at bottom, 1.02517. Cat. No. 237577, U.S.N.M.

Station 5423, south of Cagayan Island, Jolo Sea (lat. 9° 38′ 30″ N.; long. 121° 11′ E.), in 508 fathoms, on gray mud and coral sand bottom; bottom temperature, 49°.8. Cat. No. 255175, U.S.N.M.

Station 5513, off Camp Overton Light, Mindanao (lat. 8° 16′ 45″ N.; long. 124° 02′ 48″ E.), in 505 fathoms, on gray mud and fine sand bottom. Cat. No. 255177, U.S.N.M.

Station 5533, off Balicasag Island (lat. 9° 27′ 15″ N.; long. 123° 31′ 48″ E.), in 432 fathoms, on green mud and sand bottom; bottom temperature, 53°.3. Cat. No. 256977, U.S.N.M.

LIMA (CALLOLIMA) PHILIPPINENSIS, new species.

Plates 14 and 15.

Shell large, of spatulate outline, slightly gaping at the lunule and narrowly so for the entire length of the posterior lateral margin; yellowish white, with concentric bands of pale lemon yellow, which probably mark resting stages. Hinge slightly curved, bending slightly upward posteriorly; scarcely at all produced anteriorly beyond the beak. Outer surface marked with well-incised, fine, quite regular and fairly regularly spaced wavy radiating riblets excepting a narrow band that extends from the beak ventrally, spreading slightly to form a triangular area with the beak at the angle, which is free from these markings. The incised lines are a little stronger at the lunule than anywhere else. Interior bluish white, through which the yellow areas of the outside show. Dorsal boundary of the resilium evenly curved; the ventral sigmoid.

The type, Cat. No. 256976, U.S.N.M., was dredged at station 5373, off the outer Tayabas Light (lat. 13° 40′ N.; long. 121° 31′ 10″ E.), in 190 fathoms (sounding not made but taken from chart), on gray mud bottom. It measures: alt. 177 mm., lat. 111 mm.; diameter 37 mm.

LIMA (CALLOLIMA) RATHBUNI, new species.

Plates 16 and 17.

Shell very large, slightly gaping for about a third of the anterior lateral margin and for about half of the posterior lateral; lemon yellow, fading to yellowish white at the edges. Outlines irregularly oval; hinge slightly, obliquely, downward slanting posteriorly, scarcely produced anterior to the beak; lunule concavely, obliquely sloping; the remaining outline curving in a regular oval. Outer

surface marked with irregular wavy, faintly impressed, and irregularly distributed radiating lines, and fine concentric lines of growth. The radiating lines are decidedly stronger on the lunule than on any other part of the shell. Interior bluish white; within the umbones an iridescent intensified canary yellow callus patch occurs, which gradually becomes attenuated and diffused ventrally, extending weakly as far as the palial line. A rosy flush extends from a little within the ventral border dorsally, over about two-thirds of the inner surface of the shell. Resilium almost straight dorsally, with a sigmoid curve ventrally. Hinge with obsolete lateral teeth indicated, the anterior one of which is a little stronger than the posterior.

The type, Cat. No. 256975, U.S.N.M., was dredged at station 5173, off Jolo Light, in 186 fathoms, on shell and coral bottom. It measures: alt. 182 mm., lat. 135 mm.; diameter 52 mm. The smallest specimen obtained, Cat. No. 254979, U.S.N.M., comes from station 5519 and measures: alt. 63 mm., lat. 51 mm.; diameter 22.3 mm. The largest specimen, Cat. No. 254978, U.S.N.M., comes from station 5371 and measures: alt. 208 mm., lat. 156; diameter 59 mm.

This species was obtained at the following stations:

Station 5135, off Jolo Light (lat. 6° 11′ 50″ N.; long. 21° 08′ 20″ E.), in 161 fathoms, on fine coral sand bottom; bottom temperature, 57°.4. Cat. No. 254980, U.S.N.M.

Station 5173, off Jolo Light (lat. 6° 02′ 55″ N.; long. 120° 53′ 00″ E.), in 186 fathoms, on shell and coral bottom. Cat. No. 256975, U.S.N.M.

Station 5198, off Baliscasag Island (lat. 9° 31′ 50″ N.; long. 123° 39′ 45″ E.), in 220 fathoms, on green mud bottom; bottom temperature, 53°.9; density of water at bottom, 1.02500. Cat. No. 256975, U.S.N.M.

Station 5371, off outer Tayabas Light (lat. 13° 49′ 40″ N.; long. 121° 40′ 15″ E.). Sounding not made, depth taken from chart which says 83 fathoms. (This is probably incorrect, for all the other Giant Limas were taken at much greater depth.) Bottom green mud. Cat. No. 254978, U.S.N.M.

Station 5387, off outer Bagatao Island Light (lat. 12° 54′ 40″ N.; long. 123° 20′ 30″ E.), in 209 fathoms, on soft green mud bottom; bottom temperature, 52°.4. Cat. No. 254976, U.S.N.M.

Station 5503, off Macubalan Point Light, Mindanao (lat. 8° 36′ 26″ N.; long. 124° 36′ 08″ E.), in 226 fathoms, on green mud bottom; bottom temperature, 53°.3. Cat. No. 254976, U.S.N.M.

Station 5516, off Point Tagolo Light, Mindanao (lat. 8° 46′ 00″ N.; long. 123° 32′ 30″ E.), in 175 fathoms, on globigerina bottom; bottom temperature, 54°.3. Cat. No. 254974, U.S.N.M.

Station 5519, off Point Tagolo Light, Mindanao (lat. 8° 47′ 00″ N.; long. 123° 31′ 15″ E.), in 182 fathoms, on globigerina and sand bottom; bottom temperature, 54°.3. Cat. No. 254979, U.S.N.M.

From the above one sees that *Lima* (*Callolima*) *rathbuni* seems to like a soft mud habitat, ranging in depth from 161 to 226, or an average of 194 fathoms.

This species is named for Dr. Richard Rathbun.

LIMA (CALLOLIMA?) BORNEENSIS, new species.

Plate 20, figs. 1, 2.

Shell apparently large, of suboval outline. Hinge slanting slightly upward, with the area occupied by the lunule concavely excavated. Pale canary yellow. Outer surface marked by numerous, somewhat wavy, almost equal and equally spaced radiating riblets, which are a little stronger at the lunule than on the rest of the shell. In addition to these riblets, the surface is marked by concentric lines of growth with stronger ridges at intervals indicating resting stages. The hinge area is slightly worn which makes it impossible to be positive about the type of resilium. Interior white, edged with a yellowish band.

This type, a young specimen, Cat. No. 229312, U.S.N.M., differs from the young shells of any of the species we know, and forces us to consider it distinct. It comes from station 5592, off Silungan Island, Borneo (lat. 4° 12′ 44″ N.; long. 118° 27′ 44″ E.), in 305 fathoms, on green mud bottom; bottom temperature 43° .2. The shell measures: alt. 39.2 mm., lat. 33 mm.; diameter of the single valve 8 mm.

LIMA (ACESTA) VERDENSIS, new species.

Plate 20, figs. 5, 6.

Shell moderately large, irregularly oval; bluish white; slightly gaping at the lunule. Outer surface marked by numerous, quite regular and regularly spaced radiating riblets which are stronger on and near the lunule than on the rest of the shell. The early central portion of the disk is almost smooth. In addition to the radial sculpture, the surface is marked with numerous lines of growth, some of which, marking resting stages, are much stronger than the rest. Hinge slightly curved, almost at right angles to the long diameter of the shell, extending very slightly anterior to the beaks. Resilium deeply impressed, wedge shaped. Lunule strongly developed and deeply impressed. Interior bluish white.

The young type, Cat. No. 249132, U.S.N.M., was dredged at station 5119, off Sombrero Island (lat. 13° 45′ 05″ N.; long. 120° 30′ 30″ E.), in 394 fathoms, on green mud and sand bottom; bottom temperature, 43° .7; density of water at bottom, 1.02468. It measures: alt. 48 mm., lat. 40.4 mm.; diameter, 21.5.

LIMA (ACESTA) CELEBENSIS, new species.

Plates 18 and 19.

Shell large, oval, with the hinge slightly curved, forming almost a right angle with the long diameter of the shell, and scarcely at all produced anterior to the beak. Outer surface marked by many coarse radiating ribs which are strongest on the lateral borders, particularly on the very strongly excavated lunule. In the depressed grooves between these ribs, finer threads frequently occur. Hinge broad. Resilium deeply impressed, wedge shaped, as in *Lima (Acesta) excavata.*

Two left valves and a lot of fragments probably belonging to these two valves, Cat. No. 249133, U.S.N.M., were dredged at station 5647, south of North Island, Buton Strait (lat. 5° 34′ 00″ S.; long. 122° 18′ 15″ E.), in 519 fathoms, on green mud bottom. One of these measures: alt. 159 mm.

A young specimen collected on the Philippine Expedition, Cat. No. 229395, U.S.N.M., without specific locality, undoubtedly belongs here. I have given a figure of this also.

LIMA (ACESTA) BUTONENSIS, new species.

Plate 20, figs. 3, 4.

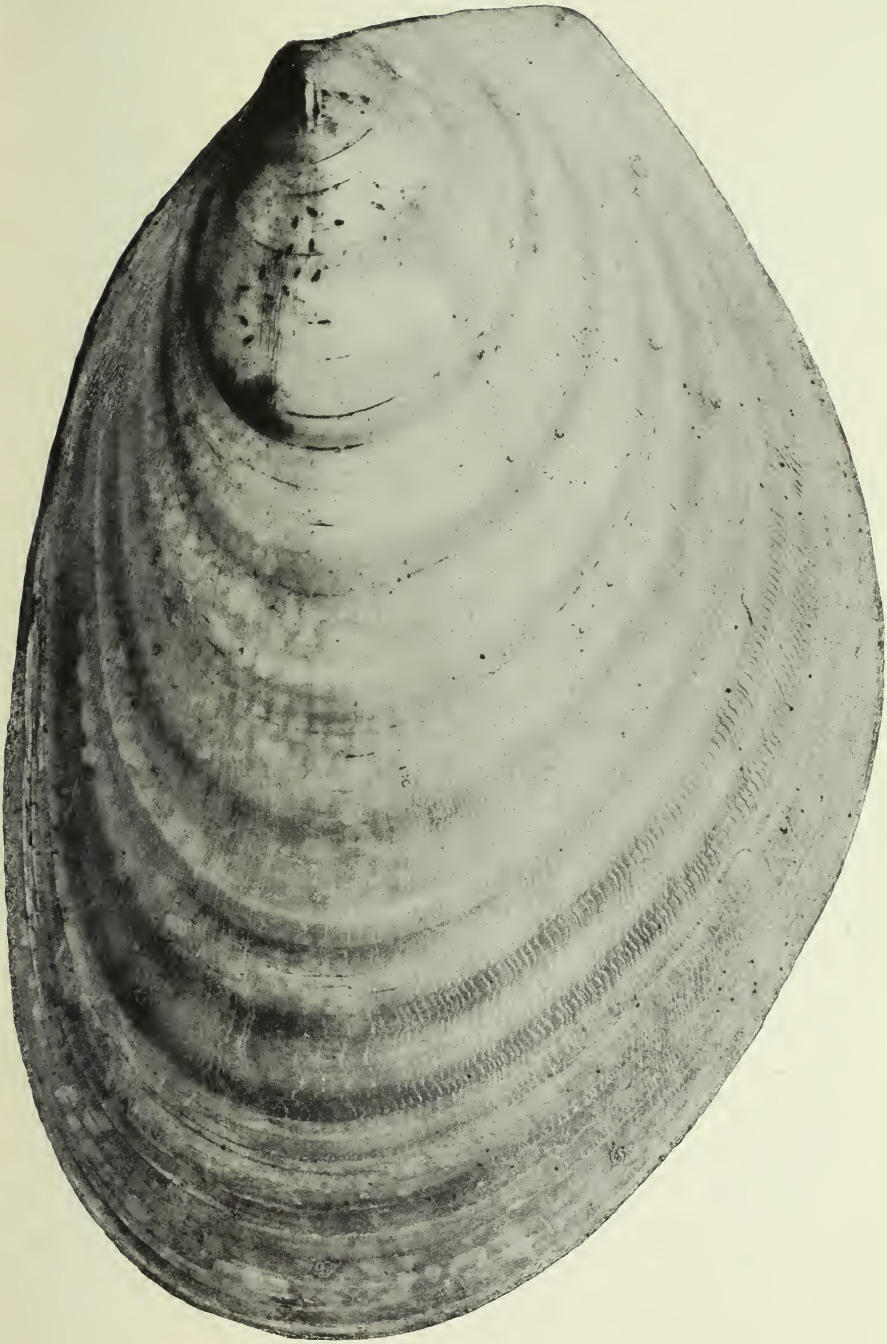
Shell small, irregularly oval. Hinge very slightly curved, extending almost at a right angle to the long axis of the shell. Lunule excavated. Outer surface marked by very fine, regular, and regularly spaced radiating riblets which are a little stronger near the lunule than on the rest of the surface and weakest on the middle of the disk. In addition to the radiating sculpture, the surface is marked with fine concentric lines which are emphasized in the form of resting stages at irregular intervals. Ligament wedge shaped. Interior bluish white, edged with a yellowish border.

The single valve of this species, Cat. 239399, U.S.N.M., was dredged at station 5648, south of North Island, Buton Strait (lat. 5° 35′ 00″ S.; long. 122° 20′ 00″ E.), in 559 fathoms on green mud bottom. It measures: alt. 26.8 mm., lat. 22 mm.; diameter of single valve 5.5 mm.

EXPLANATION OF PLATES.

All figures natural size.

Plate 12. *Lima (Callolima) smithi*, exterior. See page 236.
13. *Lima (Callolima) smithi*, interior. See page 236.
14. *Lima (Callolima) philippinensis*, exterior. See page 237.
15. *Lima (Callolima) philippinensis*, interior. See page 237.
16. *Lima (Callolima) rathbuni*, exterior. See page 237.
17. *Lima (Callolima) rathbuni*, interior. See page 237.
18. *Lima (Acesta) celebensis*, exterior. See page 240.
19. *Lima (Acesta) celebensis*, interior. See page 240.
20, fig. 1. *Lima (Callolima?) borneensis*, exterior. See page 239.
2. *Lima (Callolima?) borneensis*, interior. See page 239.
3. *Lima (Acesta) butonensis*, exterior. See page 240.
4. *Lima (Acesta) butonensis*, interior. See page 240.
5. *Lima (Acesta) verdensis*, exterior. See page 239.
6. *Lima (Acesta) verdensis*, interior. See page 239.



LIMA (CALLOLIMA) SMITHI.

FOR EXPLANATION OF PLATE SEE PAGE 240.

LIMA (CALLOLIMA) SMITHI.

FOR EXPLANATION OF PLATE SEE PAGE 240.

LIMA (CALLOLIMA) PHILIPPINENSIS.

FOR EXPLANATION OF PLATE SEE PAGE 240.

LIMA (CALLOLIMA) PHILIPPINENSIS.

FOR EXPLANATION OF PLATE SEE PAGE 240.

LIMA (CALLOLIMA) RATHBUNI.

FOR EXPLANATION OF PLATE SEE PAGE 240.

LIMA (CALLOLIMA) RATHBUNI.

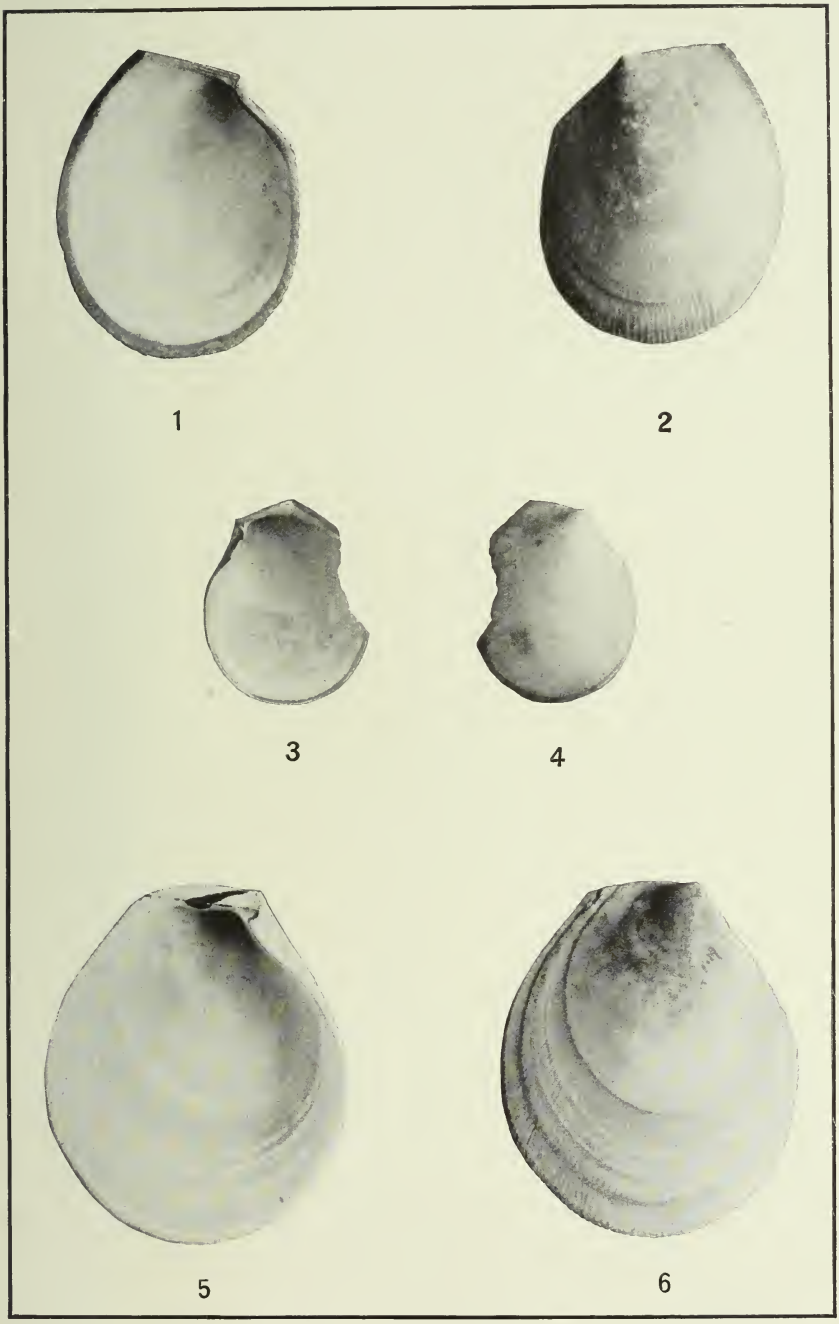
FOR EXPLANATION OF PLATE SEE PAGE 240.

LIMA (ACESTA) CELEBENSIS.

FOR EXPLANATION OF PLATE SEE PAGE 240.

LIMA (ACESTA) CELEBENSIS.

FOR EXPLANATION OF PLATE SEE PAGE 240.



NEW GIANT LIMAS.

FOR EXPLANATION OF PLATE SEE PAGE 240.

A MONOGRAPH OF WEST AMERICAN MELANELLID MOLLUSKS

BY

PAUL BARTSCH

Curator, Division of Marine Invertebrates, United States National Museum

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No 2207.—From the Proceedings of the United States National Museum, Vol. 53, pages 295–356, with Plates 34–49

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A MONOGRAPH OF WEST AMERICAN MELANELLID MOLLUSKS.

By Paul Bartsch,

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The present monograph completes the discussion of the West American Mollusks of the superfamily Pyramidelloideae, the Gymnoglossa, of Malacological Manuals. The superfamily consists of the families Pyramidellidae, which has been previously treated,[1] and the Melanellidae, here considered.

All the members of the superfamily are small mollusks, the largest attaining a size but little more than an inch in length. By far the greater number are elongate conic, but there are some which are quite rotund and others that range between these two extremes. In sculpture they vary from smooth to axially ribbed, to spirally striate or lirate, and combinations of these elements. Anatomically the members of this superfamily are differentiated from the other Prosobranchiate mollusks by the absence or extreme depauperation of the radula.

The members of the family Pyramidellidae are readily distinguished from those of the Melanellidae by the fact that the nepionic whorls are sinistral and tilted; the axis of the early whorls usually

[1] The Pyramidellidae of the Marine Pliocene and Pleistocene Deposits of California, William H. Dall and Paul Bartsch, Mem. Cal. Acad. Sci., vol. 3, 1903, pp. 269–285.

Synopsis of the Genera, Subgenera, and section of the Family Pyramidellidae, William H. Dall and Paul Bartsch, Proc. Biol. Soc. Wash., vol. 17, 1904, pp. 1–16.

Notes on Japanese, Indo-Pacific, and American Pyramidellidae, William H. Dall and Paul Bartsch, Proc. U. S. Nat. Mus., vol. 30, pp. 321–369, pls. 17–26, May 9, 1906.

The Pyramidellid Mollusks of the Oregonian Faunal Area, William H. Dall and Paul Bartsch, Proc. U. S. Nat. Mus., vol. 33, pp. 491–534, pl. 44–48, Washington, December, 1907.

Pyramidellidae of New England and the adjacent Region, Paul Bartsch, Proc. Bost. Soc. Nat. Hist., vol. 24, pp. 67–113, pls. 11–14, February, 1909.

A Monograph of West American Pyramidellid Mollusks, William H. Dall and Paul Bartsch, Bull. U. S. Nat. Mus. No. 68, pp. I–XII and 1–258, pls. 1–30, Washington, Nov. 10, 1909.

More Notes on the Family Pyramidellidae, Paul Bartsch, The Nautilus, vol. 23, 1909, pp. 54–59.

New species of Shells collected by Mr. John Macoun, at Barclay Sound, Vancouver Islands, British Columbia, William H. Dall and Paul Bartsch, Canada Dept. of Mines, Memoir No. 14–N, 1910.

Additions to West American Pyramidellid Mollusk Fauna, with descriptions of new species, Paul Bartsch, Proc. U. S. Nat. Mus., vol. 42, May 17, 1912, pp. 261–289, pl. 35–38.

A Zoogeographic Study based on the Pyramidellid Mollusks of the West Coast of America, Paul Bartsch, Proc. U. S. Nat. Mus., vol. 42, 1912, pp. 297–349.

New species of Mollusks from the Atlantic and Pacific Coasts of Canada, William H. Dall and Paul Bartsch, Bull. No. 1, Victoria Memorial Museum, pp. 139–146, Oct. 23, 1913.

being at right angles to that of the succeeding turns, in the first of which the nuclear whorls are frequently quite strongly embedded. In the Melanellidae, on the other hand, the early whorls are dextral and never tilted or immersed. By far the greater number of the Pyramidellid mollusks are highly sculptured, a feature almost absent in the Melanellidae, where varices mark the strongest axial sculptural element and the spiral sculpture scarcely exceeds that of finely incised lines.

The first Melanellid to be reported from the west coast of America was *Stilifer astericolus* Broderip, a mollusk collected on starfish at Hood Island of the Galapagos group by Hugh Cuming. This is not only described here by Broderip [1] as a new species, but constitutes the type of the genus *Stilifer* there characterized.

Two years after this appeared G. B. Sowerby's paper on the "*Eulimas*," collected by Hugh Cuming and this describes seven new West American forms [2]. These are:

Eulima splendidula Sowerby, from Sancta Elena.
Eulima interrupta Sowerby, from the Gulf of Nocoiyo.
Eulima imbricata Sowerby, from Sancta Elena.
Eulima hastata Sowerby, from Sancta Elena.
Eulima pusilla Sowerby, from Sancta Elena.
Eulima varians Sowerby, from Xipixapi.
Eulima acuta Sowerby, from Montiji Bay.

Eight years later (1852), C. B. Adams published his catalogue of shells collected at Panama, in which he described [3] *Eulima iota*, *Eulima recta*, *Eulima solitaria*.

Two years after this Arthur Adams's Monographs of the Genera *Eulima*, *Niso* and *Leiostraca* were published.[4] Here we find the previously described species redescribed and figured, and some of them referred to other genera than those under which they were originally described:

Eulima hastata Sowerby, page 794, plate 169, figures 7, 8.
Eulima pusilla Sowerby, page 794, plate 169, figures 9, 10, 21.
Eulima iota C. B. Adams, page 798, plate 169, figure 19.
Niso interrupta Sowerby, page 801, plate 170, figure 9.
Niso splendidula Sowerby, page 801, plate 170, figure 8.
Niso imbricata Sowerby, page 802, plate 170, figure 10.
Leiostraca acuta Sowerby, page 803, plate 170, figure 11.
Leiostraca varians Sowerby, page 804, plate 170, figures 23, 24.
Leiostraca recta C. B. Adams, page 804, plate 170, figure 25.

The next to make contributions to the west coast members of this family was Philip P. Carpenter, who devotes pages 438–442 of his

[1] Proc. Zool. Soc. London, 1832, p. 60.
[2] Idem, 1834, pp. 6–8.
[3] Ann. Lyc. Nat. Hist., N. Y., 1852, pp. 198–199.
[4] Sowerby's Thes. Conch., 1854.

Catalogue of Mazatlan Shells, published in 1857, to it. Here we find the following listed:

Eulima? *hastata* Sowerby, page 438.
Eulima ——— sp. ind. (*a*), page 438.
Eulima ——— sp. ind. (*b*), page 438.
Leiostraca? *recta* C. B. Adams, page 439.
Leiostraca? *solitaria* C. B. Adams, page 439.
Leiostraca ——— sp. ind. (*a*), page 439.
Leiostraca ——— sp. ind. (*b*), page 440.
Leiostraca linearis Carpenter, page 440.
Leiostraca? *iota*, var. *retexta* Carpenter.
Leiostraca? *distorta*, var. *yod* Carpenter.

All of the forms attributed to C. B. Adams were later found to be distinct by Carpenter and given names by him.

In 1860 O. A. L. Mörch, in his Beiträge zur Molluskenfauna Central-Amerika's, reached the genus *Eulima* on page 120 [1] and described *Eulima bipartita* Mörch, from Sonsonate, Mexico, and discussed *Eulima distorta* Sowerby and *Eulima recta* C. B. Adams.

The next publication dealing with West American Melanellidae is P. P. Carpenter's Review of Prof. C. B. Adams's Catalogue of the Shells of Panama, from the Type Specimens.[2] Here he discusses on pages 356 and 357 the shells described by C. B. Adams and his own efforts in the Mazatlan Catalogue.

He here raises the name *Leiostraca? iota retexta* Carpenter, previously given to his Mazatlan shell [3] to specific rank. He also separates the Mazatlan shells which he listed under the name *Leiostraca recta* C. B. Adams [4] from the true *M. recta* C. B. Adams, a Panamic species, and gives to the Mazatlanic species the name *Leiostraca involuta* Carpenter, but it will be found that this has a tilted nucleus which places it in the genus *Odostomia*. The shell which he described as *Leiostraca solitaria* he now considers distinct from C. B. Adams *Eulima solitaria*, and he gives it the name *Leiostraca producta*.

The next paper to deal with these shells was also published by P. P. Carpenter. It was his Supplementary Report on the Present State of our Knowledge with Regard to the Mollusca of the West Coast of America.[5] Here, on page 659, we find the following species listed as—

Eulima micans? new species.
Eulima compacta? new species.
Eulima rutila? new species.
Eulima thersites new species.

There are only a few words of description, which would not enable even a specialist to determine the species these names were intended for. They are, however, more fully described later.

[1] Malak. Blät., vol. 6, pp. 120–121.
[2] Proc. Zool. Soc. London, 1863.
[3] Mazatlan Catalogue, 1857, pp. 440–441.
[4] Mazatlan Catalogue, 1857, p. 439.
[5] Rept. Brit. Ass. Adv. Sci. 1863 (1864).

In the following year Doctor Carpenter published his Diagnoses of New Forms of Mollusks Collected at Cape St. Lucas by Mr. J. Xantus.[1] On pages 47 and 48 is his *Eulima fuscostrigata* described as new.

The next effort was also by Carpenter. In his paper Diagnoses Specierum et Varietatum novarum Molluscorum, prope Sinum Pugetianum a Kennerlio Doctore, nuper decesso, collectorium,[2] on page 63, there is a complete description of *Eulima micans* Carpe ter.

In the same year Carpenter published a paper Diagnoses of New Forms of Mollusks from the West Coast of North America first collected by Col. E. Jewett.[3] On pages 396 and 397, *Eulima thersites* Carpenter is fully described.

Still another paper by the same author, Descriptions of New Marine Shells from the Coast of California, appeared the same year.[4] On page 221 of this paper we find *Eulima* (? var.) *compacta* Carpenter and *Eulima* (? var.) *rutila* Carpenter more fully diagnosed.

In 1866 the Monographs on the genera *Leiostraca*, *Eulima*, and *Niso* appeared in Lovell Augustus Reeve's Conchologia Iconica, and while there is only a single new species, *Eulima parva* Reeve, described here, some of the previously described species are here figured. We find:

Leiostraca varians Sowerby, plate 1, figures, 1*a*, 1*b*.
Leiostraca recta C. B. Adams, plate 1, figure 3.
Leiostraca acuta Sowerby, plate 2, figure 7.
Eulima hastata Sowerby, plate 2, figure 9.
Eulima pusilla Sowerby, plate 3, figure 25.
Eulima micans Carpenter, plate 3, figure 33.
Eulima iota C. B. Adams, plate 5, figure 34.
Eulima rutila Carpenter, plate 5, figure 37.
Eulima parva Sowerby, plate 5, figure 41.
Niso imbricata Sowerby, plate 1, figure 3.
Niso splendidula Sowerby, plate 1, figure 7.
Niso interrupta Sowerby, plate 1, figures 8*a*, 8*b*.

The next year De Folin published his paper Les Meleagrinicoles, in which the following Melanellids are described:

Chemnitzia rangii De Folin.
Eulima adamantina De Folin.
Eulima proca De Folin.
Eulima gibba De Folin.
Eulima elegantissima De Folin.
Eulima elodia De Folin.
Eulima opalina De Folin.

[1] Ann. Mag. Nat. Hist., ser. 3, vol. 14, 1864.
[2] Proc. Acad. Nat. Sci. Philadelphia, vol. 17, 1865.
[3] Ann. Mag. Nat. Hist., ser. 3, vol. 15, 1865.
[4] Proc. Cala. Acad. Nat. Sci., vol. 3, 1865.

De Folin unfortunately cites as type-locality for all the shells described in this paper two places—one the environs of *Negritos* (which may mean Negros Island, Philippines), and the other Isle aux Perles—i. e., Margarita Island, Bay of Panama. In order not to miss any West American members, I have quoted all the described forms.

In 1878 G. B. Sowerby published his Monograph on the genus *Stylifer*.[1] In this he redescribes and figures plate 1, figure 3, *Stylifer astericola* Broderip.

Six years later G. B. Sowerby's Monograph on the genus *Stylifer* appeared.[2] In this we find *Stylifer astericolus* Broderip described on page 159 and figured on plate 479, figures 4 and 5.

Two years later Tryon, in his Manual, reached our family.[3] Besides giving a treatment of the superspecific groups he describes and figures all those previously figured. He also gives figures of such as he had represented in his collection and he cites all those known to him to date. From the West Coast of America the following are listed:

Eulima micans Carpenter, page 272, plate 69, figures 29, 30.
Eulima elodia De Folin, page 272.
Eulima parva Sowerby, page 272, plate 69, figures 32, 33.
Eulima adamantina De Folin, page 272.
Eulima gibba De Folin, page 272, plate 69, figure 34.
Eulima opalina De Folin, page 273, plate 69, figure 37.
Eulima proca De Folin, page 273, plate 69, figure 38.
Eulima hastata Sowerby, page 273, plate 69, figure 39.
Eulima iota C. B. Adams, page 274, plate 69, figure 42.
Eulima compacta Carpenter, page 278.
Eulima thersites Carpenter, page 278.
Eulima fuscostrigata, Carpenter, page 278.
Eulima bipartita Mörch, page 278.
Eulima varians Sowerby, page 278, plate 70, figures 65, 67.
Eulima rutila Carpenter, page 279, plate 70, figure 68.
Eulima elegantissima De Folin, page 279, plate 70, figure 69.
Eulima recta C. B. Adams, page 280, plate 70, figure 81.
Eulima acuta Sowerby, page 280, plate 70, figure 82.
Eulima rangii De Folin, page 287, plate 70, figure 20.
Niso splendidula Sowerby, page 287, plate 71, figure 24.
Niso interrupta Sowerby, page 288, plate 71, figures 22, 23.
Niso imbricata Sowerby, page 289, plate 71, figure 31.
Stylifer astericola Broderip, page 290, plate 71, figure 38.

[1] Reeve's Conch. Icon., vol. 20, 1878.
[2] Sowerby's Thes. Conch., 1884.
[3] Tryon's Man. Conch., vol. 8, 1886.

The next Melanellid to be cited is one referred to but not named by von C. Hartlaub, who in his Report on the Dredging Operations off the West Coast of Central America to the Galapagos, to the West Coast of Mexico, and in the Gulf of California, in charge of Alexander Agassiz, carried on by the U. S. Fish Commission steamer *Albatross* during 1891, Lieut. Commander Z. L. Tanner, U. S. N., commanding,[1] calls attention (p. 147, pl. 4, fig. 25) to a "*Stylifer* (*Mucronalia*) parasitic upon a crinoid found in the Gulf of Panama." This is named by Dr. W. H. Dall in 1908.

In 1899 Edward G. Vanatta published a paper on West American *Eulimidae*[2] in which he described the following:

Eulima lowei Vanatta, page 254, plate 11, figures 9, 10.
Eulima bistorta Vanatta, pages 254–5, plate 11, figures 7, 8.
Eulima compacta Carpenter, pages 255–6, plate 11, figures 11, 12.
Eulima randolphi Vanatta, page 256, plate 11, figures 13, 14.
Eulima micans Carpenter, pages 256–7, plate 11, figures 1, 2.
Eulima rutila Carpenter, plate 11, figures 5, 6.

Nine years later the present writer published A New Parasitic Mollusk of the Genus Eulima.[3] In this *Eulima ptilocrinicola* Bartsch is characterized.

The year following Dr. William H. Dall[4] bestowed the name *Stilifer* (*Mucronalia*) *bathymetrae* upon the mollusk mentioned by Hartlaub in 1895.

In the same year he published his Descriptions of New Species of Mollusks from the Pacific Coast of the United States with Notes on other Mollusks from the same Region.[5] On page 253 of this paper he describes *Eulima* (*?*) *lomana* Dall.

The year following William H. Dall and the present writer published A Monograph of West American Pyramidellid Mollusks.[6] On page 230, *Odostomia* (*Scalenostoma*) *rangii* De Folin is described and figured. This is now transferred to the family Melanellidae.

In 1912 the present writer referred to *Odostomia* (*Scalenostoma*) *rangii* De Folin on page 342; he also described and figured *Odostomia* (*Scalenostoma*) *babylonia* Bartsch (pp. 287–288, pl. 38, fig. 3) of his paper on Additions to the West American *Pyramidellid* Mollusk Fauna, with Descriptions of New Species,[7] which must now be referred to the family here discussed.

The last paper dealing with West American *Melanellids* was published by Frank M. Anderson and Bruce Martin on Neocene Record

[1] Bull. Mus. Comp. Zool. Cambridge, vol. 27, No. 4, 1895.
[2] Proc. Acad. Nat. Sci. Philadelphia, 1908, pp. 254, 257, pl. 11.
[3] Proc. U. S. Nat. Mus., vol. 32, 1907, pp. 255–256, pl. 33.
[4] Bull. Mus. Comp. Zool. Cambridge, vol. 43, 1908, pp. 317–318.
[5] Proc. U. S. Nat. Mus., vol. 34, 1908.
[6] Bull. 68, U. S. Nat. Mus., 1909.
[7] Proc. U. S. Nat. Mus., vol. 42, 1912.

in the Temblor Basin, California, and Neocene Deposits of the San Juan District, San Louis Obispo County.[1] Here the following are described and figured: *Niso* (?) *antiselli* Anderson and Martin, p. 65, pl. 7, fig. 22, and *Eulima gabbiana* Anderson and Martin, p. 68, pl. 7, fig. 20, the last being a *Melanella.*

The group covered by the present monograph is by far the most difficult one that I have thus far treated; the characters are few and confined in the different groups chiefly to differences in outline, flexure, size, weight, and in addition to these, in the case of *Strombiformis* and *Niso,* to color patterns. Whatever there may be of merit in this study, I feel that the credit for it should fall upon the collectors and institutions that have placed all their material in my hands, for without this abundance of material, it would have been entirely impossible to reach the positive conclusions expressed in these pages. Foremost among these I wish to express my thanks to Dr. H. A. Pilsbry, of the Philadelphia Academy of Natural Sciences, for the loan of types, and to Prof. F. B. Loomis of Amherst College, for the loan of C. B. Adams's types from Panama. Also to the California Academy of Sciences for similar favors and the Stanford University for the loan of specimens. Of the private collectors, the material submitted by Mr. and Mrs. T. S. Oldroyd leads easily, both as far as number of species and specimens are concerned. These collections are followed by those of Miss J. M. Cooke; Mrs. Kate Stephens; Dr. Frank Baker; Dr. Ralph Arnold, whose collection is particularly rich in fossil material; Dr. S. S. Berry; Prof. F. W. Kelsey; Mr. F. L. Button; Mrs. Elizabeth E. Johnston; Mr. H. N. Lowe; Mrs. Paula Ball; Mrs. W. H. Eshnaur; and Mrs. Maria Baldridge. It should also be here stated that the splendid collections made by the late Mr. Henry Hemphill and the late Mr. C. W. Gripp, now in other hands, have materially added to the knowledge of these forms.

This paper would be incomplete, did I fail to express my appreciation to Dr. William H. Dall, honorary curator of the section of Mollusks, for his kindly counsel and encouragement while working on this difficult problem.

The photographs used in the illustrations were mostly made by Mr. T. W. Smillie, of the United States National Museum. A few were taken by Mr. John H. Paine, and all of them were retouched by Mrs. E. B. Decker, under my personal supervision.

KEY TO THE WEST AMERICAN GENERA AND SUBGENERA OF THE FAMILY.

Shell umbilicated.....*Niso*, p. 348.
Shell not umblilicated.
  Nuclear whorls forming a mucronate apex.
    Postnuclear whorls globular.....*Stilifer*, p. 352.
    Postnuclear whorls not globular.
      Postnuclear whorls oval.....*Lambertia*, p. 354.
      Postnuclear whorls cylindric.....*Mucronalia*, p. 353.

[1] Proc. Cala. Acad. Sci., ser. 4, vol. 4, 1914.

Nuclear whorls not forming a mucronate apex.
Shell with a strong peripheral keel.....*Scalenostoma*, p. 337.
Shell without a strong peripheral keel.
Inner lip with a twist resembling an obsolete fold.....*Haliella*, p. 336.
Inner lip without a twist resembling an obsolete fold.
Inner lip free, color bands present.....*Eulimostraca*, p. 333.
Color bands absent.....*Sabinella*, p. 333.
Inner lip not free, appressed to the attenuated base.
Shell with color markings.....*Strombiformis*, p. 339.
Shell without color markings.
Shell straight.....*Melanella*, p. 302.
Shell flexed.....*Balcis*, p. 319.

Genus MELANELLA Bowdich.

Melanella Bowdich, Elem. Conch., vol. 1, 1822, p. 27. Type *Melanella dufresnii* Bowdich=*Eulima* Risso, Hist. Nat. Eur. Mer., vol. 4, 1826, p. 123. Type *Eulima elegantissima* Risso=*Melanella polita* (Linnaeus)=*Balcis* Leach, Syn. Moll. Grt. Brit., 1852, p. 200. Type *Balcis arcuata* Leach (=*Melanella distorta* Jeffreys, see Jeffrey Brit. Conch., vol. 4, 1867, p. 207)=*Vitreolina monterosato*, Nom. Conch. Medit., 1884, p. 100. Type *Eulima incurva* (Renier) (=*Melania distorta* Jeffreys, see Bucquoy, Dautzenberg, and Dollfus, Mar. Rous., vol. 2, 1887, p. 769).

The genus as here constituted embraces the white polished mollusks that have the last whorl produced and the inner lip appressed for its entire length, or at least for the greater part of its length, to the attenuated base. The shells may be straight or flexed.

The large amount of material before us shows several species which completely bridge the gap between the straight and the flexed forms; the flexure in these instances being extremely slight. For this reason I have combined *Balcis* with *Melanella*. For convenience sake, however, rather than for difference in structural characters, we may retain the name *Balcis* as a group designation.

Subgenus Melanella Bowdich.

Melanella Bowdich, Elm. Conch., vol. 1, 1822, p. 27. Type *Melanella dufresnii* Bowdich=*Eulima* Risso, Hist. Nat. Eur. Mer., vol. 4, 1826, p. 123. Type *Eulima elegantissima* Risso=*Melanella polita* (Linnaeus).

Melanellas with straight shells.

MELANELLA (MELANELLA) DALLI, new species.

Plate 35, fig. 5.

Shell straight, large, stout, polished, milk-white with irregularly disposed varices. (Early whorls decollated on both of our specimens), later whorls slightly rounded, appressed at the summit. Sutures slightly constricted. Base short, well rounded. Aperture oval, posterior angle acute, outer lip thin, bending slightly forward immediately after leaving the summit, then backward from the

periphery, so that the basal portion is behind the plane of the peripheral edge; inner lip short, moderately thick, curved and slightly reflected over the base, the reflected portion fusing with the thin parietal callus.

Two specimens of this species (Cat. No. 132072), are in the collection of the United States National Museum. They came from the Gulf of California. Both have lost their tips; one of these, the type, has $10\frac{1}{2}$ whorls remaining, and measures—length, 20 mm.; diameter, 7.5 mm. This is the largest species so far known from the west coast of America.

MELANELLA (MELANELLA) MICANS Carpenter.

Plate 34, figs. 1–6.

Eulima micans CARPENTER, Rep. Brit. Ass. Adv. Sci. (1863) 1864, p. 659; Proc. Phila. Acad. Nat. Sci., 1865, p. 63.

Shell straight, elongate-conic, bluish-white when the animal has been removed. When the animal has been allowed to dry in the shell, it appears through the substance of the shell and gives it a mottled brownish aspect. The brownish coloration when present usually extends over the upper half of the specimen. Whorls flattened, decidedly appressed at the summit. Sutures appearing as a very fine impressed line. Base moderately long, well rounded. Aperture oval; posterior angle very acute; outer lip thin at the edge, bent back immediately below the summit, then forward to form a claw-shaped element, the center of which coincides with the periphery: there is another backward deflection of the outer lip at its junction with the inner lip which is moderately strong, curved and twisted and partly reflected over and adnate to the base; parietal wall covered with a moderately thick callus.

The type and another specimen (Cat. No. 14850, U.S.N.M.) were collected by Doctor Cooper, at San Pedro, California. The type has four whorls and measures—length, 9.5 mm.; diameter, 3 mm. An adult specimen (Cat. No. 15317, U.S.N.M.), having 15 whorls, measures—length, 12.5 mm.; diameter, 4 mm. The present form ranges over the Oregonian and Californian faunal areas, decreasing in size from the north, southward. Geologically it is known from the upper and lower San Pedro series of California.

The following specimens have been examined:

Number of specimens.	Collection of—	Catalogue number.	Locality.	Remarks.
2[1]	U.S.N.M.	14850	San Pedro, Cal.	Fig'd, pl. 34, fig. 6
3	do.	207775	Departure Bay, B. C.	
3	Stanford University.		False Narrows, Vancouver Island, B. C.	15 fathoms.
1	U.S.N.M.	215662	San Juan Island, Wash.	
1	do.	109640	Monterey, Cal.	
4	Button	259	do.	
1	U.S.N.M.	56458	Monterey Harbor	8 to 10 fathoms mud bottom.

[1] 1 Type.

Number of specimens.	Collection of—	Catalogue number.	Locality.	Remarks.
2	Berry	3075	Monterey Bay	28 fathoms.
3	U.S.N.M.	160086	Catalina Island	
1	do	251070	Pacific Grove	
9	do	128257	San Pedro	
1	Oldroyd		do	Deep water.
3	do		do	Low tide. Sand bottom.
4	Berry	236	San Pedro Bay	3 fathoms.
3	Button		do	1 fathom.
127	Oldroyd		San Pedro	
49	do		do	
1	Johnston		do	
1	U.S.N.M.	322287	do	
15	Lowe	3499	do	
2	do		do	10 fathoms.
104	Eshnaur		Terminal Island	
1	U.S.N.M.	15317	Between San Pedro and San Diego.	Fig'd, pl. 34, fig. 5.
2	Oldroyd		Pacific Beach	Drift.
1	Baker		San Diego	12 to 30 fathoms.
15	U.S.N.M.	46509	do	
1	do	251069	do	
22	do	56765	do	
107	do	322288	do	
4	do	208503	do	
30	Baker		do	
3	do		Below Ballast Point	10 fathoms.
3	do		Outside Zunniga	Dredged.
1	do		False Bay	Do.
15	Kelsey		San Diego Flats	
12	Oldroyd		San Diego	
13	Button		do	
25	Cooke		do	
1	Mrs. Ball		Los Angeles	
20	Baldridge		California	
4	Stephens	2461	San Diego	
27	do	3016	do	
4	Johnston		do	
3	Oldroyd		Point Abreojos, L. C	

FOSSILS.

UPPER SAN PEDRO SERIES.

400	U.S.N.M.	324207	Santa Monica Canyon	
447	Arnold		do	
20	U.S.N.M.	148621	San Pedro	
3	do	324208	Lumber yard, San Pedro	1 fig'd, pl. 34, fig. 4.
7	Arnold		do	
1	U.S.N.M.	324210	Sand Rock, Dead Mans Island.	
4	Arnold		do	
10	do		Lumber yard, San Pedro	
2	U.S.N.M.	324209	San Diego	1 fig'd, pl. 34, fig. 3.
9	Arnold		do	
6	U.S.N.M.	7987	do	
15	do	148627	do	
22	Arnold		Spanish Bight	
109	Stephens	3014	do	
195	U.S.N.M.	148622	Spanish Bight No. 1	
21	do	148628	Spanish Bight No. 2	
32	do	148624	Spanish Bight No. 4	1 fig'd, pl. 34, fig. 1.
14	do	148623	Spanish Bight No. 2	
4	Stephens	5245	Spanish Bight	
4	do	3007	do	
2	do	3005	do	
1	do	3002	do	
4	do	5246	do	
3	do	3004	do	

LOWER SAN PEDRO SERIES.

7	U.S.N.M.	324213	Cerritos	1 fig'd, pl. 34, fig. 2.
19	Arnold		do	
3	U.S.N.M.	324212	Dead Mans Island	
7	Arnold		do	
1	Stephens	2211	San Pedro Railroad cut	

MELANELLA (MELANELLA) MICANS BOREALIS, new subspecies.

Plate 35, fig. 7.

From Vancouver north we have a race of *M. micans* which is uniformly more slender than the race to the south. This may have the subspecific name applied to it above.

The type (Cat. No. 150954, U.S.N.M.) comes from Comox, Vancouver Island. It has 12 whorls and measures—length, 11.3 mm., diameter, 3.3 mm. In addition to this I have seen four specimens: Cat. No. 214039, U.S.N.M. dredged in 13 fathoms, on mud bottom, at St. Paul, Kodiak Island, Alaska; 1, Cat. No. 160084, U.S.N.M. from Kodiak Island; 2, Cat. No. 208774, U.S.N.M. from Alert Bay, British Columbia; 1, Cat. No. 150954, U.S.N.M., from Comox, Vancouver Island, British Columbia; and 1 in Dr. Fred Baker's collection from Departure Bay, British Columbia.

MELANELLA (MELANELLA) OCHSNERI, new species.

Plate 35, fig. 1.

Shell rather large, almost straight, polished, bluish-white. The whorls are very slightly rounded; appressed at the summit, which scarcely shows at its junction with the preceding turns. The basal portion of the preceding whorls show through the substance of the succeeding turns in such a manner as to render this more conspicuous than the suture. Last turn moderately long, well rounded. Aperture very small; posterior angle pinched in, acute, outer lip thick, coming to a sharp edge; inner lip very strong, slightly oblique; the parietal wall covered by a very strong callus which is reflected over and about the columella and renders the peritreme complete.

The type and 42 specimens of this species were collected at Banks Bay, Albemarle Island, Galapagos Islands, on and near sea-cucumbers. The type has lost the nucleus and probably the first two post-nuclear turns. The 12 remaining measure—length, 9 mm.; diameter, 3 mm. The type is in the University of California collection. Four of these specimens are in the collection of the U. S. National Museum, Cat. No. 322282. Two additional specimens, also in the collection of the University of California, came from Sappho Cove, Chatham Island.

This species in a way recalls the northern *Melanella micans* Carpenter, but it differs from it by being stouter and by having a much smaller aperture with a remarkable callus, which is absent in the case of *micans*, or practically so.

MELANELLA (MELANELLA) RUTILA Carpenter.

Plate 35, figs. 2, 3, 6.

Eulima rutila CARPENTER, Rept. Brit. Ass. Adv. Sci. (1863) 1864, p. 659; Proc. Cala. Acad. Nat. Sci., vol. 3, 1865, p. 221.

Shell of medium size, elongate-conic, slender, straight, surface polished, glassy without perceptible sculpture, excepting irregularly distributed varices. Whorls appressed at the summit to such an extent that the suture is scarcely perceptible; the basal portion of the preceding whorls, shining through the substance of the succeeding turns as a false suture; the true suture appearing about one-third of the way between the summit and the false suture above the latter. Periphery of the last whorl rounded, base sloping in such a way as to lend the left outline a somewhat flattened appearance. Aperture large, oval; posterior angle acute; outer lip decidedly protracted between the base and the posterior angle, forming a clawlike extension; inner lip short, moderately stout, somewhat curved, reflected over and appressed to the base; parietal wall covered with a moderately thick callus.

Carpenter's type (Cat. No. 14928, U.S.N.M.) comes from Monterey, California; it has 13 whorls and measures—length, 6.8 mm.; diameter, 1.9 mm.

The following specimens have been examined:

Number of specimens.	Collection of—	Catalogue number.	Locality.	Remarks.
1[1]	U.S.N.M.	14928	Monterey, Cal.	
1	do	222423	Station 2863, Gulf of Georgia, British Columbia.	67 fathoms, sand bottom, 48.5° bottom temperature.
5	Stanford University.		False Narrows, Nanaimo, Vancouver, B. C.	
1	Baker		Near Orcas Islands, Wash.	
1	U.S.N.M.	224456	Station 3068, Puget Sound	135 fathoms, mud bottom.
17	do	322291	Elliott Bay, N. W. Point Seattle.	
1	do	251270	Station 2867-2868, off northwestern Washington.	31-37 fathoms, fine gray sand, 46.9° bottom temperature.
1	do	251269	Monterey, Cal.	
1	Lowe	3501	do	
7	Button		do	
2	U.S.N.M.	322292	Station 3194, off Estero Bay, Cal.	92 fathoms, gray sand bottom, 45.9° bottom temperature.
2	do	211822	Station 2901, off St. Rosa Island, Cal.	48 fathoms, mud bottom, 55° bottom temperature.
2	do	251285	Station 3664, 2 miles off Avalon, Cal.	80 fathoms, fine gray sand.
2	Oldroyd		Whites Point	Drift.
37	U.S.N.M.	251267	San Pedro, Cal.	
16	do	322289	San Pedro	
5	do	322293	Off starfish, San Pedro	Deep water.
2	S. S. Berry		San Pedro	
31	do		San Pedro Bay	15 fathoms.
9	Johnston		San Pedro	
9	H. N. Lowe	3501	do	10 fathoms.
100	Oldroyd		Off San Pedro Bay	
4	do		Off San Pedro	Berkeley dredging.
2	do		do	Deep water.

[1] Type.

Number of specimens.	Collection of—	Catalogue number.	Locality.	Remarks.
3	Oldroyd		San Pedro	Off stones.
23	do		Off starfish, San Pedro	Deep water.
4	do		Ventral side of starfish	Sandy bottom.
1	Stephens		San Pedro, Cal	
19	Eshnaur		Terminal Island	
3	U.S.N.M	251271	Station 4322, off Point La Jolla, Cal.	110 to 199 fathoms, green mud - shell bottom, 45.4° bottom temperature.
38	do	251272	Station 4323, off Point La Jolla, Cal.	193 to 227 fathoms, soft green mud bottom, 45.8° bottom temperature.
16	do	251274	Station 4325, off Point La Jolla, Cal.	192 to 292 fathoms, green mud, fine sand bottom, 43°-46° bottom temperature.
1	do	211207	Station 4327, off La Jolla, Cal.	263 to 300 fathoms, mud bottom.
1	do	251275	Station 4369, 10 miles off Point Loma Light, Cal.	260 to 284 fathoms, green sand, green mud, rocks, bottom.
1	do	251276	Station 4362, off Point Loma Light.	100 to 159 fathoms, fine gray sand, blue specks bottom.
3	do	251277	Station 4475, 10 miles off Point Loma Light.	142 to 158 fathoms, gray mud bottom.
1	do	210100	Station 4232, off Point Loma, Cal.	62 to 183 fathoms, sand specks, rocks, bottom.
1	do	173074	Northwest of San Diego, 8 miles offshore.	50 fathoms, dark sand bottom.
1	do	251274	Station 4356, San Diego Harbor, Cal.	120 to 131 fathoms, sand, mud bottom.
2	do	211907	Station 3564, San Diego Bay, Cal.	5 fathoms, sand, mud, shell bottom.
35	do	322290	San Diego, Cal	
2	do	268503A	San Diego	
3	do	273392	do	
1	do	250631	do	15 fathoms.
3	do	274022	San Diego, foot of Broadway	Dredged.
3	do	322294	San Diego, Cal	50 fathoms.
7	Baker		San Diego, midspit	
1	do		San Diego	12 to 30 fathoms.
2	do		do	12 to 15 fathoms.
4	do		do	50 fathoms.
2	S. S. Berry		do	Do.
3	Button		do	
3	Cooke		do	
19	Kelsey		do	12 to 30 fathoms.
39	Oldroyd		do	
48	do		San Diego, Pacific beach	Drift.
1	Baker		Near Ballast Point, Cal	
2	U.S.N.M	153043	Ocean Beach, Cal	
2	Cooke		do	
7	do		Coronado Island	
2	Baker		South end South Coronado Island.	
2	do		South Coronado Island	7 to 10 fathoms.
2	U.S.N.M	193660	From *Strongylocentrotus*, station 2935, off southern California.	124 fathoms, fine gray sand bottom, 49.2° bottom temperature.
1	do	251278	Off southern California, station 2936.	359 fathoms, mud bottom, 49° bottom temperature.
3	S. S. Berry		Lower California	Drift.
1	Johnston		do	Do.
1	U.S.N.M	151935	Station 2826-7-8, Cerros Island, off Lower California.	9½ to 10 fathoms.
2	do	106515	Scammons Lagoon	Mud flats, low tide, rare.
2	Oldroyd		do	
20	U.S.N.M	322295	San Hipolito Point	
59	Cooke		do	
4	Kelsey		San Hipolito Point, Lower California.	
1	Oldroyd		do	

Number of specimens.	Collection of—	Catalogue number.	Locality.	Remarks.
2	U.S.N.M.	322296	Point Abreojos, Lower California.	
2	Oldroyd.		do.	
1	U.S.N.M.	268637	Station 5678, Magdelena Bay, off Redondo Point, Lower California.	13½ fathoms.
1	Cooke		Magdalena Bay, Lower California.	
181	Baldridge		California	
1	Cooke		do.	

FOSSILS.

UPPER SAN PEDRO SERIES.

2	U.S.N.M.	251279	Santa Monica	
13	Arnold		Santa Monica Canyon	
1	U.S.N.M.	324216	Cerritos Island	1 figured, pl. 35, fig. 6.
1	Arnold		do.	
2	U.S.N.M.	324217	San Pedro	
4	Arnold		Lumber yard, San Pedro	
2	U.S.N.M.	148626	San Diego, Cal	
1	do.	148603	Station 2127, Dosinia beds, lower stratum, railroad crossing foot Twenty-third Street, San Diego.	
1	do.	148705	Dosinia beds upper stratum, railroad crossing, foot of Twenty-third Street, San Diego.	
2	Stephens		Twenty-sixth Street, San Diego, Cal.	
1	do.		San Diego, Cal	
4	U.S.N.M.	324215	Spanish Bight	
4	do.	251286	do.	
24	Stephens		do.	
1	U.S.N.M.	324214	Station 7498, San Quentin	

LOWER SAN PEDRO SERIES.

2	U.S.N.M.	324218	Sand Rock, Dead Mans Island.	1 figured, pl. 35, fig. 3.
2	Arnold		do.	

MELANELLA (MELANELLA) SOLITARIA C. B. Adams.

Plate 35, fig. 4.

Eulima solitaria C. B. ADAMS, Ann. Lyc. Nat. Hist. New York, vol. 5, 1852, p. 423.

Shell of medium size, broadly elongate conic, milk-white, polished. Early whorls rather well rounded; succeeding turns flattened; marked by exceedingly fine lines of growth only. Suture poorly defined. Periphery of the last whorl somewhat inflated, well rounded. Base moderately long, well rounded. Aperture short, subcircular; posterior angle acute; outer lip decidedly drawn forward in the middle; inner lip stout, strongly curved, reflected over and appressed to the base; parietal wall covered by a thick callus.

The type in the collection of Amherst College, Amherst, Massachusetts, was collected by Prof. Adams on a large holothurian on Taboga Island, Bay of Panama. It has 12 whorls and measures—length, 4.7 mm.; diameter, 1.7 mm.

MELANELLA (MELANELLA) MONIÇENSIS, new species.

Plate 36, fig. 2.

Shell elongate conic, with perfectly straight-sided spire, yellowish-white, polished, marked by fine lines of growth only. Whorls decidedly flattened, suture very poorly defined. Periphery of the last whorl decidedly angulated. Base short, well rounded. Aperture rhomboid, with a decided angle at the junction of the outer and basal lip; posterior angle acute; outer lip thin, inner short, straight, revolute; parietal wall covered by a thin callus.

The type and another specimen (Cat. No. 251301 U.S.N.M.) come from the Upper San Pedro series at Santa Monica, California. The type has lost the early whorls, the 11 remaining measure—length, 8 mm., diameter, 2.9 mm. Three additional specimens from the same locality are in Mr. Arnold's collection.

MELANELLA (MELANELLA) NECROPOLITANA, new species.

Plate 36, fig. 3.

Shell moderately large, elongate-conic, slender, with perfectly straight-sided spire. First two whorls moderately rounded, separated by well marked suture, the remaining flattened, with scarcely impressed suture. Periphery of the last whorl angulated. Base moderately long, well rounded. Aperture oval; posterior angle acute; outer lip angulated at the junction of the outer and basal lip; inner lip oblique, curved, slightly revolute, reflected over and appressed to the base posteriorly; parietal wall covered with a thin callus.

The type (Cat. No. 251314, U.S.N.M.) comes from Sand Rock, Lower San Pedro Series of Dead Mans Island, California. It has 13 whorls and measures—length, 7.5 mm.; diameter, 2 mm.

MELANELLA (MELANELLA) OLDROYDI, new species.

Plate 36, figs. 5, 6, 7.

Shell rather broadly elongate-conic, bluish-white in the living form, yellowish-white in the fossil, polished, marked by exceedingly fine lines of growth only. The first three whorls well rounded, separated by a moderately impressed suture; the succeeding flattened, separated by a feebly defined suture. Periphery of the last whorl weakly angulated. Base short, well rounded. Aperture oval; posterior angle acute; outer lip angulated at the junction with the basal lip and slightly protracted at the angle; inner lip short, curved, strongly reflected and appressed to the base posteriorly; parietal wall covered with a thick callus.

The type and another specimen (Cat. No. 109641, U.S.N.M.) were collected by Mrs. Oldroyd at San Pedro, California. The type has 14 whorls and measures—length, 9.2 mm.; diameter, 3 mm.

The following specimens have been examined:

Number of specimens.	Collection of—	Catalogue number.	Locality.	Remarks.
2[1]	U.S.N.M.	109641	San Pedro, Cal.	
3	do	251302	Station 2901, off Santa Rosa Island.	48 fathoms, gray sand mud bottom, 55.1° bottom temperature.
10	do	322298	San Pedro	
1	Johnston		do	
10	H. N. Lowe	3499	do	
1	Johnston		do	
28	Oldroyd		do	
7	Eshnaur		Terminal Island	
2	Cooke		Ocean Beach	
1	Button		La Jolla	
8	Oldroyd		Pacific Beach	
9	U.S.N.M.	322297	San Diego	
2	do	274021	San Diego, foot of Broadway	Dredged.
2	do	160087	San Diego Bay	3 fathoms, mud bottom.
2	Cooke		San Diego	
12	Oldroyd		do	
2	Baker		Below Ballast Point	10 fathoms.
1	do		Hipolita Point	
4	Oldroyd		Abreojos Point	
2	Baldridge		California	

FOSSILS.

UPPER SAN PEDRO SERIES.

10	U.S.N.M.	324223	Santa Monica Cañon	
34	Arnold		do	
8	U.S.N.M.	324219	Santa Monica	
1	do	324220	Lumber yard, San Pedro	1 figured, pl. 36, fig. 5.
6	Arnold		do	
1	do		San Pedro	
3	U.S.N.M.	324221	Spanish Bight	
3	Arnold		do	
18	Stephens		do	
1	U.S.N.M.	324222	Station 7495 San Quentin, Lower California, from bed on stratum of lava, west side of bay.	

LOWER SAN PEDRO SERIES.

4	U.S.N.M.	251313	Dead Mans Island, Cal.	1 figured, pl. 36, fig. 7.
3	Arnold		Sand Rock, Dead Mans Island.	

[1] 1 type.

MELANELLA (MELANELLA) LINEARIS Carpenter.

Plate 36, fig. 4.

Leiostraca linearis CARPENTER, Cat. Maz. Shells, 1858, p. 440.

Shell small, very slender, elongate-conic, yellowish-white, polished; surface marked by exceedingly fine lines of growth only. First four whorls well rounded, separated by a strongly impressed suture, the succeeding turns flattened, rather high, with a scarcely recognizable suture. Periphery of the last whorl feebly angulated. Base rather long, evenly curved. Aperture quite large, broadly oval; posterior angle acute; outer lip decidedly protracted between the posterior angle and the base; inner lip oblique, slightly curved, revolute, the

upper half appressed to the base; parietal wall covered with a thin callus.

Three specimens of this species were dredged by the United States Bureau of Fisheries steamer *Albatross* at station No. 2823 in 26½ fathoms on broken shell bottom, bottom temperature 73°, off La Paz, Lower California. Two of these we have described and figured. The smaller of these two is a young individual of 10 whorls and measures—length, 1.7 mm.; diameter, 0.5 mm. The adult has eight whorls, having lost the early turns, and measures—length, 2.6 mm.; diamater, 0.8 mm.

Carpenter's type, which is in the British Museum, Liverpool collection, Tablet 2025, is a young specimen, having nine whorls, which measure—length, 1.8 mm.; diameter, 0.55 mm.

The following additional specimens, all dredged by the United States Bureau of Fisheries steamer *Albatross*, in the Gulf of California, have been examined. 1, specimen (Cat. No. 191567, U.S.N.M.), at stations 2826 to 2828, near La Paz, in 9½ to 10 fathoms, on shell bottom; 1 (Cat. No. 251300, U.S.N.M.), off Cerralvo Island, station 2822, in 21 fathoms, on gray sand and broken shell bottom, bottom temperature 73°.

MELANELLA (MELANELLA) PANAMENSIS, new species.

Plate 36, fig. 1.

Shell small, elongate-conic, yellowish-white, polished, marked by exceedingly fine lines of growth only. The first three whorls well rounded, separated by a well-impressed suture, succeeding turns flattened, with poorly defined suture. Periphery of the last whorl decidedly angulated. Base short, well rounded. Aperture small, broadly oval; posterior angle acute; outer lip angulated at the junction with the basal lip; inner lip very oblique, stout, slightly curved, reflected over and appressed to the base posteriorly; parietal wall covered with a thick callus.

The type (Cat. No. 251312, U.S.N.M.) was dredged by the United States Bureau of Fisheries steamer *Albatross* at station 2794, in the Bay of Panama, in 62 fathoms on gray sand and broken shell bottom, bottom temperature 59.6°. It has lost the first whorl; the nine remaining measure—length, 2.8 mm.; diameter, 1 mm.

MELANELLA (MELANELLA) RECTA C. B. Adams.

Plate 39, fig. 3.

Eulima recta C. B. Adams, Ann. Lyc. Nat. Hist. New York, vol. 5, 1852, p. 423.

Shell acicular, bluish-white. Early whorls slightly rounded, the later ones decidedly flattened, appressed at the summit, marked by exceedingly fine lines of growth only. Suture scarcely indicated. Periphery of the last whorl well rounded. Base produced, well

rounded. Aperture very elongate-ovate; posterior angle very acute; outer lip pinched immediately below the summit, and slightly protracted in the middle to form a short, claw-like element; inner lip stout, almost straight, reflected over and appressed to the attenuated base; parietal wall covered with a moderately thick callus.

Professor Adams collected five specimens at Taboga Island, in the Gulf of Panama. The type and two of these are in the collection of Amherst College, Amherst, Massachusetts. The type has lost probably the first three whorls. The 10 remaining measure—length, 10.4 mm.; diameter, 2.7 mm. A younger specimen of 12 whorls measures—length, 8.7 mm.; diameter, 2.3 mm.

MELANELLA (MELANELLA) RANDOLPHI Vanatta.

Plate 37, fig. 4.

Eulima randolphi VANATTA, Proc. Phila. Acad. Nat. Sci., 1899, p. 256, pl. 11, figs. 13, 14.

Shell moderately large, rather broadly conic, straight, polished, marked by exceedingly fine lines of growth and scarcely perceptible microscopic spiral striations; bluish white, except where the dry animal within shines through the shell, there it appears light brown. Nuclear whorls, scarcely differentiated from the succeeding turns; post-nuclear whorls, moderately well rounded, separated by a slightly impressed suture. Periphery of the last whorl, well rounded, base rather short, moderately well rounded. Aperture oval; posterior angle acute; outer lip thin, drawn slightly forward in the middle between the posterior angle and the base; parietal wall covered by a thin callus.

The type and six specimens (Cat. No. 73729), Philadelphia Academy of Natural Sciences, were collected by Mr. Randolph at Unalaska, Aleutian Islands. The type has 9 whorls and measures—length, 7 mm.; diameter, 2.6 mm.

The following specimens have been examined:

Number of specimens.	Collection of—	Catalogue number.	Locality.	Remarks.
7[1]	Phila.Acad.Nat.Sci.	73729	Unalaska	
6	U.S.N.M	100145	do	
1	do	100085	Kyska	
1	do	214036	Kyska Harbor	
2	do	214037	Constantine Harbor, Amchitka.	
2	Berry		Dutch Harbor, Unalaska	
36	U.S.N.M	206300	do	
6	Button		do	
7	U.S.N.M	151597	Unalaska	
9	do	251263	Station 2862, off Vancouver Island.	238 fathoms, sand bottom, 44.7° bottom temperature.
1	Kelsey		Puget Sound	
1	Baker		do	
2	Oldroyd		do	

[1] 1 type.

MELANELLA (MELANELLA) CALIFORNICA, new species.

Plate 37, fig. 1.

Shell elongate-conic, straight, polished, marked by exceedingly fine lines of growth and scarcely perceptible microscopic spiral striations, bluish-white, except where the dry animal shines through the texture of the shell, there it lends this a rosy flush. Whorls moderately rounded, separated by a slightly constricted suture. Periphery of the last whorl well rounded. Base moderately long, well rounded. Aperture elongate oval; posterior angle acute; outer lip drawn forward between the posterior angle and the base; inner lip slightly curved and partly appressed to the base; parietal wall covered by a thin callus.

The type (Cat. No. 56911, U.S.N.M.) comes from Catalina Island, California. It has eight whorls and measures—length, 6.2 mm; diameter, 2.3 mm.

The present species resembles quite closely *M. randolphi*, but differs from it in being uniformly smaller and more slender, with the aperture proportionately longer than that species. An additional specimen is in Doctor Baker's collection from San Martin.

MELANELLA (MELANELLA) HEMPHILLI, new species.

Plate 37, fig. 6.

Shell straight, stout, elongate-conic, polished, marked by exceedingly fine lines of growth and scarcely perceptible microscopic spiral striations, the two forming an exceedingly fine and very regular incised grating on the surface; bluish white. Whorls moderately rounded, very slightly constricted at the sutures. Periphery of the last whorl well rounded. Base moderately long, but somewhat inflated, well rounded. Aperture small, oval; posterior angle acute; outer lip thin at the edge, which is scarcely at all drawn forward between the posterior angle and the base. Parietal wall covered with a thick callus.

The type and three specimens (Cat. No. 106514, U.S.N.M.) were collected by Henry Hemphill, on mossy rocks between tides, at Point Abreojos, Lower California. The type has 10 whorls and measures—length, 8.3 mm; diameter, 3 mm.

The present species is readily distinguished from the other straight West Coast forms, that have rounded whorls, by its larger size and by the fact that the spiral sculpture is much stronger than in *randolphi*, or *californica*.

The following specimens have been examined:

Number of specimens.	Collection of—	Catalogue number.	Locality.
4[1]	U.S.N.M.	127554	Point Abreojos, Lower California.
1	Oldroyd		San Diego.
1	do		Todos Santos Bay, Lower California.
10	do		Point Abreojos.
2	do		Lower California.
2	Johnston		Do.
2	Stephens		Without locality.

[1] 1 type.

MELANELLA (MELANELLA) COMPACTA Carpenter.

Plate 37, fig. 3.

Eulima compacta CARPENTER, Rept. Brit. Ass. Sci. 1863, 1864, p. 659; Proc. Cala. Acad. Nat. Sci., vol. 3, 1865, p. 221.

Shell broadly elongate-conic, straight, polished, the surface marked by exceedingly fine lines of growth and scarcely perceptible microscopic spiral striations. Whorls flattened, separated by a scarcely defined suture; in fact, the basal portion of the preceding whorl shines through the substance of the succeeding turn and causes it at this point to appear as the suture. Periphery of the last whorl well rounded. Base moderately long, well rounded. Aperture quite long, oval, posterior angle acute; outer lip thin, protracted a little anterior to the middle between the posterior angle and the base; inner lip slightly curved, rather thick, reflected over and appressed to the base; parietal wall covered by a moderately strong callus.

Carpenter's type (Cat. No. 13517*b*, U.S.N.M.) was collected by Cooper at San Pedro, California. It has lost the first turn; the eight remaining measure—length, 6.8 mm.; diameter, 2.2 mm. Cat. No. 322300, U.S.N.M. contains another specimen from Lower California. Two additional specimens collected by Henry Hemphill, Point Abreojos, Lower California, are in Mr. Kelsey's collection, and two more collected by the same gentleman, in Lower California, are in Mrs. Oldroyd's collection.

MELANELLA (MELANELLA) BALDRA, new species.

Plate 37, fig. 2.

Shell of medium size, broadly, regularly conic, bluish-white. The first two whorls well rounded, the rest almost flat. Decidedly appressed at the summit, polished, marked by exceedingly fine incremental lines only. The basal portion of the preceding whorl shines through the substance of the succeeding turn and gives this the aspect of having a double suture. Sutures faintly marked. Periphery of the last whorl feebly angulated. Base well rounded. Aperture very small, broadly oval; posterior angle acute; outer lip

thick within, thin at the edge, somewhat protracted in the middle; inner lip short, stout, reflected over and appressed to the base anteriorly; parietal wall covered with a thick callus.

The type and another specimen (Cat. No. 322299, U.S.N.M.), come from San Hipolito Point, Lower California. The type has nine and a half post-nuclear whorls and measures—length, 5.1 mm.; diameter, 2 mm.

MELANELLA (MELANELLA) MEXICANA, new species.

Plate 37, fig. 5.

Shell elongate-conic, straight, polished, marked by exceedingly fine lines of growth and scarcely perceptible microscopic spiral striations; bluish-white. Whorls flattened, separated by an ill-defined suture. The basal portion of the preceding whorl, shining through the succeeding turn, gives to this an appearance of having a false suture. Periphery well rounded. Base rather short, well rounded. Aperture moderately long, oval; posterior angle acute; outer lip thin, decidedly protracted halfway between the posterior angle and the base; inner lip oblique, slightly curved, reflected over and appressed to the base; parietal wall covered with a moderately thick callus.

The type (Cat. No. 267304, U.S.N.M.) comes from the Gulf Coast of Lower California. It has 12 whorls and measures—length, 6.4 mm.; diameter, 2 mm.

The present species is much smaller than *M. compacta* and has a much shorter aperture than that species.

The following specimens have been examined:

Number of specimens.	Collection of.	Catalogue number.	Locality.	Remarks.
1[1]	U.S.N.M	267304	Gulf of California	
2	do	268600	South End Angel de la Guardia.	
2	do	265936	Mulege, Gulf of California	2 fathoms.
1	do	267837	Pichilinque Bay	
7	do	267813	do	
7	do	251280	Off Cacachitas, Gulf of California, station 2823.	26½ fathoms, broken shell bottom.
1	do	267292	Gulf Coast, Lower California.	
1	do	23759	Gulf of California	
1	do	25319	Acapulco	

[1] Type.

MELANELLA (MELANELLA) ABREOJOSENSIS, new species.

Plate 40, fig. 4.

Shell small, acicular, bluish-white, semitranslucent. Whorls rather high between the sutures, well rounded, separated by a constricted suture. Marked by extremely fine incremental lines and irregularly spaced varices. Periphery well rounded. Base rather protracted, well rounded. Aperture moderately large; posterior

angle acute; outer lip thick within, thin at the edge; inner lip somewhat curved, slightly twisted, reflected over and appressed to the base; parietal wall covered by a moderately thick callus.

The type and three specimens (Cat. No. 105578, U.S.N.M.) were collected at Point Abreojos, Lower California. The type has nine whorls, and measures—length, 3.1 mm.; diameter, 1 mm. Twelve additional specimens of the same locality are in Mrs. Oldroyd's collection.

MELANELLA (MELANELLA) TACOMAENSIS, new species.

Plate 38, fig. 5.

Shell small, straight, broadly elongate-conic, bluish-white, except where the animal shines through, there it appears golden brown; surface marked by exceedingly fine lines of growth and almost invisible microscopic spiral striations. Whorls flattened, separated by a scarcely defined suture; the basal portion of the preceding whorl shining through the substance of the succeeding turn appears as a conspicuous false suture. Periphery obscurely angulated; base short, flattened, the left margin very obliquely sloping. Aperture moderately large; posterior angle acute; outer lip very thick within, thin at the edge, decidedly protracted a little anterior to the middle between the posterior angle and the base; inner lip very stout, somewhat flexuose, reflected over and appressed to the base; parietal wall covered with a thick callus.

The type (Cat. No. 159268, U.S.N.M.) was collected by Mr. Fisher at Tacoma, Washington. It has 10 whorls and measures—length, 5 mm.; diameter, 2.1 mm. The sloping base gives the basal portion of the shell a decidedly oblique appearance, which distinguishes this form from all the other straight Melanellas from the west coast.

MELANELLA (MELANELLA) GABBIANA Anderson and Martin.

Plate 38, fig. 3.

Eulimella gabbiana Anderson and Martin, Proc. Cala. Acad. Sci., ser. 4, vol. 4, 1914, p. 68, pl. 7, fig. 20.

"Shell very small, slender, and smooth, polished, with numerous whorls; apex acute (broken in the type-specimen), whorls nearly flat, unsculptured; suture appressed, indistinct; base unflattened; aperture ovally elongated; outer lip sharply rounded anteriorly; inner lip concave, incrusted.

"*Dimensions.*—Altitude of the figured specimen, upper whorls lost, 4 mm.; maximum width, 1.3 mm.

"*Occurrence.*—Lower Miocene of Kern River, California, locality 64.

"This species is distinguished by its small size, slender and smooth form and its long narrow aperture.

"*Type.*—No. 143, Cal. Acad. Sci., in the bottom of a small canyon about 1¼ miles due north of Barker's ranch house, Kern County, California.

"Named in honor of William Gabb."

MELANELLA (MELANELLA) RETEXTA Carpenter.

Plate 38, fig. 1.

Leiostraca retexta CARPENTER, Proc. Zool. Soc. London, 1863, p. 356.
"*Leiostraca* ? *iota*, var. *retexta* CARPENTER, Cat. Maz. Shells, 1857, p. 440. Comp. *Eulima iota*, C. B. Adams, Pan. Shells, No. 290, pp. 198, 317.—SOWERBY, Thes. Conch. in loco.—H. and A. ADAMS, Gen. Rec. Moll., vol. 1, 1854, p. 236.

"*L.* ? *iota, axi recta.*

"The form above indicated accords somewhat better with the Panama species than with the British, but is entirely without twist. The British specimens are also sometimes straight. The shells in this genus afford so very few distinctive characters that no species can be certainly established without an accurate knowledge of the animals. The only two specimens found vary in proportion; the smaller, with 6 normal turns, measuring long., '06; lat., '028 inches; the larger, long., '087; lat., '033 inches.

"Habitat.—Mazatlan; extremely rare, off *Spondylus;* L'pool Col.

"Tablet 2026 contains the larger specimen."

I have not seen specimens referable to this subspecies, and quote Doctor Carpenter's description and give an unpublished camera lucida drawing made by him of the type.

MELANELLA (MELANELLA) PUSILLA Sowerby.

Plate 38, fig. 2.

Eulima pusilla SOWERBY, Proc. Zool. Soc. London, 1834, p. 8.
Eulima pusilla SOWERBY, Thes. Conch., 1854, pp. 794–5, pl. 169, figs. 9, 10, 21.

"Straight, subulate, thin, white, transparent; whorls slightly convex; aperture elongate-oval, pointed posteriorly.

"Sancta Elena. (Mus. Cuming.)"

I have seen no specimens agreeing with this species and have copied Sowerby's description and figure.

MELANELLA (MELANELLA) HASTATA Sowerby.

Plate 38, figs. 4, 6.

Eulima hastata SOWERBY, Proc. Zool. Soc. London, 1834, p. 7.
Eulima hastata SOWERBY, Thes. Conch., 1854, p. 794, pl. 169, figs. 7, 8.

"Whorls flattened, the first opaque and yellowish, the last white and diaphanous, the last whorl subangular; aperture small, oval, pointed posteriorly.

"Sancta Elena. (Mus. Cuming.)"

I have not seen specimens of this species and copy Sowerby's description and figure.

MELANELLA (MELANELLA) PRODUCTA Carpenter.

Plate 39, fig. 5.

Leiostraca producta CARPENTER, Proc. Zool. Soc. London, 1863, p. 357.=*Leiostraca* ? *solitaria* Carpenter, Cat. Mazatlan Shells, 1857, p. 439. Not *Eulima solitaria* C. B. Adams, Ann. Lyc. Nat. Hist. New York, 1852, p. 423.

Carpenter's manuscript figure, a camera lucida sketch, shows a broadly conic young *Melanella*. I have seen nothing that agrees with it. I add from Carpenter:[1]

"One nearly perfect shell and some fragments answer to the description of this species. It differs from *L. iota* var. *retexta*, in being larger, broader, flatter, with the whorls in different proportion Long. (anfr. ix.), 123, long. spir. '08, lat. '046, div. 23°.

"Hab.—Taboga; a solitary specimen in large *Holothuria;*

"C. B. Adams.—Mazatlan; extremely rare, on *Spondylus;*

"L.'pool Col.

"Tablet 2022 contains the specimen."

And again:[2]

"*L. solitaria* M. 551, * * * agrees in shape with the unique Panama shell, whorl for whorl; but its base and labrum are much more produced anteriorly. For this reason, it may be known as *L. producta*."

He also states under *Eulima* (? var.) *rutila* Carpenter:[3]

"Closely allied to *Leiostraca producta* Carpenter, Maz. Cat. No. 551, but displays no varices."

MELANELLA (MELANELLA) ELODIA de Folin.

Plate 39, fig. 1.

Eulima elodia DE FOLIN, Les Meleagrinicoles, 1867, pp. 66, 67, pl. 6, fig. 6.

"Shell imperforate, elongate, polished, milky-white, subopaque; spire conoidal, the apex rather obtuse. Whorls 11 to 12, slowly increasing, united by a simple suture, the last whorl approximately two-fifths as high as the entire shell. Aperture cordate, subopaque, rounded at base, the margins a little thickened; the columella feebly reflexed. Long., 0.005; diam., 0.0015.

"This species is like the other *Eulimas*, graceful and elegant in outline, and in the beauty of its luster. It is much elongated; the right side is almost rectilinear; the left is slightly convex, but that does not prevent the shell from appearing conoidal. The apex, although very slightly obtuse, may be said to be acute, because it in no way way clashes with the acuminate outline. The spire is composed of 11 or 12 whorls, which increase very slowly. The final whorl, which is imperforate, is equal to about two-fifths of the total

[1] Cat. Maz. Shells, 1857, p. 439.
[2] Proc. Zool. Soc. London, 1863, p. 357.
[3] Proc. Cala. Acad. Nat. Sci., vol. 3, 1866, p. 221.

altitude. The whorls are united by a simple suture, which may be called a very clearly and feebly impressed line. The aperture is slightly oblique, and cordate; its margins are smoothly united at the base by a curve which marks the greatest width. Though not sharp, the margins are scarcely at all thickened, the left margin enlarging a little in order to spread out over the side of the last whorl and over the columella, which is enlarged somewhat and seems to be reflected. On certain days *Eulima elodia*, which is milky-white, seems to be almost opaque. Nevertheless it is brilliantly polished and rather diaphanous, so that a certain direction of the light may make all the details of the interior structure apparent, and give to it the appearance of a double suture. It may be said that the true suture is a white ribbon, more strongly marked than that which is posterior to it, and which exactly simulates it. By following this ribbon, at the same time the suture, as far as the angle of the aperture on the final whorl, the illusion will be naturally dissipated.

"*Type locality.*—Negritos; or Margarita Island, Panama."

I have not seen specimens of this species and quote the description and figure.

Subgenus BALCIS Leach.

Balcis LEACH, Syn. Moll. Grt. Brit., 1852, p. 200. Type *Balcis arcuata* Leach. (=*Melanella distorta* Jeffreys, see Jeffrey Brit. Conch., vol. 4, 1867, p. 207.) =>*Vitreolina* Monterosato, Nom. Conch. Medit., 1884, p. 100. Type *Eulima incurva* (Renier) (=*Melania distorta* Jeffreys, see Bucquoy, Dautzenberg, and Dollfus, Mar. Rous., vol. 2, 1887, p. 769.

Melanellas with flexed shells.

MELANELLA (BALCIS) DRACONIS, new species.

Plate 39, fig. 2.

Shell short, very broadly conic, milk-white, flexed in one direction only. The tip of our shell is broken. The first two whorls remaining are slightly rounded, the rest almost flat. Suture well marked. Last whorl rather stout. Periphery decidedly angulated. Base short, somewhat tumid anteriorly, well rounded. Aperture broadly oval; posterior angle acute; outer lip decidedly sinuous, strongly protracted in the middle, to form a decidedly claw-like element; inner lip stout, strongly reflected over and appressed to the base; parietal wall covered by a rather thick callus.

The type (Cat. No. 215766 U.S.N.M.) comes from Dead Man's Island, California. It has seven and a half whorls remaining, and measures—length, 6.1 mm.; diameter, 2.7 mm. This fossil species is the stoutest of the single curved Eulimellas known from the west coast of America.

MELANELLA (BALCIS) MONTEREYENSIS, new species.

Plate 39, fig. 6.

Shell broadly conic, falcate, flexed to the right, bluish-white, with a series of opaque areas, marking varicial streaks. Early whorls well rounded, the later ones slightly rounded, a little more so on the convex than the concave side. Sutures scarcely marked. The posterior determination on the inside of the turns, shines through the substance of the shell and appears as a conspicuous false suture. Periphery weakly angulated. Base short, very strongly curved on the left side. Aperture short, broadly oval; posterior angle acute; outer lip quite strongly protracted at the periphery, inner lip oblique, curved, reflected and appressed to the base; parietal wall covered by a thick callus.

The type (Cat. No. 176623, U.S.N.M.) was dredged by Dr. S. S. Berry, at Pacific Grove, California. It has lost probably the first three turns. The eight remaining measure—length, 5 mm.; diameter, 2.2 mm.

Cat. No. 181307, U.S.N.M., contains a young specimen, collected by Mrs. Merrihew, at Monterey, California.

MELANELLA (BALCIS) PENINSULARIS, new species.

Plate 39, fig. 4.

Shell elongate-conic, very slightly curved, polished, surface marked by exceedingly fine lines of growth and exceedingly regular, very fine, microscopic, spiral striations; bluish-white, except where the animal shines through the substance of the shell, when it appears brown. Whorls separated by a very poorly defined suture, which is inconspicuous compared to the false suture caused by the base of the preceding whorl shining through the substance of the succeeding turn. The whorls are marked at irregular intervals by thickened varices, which are very prominent. Periphery of the last whorl well rounded. Base short, slightly rounded, the left sides sloping very obliquely. Aperture broadly oval; posterior angle acute, outer lip decidedly protracted half way between the posterior angle and the base; inner lip very oblique, moderately strong, slightly curved, reflected over and appressed to the base; parietal wall covered with a thick callus.

The type (Cat. No. 251264, U.S.N.M.) comes from Lower California. It has 11 whorls and measures—length, 5.2 mm.; diameter, 2.2 mm.

The following additional specimens have been examined:

Number of specimens.	Collection of—	Catalogue number.	Locality.	Remarks.
1 [1]	U.S.N.M.	251264	Lower California	
8	do	215763	San Diego	
1	do	273993	do	
5	do	127543	San Hipolito Point	
7	do	130613	do	On *Haliotis*.
20	Baker		do	
2	Button		do	
6	Cooke		do	
2	Kelsey		do	
18	Oldroyd		do	
3	U.S.N.M.	106516	Point Abreojos	
17	Oldroyd		do	
2	Cooke		Magdalena Bay	
1	U.S.N.M.	268583	Lower California	
1	Johnston		do	
3	Oldroyd		do	

[1] Type.

MELANELLA (BALCIS) LASTRA, new species.

Plate 40, fig. 3.

Shell small, conic, only very slightly flexed; bluish-white, semi-translucent; polished, marked by exceedingly fine lines of growth only. The first three whorls well rounded, separated by a well-impressed suture, the rest very slightly rounded, with a scarcely defined suture. Periphery well rounded. Base short, well rounded. Aperture very broadly oval; posterior angle acute; outer lip decidedly protracted a little anterior to the middle; inner lip short, curved, reflected over and appressed to the base; parietal wall covered with a thick callus.

This species is similar to *M. peninsularis*, but is uniformly more slender, with the varices much less conspicuously marked.

The type and three specimens (Cat. No. 105519, U.S.N.M.) were collected by Mr. Henry Hemphill at Point Abreojos, Lower California. The type, an adult shell, which has lost probably the first two whorls, retaining eight, measures—length, 4.1 mm.; diameter, 1.6 mm, Another, an immature specimen of nine whorls, measures—length, 2.6 mm.; diameter, 1 mm.

The following additional specimens have been examined:

Number of specimens.	Collection of—	Catalogue No.	Locality.	Remarks.
5 [1]	U.S.N.M.	105519	Point Abreojos	
2	do		San Pedro	Deep water, off stones.
4	Oldroyd		do	Do.
2	Berry		San Hipolito Point	
6	U.S.N.M.	105577	Point Abreojos, Lower California.	
1	Cooke		Magdalena Bay	

[1] Type.

MELANELLA (BALCIS) ARNOLDI, new species.

Plate 40, fig. 8.

Shell broadly conic, with very slight flexure; milk-white. Early whorls well rounded, separated by a well-constricted suture, later ones almost flattened, appressed at the summit with a very poorly defined suture. Periphery weakly angulated. Base short, well rounded. Aperture broadly oval; posterior angle acute; outer lip protracted in the middle; inner lip short, slightly sinuous, reflected over and appressed to the base; parietal wall covered with a thick callus.

The type (Cat. No. 215765, U.S.N.M.) was collected at Sand Rock, Lower San Pedro Series, Dead Man's Island, California. It has 11 whorls and measures—length, 5.5 mm.; diameter, 2.1 mm. Another specimen from the same locality is in Mr. Arnold's collection; still another from San Pedro is also in Mr. Arnold's collection.

MELANELLA (BALCIS) COSMIA, new species.

Plate 40, fig. 6.

Shell very small, broadly conic, flexed to the right; bluish-white; semitranslucent; polished. The first three whorls well rounded, separated by a moderately well-constricted suture; the rest slightly rounded, with scarcely defined suture. Periphery of the last whorl weakly angulated. Base short, well rounded. Aperture very broadly ovate; posterior angle acute; outer lip strongly protracted a little anterior to the middle; inner lip curved, reflected over and appressed to the base; parietal wall covered with a moderately thick callus.

The type and three specimens of this species (Cat. No. 105580, U.S.N.M.) were collected by Mr. Henry Hemphill at Point Abreojos. The type has nine whorls and measures—length, 2.7 mm.; diameter, 1 mm. Mr. Kelsey's collection contains two from the same place, while Mrs. Oldroyd's collection has two from the same locality and two labeled Lower California, without specific locality.

MELANELLA (BALCIS) HALIA, new species.

Plate 40, fig. 2.

Shell very minute, translucent, showing the entire internal structure within, slightly flexed in one direction at the tip. Whorls very evenly rounded, separated by a rather strongly marked suture, polished, without sculpture excepting slightly impressed varicial streaks at irregular intervals. Periphery of the last whorl well rounded. Base short, slightly inflated, well rounded. Aperture small, oval; posterior angle acute; outer lip thin, slightly protracted in the middle; inner lip short, slightly curved, reflected over and appressed to the base; parietal wall covered by a moderately thick callus.

The type (Cat. No. 215767, U.S.N.M.) was collected by Mr. Hemphill at Point Abreojos, Lower California. It has eight whorls and measures—length, 1.8 mm.; diameter, 0.7 mm. Another specimen from the same locality is in Mr. Kelsey's collection, while a third, in Mrs. Oldroyd's collection, comes also from the same place.

MELANELLA (BALCIS) TOWNSENDI, new species.

Plate 40, fig. 1.

Shell small, straight, excepting the tip, which is flexed in one direction, semitranslucent, bluish-white. The first three whorls well rounded, separated by a well-impressed suture. The rest almost flat, with inconspicuous suture. Periphery of the last whorl rounded. Base rather protracted, somewhat flat on the left side, slightly tumid anteriorly. Aperture broadly oval; posterior angle acute; outer lip thick at the edge, decidedly protracted in the middle; inner lip short, curved, reflected over and appressed to the base; parietal wall covered by a moderately thick callus.

The type and another specimen (Cat. No. 267812*a*, U.S.N.M.) were collected by the author in shallow water at Pichilinque Bay, Gulf of California. The type has 13 whorls and measures—length, 3.8 mm.; diameter, 1.1 mm.

MELANELLA (BALCIS) THERSITES Carpenter.

Plate 41, figs. 1, 2, 3.

Eulima thersites CARPENTER, Rept. Brit. Ass. Adv. Sci. (1863) 1864, p. 659; Ann. Mag. Nat. Hist., ser. 3, vol. 15, 1865, pp. 396–7.
Eulima lowei VANATTA, Proc. Acad. Nat. Sci. Phila., 1899, p. 254, pl. 11, figs. 9, 10.
Eulima bistorta VANATTA, Proc. Acad. Nat. Sci. Phila., 1899, pp. 254–5, pl. 11, figs. 7, 8.

Shell broadly conic, rather stout and heavy, polished, shining, usually flexed in one direction only, though sometimes in two. Whorls rather strongly rounded, marked by exceedingly fine incremental lines and irregularly scattered varices only. Sutures strongly marked. Periphery of the last whorl somewhat inflated, well rounded. Base short, well rounded. Aperture oval; posterior angle acute; outer lip thick within, sharp at the edge, and decidedly protracted a little anterior to the middle; inner lip stout, slightly curved, the posterior half reflected over and appressed to the base. Parietal wall covered by a very thick callus which renders the peritreme complete.

Carpenter's type (Cat. No. 11795 U.S.N.M.) comes from Santa Barbara, California. It has lost the early whorls. The six and a half remaining measure—length, 5.1 mm.; diameter, 2.5 mm. An absolutely perfect specimen of 12 whorls measures—length, 6.3 mm.; diameter, 2.3 mm.

In addition to the figure of the type, we are also giving figures of Doctor Vanatta's two species, *Melanella bistorta*, and *Melanella lowei*.

The large amount of material which we have seen of this species makes it impossible for us to consider these distinct forms.

I have seen the following species:

Number of specimens.	Collection of—	Catalogue number.	Locality.	Remarks.
1 [1]	U.S.N.M.	11795	Santa Barbara	
3	do	46510	Monterey	
4	do	56893	do	
11	Button		do	
1	Eshnaur		do	12 fathoms.
1	Kelsey		do	
1	Oldroyd		do	
1 [2]	Phila. Acad. Nat. Sci.	65881	Monterey [2]	On starfish.
4	Berry		Monterey, off del Monte	12 fathoms.
1	do		Pacific Grove	
3	U.S.N.M.	215768	Off St. Cruz (off *Haliotis*)	
3	Oldroyd		do	
3	U.S.N.M.	215770	Off Santa Rosa Island, U. S. B. F. station 2900.	13 fathoms, sandy bottom.
2	do	215769	Off Catalina Island	
1	Oldroyd		Catalina Island	
4	U.S.N.M.	215771	San Pedro	Deep water.
2	Lowe		do	10 fathoms.
22	Oldroyd		do	
6	do		do	Deep water.
1 [3]	Phila. Acad. Nat. Sci.	57262	Long Beach [3]	
2	Cooke		Ocean Beach	
1	Stephens	2451	Imperial Beach	
1	Cooke		La Jolla	
17	U.S.N.M.	215772	San Diego	
1	Baker		do	15 fathoms.
1	do		do	
1	Berry		do	Do.
2	Cooke		do	
2	Kelsey		do	
1	do		do	Do.
3	Oldroyd		do	
2	Baker		Ballast Point	8 fathoms.
2	U.S.N.M.	226460	Off South Coronado Island	3 fathoms.
2	Baker		South Coronado Island	6 to 8 fathoms.
2	do		do	3 fathoms.
1	do		do	
1	do		do	3 to 6 fathoms.
1	Cooke		do	
2	Oldroyd		Todos Santos	
4	U.S.N.M.	215773	San Hipolito Point	
4	Cooke		do	
4	Kelsey		do	
7	Oldroyd		do	
1	do		Point Abreojos	
1	do		Round Island, Lower California.	
1	Lowe		San Geronimo Island	
	Berry	1411A	Lower California	

[1] Type. [2] Type of *Eulima bistorta* Vanatta. [3] Type of *Eulima lowei* Vanatta.

MELANELLA (BALCIS) COLUMBIANA, new species.

Plate 41, fig. 5.

Shell large, rather stout, polished, with a double flexure; when viewed with the aperture to the front it shows the early whorls bent backward and the succeeding turns flexed to the right. Shell bluish-white, except where the dried animal shines through its substance; there it has a granular, light brown to buff appearance. First three turns well rounded, separated by a well-marked suture, the remaining turns slightly rounded with scarcely defined suture. The posterior termination of the inside of the whorl shines through the shell and

appears as a conspicuous false suture. Surface marked by fine lines of growth only. Periphery of the last whorl weakly angulated. Base strongly rounded on the left side. Aperture very oblique, ovate; posterior angle acute; outer lip decidedly protracted at the periphery; inner lip short, curved, slightly sinuous, reflected over and appressed to the base; parietal wall covered by a thick callus.

The type and four specimens (Cat. No. 207771, U.S.N.M.) were collected by Rev. G. W. Taylor, at Departure Bay, British Columbia. The type has 15 whorls and measures—length, 9.5 mm.; diameter, 3 mm. This is the largest of flexed Melanellas known from the West Coast of America.

Number of specimens.	Collection of—	Catalogue number.	Locality.
12	Taylor		Departure Bay, British Columbia.
1	Baker		Alaska.
1	U.S.N.M.	204016	Bear Bay, Baranoff Island, Peril Strait, Alaska.
3	Stephens		Do.
2	Baker		Departure Bay, British Columbia.
7	Kelsey		Do.

MELANELLA (BALCIS) COMOXENSIS, new species.

Plate 41, fig. 4.

Shell broadly conic, with a double flexure, the early portion being turned back while the later is turned to the right; bluish-white, polished. First two whorls well rounded, separated by a constricted suture, the rest slightly rounded, a little more so on the convex than the concave side, marked by exceedingly fine lines of growth and microscopic spiral striations and occasional varicial streaks, which appear as an opaque spot in the shell. Suture scarcely defined. The posterior limit of the inside of the whorls shines through the substance of the shell and appears as a false suture. Periphery of the last whorl slightly angulated. Base short, strongly rounded. Aperture broadly oval, rather short; posterior angle acute; outer lip protracted at the periphery; inner lip short, slightly curved, strongly reflected and appressed to the base; parietal wall covered with a thick callus.

The type and five specimens (Cat. No. 207773, U.S.N.M.) were collected at Comox, British Columbia, by Rev. G. W. Taylor. The type has 11 whorls and measures—length, 7.1 mm.; diameter, 3 mm.

Twenty-eight additional specimens from the same locality are in Rev. G. W. Taylor's collection.

MELANELLA (BALCIS) MACRA, new species.

Plate 41, fig. 6.

Shell of medium size, slender, with a double flexure. When viewed with the aperture to the front, it shows the early whorls bent backward and the succeeding turns flexed to the right. Shell bluish-white, except where the dried animal shines through its substance; there it has a granular light brown to buff appearance. First four whorls well rounded, with well-impressed suture, the remainder almost flattened, marked by exceedingly fine lines of growth only, and separated by a scarcely visible suture. The posterior limit of the inside of the whorls shines through the substance of the shell and appears as a conspicuous false suture. Periphery of the last whorl weakly angulated. Base somewhat prolonged, well rounded. Aperture long, ovate; posterior angle acute; outer lip considerably protracted, particularly so at the periphery; inner lip stout, curved, reflected over and appressed to the base; parietal wall covered by a thick callus.

The type and three specimens of this species (Cat. No. 207772, U.S.N.M.) were collected by Rev. G. W. Taylor at Departure Bay, British Columbia. The type has 13 whorls and measures—length, 7.5 mm.; diameter, 1.9 mm.

The present species is very similar to *Melanella columbiana*, but uniformly smaller and much more slender.

The following additional specimens have been examined:

Number of specimens.	Collection of—	Catalogue number.	Locality.
11	Taylor		Departure Bay, British Columbia.
1	Kelsey		Do.
7	Berry		Do.
2	Button		Nanaimo, British Columbia.
2	Stanford University		False Narrows, Nanaimo, Vancouver Island, British Columbia.
1	U.S.N.M.	129124	Seattle, Washington.

MELANELLA (BALCIS) BERRYI, new species.

Plate 42, fig. 3.

Shell elongate-conic, with a double flexure; the first bend when the specimen is viewed with the aperture to the front, is to the right, and the second flexure is backward. The clean shell is bluish-white, but when the animal has been allowed to dry in it, it appears brown. The first two turns well rounded, separated by a constricted suture, the remainder flattened, marked by exceedingly fine lines of growth and very fine microscopic spiral striations. Sutures scarcely perceptible. The posterior limit of the inside of the whorls appears through the

mass of the shell as a false suture. Periphery of the last whorl well rounded. Base short, somewhat inflated anteriorly. Aperture oblique, broadly oval; posterior angle very acute; outer lip strongly protracted between the base and the posterior angle, the greatest extension falling at the periphery; inner lip oblique, slightly sinuous, reflected over and appressed to the base; parietal wall covered with a strong callus.

The type (Cat. No. 216820, U.S.N.M.) was dredged in 12 fathoms off Del Monte, Monterey, California, by Dr. S. S. Berry. It has 12 whorls and measures—length, 6 mm.; diameter, 2 mm.

Cat. No., 193697, U.S.N.M., contains another specimen dredged by the United States Bureau of Fisheries steamer *Albatross*, off Catalina Island.

MELANELLA (BALCIS) PREFALCATA, new species.

Plate 42, fig. 4.

Shell elongate-conic, yellowish-white, doubly flexed, the anterior portion being turned to the right and the tip backward. Early whorls slightly rounded, separated by a well marked suture, the succeeding turns appressed at the summit, moderately rounded on the curved side of the shell and slightly so on the concave side of the spire, marked by exceedingly fine lines of growth only. Sutures scarcely indicated. Periphery slightly angulated. Base somewhat produced, well rounded. Aperture moderately large; posterior angle acute; outer lip decidedly protracted at the peripheral angle; inner lip short, curved, reflected over and appressed to the base; parietal wall covered with a thick callus.

The type (Cat. No. 215774, U.S.N.M.) comes from the Lower San Pedro Series, Sand Rock, Dead Man's Island. It has 11 whorls and measures—length, 6.9 mm.; diameter, 2 mm. Five additional specimens are entered under the same catalogue number and 16 are in Doctor Arnold's collection, by whom they were collected. Three additional specimens without locality are in Arnold's collection.

The species resembles closely *falcata*, but differs from it by its comparatively longer aperture.

MELANELLA (BALCIS) GRIPPI, new species.

Plate 42, fig. 5.

Shell elongate-conic, moderately stout, doubly flexed; the anterior portion is turned to the right, while the tip is bent backward; polished, marked by exceedingly fine lines of growth only; milk-white, except where the dried animal shines through the texture of the shell where it appears yellowish-brown, or where varices cross the whorls, behind which there is always an opaque area. First five whorls well

rounded, separated by a somewhat constricted suture, the remainder, moderately rounded, a little more so on the convex side than the concave. Summit of the whorls appressed, separated by a very ill-defined suture. The posterior termination shows conspicuously through the substance of the shell on the inside of the whorls and appears as a false suture. Last whorl somewhat inflated. Periphery moderately protracted. Base rounded. Aperture ovate; posterior angle acute; outer lip protracted at the periphery; inner lip short, slightly curved, reflected and appressed to the base; parietal wall covered by a moderately thick callus.

The varices of this species practically form a continuous oblique line from the aperture almost to the tip.

The type and five additional specimens (Cat. No. 203665, U.S.N.M.) were collected by Mr. Gripp at Newport, California. The type has 12 whorls and measures—length, 8 mm.; diameter, 2.6 mm.

Number of specimens.	Collection of—	Catalogue number.	Locality.	Remarks.
2	U.S.N.M.	215775	Off San Pedro	Deep water.
11	Oldroyd		do	Do.
2	U.S.N.M.	215776	do	75 fathoms, on stones.
8	Oldroyd		do	Do.
7	do		San Pedro	
1	Button		San Diego	15 fathoms.
1	Kelsey		Off San Diego	Do.
9	U.S.N.M.	215777	San Diego	
1	Baker		Off south end of Coronado Island.	12 to 15 fathoms.
2	U.S.N.M.	215778	Point Abreojos	
3	Oldroyd		do	

MELANELLA (BALCIS) TARAVALI, new species.

Plate 42, fig. 2.

Shell very minute, bluish-white, doubly flexed; the anterior portion turned to the right, the tip flexed backward. The first three whorls well rounded, separated by a well impressed suture. The rest almost flat, separated by an inconspicuous suture, marked by exceedingly fine incremental lines only. The last whorl inflated. Periphery well rounded. Base short, well rounded. Aperture broadly oval; posterior angle acute; outer lip thin, slightly protracted in the middle; inner lip short, slightly curved, reflected over and appressed to the base; parietal wall covered by a rather thick callus.

The type (Cat. No. 215779, U.S.N.M.) was collected by Mr. Hemphill at Point Abreojos, Lower California. It has nine whorls and measures—length, 1.2 mm.; diameter, 0.3 mm. Two additional specimens from the same locality are in Mrs. Oldroyd's collection.

MELANELLA (BALCIS) CATALINENSIS, new species.

Plate 40, fig. 7.

Shell elongate-conic, slender, doubly flexed, the main flexure being turned to the right, while the extreme tip is slightly bent backward; bluish-white, polished. First two whorls well rounded, separated by a well-constricted suture, the rest moderately rounded on the convex, and slightly so on the concave side of the spire, separated by a scarcely defined suture. The posterior limit of the whorls shines through the substance of the shell and appears as a conspicuous false suture. Periphery of the last whorl slightly angulated. Base moderately produced, well rounded. Aperture oval; posterior angle acute; outer lip produced at the periphery; inner lip somewhat sinuous, very oblique, slightly reflected and appressed to the base; parietal wall covered with a thick callus.

The type (Cat. No. 173802, U.S.N.M.) was dredged in Catalina Channel. It has 10 whorls and measures—length, 5.2 mm.; diameter, 1.6 mm.

Number of specimens.	Collection of—	Catalogue number.	Locality.	Remarks.
1	U.S.N.M.	211822	Off Santa Rosa Island, station 2901.	48 fathoms, mud bottom, 55° bottom temperature.
1	Oldroyd		Off San Pedro	Deep water.
1	Cooke		Off Coronado Islands	
1	Kelsey		San Hipolito Point	

MELANELLA (BALCIS) FALCATA Carpenter.

Plate 42, fig. 6.

Eulima falcata CARPENTER, Proc. Zool. Soc., 1865, p. 280.

Shell doubly flexed, the anterior portion being turned to the right and the tip backward, yellowish-white. Early whorls decollated, the succeeding turns slightly rounded, more so on the curved than the concave side of the spire, marked by exceedingly fine lines of growth only, separated by a weakly impressed suture. Periphery of the last whorl subangulated, base moderately produced, well rounded. Aperture ovate; posterior angle acute; outer lip (fractured); inner lip short, curved, reflected over and appressed to the base; parietal wall covered by a moderately thick callus.

Carpenter's type (Cat. No. 123, U.S.N.M.) was collected by Mr. Rowell at Acapulco, Mexico. It has eight whorls remaining and measures—length, 7.6 mm.; diameter, 2.2 mm.

MELANELLA (BALCIS) YOD Carpenter.

Plate 40, fig. 9.

Leiostraca yod CARPENTER, Cat. Maz. Shells, 1857, p. 441.
Melania distorta PHILIPPI, Moll. Sci., vol. 1, p. 158, pl. 9, fig. 10.
Eulima distorta DESHAYES in Lamarck An. s. Vert., vol. 8, p. 454.—PHILIPPI, Moll. Sci., vol. 2, p. 135.—FORBES and HANLEY, Brit. Moll., vol. 3, p. 232.—CLARK, Moll. Test. Mar. Brit., p. 451.
Leiostraca distorta, H. and A. ADAMS, Gen. Rec. Moll., vol. 1, 1854, 236.

"L. t. '*L. distortae*' simillima, sed minima; parte suturali paululum latiore.

"The type of *Leiostraca iota* C. B. Ad. erroneously labeled 'Jamaica' in Mus. Cuming, and very incorrectly figured by Sow. is somewhat broader and less bent than the Mazatlan shells; in other respects it exactly accords. After repeated comparison of very fresh specimens with the British dwarf variety of *L. distorta*, the characters appear exactly alike, except that the sutural portion, which (the shell being transparent) gives an appearance of a spiral line, is slightly narrower in the Scarborough specimens received from Mr. Bean. The same glossy deposit over the base, with the rather separate parietal lip, giving in some directions of light the appearance of an umbilicus, appears in each, and of the same shape. No difference can be traced in the minute vertex, nor in the varices. The colour in fresh specimens exactly accords. The specimens in Mr. Andrew's collection, grouped under *Eu. distorta*, vary extremely in size and arcuation. The Mazatlan shells are on a much smaller scale, generally more bent, and most beautifully glossy and transparent. The same form occurs in the West Indies (B. M.). According to Deshayes (Lam. An. s. Vert., vol. 3, p. 455, No. 8) it is found fossil in Grignon and other places. If it extends so far back in time, it is natural that the living shell should occupy a widely distributed space. As, however, the animals may be distinct, both in this and in *L. iota*, a name is added expressive of its (for the genus) extreme minuteness. The smallest sp. (of 3 normal whorls) measures '035 by '016. A remarkably large sp. measures long. '082, long. spir. '055, lat. '033, div. 18°.

"*Hab.*—Norway to Mediterranean, Forbes; W. Indies, B. M.

"(Var. *Yod.*) Mazatlan; 34 sp. living on *Spondylus*, dead on *Chama;* L'pool Col.

"Tablet 2027 contains 4 sp. of different ages. The largest possesses its operculum, which appears like that of *Chrysallida*, but with the rugae much coarser. Another is broken so as to show the axis of the upper whorls."

We have not seen specimens of this minute, curved species and have copied Carpenter's description and figure: the latter is a camera lucida sketch.

STROMBIFORMIS (BALCIS) BIPARTITA Mörch.

Eulima bipartita MÖRCH, Mal. Blät., vol. 6, 1860, pp. 120–121.

"Shell shining, diaphanous, flexed to the right. Whorls 10, flattened, divided by a spiral band a little below the middle; the upper band white, the lower milk-white. Last whorl subangulated at the periphery. Aperture piriform, outer lip arcuate, produced; inner lip straight, with a callus; parietal wall covered with a moderately thick callus, which renders the peritreme complete. A series of impressed varices form an oblique line on the right side. Length, 7.5 mm.; diameter, 2.5 mm. Hab.: Sansonate Mexico. Three specimens with broken apex."

The above is a translation of Mörch's description. I have so far not seen specimens agreeing with it.

MELANELLA (BALCIS) ADAMANTINA de Folin.

Plate 42, fig. 1.

Eulima adamantina DE FOLIN, Les Meleagrinicoles, 1867, p. 62, pl. 6, fig. 2.

"Shell very small, imperforate, elongate, arcuate, acuminate, very highly polished, hyaline. Whorls nine in number, flattened, with a barely perceptible suture. Altitude of body whorl equal to one-third that of the entire shell. Aperture semilunate; margins a little thickened, the left slightly reflexed. Long., 0.0025, diam., 0.0008.

"Nothing is more brilliant than this species of *Eulima*. The outline is very much elongated, although its apex, a little obtuse. The altitude of the shell makes it appear acute. It is crystalline, extremely diaphanous, with a considerable luster. The spire is composed of nine whorls, which at first increase showly. The curvature of the spire is rather pronounced, turning the shell from right to left, so that the right side is concave and the left side convex. The whorls of the spire are united by a simple linear suture, very finely and very clearly traced. The transparency of the shell allows the base of each of the whorls to be seen, and the shell is thickened a little both above and below the suture. The final whorl is equal to about one-third of the total altitude and it is imperforate. The aperture is elongate and semicircular. Its margins are simple and joined very sharp, and the left is slightly reflected and turned back upon the columella.

"*Type locality.*—Negritos, or Margarita Island, Panama."

I have not seen specimens of this species and quote the description and figure.

MELANELLA (BALCIS) GIBBA de Folin.

Plate 43, fig. 2.

Eulima gibba De Folin, Les Meleagrinicoles, 1867, p. 64, pl. 6, fig. 4.

"Shell imperforate, ventricose, acuminate posteriorly. The apex rather obtuse, crystalline, very highly polished; whorls nine in number, increasing slowly in size, united by a simple suture. The final whorl tumid, more strongly inflated toward the left. Aperture semilunate. Margins simple; columella strongly reflected. Long., 0.003; diam., 0.0013.

"Like the preceding, this species may also be considered remarkable. It is corpulent, rather acuminate, recurved posteriorly, its apex seeming to try to unite with the aperture. It is quite as diaphanous as *adamantina* and as highly polished. The spire is composed of nine whorls. The early whorls increase slowly in diameter, but proportionately they enlarge rather rapidly; the increase takes place especially upon the left side. The final whorl, which alone constitutes one-half of the entire shell, is very much developed on this side. It is inflated and extends considerably beyond the line, which, judging from the margins of the preceding whorls, would serve as contours for it. In order to recognize the aperture when the final whorl has reached its maximum extension, it is necessary that it be oriented toward the right following a very oblique line. These abnormal conditions upon it, and consequently upon the entire shell, cause a hunchbacked outline, which serves as one of the principal diagnostics of this species. The suture is the same as that of *E. adamantina*. The aperture is cordate, elongate; its margins are well joined, and are united by a curve which represents its greatest diameter. The margins are somewhat thickened; the left, especially at the base of the aperture, is reflected, and is expanded over the final whorl in a decurrent angle, and at the same time it is reflected backwards over the columella.

"*Type locality.*—Negritos; or Margarita Island, Panama."

I have not seen specimens of this species and quote the description and figure.

MELANELLA (BALCIS) IOTA C. B. Adams.

Plate 40, fig. 5.

Eulima iota C. B. Adams, Ann. Lyc. Nat. Hist. New York, vol. 5, 1852, p. 422.

Shell very small, doubly flexed, semitranslucent, polished. Early whorls slightly rounded, the later ones flat, scarcely marked by lines of growth. Suture well marked. Periphery of the last whorl obscurely angulated. Base short, well rounded. Aperture moderately large; posterior angle acute; outer lip thin, inner lip fractured (reconstructing from the preceding whorls, we may say that it is concavely curved, reflected over and appressed to the base.)

Two specimens of this species were found at Panama by Prof. C. B. Adams. One of these, the type, is in the collection of Amherst College, Amherst, Massachusetts. This has nine whorls and measures—length, 1.7 mm.; diameter, 0.6 mm.

EULIMOSTRACA, new genus.

Melanellids in which the inner lip is not appressed to the attenuated basal portion of the preceding whorl; whorls almost flattened; outer lip of aperture not expanded: color markings present.

Type.—Eulimostraca galapagensis Bartsch.

EULIMOSTRACA GALAPAGENSIS, new species.

Plate 43, fig. 1.

Shell broadly elongate-conic, thin, translucent, showing the internal structure through the substance of the shell. Whorls rather high between the sutures, moderately well rounded, appressed at the summit; polished, marked by exceedingly fine incremental lines only. Suture lightly impressed. Periphery of the last whorl somewhat inflated; strongly angulated, marked by a narrow brownish band. Base short, well rounded. Aperture very broadly oval; posterior angle acute; outer lip thin, tinged with brown on the posterior half, decidedly protracted in the middle, to form a claw-like element; inner lip strongly curved, slightly reflected, fusing only slightly, posteriorly, with the preceding whorl; parietal wall covered by a thin callus.

The type and seven specimens (Cat. No. 251281, U.S.N.M.) were dredged off Galapagos Island, by the United States Bureau of Fisheries steamer *Albatross*, at station 2813, in 40 fathoms, on coral sand bottom, bottom temperature 80°. The type has 11 whorls and measures—length, 3.8 mm.; diameter, 1.2 mm.

Genus SABINELLA Monterosato.

Sabinella Monterosato, Natur. Sicil., 1890, p. 15. Type, *Sabinella piriformis* Brugnone.

Melanellids in which the inner lip is not appressed to the attenuated basal portion of the preceding whorl; whorls strongly rounded; aperture very large and outer lip decidedly expanded; color markings absent.

SABINELLA CHATHAMENSIS, new species.

Plate 43, fig. 4.

Shell broadly conic, yellowish-white, polished, marked by exceedingly fine protractive lines of growth only. The first two whorls well rounded, separated by a well-impressed suture, succeeding ones moderately rounded. Aperture very large, somewhat channeled

anteriorly; posterior angle acute; outer lip very strongly protracted between the posterior angle and the base, forming a decidedly claw-like element; inner lip decidedly curved, revolute with the posterior half appressed to the base; parietal wall covered with a thin callus.

The type (Cat. No. 251283, U.S.N.M.) was dredged by the United States Bureau of Fisheries steamer *Albatross* at station 2808, off the Galapagos Islands, in 634 fathoms, on coral sand bottom, bottom temperature 40°. It has nine whorls and measures—length, 3 8 mm., diameter, 1.3 mm.

SABINELLA BAKERI, new species.

Plate 43, fig. 5.

Shell small, very broadly conic, creamy-white. All the whorls moderately rounded, excepting the last which is very strongly rounded. All marked by rather prominent lines of growth, and rather numerous irregularly disposed varices, of which there are sometimes several to a single whorl. Suture moderately constricted. Periphery of the last whorl inflated, strongly rounded. Base short, strongly rounded, marked like the spire. Aperture very large; posterior angle acute; outer lip thin at the edge, decidedly produced, and protracted in the middle to form a strong claw-like element; inner lip slender, slightly curved, somewhat revolute, free for its entire length; parietal wall glazed by a thin callus.

The unique type (Cat. No. 215786, U.S.N.M.) was collected by Dr. Fred Baker, at San Diego, California. It has nine whorls and measures—length, 2.7 mm.; diameter, 1.1 mm.

SABINELLA OPALINA de Folin.

Plate 43, fig. 7.

Eulima opalina De Folin, Les Meleagrinicoles, 1867, pp. 67, 68, pl. 6, fig. 7.

"Shell imperforate, rather elongate, opaque, shining, opaline, darkly spotted with red. Spire conic, attenuated, tapering to a subacute apex. Whorls, 10 in number, increasing slowly in diameter, united by a simple suture, final whorl equal to one-third the altitude of the entire shell, strongly depressed at the base. Aperture subquadrate, the margin slightly thickened, columella reflected. Long., 0.0035; diam., 0.0018.

"This, again, is one of the prettiest of the species. It is red, elongated, but less so than those which precede it, and for this reason its diameter is relatively greater.

"It is conspicuously conic, and for this reason appears less acuminate, although its apex is acute. The spire is made up of 10 whorls, which increase slowly in diameter, but which increase more rapidly in diameter than in altitude. The final whorl, which is almost one-third as long as the entire shell, is imperforate, and very much depressed

at the base. A simple suture, similar to that of the preceding species, unites these 10 whorls. The aperture is subquadrate, acute at the point of union of the right margin with that of the final whorl. The right margin is simple, very slightly thickened. It is feebly reflected and merges smoothly into the left margin, which, with the increasing reflection of the margin, is spread out over the final whorl, and the columella. This species is almost opaque, colored in an opaline shade, which is very pronounced on the final whorls. On the medial portion of the shell the carmine tints of the spire are lost in the background.

"*Type locality.*—Negritos; or Margarita Island, Panama."

I have not seen specimens of this species and quote the description and figure.

SABINELLA? PTILOCRINICOLA Bartsch.

Plate 44, fig. 2.

Eulima ptilocrinicola BARTSCH, Proc. U. S. Nat. Museum, vol. 32, 1907, pp. 555–556, pl. 53.

Shell elongate-conic, thin, polished, transparent, tinged with bluish-white (the dried animal showing through the upper whorls as a granular golden-yellow mass.) Whorls 11, increasing regularly in size, decidedly rounded, with the surface weakly malleated, having a few feebly developed varices which appear at irregular intervals as narrow opaque vertical bands. Summit of the whorls closely appressed to the preceding turn, the extreme edge forming a slender spiral sutural band. Last whorl quite strongly inflated basally. Periphery and base well rounded, marked like the spire. Aperture moderately large, suboval; outer lip thin, evenly curved; inner lip slender, vertical, slightly reflected; parietal wall covered by a thin callus. Operculum thin, corneous.

The type (Cat. No. 195373, U.S.N.M.) was dredged by the United States Bureau of Fisheries steamer *Albatross* at station 3342, in 1,588 fathoms, off British Columbia, and measures—length, 9.5 mm.; diameter, 3.9 mm.

SABINELLA MERIDIONALIS, new species.

Plate 43, fig. 3.

Shell small, bluish-white, polished, marked by exceedingly fine lines of growth only. Early whorls decollated, later ones well rounded, separated by a moderately compressed suture. Periphery of the last whorl well rounded; base moderately long, well rounded. Aperture very broadly oval; posterior angle acute; outer lip thin, decidedly protracted in the middle between the posterior angle and the base; inner lip slender, curved, reflected over and partly appressed to the base posteriorly; parietal wall covered by a thin callus.

The type (Cat. No. 251282, U.S.N.M.) was dredged by the United States Bureau of Fisheries steamer *Albatross* at station 2808 off the Galapagos Islands, in 634 fathoms, on coral sand bottom, bottom temperature 40°. The last five whorls only remain in our specimen, but they are so distinct from any other that the species will readily be recognized by them. These measure—length, 3.9 mm.; diameter, 1.3 mm.

Genus HALIELLA Monterosato.

Haliella Monterosato, Enum. & Syn., 1873, p. 35, Type, *Haliella stenostoma* (Jeffreys).

Melanellids in which the inner lip is provided with a twist which gives it the appearance of having an obsolete fold.

HALIELLA ABYSSICOLA, new species.

Plate 43, fig. 8.

Shell elongate-conic, straight, semitransparent, polished, bluish-white, marked by scarcely perceptible lines of growth. Whorls slightly rounded, rather high between the sutures; the appressed portion of the summit appearing as a narrow white band, the posterior limit of which forming the suture is scarcely perceptible since it practically fuses with the preceding turn. Periphery of the last whorl well rounded. Base moderately long, well rounded. Aperture very large, ear-shaped; posterior angle acute; outer lip very thin, becoming gradually protracted from the posterior angle to the periphery, then more rapidly retractive toward the base, basal portion of the outer lip forming a broad, rounded channel; inner lip long, decidedly sigmoid, slightly reflected and partly appressed to the base, provided with a twist a little anterior to its insertion; parietal wall covered with a thin callus.

The type (Cat. No. 251266 U.S.N.M.) was dredged by the United States Bureau of Fisheries steamer *Albatross* at station 2923, off Southern California, in 822 fathoms, on green mud bottom, bottom temperature 39°. It has 10 whorls and measures—length, 10.4 mm.; diameter, 2.9 mm. Cat. No. 251265 U.S.N.M. was also collected by the *Albatross* at station 4368, off Point Loma Light, California, in 215 to 240 fathoms, on green mud. Cat. No. 266887 U.S.N.M. contains still another specimen of this species dredged off San Pablo Point, Mexico, by the *Albatross* at station 5675, in 284 fathoms, on green mud and fine sand bottom, bottom temperature 44.8°

HALIELLA CHILENSIS, new species.

Plate 43, fig. 6.

Shell elongate-conic, slender, semitranslucent to bluish-white, polished, surface marked by exceedingly fine lines of growth only. Whorls almost flattened, separated by a scarcely defined suture. Periphery of the last whorl well rounded. Base moderately long, well rounded. Aperture ovate; posterior angle acute; outer lip mod-

erately protracted between the posterior angle and the base; inner lip slender, curved, partly reflected over and appressed to the base posteriorly; parietal wall covered with a thin callus.

The type and four specimens (Cat. No. 251284, U.S.N.M.) were dredged by the United States Bureau of Fisheries steamer *Albatross* at station 2784, off Chile, in 194 fathoms on blue mud bottom, bottom temperature 51.9°. The type has nine whorls and measures—length, 5.5 mm.; diameter, 1.3 mm.

HALIELLA LOMANA Dall.

Plate 44, fig. 1.

Eulima (?) *lomana* DALL, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 253.

Shell very large, regularly elongate-conic, creamy white. The early whorls decollated. The succeeding turns slightly rounded, very narrowly and feebly shouldered at the summit, marked by faint, retractive, incremental lines, and numerous very regularly incised equal and closely-spaced spiral striations. Suture moderately impressed. Periphery of the last whorl angulated. Base moderately long, well rounded, marked like the spire. Aperture large, broadly oval, outer lip thin, fractured at the edge; inner lip rendered slightly sinuous by a twist a little anterior to its insertion; somewhat revolute, entirely free from the base; parietal wall covered by a thin callus.

The type and another specimen of this species (Cat. No. 110652, U.S.N.M.) were dredged by the United States Bureau of Fisheries steamer *Albatross* at station 4354, 16 miles off Point Loma Light, California, in 642 to 650 fathoms, on gray mud bottom, bottom temperature 38.5° to 39°. The type has nine whorls remaining and measures—length, 20.2 mm.; diameter, 7 mm.

Genus SCALENOSTOMA Deshayes.

Scalenostoma DESHAYES, Cat. Moll. Ile de la Reunion, 1863, pp. 58–60, pl. 7, figs. 26–8, Type *Scalenostoma carinatum* Deshayes=*Subeulima* Souverbie Journ. de Conch., vol. 23, 1875, p. 296, Type *Subeulima lamberti* Souverbie.= *Amblyspira* Dall, Proc. U. S. Nat. Mus., vol. 19, 1896, p. 314, Type *Aclis*? (*Amblyspira*) *teres* Guppy.

Melanellids having an acute keel at the periphery of the whorls, which gives to the outer lip of the aperture a }-shaped appearance.

SCALENOSTOMA RANGII De Folin.

Plate 45, fig. 4.

Chemnitzia rangii DE FOLIN, Les Meleagrinicoles, 1867, pp. 61–62, pl. 6, fig. 1.
Odostomia (*Scalenostoma*) *rangii* DALL and BARTSCH, Bull. 68, U. S. Nat. Mus., 1909, p. 230.
Odostomia (*Scalenostoma*) *rangii* BARTSCH, Proc. U. S. Nat. Mus., vol. 42, 1916, p. 344.

"Shell imperforate, elongate-conic. Apex rather obtuse, light colored. Whorls smooth, 12 in number. The earlier whorls nor-

mal, increasing regularly in diameter; the altitude of the body whorl one-third that of the entire shell. Suture simple above, afterward keeled by the preceding whorl. Aperture quadrate; the margins simple; the left lip somewhat reflected. Alt., 0.0027; diam., 0.0011.

"It is in honor to the memory of the learned Commodore Rang that we have given his name to this odd species of *Chemnitzia* and we feel a considerable satisfaction in being able thus to give witness to our feelings of profound esteem for a leader under whose orders we have served, as well as to express our admiration for his high scholarship. This shell is somewhat elongate, yellowish in color, tending a little toward a brown. The apex is rather obtuse. The spire is made up of 12 whorls, all of them smooth. The sides of the early whorls are almost straight, and this part of the shell is regularly conic. The four or five later whorls differ from the first anteriorly in that they escape from the profile of the cone and widen on a plane with the base, thus forming a prominent keel, which is very thin, almost sharp edged, upon the periphery. This expansion of the base follows the whorls of the spire, increasing in prominence as they increase in diameter. Thus the keel terminates on the right margin of the aperture. The suture is extremely narrow, and on the whorls furnished with the keel which we have just described it occurs in front of the keel, between the keel and the succeeding whorl. The aperture is almost quadrate; the margins are simple, and the left margin is slightly reflected upon the columella.

"*Type locality.*—Negritos, or Margarita Island, Panama."

I have not seen specimens of this species, and quote the description and figure.

SCALENOSTOMA BABYLONIA Bartsch.

Plate 45, fig. 2.

Odostomia (*Scalenostoma*) *babylonia* BARTSCH, Proc. U. S. Nat. Mus., vol. 42, 1912, p. 287, pl. 38, fig. 3.

Shell elongate-conic, light yellowish-brown, excepting the umbilical area, the extreme basal portion, and tip, which are white. Nuclear whorls very small. Postnuclear whorls flattened, separated by a scarcely impressed suture. On the last three turns the whorls are marked at the periphery by an exceedingly strong, acute, spiral keel, which is slightly bent downward. Base of the last whorl short, well rounded. Entire surface of spire and base smooth, except for exceedingly fine, incremental lines. Aperture oval; posterior angle acute; outer lip rendered }-shaped by the spiral keel; inner lip slender, evenly curved, very slightly revolute; parietal wall glazed with a thin callus.

Two specimens of this species (Cat. No. 127542, U.S.N.M.) come from San Hipolito Point, Lower California. The type has 10 post-nuclear whorls and measures—Length, 3 mm.; diameter, 1.2 mm.

STROMBIFORMIS Da Costa.

Strombiformis Da Costa, Brit. Conch., 1878, p. 107. Type selected by T. Iredale (Proc. Mal. Soc. London, vol. 11, 1915, pp. 293–295) *Strombiformis glaber* Da Costa.

Very attenuated, slender Melanellids, with very narrow elongated aperture, having the inner lip appressed to the attenuated basal portion of the preceding whorls; marked with one or more spiral color bands.

STROMBIFORMIS RIVERSI, new species.

Plate 45, fig. 3.

Shell large, subulate, yellowish-white with a few faint indications of spiral bands. Early whorls decollated in all the specimens seen, those remaining slightly and evenly rounded, appressed at the summit, separated by an ill-defined suture, marked by feeble, somewhat retractive lines of growth and irregularly disposed poorly impressed varicial streaks. Suture slightly constricted. Periphery of the last whorl well rounded. Base long, gently rounded. Aperture very elongate-ovate; posterior angle acute; outer lip thin; inner lip rather long, moderately thick, well rounded, reflected over and appressed to the attenuated base throughout its entire length; parietal wall glazed with a rather thick callus.

The type and seven specimens of this species were collected by Dr. J. J. Rivers, in the upper San Pedro series, at Santa Monica Canyon, California. The type and another specimen are in the collection of the United States National Museum (Cat. No. 251390). The rest are in Doctor Rivers's collection. The type has lost the nuclear whorls. The 10 remaining measure—length, 12 mm.; diameter, 2.5 mm.

This is the largest of the West American members of the genus *Strombiformis* known.

STROMBIFORMIS ALASKENSIS, new species.

Plate 45, fig. 1.

Shell small, straight, yellowish-white, marked by exceedingly fine lines of growth only. Whorls rather high, almost flattened, appressed at the summit, separated by a scarcely impressed suture. Periphery of the last whorl well rounded, base moderately long, moderately rounded. Aperture oval; posterior angle acute; outer lip decidedly protracted between the posterior angle and the base; inner lip moderately stout, curved, reflected over and appressed to the base; parietal wall glazed with a moderately thick callus.

The type (Cat. No. 322301 U.S.N.M.) comes from Dutch Harbor, Unalaska, Alaska. It has seven whorls and measures—Length, 4.2 mm.; diameter, 1.4 mm.

STROMBIFORMIS CALIFORNICA, new species.

Plate 45, fig. 5.

Shell narrowly subulate, polished. Early whorls yellowish-white, succeeding ones light brown, marked with a dark chestnut brown band at the periphery. A second one of equal strength and size is a little anterior to the middle between the summit and the periphery; lip edged with dark brown. Early whorls rounded, separated by impressed sutures, the succeeding turns flattened with scarcely defined suture, marked by exceedingly fine lines of growth and slightly retractive, irregularly disposed pale brown varicial streaks. Periphery of the last whorl well rounded. Base produced, well rounded. Aperture elongate, oval; posterior angle acute, slightly effuse anteriorly; outer lip thin, inner lip long, curved, revolute appressed to the base, except at the very tip, where it is free; parietal wall covered with a moderately thick callus.

The type and six specimens (Cat. No. 249619, U.S.N.M.) were dredged in San Diego Bay. The type has 13 whorls and measures—Length, 11.5 mm.; diameter, 2.1 mm. This species resembles *Strombiformis townsendi* from the Gulf of California, but differs from it in being uniformly more slender, and also in the color markings.

The following additional specimens have been examined:

Number of specimens.	Collection of—	Catalogue number.	Locality.	Remarks.
2	U.S.N.M.	203667	Off San Diego	20 fathoms.
1	Oldroyd		do	14 fathoms dredged by Mr. Gripp.
1[1]	Kelsey		do	60 fathoms.
1	U.S.N.M.	251392	Off Catalina Island	50 fathoms.
1	Lowe	3501	Catalina Island	

[1] Fragment.

STROMBIFORMIS TOWNSENDI, new species.

Plate 46, fig. 4.

Shell subulate, polished, tip white, the rest flesh colored with a broad pale zone of brown near the summit, in the middle of which is a darker line. A second pale zone of brown surrounds the middle of the whorl and is separated from the one of the summit by a clear flesh-colored band, which is about as wide as the band, separating it from a third brown zone at the periphery. This third zone extends about as far below the periphery of the last whorl as it extends above it, and is edged on both sides by a very dark, translucent brown band. The middle of the base is surrounded by another brown band, and the

lip is edged with pale brown. Early whorls moderately well rounded, separated by a well-impressed suture; succeeding turns flattened and separated by a scarcely defined suture. Surface marked by exceedingly fine retractive lines of growth and an occasional narrow varicial streak. Periphery of the last whorl well rounded. Base somewhat produced, well rounded. Aperture elongate ovate; posterior angle acute; outer lip thin; inner lip strong, curved, reflected over and appressed to the base throughout its entire length; parietal wall glazed with a thick callus.

The type and three specimens (Cat. No. 251391, U.S.N.M.) were dredged by the United States Bureau of Fisheries steamer *Albatross* at station 2822 off La Paz, Gulf of California, in 21 fathoms on gray sand and broken shell bottom. The type has 13 whorls and measures—length, 11 mm.; diameter, 2.5 mm.

The following additional specimens have been examined:

Number of specimens.	Collection of—	Catalogue number.	Locality.	Remarks.
6	U.S.N.M.	268591	South end of Angel de la Guardia Island, Gulf of California.	Shallow water; dredged by the author.
3	do	266359	Agua Verde Bay, Gulf of California.	2 fathoms; dredged by the author.
1	do	268592	Gulf of California	
1	Cooke		do	

STROMBIFORMIS LAPAZANA, new species.

Plate 46, fig. 3.

Shell narrowly subulate, polished, tip yellowish-white, the rest flesh-colored with a broad translucent zone of light brown, which is edged on either side by a narrow vary dark band, the anterior one of which marks the periphery, while the posterior falls a little anterior to the middle of the space between the summit and the suture. Early whorls rounded, separated by a well-marked suture, all the rest flattened, marked by feeble lines of growth and an occasional pale brown retractive varicial streak. Suture poorly defined. Periphery of the last whorl well rounded. Base produced, well rounded. Aperture elongate-ovate, slightly effuse anteriorly; posterior angle acute; inner lip short, curved, revolute, reflected over, and appressed to the base; parietal wall covered with a moderately thick callus.

The type and 43 specimens (Cat. No. 211388, U.S.N.M.) were dredged by the United States Bureau of Fisheries steamer *Albatross* at station 2823, in 26½ fathoms off La Paz, Gulf of California, on broken shell bottom. The type has 13 whorls and measures—length, 7.8 mm.; diameter, 1.3 mm.

The following additional specimens have been examined:

Number of specimens.	Collection of—	Catalogue number.	Locality.	Remarks.
3	U.S.N.M.	96715	Off La Paz, Gulf of California, U. S. B. F. station 2823.	26½ fathoms, broken shell bottom.
11	do	211670	Off La Paz, Gulf of California, U. S. B. F. station 2822.	21 fathoms on gray sand and broken shell bottom.
5	do	251394	Off Ceralvo Island, Gulf of California, U. S. B. F. station 2826–2828.	9½–10 fathoms, shell bottom, 74° bottom temperature.
1	do	251393	Agua Verde Bay, Gulf of California.	

STROMBIFORMIS ALMO, new species.

Plate 46, fig. 5.

Shell broadly elongate-conic, polished, bluish-white, excepting a broad band of light chestnut brown, which encircles the turns covering a little more than half the spaces between the periphery and the summit and extending for an equal distance over the base. Early whorls rounded, separated by a well-impressed suture; the succeeding turns moderately rounded, with very poorly impressed suture, marked by faint lines of growth and an occasional almost vertical varicial line, which is not accompanied by any brown marking. Periphery of the last whorl well rounded. Base produced, well rounded. Aperture broadly ovate, somewhat patulose anteriorly; posterior angle acute; outer lip thin; inner lip short, moderately stout, curved, reflected over, and appressed to the base, except at the extreme tip, where it is free; parietal wall covered with a thick callus.

The type and two specimens (Cat. No. 251395, U.S.N.M.) were dredged by the United States Bureau of Fisheries steamer *Albatross* at station 2902, in 53 fathoms off Santa Rosa Island, California, on fine gray sand and mud bottom, bottom temperature 45°. The type has 10 whorls and measures—length, 7 mm.; diameter, 1.8 mm.

The following additional specimens have been examined:

Number of specimens.	Collection of—	Catalogue number.	Locality.	Remarks.
2	Oldroyd		Off San Pedro	Deep water.
3	do		Off San Pedro, Cal.; dredged by University of California.	
1	U.S.N.M.	251396	Off Point Loma Light, Cal.; dredged by U. S. B. F. steamer *Albatross*, station 4348.	59–113 fathoms; fine gray sand and broken shell and mud bottom.
1	Baker		Off San Diego	60 fathoms.
1	Button		San Diego	

STROMBIFORMIS FUSCOSTRIGATA Carpenter.

Plate 46, fig. 1.

Eulima fuscostrigata CARPENTER, Ann. Mag. Nat. Hist., ser. 3, vol. 14, 1864, p. 47.

Shell broadly conic, polished, tip brown; the anterior third between the sutures of each turn and the base of the last turn, dark brown. On the last half of the last turn the brown of the basal portion splits into two bands, one a little below the periphery and the other marking the extremity. Early whorls strongly rounded, separated by a well impressed suture, the succeeding ones almost flat with an ill-defined suture. Surface marked by fine lines of growth only. Periphery of the last whorl weakly angulated. Base somewhat produced, moderately rounded. Aperture ovate; posterior angle acute; outer lip thin; inner lip moderately long, rather stout, curved, revolute, and appressed to the base; parietal wall covered by a moderately thick callus.

Carpenter's type (Cat. No. 4105, U.S.N.M.) comes from Cape San Lucas, Lower California. It has 10 whorls and measures—length, 4.7 mm.; diameter, 1.3 mm.

STROMBIFORMIS PANAMENSIS, new species.

Plate 46, fig. 2.

Shell elongate-conic, bluish-white, polished, with a narrow pale-brown band marking the appressed summit of the whorls; half of the space between this dark band and the suture is white; the rest of the whorl is suffused with pale brown; the aperture, too, is edged with pale brown, while the extremity of the base is white. Early whorls slightly rounded, separated by an impressed suture, the succeeding turns almost flattened, marked by exceedingly fine lines of growth and an occasional retractive varicial line which is not accompanied with any color markings. The appressed portion of the whorls is dark in color and the anterior limit of the appressed portion appears as a false suture, the true suture being very inconspicuous. Periphery of the last whorl well rounded. Base produced, well rounded. Aperture elongate-ovate, slightly effuse anteriorly; posterior angle acute; outer lip thin; inner lip moderately long, curved, reflected and appressed to the base for its entire length; parietal wall covered with a moderately thick callus.

The type (Cat. No. 215787, U.S.N.M.) was dredged by the United States Bureau of Fisheries steamer *Albatross* at station 2799 in 29½ fathoms, in Panama Bay, on green mud bottom. It has 11 whorls and measures—length, 6 mm.; diameter, 1.3 mm.

STROMBIFORMIS BARTHELOWI, new species.

Plate 47, fig. 7.

Shell polished, acicular, uniformly pale brown. Early whorls well rounded, separated by a constricted suture; the succeeding turns flat, with a less conspicuous suture, marked by very fine vertical lines of growth only. Periphery of the last whorl well rounded. Base rather long, evenly rounded. Aperture very elongate-ovate; posterior angle acute; outer lip thin, not protrated in the middle; inner lip slender, slightly curved, reflected over and appressed to the base throughout its entire length; parietal wall glazed with a thin callus.

The type (Cat. No. 268622, U.S.N.M.) was collected by the author in Santa Maria Bay, Lower California. It has eleven whorls and measures—length, 5 mm.; diameter, 1.3 mm. Cat. No. 267746, U.S.N.M., contains another specimen dredged by the author in shallow water in the same place.

STROMBIFORMIS HEMPHILLI, new species.

Plate 47, fig. 4.

Shell polished, the three or four early whorls increasing slowly in size, the rest more rapidly, which lends the outline of the spire a somewhat constricted appearance near the summit. Early whorls well rounded, with moderately impressed suture. The whorls are marked with irregular, triangularly shaped streaks of brown, which are broadest at the varicial streaks and taper backward to a point, one side following the summit. Base marked by an interrupted brown band, situated a little anterior to the periphery, and the second, slightly narrower, about one-third the distance between the peripheral band and tip of the base, anterior to the peripheral band. The extreme tip of the inner lip is brown. Early whorls moderately rounded, separated by an impressed suture, the later ones very slightly rounded, separated by an inconspicuous suture, marked by exceedingly fine lines of growth and occasional varicial streaks. Periphery of the last whorl feebly rounded. Base moderately long, well rounded. Aperture rather small, ovate; posterior angle acute; outer lip thin; inner lip very oblique, somewhat sinuous, slightly reflected with posterior portion appressed to the base; parietal wall covered by a thick callus.

The type and three specimens of this species (Cat. No. 127554, U.S.N.M.) were collected by Mr. Henry Hemphill in shell drift, at Point Abreojos, Lower California. The type has 9 whorls and measures—length, 3.1 mm.; diameter, 1.1 mm.

I have seen the following additional specimens:

Number of specimens.	Collection of—	Catalogue number.	Locality.
26	Oldroyd		Point Abreojos, Lower California.
2	Button		Do.
1	Johnston		Do.
7	U.S.N.M.	215788	San Hipolito Point, Lower California.
6	Oldroyd		Point Abreojos, Lower California.

STROMBIFORMIS BURRAGEI, new species.

Plate 47, fig. 5.

Shell very small, elongate-conic, polished, light yellow, with the tip light brown and with a broad brown band on the middle of the base. Early whorls well rounded, separated by a constricted suture. The succeeding turns weakly rounded, with a very feebly impressed suture, marked by exceedingly fine lines of growth only. Periphery obscurely angulated. Base rather short, well rounded. Aperture broadly oval; posterior angle obtuse; outer lip thin; inner lip short, decidedly curved, reflected and appressed to the base posteriorly; parietal wall covered by a thick callus.

The type (Cat. No. 267582, U.S.N.M.) was dredged in 3 fathoms at the head of Concepcion Bay, Gulf of California, by the United States Bureau of Fisheries steamer *Albatross* on mud bottom. It has lost the first turn; the eight remaining measure—length, 2.7 mm.; diameter, 0.9 mm.

The following additional specimens have been examined:

Number of specimens.	Collection of—	Catalogue number.	Locality.	Remarks.
1	U.S.N.M.	264643	Head of Concepcion Bay	Dredged by U. S. B. F. steamer *Albatross*. 3 fathoms, mud bottom.
1	do	267812	Pichilinque Bay, Gulf of California.	Dredged by the author in shallow water.

STROMBIFORMIS VARIANS Sowerby.

Plate 47, figs. 6, 8.

Eulima varians SOWERBY, Proc. Zool. Soc. London, 1834, p. 8.
Leiostraca varians SOWERBY, Thes. Conch., 1854, p. 804, pl. 170, figs. 23, 24.

"Subfusiform, acuminated, thin, color various; aperture oblong. Some varieties are white, others brown, and others are marked with brown lines and are mottled.

"Xipixapi, Meridional America. (Mus. Cuming.)

"Collected in sandy mud."

I have not seen specimens of this species and copy Sowerby's description and figure.

STROMBIFORMIS PROCA de Folin.

Plate 47, fig. 1.

Eulima proca De Folin, Les Meleagrinicoles, 1867, pp. 62, 63, pl. 6, fig. 3.

"Shell imperforate, elongate, acuminate, thin, shining, milky-white above, pinkish below, and spotted along the sutures with triangular reddish dots. Whorls 10 to 11; the early ones very narrow, the later wider and more convex. The body whorl approximately equal to one-third the altitude of the entire shell. Aperture cordate; the margin slightly thickened, the left margin strongly reflected. Long., 0.0033; diam., 0.001.

"This second species of *Eulima* is also very pretty and very remarkable. The outlines elongated; the whorls of the spire very acuminate. The later whorls, on the contrary, are somewhat wide and somewhat convex. The sides of the whorls, instead of being simply straight, or describing, as is ordinarily the case, take on, in this species, a double curve. The contour is at first concave, then it becomes convex. In consequence of this difference in the margins of the whorls of the spire, the resulting outline is very peculiar, and is a very striking diagnostic. The apex is slightly obtuse; the whorls of the spire are 10 or 11 in number. They increase slowly at first, and without perceptible enlargement, which gives to the early part of the shell, including the five or six whorls, a subcylindric aspect. These whorls are slightly rounded and are united by a rather deeply impressed suture. Near the eighth whorl the diameter increases, and the suture is fainter and becomes nothing more than a simple, very feebly impressed line. The final whorl is equal to about one-third of the total altitude, and is imperforate. The aperture is cordate, and its margins are somewhat thickened. The left margin is reflected, and they are colored a flaming scarlet. The early whorls, milk-white in color, are well flattened between the sutures and the margins; the later whorls are flesh-colored, or tinged with a clear orange. A few elongated, triangular spots, rather regular, and brilliantly colored in flaming scarlet, are disposed along the sutures, and extend for a short distance in front of it. This peculiar ornamentation adds a stamp of originality to this *Eulima*.

"*Type locality.*—Negritos; or Margarita Island, Panama."

I have not seen specimens of this species and quote the description and figure.

STROMBIFORMIS ELEGANTISSIMA de Folin.

Plate 47, fig. 3.

Eulima elegantissima De Folin, Les Meleagrinicoles, 1867, p. 65, pl. 6, fig. 5.

"Shell imperforate, oblong, very highly polished, pellucid, ornamented with two oblique bands, alternated yellow and spotted.

Spire acuminate. Apex rather obtuse. Whorls 10, slowly increasing in size, flattened; the final whorl large, its altitude half of that of the entire shell. Suture simple. Aperture elongate, pyriform, the margins thickened, yellowish; the left margin strongly reflected at the base. Long., 0.005; diam., 0.0015.

"This small shell is very remarkable by reason of its elements; elongated, acuminated outline. The spire is made up of six whorls, which increase slowly in diameter, and which are joined together by a very simple suture. The sides of these whorls are straight, smooth, without convexity, and the suture appears only as a feeble line, revolving about the shell, so that the shell does not seem to be interrupted at the suture line. The final whorl occupies approximately half of the entire altitude and is imperforate, despite the fact that a slight elongated depression, covered in part by the reflected left margin of the aperture, seems to form a convexity which at first sight simulates a perforation. The acuminate outline of the entire shell attenuates slightly the half acute, half obtuse outline of the apex so that it may be considered as acute. The aperture is entirely elongate, pyriform, the two margins colored a dark brown, rounding smoothly into each other. The left is reflected upon the columella, and spreads out over the base of the last whorl. It is not only the exceedingly graceful outline of *Eulima elegantissima* which makes this shell remarkable, it is also the exceedingly high luster with which it shines, and its transparency, equal to that of pure crystal. The luster is due to its perfect polish and also to its clearness. Each of the whorls is ornamented with two yellow ribbons which follow the spire. The color is rather deep along the middle of each ribbon. It lightens toward the margins and almost merges into the crystalline background. It is the same with the elongate spots, which, bending obliquely toward the left bind the ribbons to one another. The total of these characteristics give to *Eulima elegantissima* an aspect like that of marble. The shell near the suture seems to be thicker than away from it. Along the last whorls especially it seems as if there were a little ribbon almost opaque, which makes the shell at this point seem whiter.

"*Type locality.*—Negritos; or Margarita Island, Panama."

I have not seen specimens of this species and quote the description and figure.

STROMBIFORMIS ACUTA Sowerby.

Plate 47, fig. 2.

Eulima acuta SOWERBY, Proc. Zool. Soc. London, 1834, p. 8.
Leiostraca acuta SOWERBY, Thes. Conch., 1854, p. 803, pl. 170, fig. 11.

"Acutely turreted, white; whorls 12, smooth, sutures obsolete, varices few.

"Bay of Montiji, Central America. (Mus. Cuming.)

"Found in coarse sand at a depth of 13 fathoms."

I have not seen specimens of this species and copy Sowerby's description and figure.

Genus NISO Risso.

Niso Risso, Hist. Nat. Eur. Merid., vol. 4, 1826, p. 218, p. 7, fig. 98; type *Niso eburnea* Risso=*Bonellia* Deshayes, Lamarck's Anim. sans. Vert., vol. 8, 1838, p. 286; Type *Bonellia terebellata* Deshayes (=*Bulimus terebellatus* Lamarck)= *Janella* Grateloup, Conch. Foss. Adaur., 1838, p. 12; Type *Bulimus terebellatus* Lamarck= *Volusia* A. Adams, Ann. Mag. Nat. Hist., ser. 3, vol. 8, 1861, p. 306; Type *Volusia imbricata* Sowerby.

Melanellids having the base broadly umbilicated.

NISO SPLENDIDULA Sowerby.

Plate 48, fig. 5.

Eulima splendidula Sowerby, Proc. Zool. Soc., 1834, p. 6, = *Niso splendidula* Sowerby, Thes. Conch., 1854, p. 801, pl. 170, fig. 8.

This species is described by Sowerby as acuminately pyramidal, brownish, articulated near the sutures with white and chestnut; umbilicus large. Aperture anteriorly angulated.

Sowerby's specimen was collected by Cummings at Santa Elena, Ecuador, on sandy mud in 6 to 8 fathoms. The type, figured by Sowerby, has 18 whorls and measures—length, 38 mm.; diameter, 17 mm. It is the largest known from the west coast of America to date.

Cat. No. 251334, U.S.N.M., contains a very badly worn and fragmentary specimens of this species, which was dredged by the U. S. Bureau of Fisheries steamer *Albatross* in the Bay of Panama at station 2798, in 18 fathoms on gray sand and broken shell bottom.

NISO EXCOLPA, new species.

Plate 48, fig. 4.

Shell broadly elongate-conic, widely and openly umbilicated, flesh-colored, with irregularly interrupted axial bands of brown immediately behind the varices, and faint spiral bands. The junction of these produce the intensified color markings, and the lighter areas between them give the axial markings the interrupted aspect. Umbilicus purple, extreme tip of the shell white. Early whorls well rounded, the later ones flattened, marked by strong lines of growth only. The appressed summit of the whorls falls a little anteriorly to the periphery, and causes the preceding whorl to have an over-hanging appearance. Periphery of the last whorl strongly angulated. Base moderately long, well rounded; umbilicus about one-sixth of the greater diameter of the shell. Aperture rhomboidal, decidedly angulated at the junction of the inner and basal lip, somewhat less so, at the junction of the basal and outer lip; posterior angle

acute; inner lip strongly curved and moderately reflected; parietal wall glazed by a thin callus.

The type and 31 specimens (Cat. No. 267652, U.S.N.M.) were dredged by the U. S. Bureau of Fisheries steamer *Albatross*, in 3 fathoms, in the head of Concepcion Bay, Gulf of California. The type has lost the first whorl; the 14 remaining measure—length, 17.5 mm.; diameter, 6.5 mm.

The following specimens have been examined:

Number of specimens.	Collection of—	Catalogue number.	Locality.	Remarks.
17	U.S.N.M.	268590	South end of Angel de la Guardia Island, Gulf of California.	Shallow water.
3	do	251335	Off Ceralvo Island, Gulf of California U. S. B. F. stations 2826 to 2828, dredged by steamer *Albatross*.	9½ to 10 fathoms, shell bottom.
39	do	268073	Head of Concepcion Bay	Shallow water.
29	do	268158	Ricason Island, Concepcion Sound, Gulf of California.	Do.
1	do	106980	Espirito Santo Bay, Gulf of California, collected by W. B. Bryant.	
1	do	211389	Off La Paz, Gulf of California, U. S. B. F. station 2823, dredged by steamer *Albatross*.	26½ fathoms, broken shell bottom.
78	do	267543	Head of Concepcion Bay, Gulf of California, dredged by U. S. B. F. steamer *Albatross*.	3 fathoms, mud bottom.
1	do	46511	Mulege Bay, Gulf of California.	
1	do	46508	Gulf of California	

NISO INTERRUPTA Sowerby.

Plate 48, figs. 1, 3.

Eulima interrupta SOWERBY, Proc. Zool. Soc. London, 1834, p. 7 = *Niso interrupta* SOWERBY, Thes. Conch., 1854, p. 801, pl. 170, fig. 9.

Shell broadly elongate-conic, deeply and widely umbilicated, bluish-white, polished, marked with irregularly disposed varicial streaks of rust brown. Early whorls well rounded, later ones less rounded and slightly excurved at the appressed summit, marked by numerous lines of growth and exceedingly fine microscopic spiral striations. Summit of the whorls appressed, falling a little below the angulated periphery of the preceding whorl, thus causing the preceding whorl to appear as slightly overhanging the suture. Periphery of the last whorl angulated. Base short, well rounded, marked like the spire; umbilicus equal to about one-fifth of the greater diameter of the shell. Aperture oval, drawn out into an acute angle at the junction of the inner lip and basal lip; posterior angle acute; outer lip thin; inner lip strongly curved and slightly revolute; parietal wall covered by a thin callus.

Two specimens (Cat. No. 122793, U.S.N.M.) were dredged by the United States Bureau of Fisheries steamer *Albatross* at station 2805

in 51½ fathoms, on green mud bottom, in the Bay of Panama. One of these is a fragment containing the perfect tip and 10 whorls; the other is an adult shell having lost the first one and a half turns and having 13 whorls remaining, which measure—length, 10.3 mm.; diameter, 4.3 mm. We have figured the larger of these two. Cat. No. 251336, U.S.N.M., contains three young specimens, dredged by the United States Bureau of Fisheries steamer *Albatross* at station 2799, in 29½ fathoms on green mud, in the Bay of Panama.

Sowerby's type was collected by Cuming, in the Gulf of Nicoya, Costa Rica, in 11 to 13 fathoms, in coarse sand.

NISO LOMANA, new species.

Plate 49, fig. 4.

Shell large, broadly conic, yellowish-white. Early whorls well rounded, later ones flattened, separated by a decidedly channeled suture, narrowly shouldered at the summit and decidedly angulated at the periphery, marked only by feeble axial lines of growth. The summit of succeeding turns falls a little anteriorly to the angulated periphery and forms a channeled suture. Aperture of the type fractured.

The type (Cat. No. 251337, U.S.N.M.) was dredged by the United States Bureau of Fisheries at station 4310 in 71 to 75 fathoms, off Point Loma, California, on green mud and fine sand bottom, bottom temperature 49.7°. The type has lost the early whorls and the base. The nine whorls remaining measure—Length, 14.5 mm. The fragment of this large species, constituting the type, is so distinctive that there will be no difficulty in recognizing this species when found perfect. A second specimen (Cat. No. 211847, U.S.N.M.), which we believe to represent the tip of this species, has seven whorls and was dredged by the United States Bureau of Fisheries steamer *Albatross* at station 2901, in 48 fathoms, off Santa Rosa Island, California, on mud bottom, bottom temperature 55°.

NISO HIPOLITENSIS, new species.

Plate 49, fig. 5.

Shell very small, elongate-conic, narrowly umbilicated. Tip yellowish-white, base white with a broad median brown band; anterior half of aperture white. Surface polished, marked by fine lines of growth only. Suture feebly impressed. Periphery of the last whorl angulated. Base short, well rounded. Aperture broadly oval; posterior angle acute; outer lip thin, curved and slightly patulose; inner lip curved and revolute, almost covering the narrow umbilicus.

The type and another specimen (Cat. No. 127544, U.S.N.M.) were collected by Mr. Henry Hemphill in shell washings, at San Hipolito Point, Lower California. The type has 10 whorls and measures—length, 3.1 mm.; diameter, 1.2 mm.

We have seen the following additional specimens.

Number of specimens.	Collection of—	Catalogue number.	Locality.
1	U.S.N.M.		San Diego, California.
1	Oldroyd		Do.
2	Button		San Hipolito Point, Lower California, collected by Mr. Henry Hemphill.
13	Oldroyd		Do.

NISO IMBRICATA Sowerby.

Plate 48, fig. 6.

Eulima imbricata SOWERBY, Proc. Zool. Soc., 1834, p. 7=*Niso imbricata* Sowerby, Thes. Conch., 1854, p. 802, pl. 170, fig. 10.

"Acuminately pyramidal, whitish, longitudinally lineated with light red; whorls angulated below, prominent; umbilicus small; aperture anteriorly angulated.

"Sancta Elena; in sandy mud, from 6 to 8 fathoms. (Mus. Cuming.)"

I have not seen specimens of this species and quote the description and figure from Sowerby.

The type figured by Sowerby, in the Thesaurus, has 13 whorls and measures—length, 21 mm.; diameter, 7.7m.

NISO (?) ANTISELLI Anderson and Martin.

Plate 48, fig. 2.

Niso (?) *antiselli* ANDERSON and MARTIN, Proc. Cala. Acad. Sci., vol. 4, ser. 4, 1914, p. 65, pl. 7, fig. 22.

"Shell small, smooth, with six whorls; spire conical, upper whorls absent in the type-specimen; whorls nearly flat, tapering toward the apex, unsculptured; suture appressed; body-whorl sharply angulated at the periphery; base convex, with a distinct umbilicus; aperture quadrate; outer lip distinctly angulated, angle about 100°; inner lip thin, smooth; umbilical opening large but not extending to the apex of the shell.

"*Dimensions.*—Altitude, apex broken, 7.5 mm.; latitude of the last whorl, 4 mm.

"*Occurrence.*—The type-specimen was obtained from the lower Miocene of eastern San Luis Obispo County, California, locality 125.

"The living species of this genus are found in tropical and temperate seas. The placing of this species in the genus *Niso* is somewhat doubtful. The umbilical opening does not extend to the apex of the shell; it is, however, much more pronounced than in any of the Eulimidae or Pyramidellidae and has therefore been classed as a *Niso*.

"*Type.*—No. 135, Cal. Acad. Sci., on top of a hill in the southwest corner of the S. E. ¼ of sec. 29, T. 28, S., R. 15 E., San Luis Obispo County, California.

"Named in honor of Dr. Thomas Antisell, one of the early geologists of California."

I have not seen a specimen of this species and quote the published text and figure.

Genus STILIFER Broderip.

Stilifer BRODERIP, Proc. Zool. Soc. London, 1832, p. 60. Type *Stilifer astericola* Broderip.

Melanellids with a mucronate apex, globular form, and the inner lip not appressed or adnate to the attenuated base of the preceding whorl.

STILIFER ASTERICOLA Broderip.

Plate 49, fig. 2.

Stilifer astericolus BRODERIP, Proc. Zool. Soc. London, 1832, p. 60.

Shell large, globose, with a slender acuminate mucro, which is usually decollated; thin, semitransparent, bluish-white. Postnuclear whorls strongly inflated, marked by strong incremental lines which are almost threadlike and irregularly disposed. The appressed portion of the whorls appears as a bluish band. Body whorl slightly flattened in the middle. Periphery well rounded. Base short, strongly rounded, marked like the spire. Aperture large; posterior angle acute; outer lip very thin, strongly curved, and strongly protracted in the middle to form a clawlike element; inner lip slender, strongly curved; parietal wall covered by a scarcely perceptible callus. Radula absent.

I have seen 16 specimens collected in the water-vascular system of starfish by the California Academy of Science Galapagos Expedition at Tagus Cove, Albermarle, Galapagos. Two of these are Cat. No. 322286 U.S.N.M. One of these, the specimen figured, has 5½ whorls and measures—length, 8.6 mm.; diameter, 6.3 mm.

Broderip's specimens were collected by Hugh Cuming at Hood Island, Galapagos, and I find the following interesting remarks on them in the publication cited:

"The arrival in this country of the shell above recorded, with the soft parts, has afforded data for a generic character indicating a distinct family among the *Pectinibranchiata*, the form and disposition of whose mantle differs from that of any other genus in the order. This mantle (which in *Stil. Astericola* is of a green hue) is thick, fleshy, and cup-shaped, with a small aperture at its base and a free posterior margin enveloping the soft parts and the last whorls of the shell, which has thus somewhat the appearance of a small acorn set in its cup. On the ventral aspect of this mantle is the rudiment of a foot; and from the small basal aperture a retractile *proboscis* (which when exserted is as long as the whole animal) is protruded. At the base of this *proboscis* are two thick, round, somewhat pointed *tentacula;* and at the base of them are the eyes or rather ocular specks without pedicles. The *branchia* is placed on a single stem. At the base of the

proboscis is a spherical muscular stomach, and the intestine ascends into the spire of the shell, where it becomes attached to the liver, which, in the present species, is of an orange colour.

"Mr. Cuming found this elegant parasite burrowed in different parts of the rays of the oral disk of *Asterias solaris*, Gray, where it is almost hidden from sight, so deeply does the animal penetrate into the substance of the *Starfish*, in which it makes a comfortable cyst for itself, wherein it most probably turns by the aid of its rudimentary foot. All the specimens infested with *Stiliferi* appeared to be in the best health, though there is reason to believe that these *Mollusca* feed upon the juices of the *Starfish*. With that instinct of self-preservation imparted to all parasites whose existence depends upon that of their nidus, the *Stilifer*, like the *Ichneumon* among insects, appears to avoid the vital parts; for in no instance did Mr. Cuming find it embedded anywhere save in the rays, though some had penetrated at their base and very near the *pelvis*. When extracted the older shells have much the appearance of a milky, clouded, glass bubble; the younger shells are of an unclouded transparency."

Genus MUCRONALIA A. Adams.

Mucronalia A. ADAMS, Ann. Mag. Nat. Hist., ser. 3, vol. 5, 1860, p. 301. Type *Mucronalia bicincta* A. Adams.

Melanellids with mucronate apex, cylindric postnuclear spire and with the inner lip not appressed or adnate to the attenuated base of the preceding whorl.

MUCRONALIA? BATHYMETRAE Dall.

Plate 49, fig. 3.

Stilifer (*Mucronalia*) *bathymetrae* DALL, Bull. Mus. Comp. Zool., Cambridge, vol. 43, 1908, No. 6, pp. 317, 318.

"*Mucronalia*? HARTLAUB, Bull. Mus. Comp. Zool., Cambridge, vol. 27, No. 4, 1895, p. 146, pl. 4, fig. 25.

"On a species of *Bathymetra*, dredged by the U. S. S. *Albatross*, at station 3381, off Malpelo Island, Gulf of Panama, in 1,772 fathoms, mud, bottom temperature 37.2° F.

"In Hartlaub's account of the crinoids of the *Albatross* above cited, he mentions and figures a species, referred by E. von Martens to *Mucronalia*, parasitic on a species of crinoid, later referred by Clark to *Bathymetra*. The specimen has not yet been submitted to the writer, and the figure is insufficient to base a specific description upon. It resembles *Stilifer* (*Mucronalia*) *thomasiae* Sowerby, of the West Indies, and is fixed to one of the arms of the crinoid. If the species is hereafter recovered, it might appropriately take the specific name of *bathymetrae*."

I have not seen a specimen of the species and quote the published text and figure.

Genus LAMBERTIA Souverbie.

Lambertia SOUVERBIE, Journ. de Conch., 1869, p. 420. Type *Lambertia montrouzieri* Souverbie.

Melanellids with mucronate apex, pupiform outline, and with the inner lip appressed to the attenuated base of the preceding whorl.

LAMBERTIA COOKEANA, new species.

Plate 49, fig. 1.

Shell ovate, with a narrow cylindric mucro consisting of two turns, following these two turns, the whorls become decidedly gibbose and appressed at the summit. Surface of the whorls marked by exceedingly retractive lines of growth and very fine microscopic spiral striations. Periphery of the last whorl well rounded. Base moderately long, stout, curved, and revolute; parietal wall covered by a thick callus.

The type (Cat. No. 150869, U.S.N.M.) has four whorls in addition to the mucro, and measures—length, 3.7 mm.; diameter, 2 mm. It and 10 specimens were collected by Miss Cooke at San Hipolito Point, Lower California.

The following additional specimens have been examined:

Number of specimens.	Collection of—	Catalogue number.	Locality.
50	Cooke		San Hipolito Point, Lower California.
2	U.S.N.M.	215791	Point Abreojos, collected by Mr. H. Hemphill.
7	Oldroyd		Do.

EXPLANATION OF PLATES.

PLATE 34.

FIG. 1. *Melanella micans* Carpenter, Fossil, Upper San Pedro Series, length 10.6 mm.
2. *Melanella micans* Carpenter, Fossil, Lower San Pedro Series, length 10.2 mm.
3. *Melanella micans* Carpenter, Fossil, Upper San Pedro Series, length 11.2 mm.
4. *Melanella micans* Carpenter, Fossil, Upper San Pedro Series, length 12.7 mm.
5. *Melanella micans* Carpenter, a typical specimen, length 12.7 mm.
6. *Melanella micans* Carpenter, type, length 9.4 mm.

PLATE 35.

FIG. 1. *Melanella ochsneri* Bartsch, topotype, length 8.3 mm.
2. *Melanella rutila* Carpenter, type, length 6.8 mm.
3. *Melanella rutila* Carpenter, Fossil, Lower San Pedro Series, length 5.8 mm.
4. *Melanella solitaria* C. B. Adams, type, length 4.7 mm.
5. *Melanella dalli* Bartsch, type, length 20 mm.
6. *Melanella rutila* Carpenter, Fossil, Upper San Pedro Series, length 6.2 mm.
7. *Melanella micans borealis* Bartsch, type, length 11.3 mm.

PLATE 36.

FIG. 1. *Melanella panamensis* Bartsch, type, length 2.8 mm.
2. *Melanella monicensis* Bartsch, type, length 8 mm.
3. *Melanella necropolitana* Bartsch, type, length 7.5 mm.
4. *Melanella linearis* Carpenter, length 2.6 mm.
5. *Melanella oldroydi* Bartsch, Fossil, Upper San Pedro Series, length 7.8 mm.
6. *Melanella oldroydi* Bartsch, type, length 9.2 mm.
7. *Melanella oldroydi* Bartsch, Fossil, Lower San Pedro Series, length 8.1 mm.

PLATE 37.

FIG. 1. *Melanella californica* Bartsch, type, length 6.2 mm.
2. *Melanella baldra* Bartsch, type, length 5.1 mm.
3. *Melanella compacta* Carpenter, type, length 6.8 mm.
4. *Melanella randolphi* Vanatta, type, length 7 mm.
5. *Melanella mexicana* Bartsch, type, length 6.4 mm.
6. *Melanella hemphilli* Bartsch, type, length 8.3 mm.

PLATE 38.

FIG. 1. *Melanella retexta* Carpenter, type, length 2.2 mm.
2. *Melanella pusilla* Sowerby, type, length — mm.
3. *Melanella gabbiana* Anderson and Martin, type, length 4 mm.
4. *Melanella hastata* Sowerby, cotype, length — mm.
5. *Melanella tacomaensis* Bartsch, type, length 5 mm.
6. *Melanella hastata* Sowerby, cotype, length — mm.

PLATE 39.

FIG. 1. *Melanella elodia* de Folin, type, length 5 mm.
2. *Melanella* (*Balcis*) *draconis* Bartsch, type, length 6.1 mm.
3. *Melanella recta* C. B. Adams, type, length — mm.
4. *Melanella* (*Balcis*) *peninsularis* Bartsch, type, length 5.2 mm.
5. *Melanella producta* Carpenter, type, length 3 mm.
6. *Melanella* (*Balcis*) *montereyensis* Bartsch, type, length 5.8 mm.

PLATE 40.

FIG. 1. *Melanella* (*Balcis*) *townsendi* Bartsch, type, length 3.8 mm.
2. *Melanella* (*Balcis*) *halia* Bartsch, type, length 1.8 mm.
3. *Melanella* (*Balcis*) *lastra* Bartsch, type, length 4.1 mm.
4. *Melanella abreojosensis* Bartsch, type, length 3.1 mm.
5. *Melanella* (*Balcis*) *iota* C. B. Adams, type, length 1.7 mm.
6. *Melanella* (*Balcis*) *cosmia* Bartsch, type, length 2.7 mm.
7. *Melanella* (*Balcis*) *catalinensis* Bartsch, type, length 5.2 mm.
8. *Melanella* (*Balcis*) *arnoldi* Bartsch, type, length 5.5 mm.
9. *Melanella* (*Balcis*) *yod* Carpenter, type, length 0.9 mm.

PLATE 41.

FIG. 1. *Melanella* (*Balcis*) *lowei* Vanatta, type, length 6.85 mm.=*Melanella* (*Balcis*) *thersites* Carpenter.
2. *Melanella* (*Balcis*) *thersites* Carpenter, type, length 5.1 mm.
3. *Melanella* (*Balcis*) *bistorta* Vanatta, type, length 5.9 mm.=*Melanella* (*Balcis*) *thersites* Carpenter.
4. *Melanella* (*Balcis*) *comoxensis* Bartsch, type, length 7.1 mm.
5. *Melanella* (*Balcis*) *columbiana* Bartsch, type, length 9.5 mm.
6. *Melanella* (*Balcis*) *macra* Bartsch, type, length 7.5 mm.

PLATE 42.

FIG. 1. *Melanella* (*Balcis*) *adamantina* de Folin, type, length 2.5 mm.
2. *Melanella* (*Balcis*) *taravali* Bartsch, type, length 1.2 mm.
3. *Melanella* (*Balcis*) *berryi* Bartsch, type, length 6 mm.
4. *Melanella* (*Balcis*) *prefalcata* Bartsch, type, length 6.9 mm.
5. *Melanella* (*Balcis*) *grippi* Bartsch, type, length 8 mm.
6. *Melanella* (*Balcis*) *falcata* Carpenter, type, length 7.6 mm.

PLATE 43.

FIG. 1. *Eulimostraca galapagensis* Bartsch, type, length 3.8 mm.
2. *Melanella* (*Balcis*) *gibba* de Folin, type, length 3 mm.
3. *Sabinella meridionalis* Bartsch, type, length 3.9 mm.
4. *Sabinella chathamensis* Bartsch, type, length 3.8 mm.
5. *Sabinella bakeri* Bartsch, type, length 2.7 mm.
6. *Haliella chilensis* Bartsch, type, length 5.5 mm.
7. *Sabinella opalina* de Folin, type, length 9.5 mm.
8. *Haliella abyssicola* Bartsch, type, length 10.4 mm.

PLATE 44.

FIG. 1. *Haliella lomana* Dall, type, length 20.2 mm.
2. *Sabinella* (*?*) *ptilocrinicola* Bartsch, type, length 9.5 mm.

PLATE 45.

FIG. 1. *Strombiformis alaskensis* Bartsch, type, length 4.2 mm.
2. *Scalenostoma babylonia* Bartsch, type, length 3 mm.
3. *Strombiformis riversi* Bartsch, type, length 12 mm.
4. *Scalenostoma rangii* de Folin, type, length 2.7 mm.
5. *Strombiformis californica* Bartsch, type, length 11.5 mm.

PLATE 46.

FIG. 1. *Strombiformis fuscostrigata* Carpenter, type, length 4.7 mm.
2. *Strombiformis panamensis* Bartsch, type, length 6 mm.
3. *Strombiformis lapazana* Bartsch, type, length 7.8 mm.
4. *Strombiformis townsendi* Bartsch, type, length 11 mm.
5. *Strombiformis almo* Bartsch, type, length 7 mm.

PLATE 47.

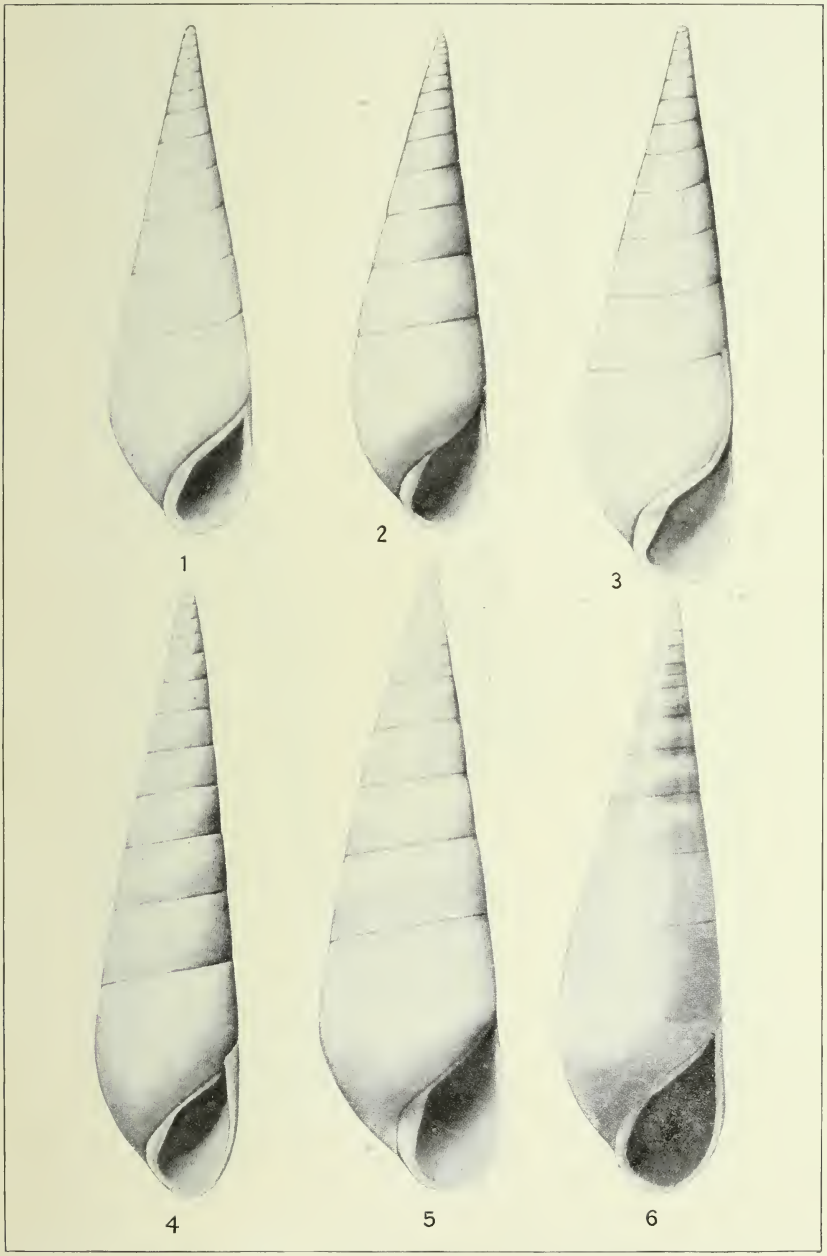
FIG. 1. *Strombiformis proca* de Folin, type, length 3.3 mm.
2. *Strombiformis acuta* Sowerby, type, length — mm.
3. *Strombiformis elegantissima* de Folin, type, length 5 mm.
4. *Strombiformis hemphilli* Bartsch, type, length 3.1 mm.
5. *Strombiformis burragei* Bartsch, type, length 2.7 mm.
6. *Strombiformis varians* Sowerby, cotype.
7. *Strombiformis barthelowi* Bartsch, type, length 5 mm.
8. *Strombiformis varians* Sowerby, cotype.

PLATE 48.

FIG. 1. *Niso interrupta* Sowerby, length 10.3 mm.
2. *Niso* (?) *antiselli* Anderson and Martin, type, length 7.5 mm.
3. *Niso interrupta* Sowerby.
4. *Niso excolpa* Bartsch, type, length 17.5 mm
5. *Niso splendidula* Sowerby, type, length 38 mm.
6. *Niso imbricata* Sowerby, type, length 21 mm.

PLATE 49.

FIG. 1. *Lambertia cookeana* Bartsch, type, length 3.7 mm.
2. *Stilifer astericola* Broderip, length 8.6 mm.
3. *Mucronalia* (?) *bathymetrae* Dall, type.
4. *Niso lomana* Bartsch, type, length, 14.5 mm.
5. *Niso hipolitensis* Bartsch, type, length 3.1 mm.



WEST AMERICAN MELANELLID MOLLUSKS.

FOR EXPLANATION OF PLATE SEE PAGE 354.

WEST AMERICAN MELANELLID MOLLUSKS.

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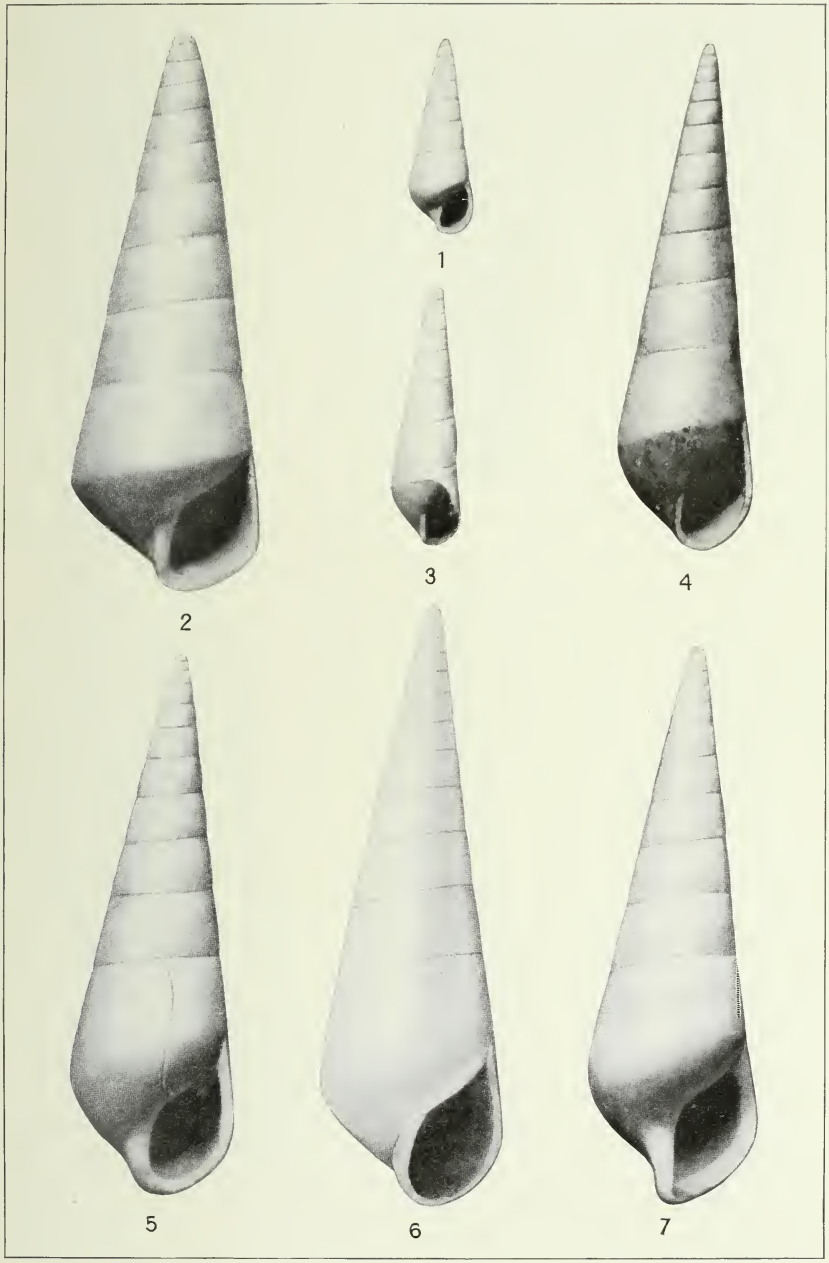

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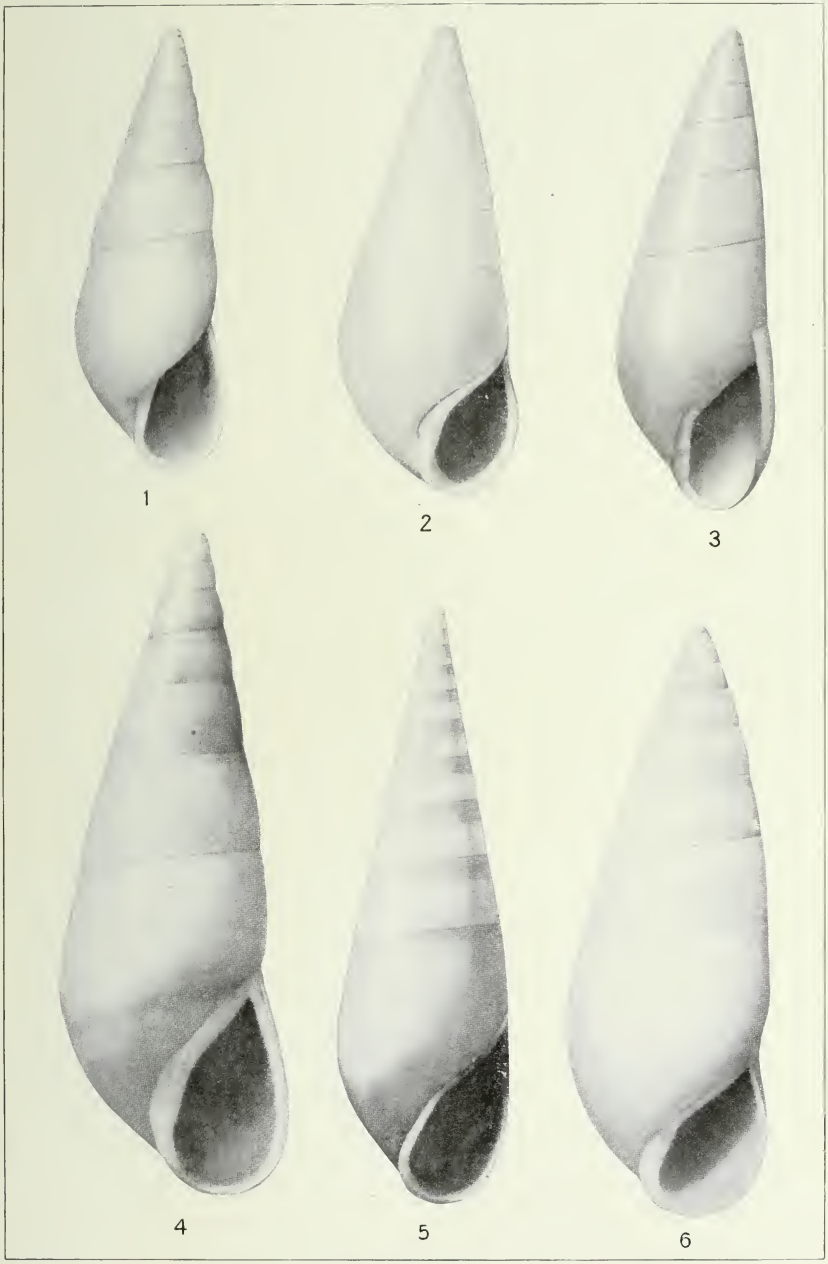

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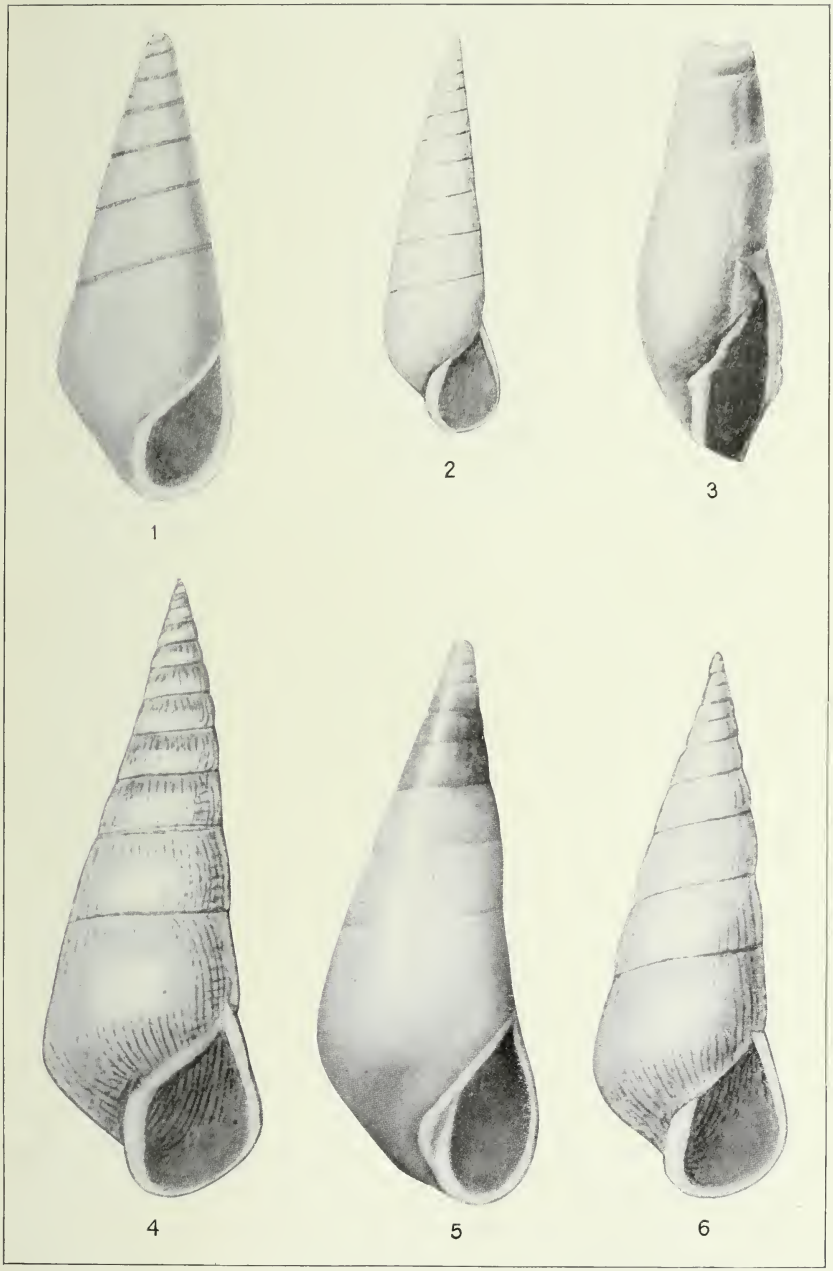

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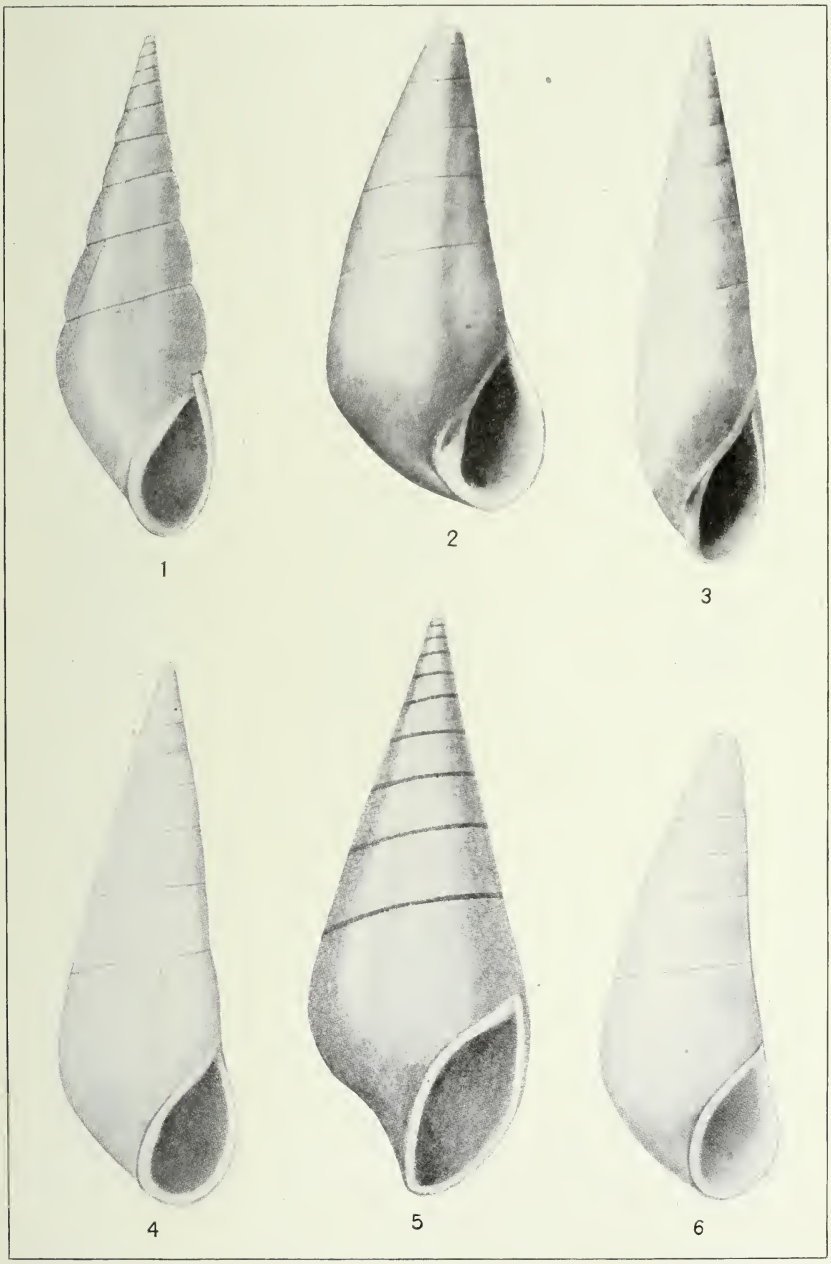

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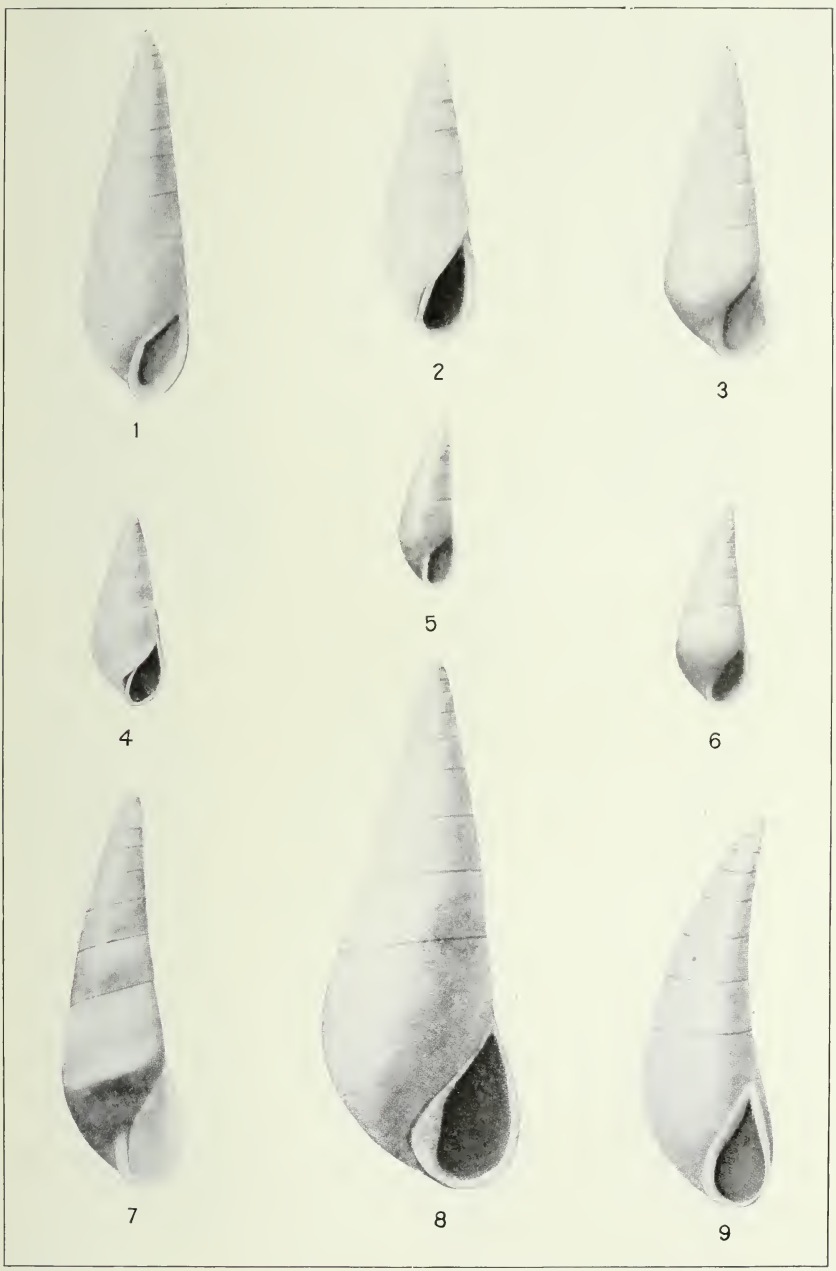

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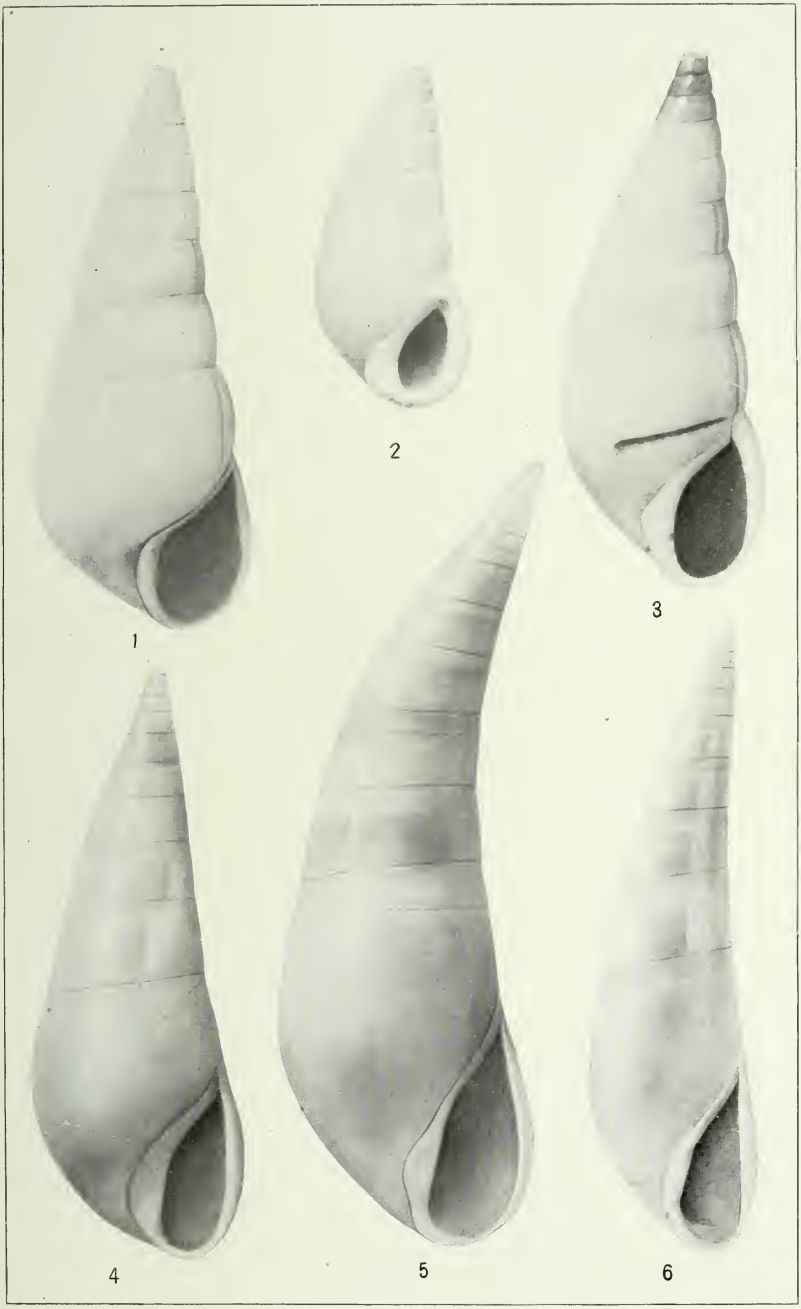

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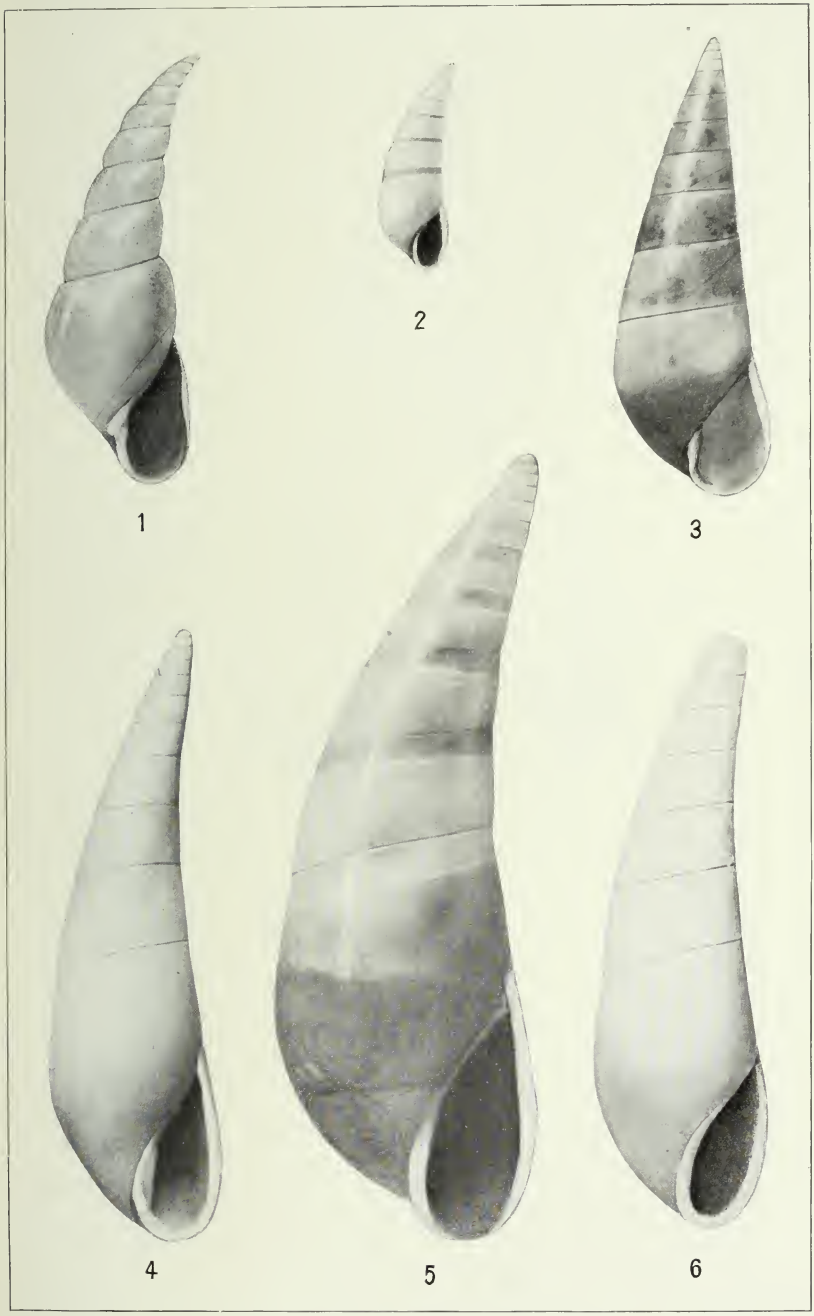

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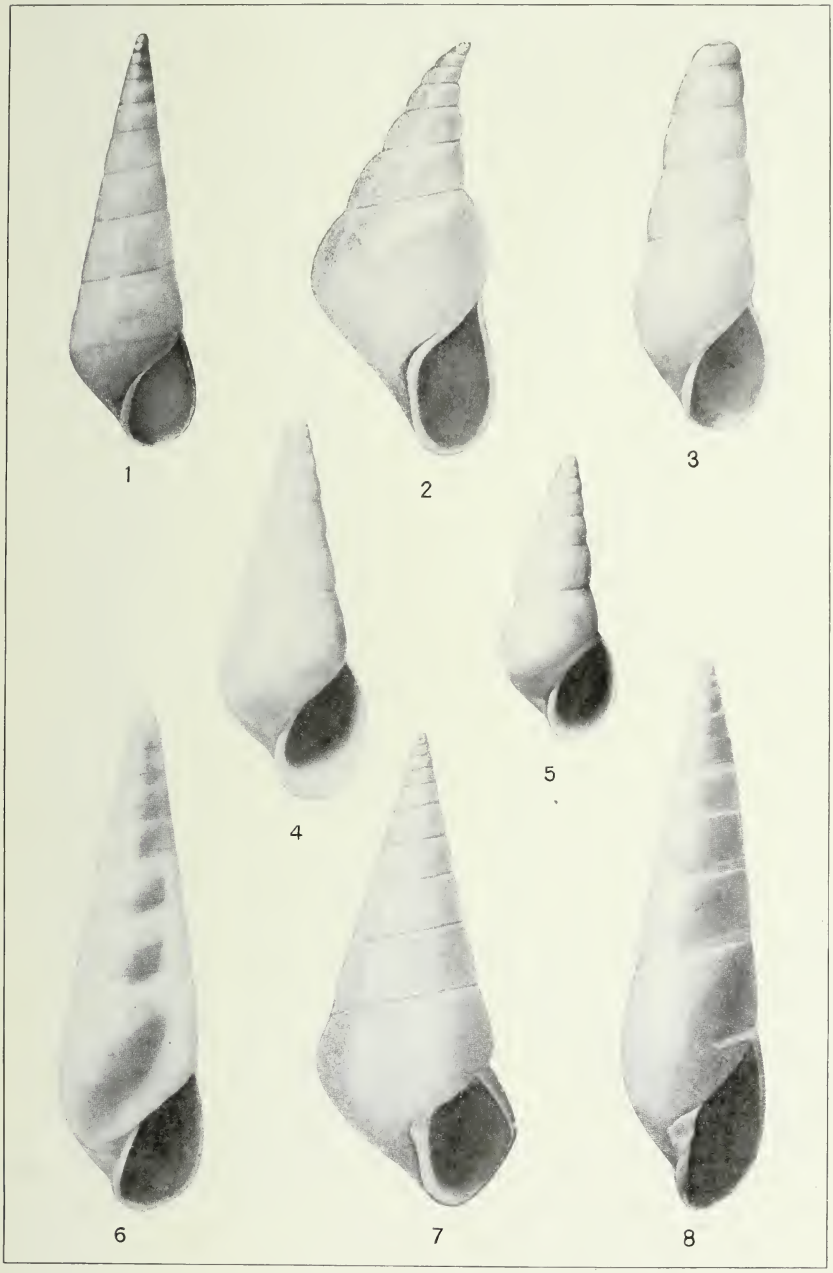

WEST AMERICAN MELANELLID MOLLUSKS.

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WEST AMERICAN MELANELLID MOLLUSKS.

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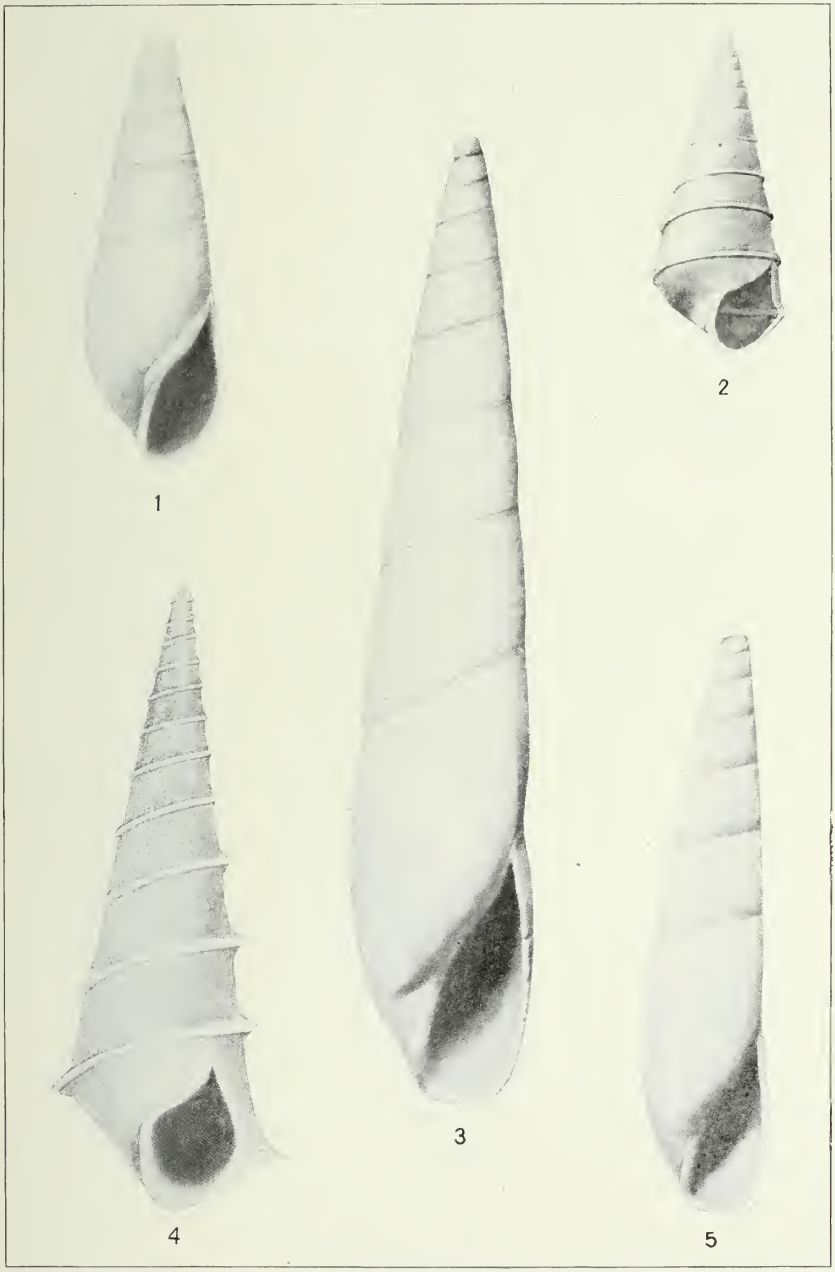

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WEST AMERICAN MELANELLID MOLLUSKS.

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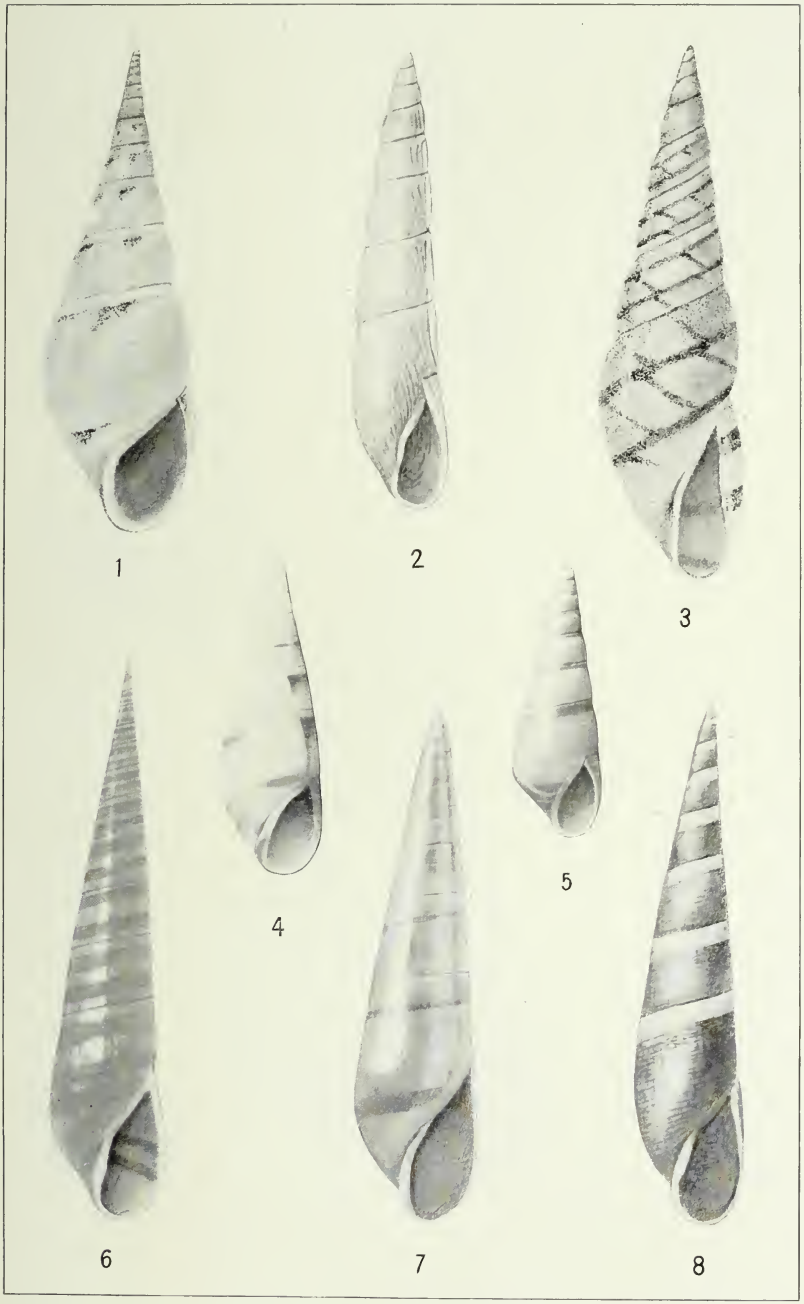

WEST AMERICAN MELANELLID MOLLUSKS.

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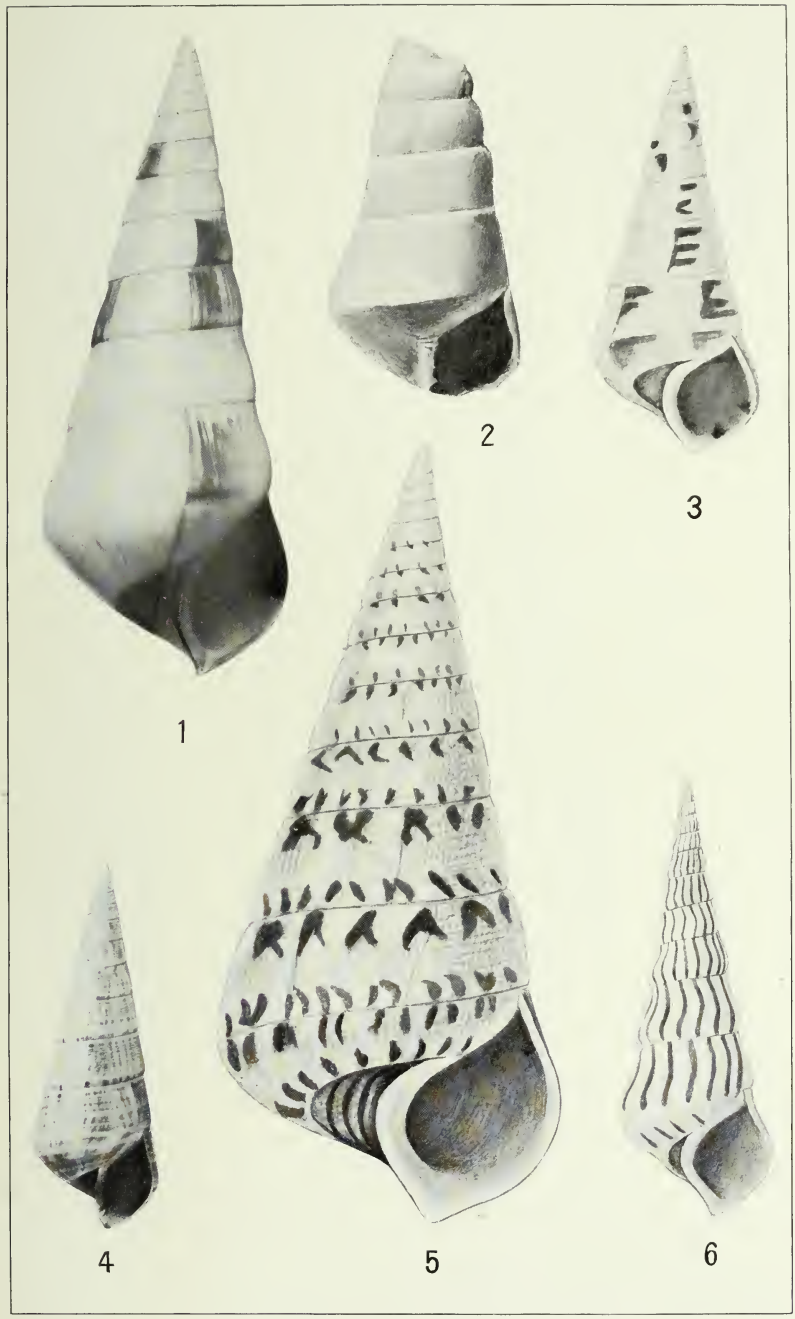

WEST AMERICAN MELANELLID MOLLUSKS.

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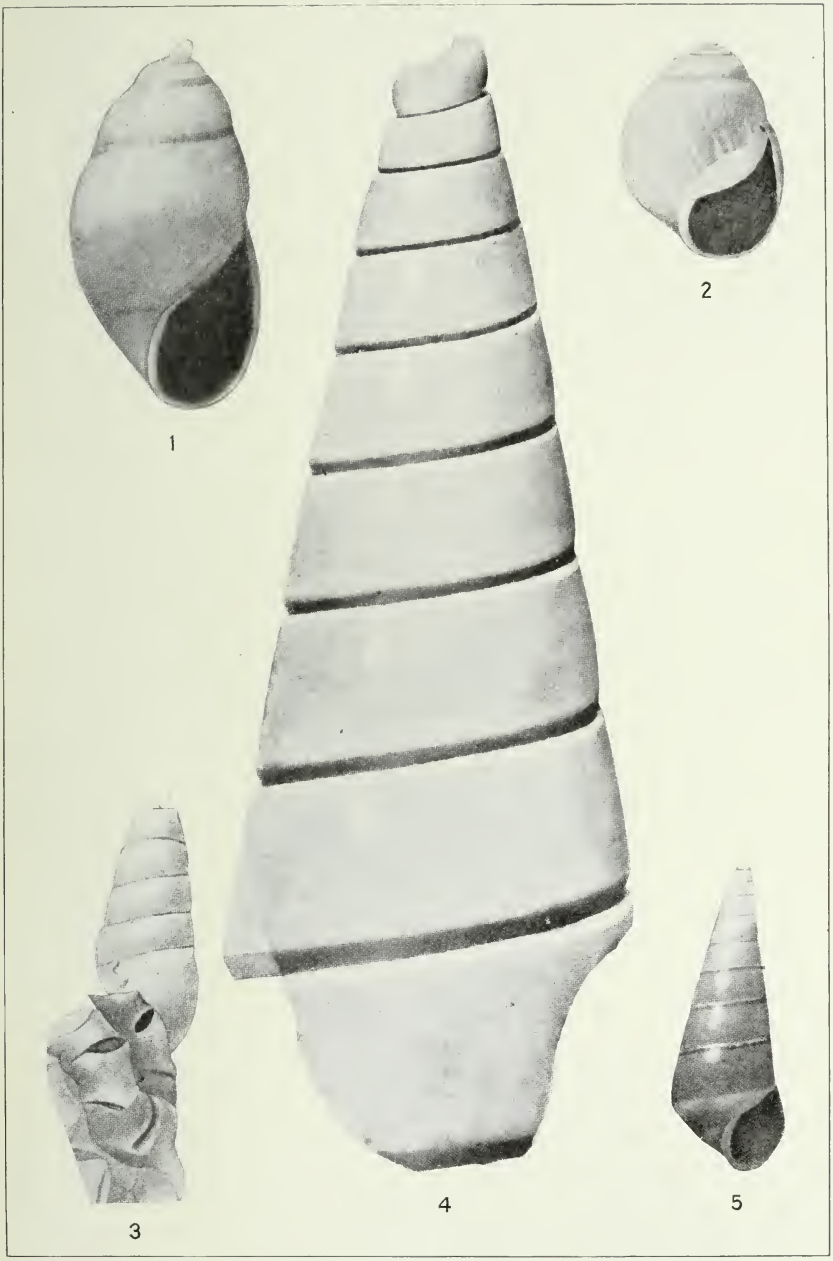

WEST AMERICAN MELANELLID MOLLUSKS.

FOR EXPLANATION OF PLATE SEE PAGE 356.

8

NEW LAND SHELLS FROM THE PHILIPPINE ISLANDS

BY

PAUL BARTSCH

Assistant Curator, Division of Mollusks, United States National Museum

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No. 1993.—From the Proceedings of the United States National Museum, Vol. 45, pages 549–553, with Plate 43

Published June 21, 1913

Washington
Government Printing Office
1913

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NEW LAND SHELLS FROM THE PHILIPPINE ISLANDS.

By Paul Bartsch,
Assistant Curator Division of Mollusks, United States National Museum.

The United States National Museum has recently received an extremely interesting collection of land shells from the Hon. Dean C. Worcester, secretary of the interior of the Philippine Islands. The shells were collected by him on two small and little-visited islands, Calusa, the westernmost of the Cagayanes Islands, and Olanivan, the northern of the Sarangani group off southeastern Mindanao.

The three species in the lot are all new; their affinity will be discussed under each species, descriptions of which follow.

OBBA WORCESTERI, new species.

Plate 43, figs. 1–3.

Shell lenticular, marked by decidedly retractive lines of growth and very fine, closely spaced spiral striations, excepting the first whorl (the nucleus), which is smooth. The following whorl is light horn-yellow; the succeeding turn gradually darkens to chocolate brown On the third whorl three spiral bands of chocolate brown become apparent, which eventually cover more of the space between the sutures and the periphery than the buff flushed areas that separate them. The middle one of these three bands is the darkest and widest and occupies the middle of the whorls between the sutures. The posterior band is separated from the summit by a very narrow light zone; the spaces separating the median from the anterior and posterior bands are of equal width and as wide as the median dark zone. Periphery strongly keeled. Base moderately broadly umbilicated; marked by two brown bands, the first of which, the narrower, is separated from the periphery by a very narrow light line; the second, which equals the median band of the spire in width, is a little farther anterior to the other band than its own width. The light zone separating these two bands and the rest of the base, yellow with a greenish flush. Aperture suboval, somewhat angulated at the junction of the superior and basal lip; the angle corresponding to the peripheral keel; peristome thickened and reflected; basal lip

without tooth; parietal wall provided with a thick cord which joins the outer and basal lips and practically renders the peristome complete. The peristome is white, excepting at the peripheral angle where the brown band continues over it.

Type.—Cat. No. 252067, U.S.N.M. This and 37 specimens were collected by the Hon. Dean C. Worcester on Olanivan Island (Sarangani group). The type has 4½ whorls and measures: Altitude, 9.5 mm.; greater diameter, 24 mm.; lesser diameter, 20.3 mm.

Ten additional specimens taken at random yield the following data:

Number of whorls.	Altitude.	Greater diameter.	Lesser diameter.
	mm.	*mm.*	*mm.*
4.3	10	22.5	19
4.5	9.5	23	19
4.6	10.5	24	20
4.3	9.5	23	19.6
4.4	10	22	18.5
4.5	10	22	18.8
4.6	10.2	20.4	17.3
4.5	10	22.7	19.7
4.4	10.3	23.2	19.3
4.3	10	21.3	18

This species is nearest related to *Obbina saranganica* Hidalgo, which comes from Sarangani Island. This is a much larger race, a specimen of 4.3 whorls measuring: Altitude, 13.4 mm.; greater diameter, 36.4 mm.; lesser diameter, 29.7 mm.

COCHLOSTYLA CALUSAENSIS, new species.

Plate 43, figs. 9, 10, 12–14.

Shell depressed, conic to ovate, marked by fine, decidedly retractive lines of growth and very fine, closely spaced spiral striations. Ground color of the first three whorls white, while that of the subsequent whorls is suffused with sage green on the base, with a band of greenish color in front of the suture on the last whorl which leaves a whitish border on both sides of the median brown band, or the whole ground color may be nearly white if slightly weathered. Beginning with the second whorl, a faint broad brown spiral band makes its appearance on the middle of the space between the summit and the periphery of the whorls, increasing steadily in intensity until it acquires a deep chocolate brown on the last turn. A second brown band, equaling the above in width, encircles the whorls immediately anterior to the periphery. Aperture moderately large; columella oblique, white; peristome reflected, white. Color bands within the outer lip as intense as on the exterior.

Six specimens of this species were collected by the Hon. Dean C. Worcester on Caluga Island (Cagayanes).

Type.—Cat. No. 252069, U.S.N.M.

These yield the following measurements:

Number of whorls.	Altitude.	Greater diameter.	Lesser diameter.
	mm.	*mm.*	*mm.*
5.5	31.8	27	25.5
5.3	25.8	23.6	21
5	25	26.8	23.7
4.6	23	24.4	21.3
4.4	20.7	23.6	20
4.4	20.3	21.8	18.5

This species is nearest related to *Cochlostyla tenera* Sowerby, from Mindoro. The latter is of much more constant form and size and has instead of the green suffusion a narrow green spiral band a little anterior to the summit and a second one of about equal width a little nearer to the subperipheral brown band than to the median. The median brown band also extends to the very tip of the shell.

Three specimens of *C. tenera* Sowerby yield the following data:

Number of whorls.	Altitude.	Greater diameter.	Lesser diameter.
	mm.	*mm.*	*mm.*
4.9	25.2	27.6	22.4
5	26.7	27.4	23.5
5	24.5	25.2	22

COCHLOSTYLA OLANIVANENSIS, new species.

Plate 43, figs. 4–8, 11.

Shell broadly depressed conic; entire surface marked by fine, decidedly retractive lines of growth and very fine, closely spaced spiral striations. Ground color white, slightly suffused with yellowish, or even white with a suffusion of light russet vinaceous; the dark tint, if present, is usually on the later whorls. In addition to the ground color, the whorls are marked with a deep chestnut band at the periphery; the summit of the succeeding turns leaving this exposed as a suprasutural band. The extreme appressed summit of the whorls is also edged with a very narrow zone of dark chestnut which is usually covered by a hydrophanous yellowish white band that extends over the posterior fourth of the space between the summit and the periphery of the whorls. The rest of this space is covered by several very narrow spiral hydrophanous lines. Base marked by a rather broad hydrophanous band, situated immediately anterior to the periphery; a second one of about half the width of this encircles the base at the posterior extremity of the anterior fourth, while between these two there appear to be several additional slender hydrophanous lines. The base of the columella is encircled by a narrow, dark chestnut zone, which is sometimes interrupted, and in some instances

fades to yellow. The anterior end of the columella is tinged on the inside by this purple zone in those specimens in which this color appears intense; in the weakest colored ones it is almost white. Peristome usually white, or nearly so, in some individuals very slightly suffused with russet vinaceous.

Eleven specimens of this species were collected by Mr. Worcester on Olanivan Island, Philippine Islands, which yield the following data:

Number of whorls.	Altitude.	Greater diameter.	Lesser diameter.
	mm.	*mm.*	*mm.*
4.3	17.5	25.3	[1] 22
4.3	19	25	21
4.3	17	24.4	21.2
4.4	16.5	24	21
4.5	17.5	25.6	22
4.2	16.2	23.7	21.1
4.5	17	24.5	20.8
4.3	17	23.6	20.5
4.3	16.3	23.5	22.3
4.5	18.3	26.0	22.5
4.4	18	26.2	22.5

[1] Type.

This species is nearest related to *C. saranganica* Möllendorff. It differs from it by its uniformly lesser size and coloration, which is in every way much darker, half of the base about the columella being chestnut brown and the entire peristome being of a light purplish brown color.

Type.—Cat. No. 252068, U.S.N.M.

Six specimens, of *Cochlostyla saranganica* Möllendorff Cat. No. 195405, U.S.N.M., received from the von Möllendorff collection, come from Balut Island, one of the Sarangani group. These yield the following data:

Number of whorls.	Altitude.	Greater diameter.	Lesser diameter.
	mm.	*mm.*	*mm.*
4.3	19.5	28.5	24
4.4	21.5	29.3	24.3
4.1	19.8	27.5	23.3
4.3	19.8	30	24.4
4.3	18	28	23.5
4.4	19.8	26.5	22.2

Cochlostyla saranganica Möllendorff is not *Cochlostyla indusiata* Pfeiffer, as supposed by Hidalgo. That is quite a different species and comes from Tukan Bessi, an island southeast of Celebes.

EXPLANATION OF PLATE 43.

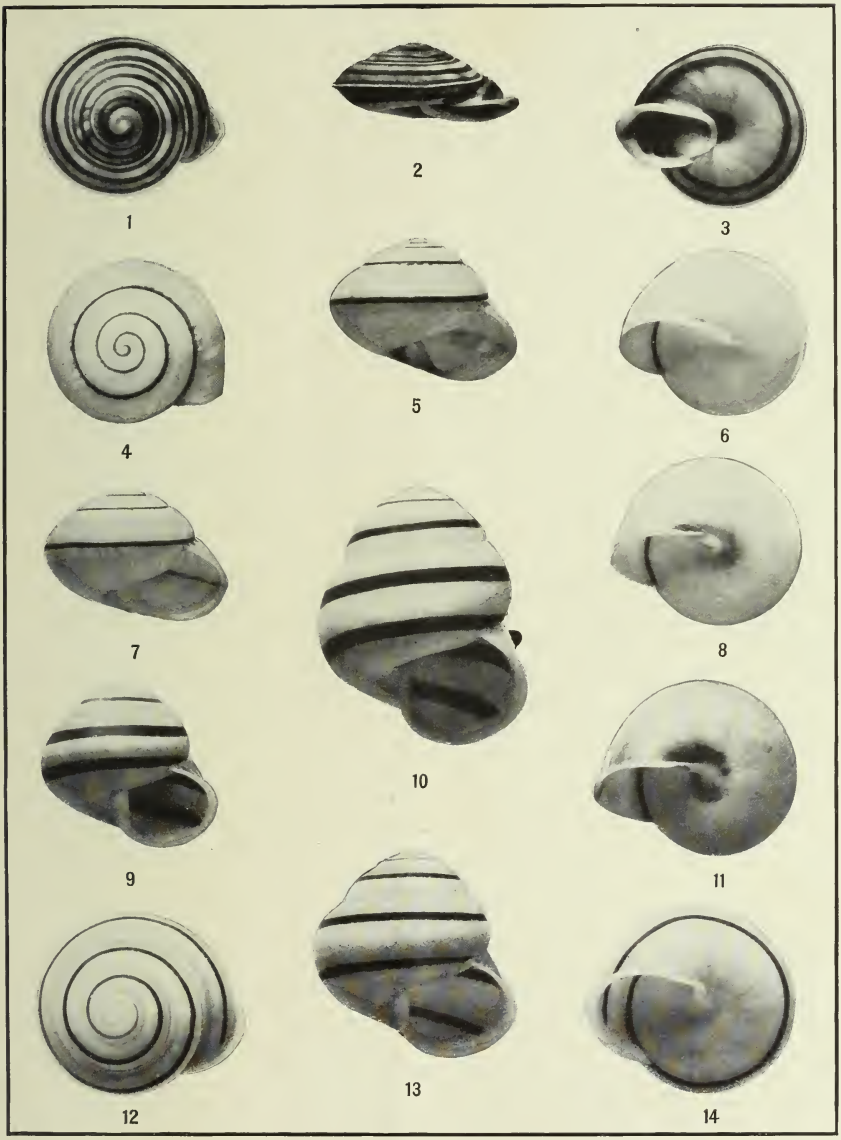
(All figures are natural size.)

Fig. 1. *Obba worcesteri*, top view. Type. See page 549.
2. *Obba worcesteri*, profile view. Type.
3. *Obba worcesteri*, basal view. Type.
4. *Cochlostyla olanivanensis*, top view. Type. See page 551.
5. *Cochlostyla olanivanensis*, profile view. Type.
6. *Cochlostyla olanivanensis*, basal view.
7. *Cochlostyla olanivanensis*, profile view.
8. *Cochlostyla olanivanensis*, basal view. Type.
11. *Cochlostyla olanivanensis*, basal view.

Figures 6, 7, and 11 showing the variations of the dark basal area.

9. *Cochlostyla calusaensis*, profile view. See page 550.
10. *Cochlostyla calusaensis*, profile view.
12. *Cochlostyla calusaensis*, top view. Type.
13. *Cochlostyla calusaensis*, profile view. Type.
14. *Cochlostyla calusaensis*, basal view. Type.

Figures 9, 10, and 13 show variations in size and shape of shell.



NEW LAND SHELLS FROM THE PHILIPPINE ISLANDS.

FOR EXPLANATION OF PLATE SEE PAGE 553.

NEW MOLLUSKS FROM SANTA ELENA BAY, ECUADOR

BY

PAUL BARTSCH
Curator of Mollusks, United States National Museum

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NEW MOLLUSKS FROM SANTA ELENA BAY, ECUADOR.

By Paul Bartsch.

Curator of Mollusks, United States National Museum.

Dr. R. A. Olsson has recently submitted to the United States National Museum a small lot of Pyramidellidae and Melanellidae collected by him in Santa Elena Bay, Ecuador. This is the first material that we have had from this locality. In fact, very little has been collected excepting the gathering made during the forties of the last century at this place by Hugh Cuming, which did not stress the minute species.

A very careful comparison of these specimens with the magnificent Panama series in the United States National Museum reveals the fact that every species represented in this gathering proves to be undescribed. This should certainly stimulate future efforts in this region, as well as in the territory to the south of it, from which very little minute material has come to hand.

All the species described in this paper are based upon Doctor Olsson's collecting at Santa Elena Bay. The specimens have been donated to the United States National Museum.

PYRAMIDELLA (LONGCHAEUS) ELENENSIS, new species.

Plate 1, fig. 5.

Shell elongate-conic, pinkish white, with a lighter median zone on each whorl. Nuclear whorls decollated. Postnuclear whorls flattened, narrowly tabulatedly shouldered at the summit, which is also minutely crenulated. Periphery of the whorls marked by a slender incised groove, crossed by numerous minute riblets and bounded posteriorly by a rather strong keel. The summit of the succeeding whorls falls below the groove and causes the suture to appear deeply channeled and finely denticulated. Base short, well rounded, smooth. Aperture fractured in both of our specimens; outer lip provided with four conspicuous spinal laminæ within, of which two are posterior and two anterior to the peripheral sulcus. Columella short, very stout, provided with a very broad lamellar fold about one-third of the distance from its insertion to the tip anterior to the insertion,

and two additional folds which are much weaker, the anterior one being the weaker.

The type, Cat. No. 359747, U.S.N.M., has lost the nuclear whorl and probably the first two and a half postnuclear turns. The 7.5 remaining measure: Length, 6.4 mm.; diameter, 2.5 mm. Cat. No. 359748, U.S.N.M., contains another specimen from the same locality.

This species suggests in size *Pyramidella* (*Pharidella*) *panamensis* Dall and Bartsch, but it is distinguished from this at once by its much broader whorls and less deep sutural channels, and absence of the axial riblets.

TURBONILLA (CHEMNITZIA) THEONE, new species.

Plate 1, fig. 6.

Shell short, stout, elongate-conic. Nuclear whorls decollated. Postnuclear whorls slightly rounded, narrowly slopingly shouldered at the summit, marked by broad, strongly protractively curved axial ribs, of which 16 occur upon the second, 18 upon the third, 20 upon the fourth, 22 upon the fifth, 24 upon the sixth, 26 upon the seventh and the last whorl. These ribs render the summit of the whorls feebly crenulated. The intercoastal spaces are a little less wide than the ribs, and only feebly impressed, terminating at the periphery. Base rather long, strongly rounded. Aperture oval; posterior angle obtuse; outer lip fractured; inner lip reflected and appressed to the base for two-thirds of its length, provided with a feeble oblique fold a little anterior to its insertion; parietal wall covered by a thin callus.

The type, Cat. No. 359756, U.S.N.M., has lost the nucleus. The 7.5 whorls remaining measure: Length, 4.9 mm. diameter, 1.7 mm. Cat. No. 359757, U.S.N.M., contains another specimen from the type locality.

This species differs from all the other members of the West coast by its almost elongate oval outline and stout shape.

TURBONILLA (CHEMNITZIA OENOA, new species.

Plate 1, fig. 3.

Shell small, subdiaphanous, yellowish white, with a bluish band at the summit of the whorls where this is appressed to the preceding turn. This band gives the shell the appearance of being ornamented by a string of beads at this place. Nuclear whorls decollated. Postnuclear whorls slightly rounded, rather strongly obliquely tabulatedly shouldered at the summit, crossed by slightly protractive ribs, which render the summit crenulated, and which are about as wide as the spaces that separate them. Of these ribs, 16 occur upon the first and second, 18 upon the third, 20 upon the fourth, 22 upon

the fifth and sixth, 24 upon the seventh, and 28 upon the last turn. Intercostal spaces moderately, deeply impressed, terminating at the periphery, which is well rounded. Base moderately long, well rounded, marked by lines of growth only. Aperture oval; posterior angle acute; outer lip thin, showing the external sculpture within; inner lip slightly sinuous, reflected over and appressed to the base, for almost its entire length, provided with a feeble, oblique fold at its insertion.

The type, Cat. No. 359753, U.S.N.M., has 8.5 whorls and measures: Length, 4.2 mm.; diameter, 1.3 mm. Cat. No. 359754, U.S.N.M., contains two additional specimens from the same locality.

The present species is nearest related to *Turbonilla* (*Chemnitzia*) *kelseyi* Dall and Bartsch, but differs from it by its much more elegant features, strongly tabulated shoulder, with the crenulations at the termination of the ribs at the summit forming a more conspicuous beaded pattern.

TURBONILLA (TURBONILLA) AXELI, new species.

Plate 1, fig. 1.

Shell small, elongate-conic, bluish white. Nuclear whorls two and a half, smooth, forming a decidedly elevated spire which has its axis at right angles to that of the succeeding whorls, in the first of which the nuclear spire is about one-fourth immersed. Postnuclear whorls rather high between summit and suture, with a broad, sloping, tabulated shoulder. The whorls are crossed by strong axial ribs which extend strongly from the summit to the periphery and feebly over the base, forming slender cusps at the shoulder near the summit. Of these ribs, 16 occur upon the first and second, 18 upon the third and fourth, 10 upon the fifth, 22 upon the sixth, and 24 upon the last turn. These ribs are about half as wide as the spaces that separate them. The latter are decidedly excavated between the shoulder and the suture, the termination of the excavation forming almost a keel at the periphery of the last whorl. Suture somewhat constricted. Base short, well rounded. Aperture oval; posterior angle obtuse; outer lip thin at the edge, showing the external sculpture within; inner lip curved, slightly reflected and appressed to the base for its anterior three-fifths.

The type, Cat. No. 359749, U.S.N.M., has 8 postnuclear whorls, having lost the nucleus, and measures: Length, 3.9 mm.; diameter, 1.2 mm. The nuclear whorls were described from a young specimen. Cat. No. 359750, U.S.N.M., contains another specimen from the type locality.

This species differs from *Turbonilla* (*Turbonilla*) *centrota* Dall and Bartsch in being stouter and having the tabulated shoulder at the summit much more sloping.

TURBONILLA (STRIOTURBONILLA) EVAGONE, new species.

Plate 1, fig. 4.

Shell elongate-conic, bluish white. Nuclear whorls decollated. Postnuclear whorls flattened on the sides, almost excurved at the summit, which is narrowly tabulatedly shouldered, crossed by numerous axial ribs, which have a decidedly protractive slant, and which feebly crenulate the summit. Of these ribs, 18 occur upon the first and second, 20 upon the third to fifth, 22 upon the sixth and seventh, 26 upon the eighth, 28 upon the ninth, and 30 upon the last turn. These ribs are about as wide as the spaces that separate them. The latter are deeply impressed and terminate a little anterior to the periphery, leaving a narrow, smooth band at the suture. Periphery of the last whorl well rounded. Base moderately long, well rounded, smooth, excepting lines of growth. The entire surface of the spire and base is marked by microscopic spiral striations. Aperture oval; posterior angle acute; outer lip moderately thick, showing the external sculpture within; inner lip somewhat sinuous, reflected and appressed for its posterior third to its preceding turn, and provided with an oblique obsolete fold a little anterior to the insertion of the columella; parietal wall covered by a thin callus.

The type, Cat. No. 359751, U.S.N.M., has 10.6 postnuclear whorls and measures. length, 6.2 mm.; diameter, 1.7 mm. Cat. No. 359752, U.S.N.M., contains 7 additional specimens from the type locality.

This is nearest related to *Turbonilla* (*Strioturbonilla*) *panamensis* C. B. Adams, but differs from it by its larger size, more robust form and more numerous ribs.

TURBONILLA (STRIOTURBONILLA) NYCHIA, new species.

Plate 2, fig. 6.

Shell broadly elongate-conic, bluish white. Nuclear whorls two and a third, forming a depressed helicoid spire, the axis of which is at right angles to the nuclear turns, in the first of which the nuclear spire is about one-third immersed. Early postnuclear whorls strongly rounded, the later ones less so, appressed at the summit, crossed by curved, protractively slanting axial ribs, of which 20 occur upon the first and second and 22 upon the remaining turns. These ribs become somewhat enfeebled toward the summit, which they render slightly sinuous. Intercostal spaces a little wider than the ribs, crossed by 23 incised spiral lines, of which the 11 occurring on the posterior two-fifths are a little finer and closer spaced than the rest, the twelfth being a little stronger. The 10 succeeding are again subequal, while the twenty-third forms a deep peripheral pit. The latter is separated from the rest by a little wider space. The space

separating the twenty-second from the twenty-third is much wider than the rest and appears like a smooth girdle. Periphery of the last whorl well rounded. Base short, well rounded, marked by twenty-five fine, incised spiral lines, those on the columella separating cords a little stronger than the rest.

The type, Cat. No. 359758, U.S.N.M., has 8.5 postnuclear whorls and measures; length, 4.5 mm.; diameter, 1.3 mm.

TURBONILLA (STRIOTURBONILLA) THYNE, new species.

Plate 1, fig. 2.

Shell very regularly conic, subdiaphanous, bluish white. Nuclear whorls two and a half, forming a moderately elevated spire, the axis of which is at right angles to that of the succeeding turns, in the first of which the nuclear spire is about one-third immersed. Postnuclear whorls slightly rounded, narrowly shouldered at the summit, marked by strong, retractively slanting, slightly curved axial ribs, of which 14 occur upon the first and second, 16 upon the third to sixth, and 18 upon the last turn. These ribs extend prominently from the summit, which they render slightly wavy, to the periphery. Intercostal spaces a little wider than the ribs, strongly impressed, terminating at the periphery. Suture moderately constricted. Periphery of the last whorl well rounded. Base short, well rounded, smooth. Aperture subquadrate; posterior angle acute; outer lip thin, showing the external sculpture within; inner lip almost vertical, slightly flexuous, reflected over the posterior half to the base, provided with an obsolete fold a little anterior to its insertion.

The type, Cat. No. 359759, U.S.N.M., has almost 8 whorls and measures: length, 3.4 mm.; diameter, 1.1 mm.

The extremely regular conic outline and large ribs will distinguish this from any of the other species.

TURBONILLA (PYRGISCUS) MELEA, new species.

Plate 2, fig. 8.

Shell very slender, elongate-conic, yellowish white, with a little deeper yellow band about one-fourth of the distance between the summit and the suture anterior to the summit. Nuclear whorls and early postnuclear whorls decollated. Postnuclear whorls very high between summit and suture, appressed at the summit, marked by broad, low, rounded, almost vertical axial ribs, of which 20 occur upon the first and second of the remaining turns, 21 upon the third and fourth, and 28 upon the last whorl. Intercostal spaces about half as wide as the ribs, marked by 18 slender spiral threads which leave the spaces between them as deeply impressed oblong pits.

Suture slightly constricted. Periphery of the last whorl well rounded. Base short, well rounded, marked on the anterior two-thirds by 6 subequally spaced incised spiral lines, of which the posterior four are a little stronger than the rest. Aperture oval; posterior angle acute; outer lip thin, showing the external sculpture within; inner lip flexuous, reflected over and appressed to the base for three-fourths of its length, and provided with a rather strong fold a little anterior to its insertion; parietal wall covered by a thin callus.

The type, Cat. No. 359760, U.S.N.M., has 5.8 whorls remaining, which measure: Length 4.1 mm., diameter 1 mm.

TURBONILLA (PYRGISCUS) EVADNA, new species.

Plate 2, fig. 7.

Shell elongate-conic, bluish white, semidiaphanous. Nuclear whorls decollated. Postnuclear whorls high between summit and suture, appressed at the summit, crossed by low, rounded, almost vertical axial ribs, of which 18 occur upon the first and second of the remaining turns, 20 upon the third, 22 upon the fourth, 24 upon the fifth, 26 upon the sixth, and 27 upon the last whorl. These ribs become enfeebled toward the summit, which they render slightly sinuous. Intercostal spaces a little wider than the ribs, crossed by 11 incised spiral lines, which are of somewhat irregular strength and spacing, the peripheral and the one posterior to the periphery being much wider than the rest. Suture moderately constricted. Periphery of the last whorl well rounded. Base short, strongly rounded, marked by 8 rather strongly incised spiral lines, between which finer striations occur. Aperture oval; posterior angle obtuse; outer lip thin, showing the external sculpture within; inner lip sinuous, reflected over and appressed to the base for the posterior two-thirds of its length, provided with a strong obtuse oblique fold a little anterior to its insertion; parietal wall covered by a thick callus.

The type, Cat. No. 359761, U.S.N.M., has 8.5 whorls remaining and measures: Length 5.4 mm., diameter 1.3 mm.

TURBONILLA (BARTSCHELLA) SEMELA, new species.

Plate 2, fig. 1.

Shell elongate-conic, bluish-white, semitranslucent. Nuclear whorls, at least two, forming a depressed helicoid spire, which is obliquely half immersed in the first of the succeeding turns. Postnuclear whorls strongly rounded, appressed at the summit, marked by very slightly protractive slender axial ribs, of which 22 occur upon the first, 24 upon the second and third, and 26 upon the remain-

ing turns. The intercostal spaces are a little wider than the ribs. In addition to the axial sculpture, the whorls are marked by 5 spiral cords of which the first is at the summit, and is a little broader than the rest. These spiral cords are equally spaced. The intersections between them and the axial ribs form low, rounded nodules, while the spaces enclosed between them form slightly elongated pits, the long axis of which coincides with the spiral sculpture. Suture moderately constricted. Periphery of the last whorl marked by a spiral cord similar to those on the spire. Base short, well rounded, marked by 5 spiral cords between the peripheral cord and the insertion of the columella, which grow consecutively smaller from the posterior anteriorly, the columella being marked by 3 slender spiral threads. Aperture broadly oval; posterior angle acute; outer lip thin, showing the external sculpture within; inner lip almost straight, reflected over and appressed to the base for almost its entire length, provided with a moderately strong fold a little anterior to its insertion.

The type, Cat. No. 359762, U.S.N.M., has 6.5 postnuclear whorls and measures: length, 3.5 mm.; diameter, 1.2 mm.

The present species is nearest related to *Turbonilla* (*Bartschella*) *andrewsi* Dall and Bartsch from Panama, from which it differs by its white color, much larger size and more elegant sculpture

ODOSTOMIA (CHRYSALLIDA) OLSSONI, new species.

Plate 2, fig. 3.

Shell elongate-ovate, bluish white. Nuclear whorls decollated in part, the remaining portion deeply immersed in the first of the succeeding turns. Postnuclear whorls strongly, tabulatedly shouldered at the summit, marked by very strong, slightly protractively slanting, almost vertical axial ribs, of which 18 occur upon the first, 20 upon the second, and 18 upon the remaining turns. Intercostal spaces about one and a half times as wide as the ribs. The spiral sculpture consists of 4 spiral cords which are not as strong as the axial ribs, the first of which is at the summit. These cords divide the space between the summit and the periphery into three equal spiral zones of pits. In the later whorls the summit of the turn drops below the periphery and leaves the peripheral cord in the suture. This is as strong as the spiral cords on the spire. Suture strongly channeled. Base rather long, marked by 5 strong spiral cords, the spaces between which are crossed by numerous fine axial threads. Aperture oval; posterior angle obtuse; outer lip fractured; inner lip stout, reflected over and appressed to the base, and provided with a very strong oblique fold a little anterior to its insertion.

The type, Cat. No. 359763, U. S. N. M., has 6⅓ postnuclear whorls and measures: Length, 3.1 mm.; diameter, 1.2 mm.

The present species is related to *Odostomia* (*Chrysallida*) *excelsa* Dall and Bartsch from Panama, but differs from it in having 5 instead of 8 much stronger spiral cords on the base.

ODOSTOMIA (CHRYSALLIDA) MELITTA, new species.

Plate 2, fig. 2.

Shell elongate-conic, bluish white, semitranslucent. Nuclear whorls decollated. Postnuclear whorls narrowly, tabulatedly shouldered at the summit, flattened in the middle, marked by very strong, slightly protractively slanting axial ribs, of which 16 occur upon the first of the remaining turns, 18 upon the second, third, and fourth, and 20 upon the last. These ribs are almost as wide as the spaces that separate them. The spiral sculpture consists of 4 strong spiral cords which do not quite equal the ribs in strength. The first of these is at the summit, while the other three divide the spaces between the summit and the suture into three equal areas. The junction of the axial ribs and spiral cords forms low rounded tubercles, while the spaces between them enclose rounded pits. Beginning with the antipenultimate turn, the peripheral cord shows at the suture, and on the last turn it is completely free therein. This cord is a little less strong than those on the spire. Base rather long, marked by 7 strong spiral cords, those near the columella being a little less developed than the rest. The latter equal the peripheral cord in strength. The spaces between the cords equal the cords and are crossed by fine axial riblets. Aperture oval; posterior angle obtuse; outer lip thin, showing the external sculpture within; inner lip very stout, reflected over and appressed to the base, and provided with a very strong, almost lamellar oblique fold a little anterior to its insertion; parietal wall covered by a thick callus.

The type, Cat. No. 359764, United States National Museum, has 6 whorls remaining and measures: Length, 4.2 mm.; diameter, 1.4 mm.

This also belongs to the group of *Odostomia* (*Chrysallida*) *excelsa* Dall and Bartsch, but differs from it by its elongate-conic form (*excelsa* is elongate-ovate) and by its much larger size.

MELANELLA (MELANELLA) OLSSONI, new species.

Plate 2, fig. 4.

Shell regularly elongate-conic, bluish white, semitranslucent. Nuclear whorls decollated. Postnuclear whorls almost flattened, giving to the spire an almost straight outline, appressed at the summit. The basal portion of the preceding whorl shines through the substance of the succeeding turn at its summit, and gives this the appearance of having a double suture. Periphery strongly rounded.

Base rather long, well rounded. The entire surface of the shell is smooth, with a silky luster. Aperture oval. Posterior angle acute; outer lip slightly contracted near the summit, rather protracted in the middle, but scarcely produced into a clawlike element, thin; inner lip stout, reflected over and appressed to the base; parietal wall covered by a moderately thick callus.

The type, Cat. No. 359765, U.S.N.M., has 8.5 whorls and measures: length, 4.5 mm.; diameter, 1.4 mm.

MELANELLA (BALCIS) ELENENSIS, new species.

Plate 2, fig. 5.

Shell elongate-conic, slightly falciform, bluish white. Nuclear whorls decollated. Postnuclear whorls appressed at the summit, very slightly rounded, forming an almost straight-sided spire. Suture but slightly constricted. Periphery of the last whorl well rounded. Base produced, well rounded. Entire surface smooth with a silky luster. Aperture suboval; posterior angle acute; outer lip thin, slightly contracted immediately below the posterior angle, but scarcely produced into a claw-like element anterior to this; inner lip stout, very oblique, reflected over and appressed to the base; parietal wall covered by a thin callus.

The type, Cat. No. 359766, U.S.N.M., has 8.5 whorls and measures: length, 4.5 mm.; diameter, 1.2 mm. Cat. No. 359767, U.S.N.M., contains a young specimen of 5.8 whorls from the same locality.

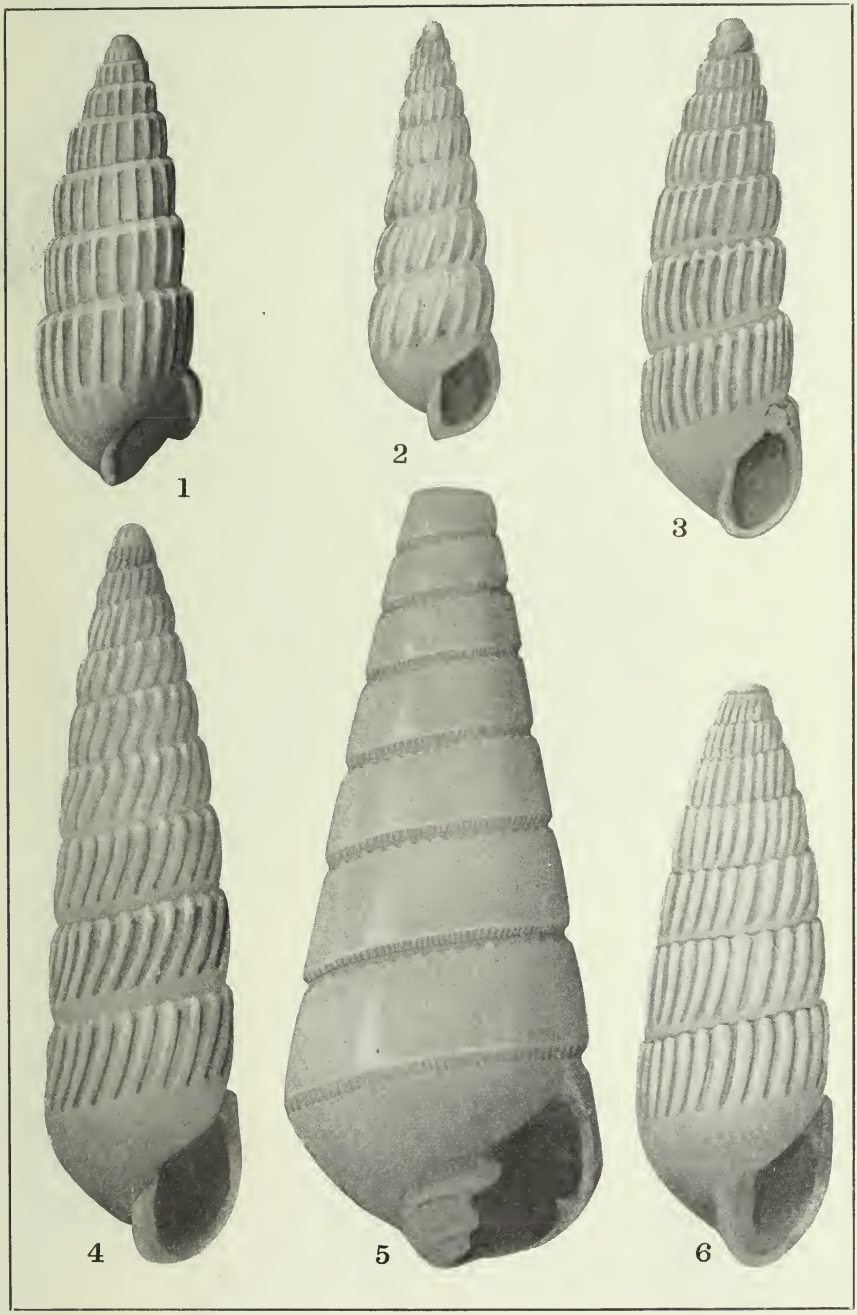
EXPLANATION OF PLATES.

PLATE 1.

FIG. 1. *Turbonilla* (*Turbonilla*) *axeli*.
2. *Turbonilla* (*Strioturbonilla*) *thyne*. Spiral sculpture too fine to be shown in figure.
3. *Turbonilla* (*Chemnitzia*) *oenoa*.
4. *Turbonilla* (*Strioturbonilla*) *evagone*. Spiral sculpture too fine to be shown in figure.
5. *Pyramidella* (*Longchaeus*) *elencnsis*.
6. *Turbonilla* (*Chemnitzia*) *theone*.

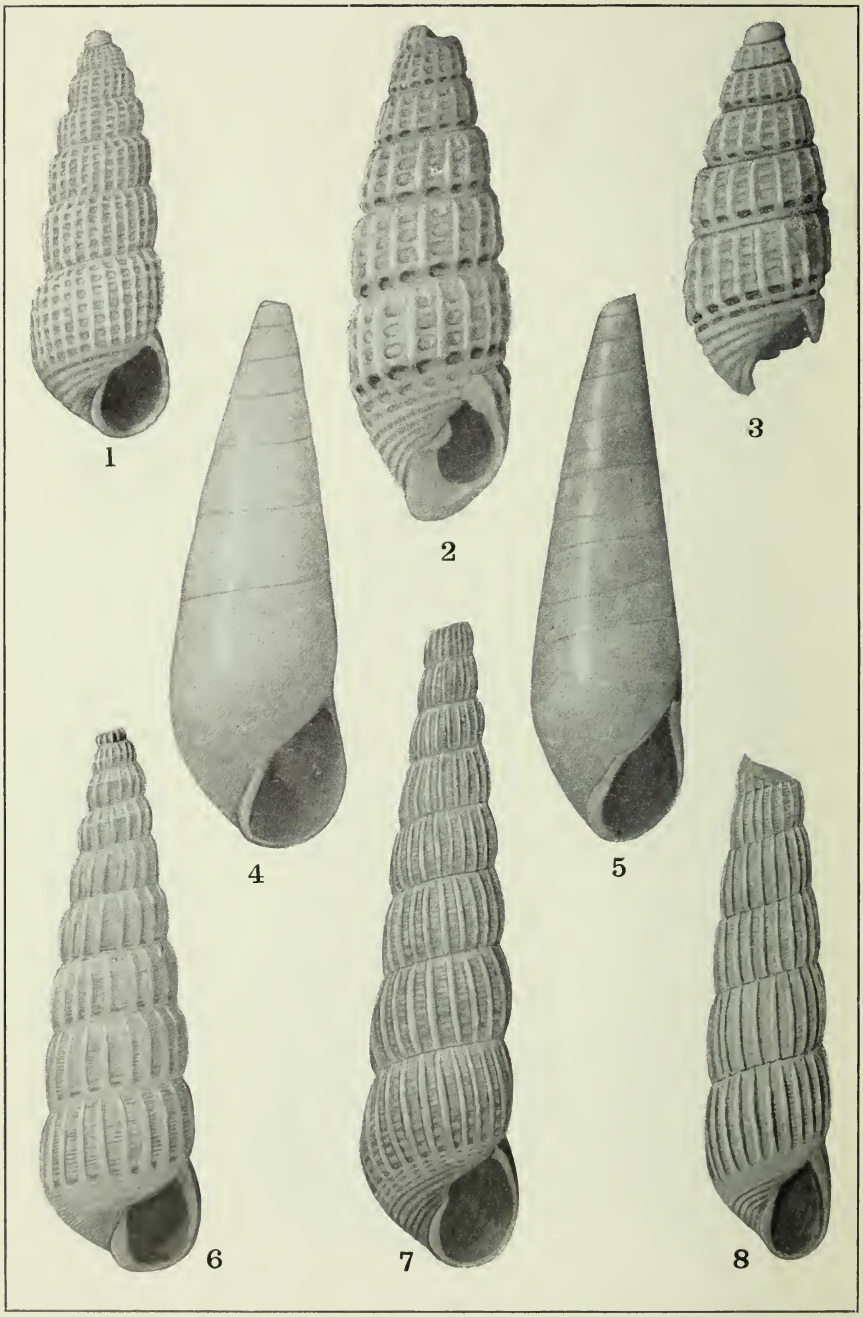
PLATE 2.

FIG. 1. *Turbonilla* (*Bartschella*) *semele*.
2. *Odostomia* (*Chrysallida*) *melitta*.
3. *Odostomia* (*Chrysallida*) *olssoni*.
4. *Melanella* (*Melanella*) *olssoni*.
5. *Melanella* (*Balcis*) *elenensis*.
6. *Turbonilla* (*Strioturbonilla*) *nychia*.
7. *Turbonilla* (*Pyrgiscus*) *evadne*.
8. *Turbonilla* (*Pyrgiscus*) *melea*.



NEW MOLLUSKS FROM ECUADOR

FOR EXPLANATION OF PLATE SEE PAGE 9



NEW MOLLUSKS FROM ECUADOR

FOR EXPLANATION OF PLATE SEE PAGE 9

10

NEW MOLLUSKS FROM THE BAHAMA ISLANDS

BY

PAUL BARTSCH

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No. 2016.—From the Proceedings of the United States National Museum, Vol. 46, pages 107–109, with Plate 3

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NEW MOLLUSKS FROM THE BAHAMA ISLANDS

BY

PAUL BARTSCH

Assistant Curator, Division of Mollusks, United States National Museum

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Published November 29, 1913

Washington
Government Printing Office
1913

NEW MOLLUSKS FROM THE BAHAMA ISLANDS.

By Paul Bartsch

Assistant Curator, Division of Mollusks, United States National Museum.

Some time ago the United States National Museum received from Mr. G. W. Pepper, of Providence, Rhode Island, a collection of Bahama land mollusks for determination. Among these shells are several forms which are sufficiently distinct from those heretofore known from these islands to merit recognition. I have therefore prepared the following descriptions and figures.

Shortly after describing these shells, I had the pleasure of visiting the Bahamas myself, and was able to make large collections there, particularly on Andros Island, which is a collective term applied to a number of minor keys separated by tortuous channels of varying width and depth. Practically each key examined, no matter how small, providing it bears vegetation, excepting those in the Tongue of the Ocean, which are at times dashed over by waves, is inhabited by Cerions of the glans group. Sufficient differentiation has taken place on each key to enable one to distinguish the shells from the different keys. On some of the keys a series of swales separate an equal number of wooded elevations, each of which is occupied by a different race of these shells. The question naturally presents itself, to what extent are these forms constant? Do they represent stable races with fixed characters, or are they continually changing in form? It seems to me that our systematic treatment of this group will have to depend upon the answer to these questions, for it would be folly to waste time and paper in describing thousands of forms if they are not constant. If they are changing, the question still presents itself, do they pass through a definite cycle of changes? Then the further question arises, are we dealing with a complex Mendelian problem? At all events it seems desirable to study the underlying factors responsible for the phenomena as they are represented, and until such studies have been completed it would be more desirable to stop indiscriminate description of new species of *Cerion*.

I have probably a hundred so-called species which I might describe, of recent years' collecting, as distinct as any that have received names in the past, which will wait for their designation until the

breeding experiments [1] I am now conducting on the Florida keys, under the auspices of the Department of Marine Biology of the Carnegie Institution of Washington, D. C., have been completed.

The *Cerion* described in the present paper is as distinct as any of the described species. Were it part of my collecting I would retain the description until the breeding experiments have given a decision upon the desirability, yes, the necessity, of describing the thousands of races which will be found when exhaustive collecting will have been done in the Bahamas. However, since the present species has been distributed under the above name, it is best that it should have a definite status. For the other forms described, no apologies are necessary.

CERION (STROPHIOPS) PEPPERI, new species.

Plate 3, figs. 1, 3, 7–12.

Shell cylindro-conic, moderately tapering at the apex, chocolate brown, crossed with slender, very retractive, somewhat irregular, whitish, axial riblets, between which appear finer lines of growth. Base rimate, crossed by the continuation of the axial ribs. Aperture small, with a white reflected peristome. Parietal wall provided with a strong fold, which is a little to the right of the middle; the second fold is at the junction of the inner lip and parietal wall.

This species was found common by Mr. G. W. Pepper, 2 miles south of Mastic Point, Andros Islands, Bahamas. The type, Cat. No. 250217, U.S.N.M., figure 10, has 12 whorls and measures: length, 31.0 mm., diameter, 9.0 mm.

With the type lot are a number of smaller specimens which have a completed aperture, but a much lesser number of whorls, figures 9 and 12. They agree in all characters with the species excepting size and number of whorls. One of these has nine whorls and measures: length, 19.9 mm., diameter, 8.2 mm. Another having nine whorls measures: length, 19.0 mm., diameter 9.5 mm.

Still another lot of specimens, of which I have seen three, figures 1, 3, and 11, are intermediate in size between these two. These three have a second lip, starting from within the first peristome, building out a new growth and leaving the original reflected peristome as a broad varix. One of these has ten and one eight turns and measures; length 22.9 mm.; diameter 10.0 mm. It would seem as if these smaller specimens indicated a forced maturity owing probably to the effects of a dry season and that with the return of favorable conditions these three have started a new growth.

Still two other specimens of this species have, probably owing to some injury, assumed a scalariform spire in the later whorls. These two, figures 7 and 8, were collected on a small unnamed key south of Mastic Point, Andros Islands, Bahamas.

[1] See Yearbook, Carnegie Institution, No. 11, pp. 129–131, and the second report in the next yearbook, not yet issued.

CEPOLIS MAYNARDI ELEVATA, new subspecies.

Plate 3, figs. 4–6.

Shell similar to *C. maynardi*, but much more elevated, with the axial sculpture a little more strongly emphasized, the individual whorls are more inflated, the aperture is considerably shorter and tends toward a subcircular rather than an oval outline. Lip edged with pink internally. Color bands absent.

Eight specimens of this species were collected by Mr. Pepper at Mastic Point, Andros Islands, Bahamas. Two of these, cotypes, are in the U. S. National Museum, Cat. No. 250221. These have five whorls and measure: Altitude, 9.8 mm., and 10.2 mm.; greatest diameter, 12.5 mm. and 13.1 mm., respectively.

LEPTINARIA BAHAMENSIS, new species.

Plate 3, fig. 2.

Shell elongate-conic, yellowish white. Whorls seven, well rounded but not inflated, marked by very fine, slender, sinuous, axial threads. Sutures strongly constricted. Periphery of the last whorl well rounded. Base narrowly umbilicated. Aperture oval; posterior angle obtuse; half the outer lip, immediately below the summit, inbent and at the same time slightly protracted into a faint claw-like element; inner lip revolute, provided with a fold a little anterior to its middle. Parietal wall glazed with a thin callus.

The type, Cat. No. 250220 U.S.N.M., was collected by Mr. G. W. Pepper at Mastic Point, Andros Islands, Bahamas. It measures: Length 7.1 mm.; diameter 3.7 mm.

VARICELLA GRACILLIMA BAHAMENSIS, new subspecies.

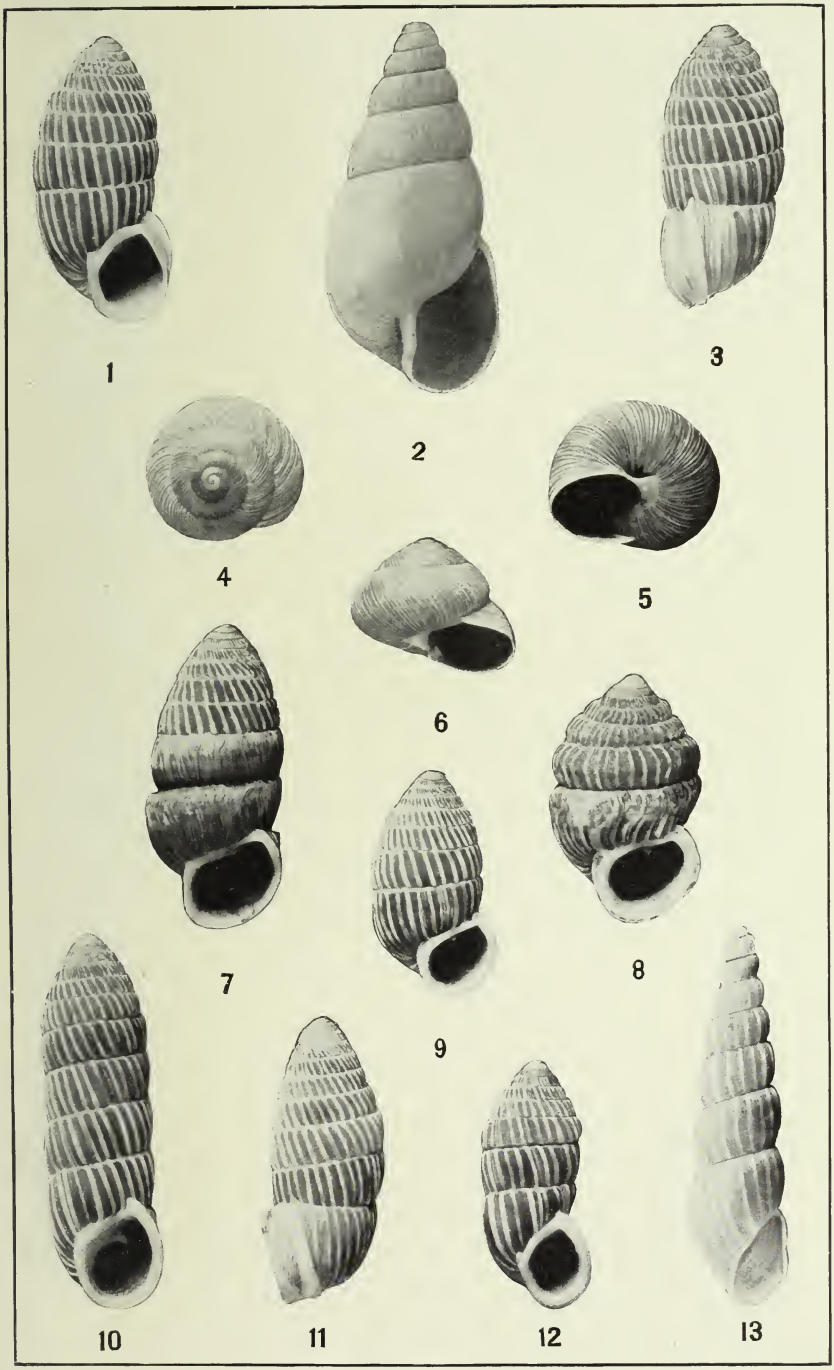
Plate 3, fig. 13.

Shell similar to *V. gracillima*, but having the whorls less inflated, and scarcely at all shouldered at the summit, and the sutures much less constricted. The ribs also in the present form are very poorly developed and much more distantly spaced than in *V. gracillima*.

The type, which has nine whorls, measures: Length 7.5 mm.; diameter 2.0 mm.; it and three specimens, Cat. No. 180661, U.S.N.M., were collected by Owen Bryant on Mangrove Cay, Andros Islands, Bahamas. Cat. No. 180660, U.S.N.M., contains six specimens, which are a little smaller in every way than the type lot, collected by the same gentleman under leaves and bushes on a hillside near Fort Charlotte, Nassau, New Providence. Still another specimen was determined for Mr. G. W. Pepper, collected on Andros Islands.

EXPLANATION OF PLATE 3.

FIGS. 1, 3, 7–12. *Cerion (Strophiops) pepperi.*
4–6. *Cepolis maynardi elevata.*
2. *Leptinaria bahamensis.*
13. *Varicella gracillima bahamensis.*



NEW MOLLUSKS FROM THE BAHAMA ISLANDS.

FOR EXPLANATION OF PLATE SEE PAGE 109.

NEW MOLLUSKS OF THE FAMILY VITRINELLIDÆ FROM THE WEST COAST OF AMERICA

BY

PAUL BARTSCH

Assistant Curator, Division of Mollusks, U. S. National Museum

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No. 1520.—From the Proceedings of the United States National Museum, Vol. XXXII, pages 167–176

Washington
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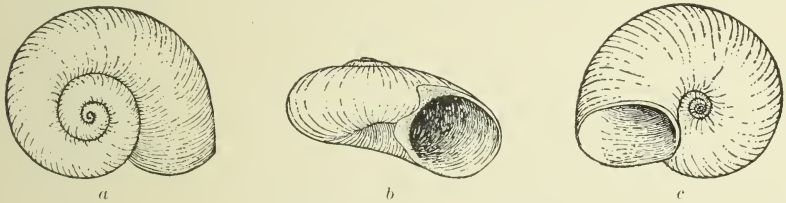
The United States National Museum has from time to time received additions to the collections of this family, among which are quite a number of undescribed forms. These are here diagnosed and figured.

VITRINELLA OLDROYDI, new species.

Shell small, sublenticular, semitransparent, a little more convex above than below. Nepionic whorls not differentiated from the rest, the entire upper surface smooth and shining, marked only by irregularly distributed incremental lines. The upper sides of the whorls are moderately and evenly rounded. Sutures well marked. Periphery of the last whorl well rounded. Base moderately well rounded, openly



a *b* *c*

Fig. 1.—Vitrinella oldroydi. *a*, top view; *b*, side view; *c*, basal view.

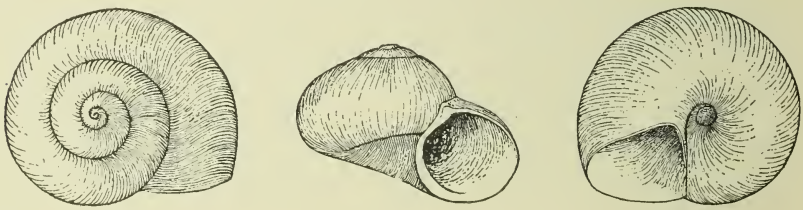
umbilicated to the very apex. Columellar wall of the base well rounded (not concaved). Aperture decidedly oblique, broadly oval; outer lip thin; columella decidedly curved and somewhat expanded at its insertion; parietal wall covered by a rather strong callus which partly fills the posterior angle.

The type, Cat. No. 158777, U.S.N.M., was collected in low water at Point Loma, California. It has three and three-fourths whorls and measures: Greater diameter, 2.1 mm.; lesser diameter, 1.6 mm.; altitude, 0.8 mm.

There are five additional lots in the collection of the U. S. National Museum: Cat. No. 127563, eleven specimens from San Pedro, California, collected by Mrs. T. S. Oldroyd; Cat. No. 192684, three from Terminal Island, California, collected by Mrs. W. H. Eshnaur; Cat. No. 60911, five specimens, collected by Mr. C. R. Orcutt, at San Diego, California; two, Cat. No. 183355, collected by Mr. Bailey, at La Jolla, California; and five, Cat. No. 105485, that were collected by Mr. H. Hemphill, at Point Abreojos, Lower California.

VITRINELLA ESHNAURI, new species.

Shell moderately elevated, subglobose, thin, almost transparent, glassy. Nepionic whorls 1½, scarcely differentiated from those which follow, well rounded, smooth. Succeeding whorls well rounded, somewhat inflated, marked only by exceedingly fine lines of growth. Sutures well impressed. Periphery of the last whorl well rounded. Base moderately rounded, marked only by incremental lines, with narrow but open umbilicus, which is obsoletely angled at the outer edge. Columellar wall of umbilicus vertical from the outer edge to



a *b* *c*

FIG. 2.—VITRINELLA ESHNAURI. *a*, TOP VIEW; *b*, SIDE VIEW; *c*, BASAL VIEW.

within a short distance of the parietal wall, where it bends outward to join the preceding turn. Aperture decidedly oblique, almost circular; outer lip thin and translucent; columella quite strong and decidedly curved; parietal wall covered by a moderate callus which forms an acute angle with the posterior margin of the lip.

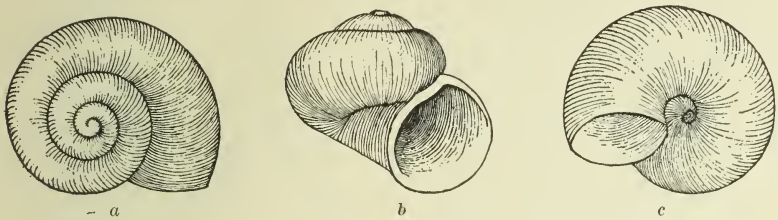
The type, Cat. No. 127557, U.S.N.M., was collected by Mrs. Oldroyd at San Pedro, California. It has 4⅛ whorls and measures: Greater diameter, 2.3 mm.; lesser diameter, 1.9 mm.; altitude, 1.3 mm.

Seven additional specimens were dredged by Mrs. Eshnaur at Terminal Island, California, three of which are entered under Cat. No. 192685, U.S.N.M., the remaining four being in Mrs. Eshnaur's collection.

VITRINELLA ALASKENSIS, new species.

Shell small, subglobose, semitransparent. Nepionic whorls 1⅛, well rounded, smooth. Succeeding turns somewhat inflated, well rounded, separated by strongly impressed sutures, marked only by incremental lines. Periphery and base of the last whorl well rounded. The latter

narrowly and openly umbilicated to the very apex. Columellar wall of the umbilicus not flattened nor angulated at the outer edge, but evenly rounded with the rest of the base. Aperture forming a broad semioval, of which the columellar side forms the short diameter; outer



a *b* *c*

FIG. 3.—VITRINELLA ALASKENSIS. *a*, TOP VIEW; *b*, SIDE VIEW; *c*, BASAL VIEW.

lip thin and semitransparent; columella slender and curved; parietal wall covered by a thin callus.

The type and eight additional specimens, Cat. No. 109470, U.S.N.M., were collected by Dr. William H. Dall at Unalaska, Alaska. The type has 3½ whorls and measures: Greater diameter, 1.6 mm.; lesser diameter, 1.2 mm.; altitude, 1.2 mm.

DOCOMPHALA, new subgenus.

Shell like typical *Vitrinella* except in the structure of the umbilicus. In *Vitrinella* ss. the columellar wall of the umbilicus is smooth. In the present group it is divided into two parts, the basal half of which is devoid of sculpture, excepting incremental lines, while the inner half is marked by strong, oblique, rounded ribs.

Type.—*Vitrinella* (*Docomphala*) *stearnsi.*

VITRINELLA (DOCOMPHALA) STEARNSI, new species.

Shell depressed, lenticular, a little more convex above than below. The nepionic portion of the shell consists of the first one and a half turns, which are small, slightly convex, and smooth. The turns which succeed the nepionic part of the shell are strongly, obliquely, transversely ribbed on the upper side, but these ribs gradually grow weaker as the shell increases in size and disappear entirely after one and one-half turns, the remaining portion being marked by mere lines of growth on the upper surface. Periphery of the last whorl well rounded. Base very gently rounded, crossed by rather strong incremental lines. Umbilicus wide and open to the very apex, decidedly angulated at the outer margin. The columellar wall is strongly concaved from the outer angulation to the junction with the preceding whorl, the inner half of it bears a series of strong ribs behind the aperture. Aperature decidedly oblique; outer lip acute, forming a regular semioval of which the parietal wall and columella form the short diameter; columella short, stout, concave; parietal wall covered

by a thick callus, which renders the peristome continuous and forms an acute angle with the outer lip posteriorly. The parietal callus and columella form a strongly sigmoid curve.

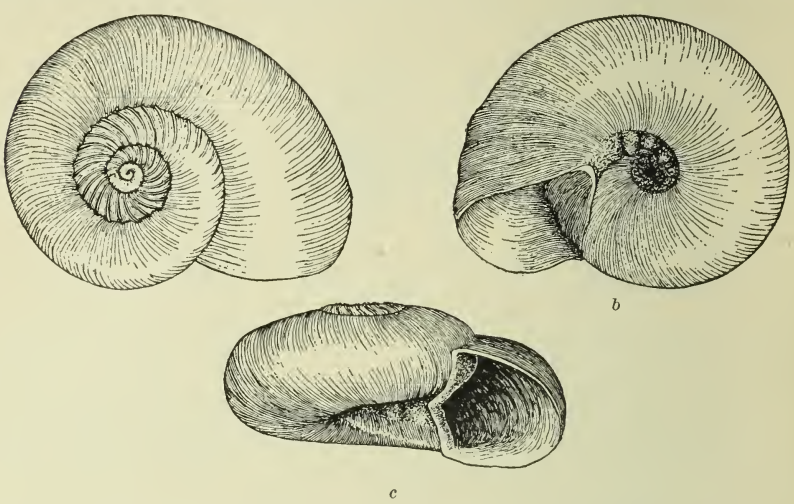


FIG. 4.—VITRINELLA (DOCOMPHALA) STEARNSI. *a*, TOP VIEW; *b*, BASAL VIEW; *c*, SIDE VIEW.

The type and three young individuals are part of the Stearns Collection and are entered as Cat. No. 74011, U.S.N.M., and come from Monterey, California.

The type has 4½ whorls and measures: Greater diameter, 3.8 mm.; lesser diameter, 3 mm.; altitude, 1.5 mm.

VITRINELLA (DOCOMPHALA) BERRYI, new species.

Shell small, semitransparent, lenticular, with the upper part only slightly more convex than the base. Nepionic whorls forming a little more than one and two-thirds turns, smooth, and moderately convex.

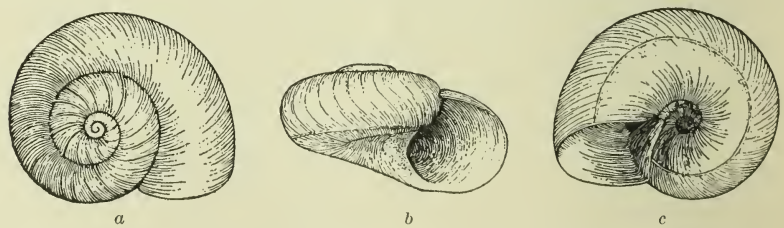


FIG. 5.—VITRINELLA (DOCOMPHALA) BERRYI. *a*, TOP VIEW; *b*, SIDE VIEW; *c*, BASAL VIEW.

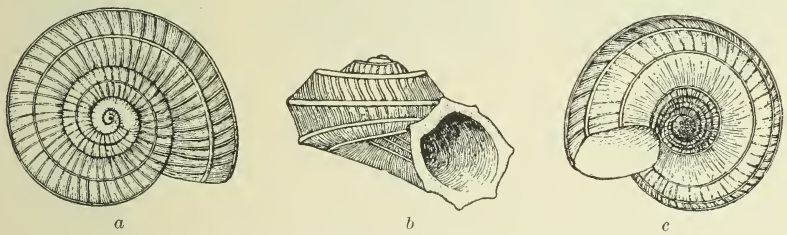
The portion following the nepionic part is crossed on the upper surface by quite regularly spaced, sublamellar riblets, which become weaker as the shell increases in size, and disappear completely after one and one-half turns; the remaining part of the upper surface being marked by weak incremental lines only. Sutures well marked. Periphery

of the last whorl well rounded, the first half showing continuations of the ribs, the rest being smooth. Base moderately rounded with a fairly strong spiral keel which is situated about one-third of the way toward the umbilical angle from the periphery. Umbilicus much narrower than *V. stearnsi*, its outer edge terminating in a blunt angle. Columellar wall decidedly concaved, the inner half marked by a series of strong riblike nodules as in *V. stearnsi*. Aperture decidedly oblique, subcircular; outer lip thin; columella very thick, concaved, provided with a moderately strong callus which bends back into the umbilicus.

The type, Cat. No. 192686, U.S.N.M., and another specimen in the collection of Mr. S. S. Berry were dredged by that gentleman in 12 fathoms, off Del Monte, Monterey Bay, California. It has 4 whorls and measures: Greater diameter, 2.2 mm.; lesser diameter, 1.7 mm.; altitude, 1 mm. Another specimen of this species, Cat. No. 192687, U.S.N.M., was collected by Mrs. T. S. Oldroyd at San Diego, California.

CYCLOSTREMA XANTUSI, new species.

Shell small, transparent, with moderately elevated spire. Nepionic whorls $1\frac{2}{3}$, well rounded, smooth. The succeeding turns are marked by a strong peripheral cord and another spiral cord which is situated



a *b* *c*

FIG. 6.—CYCLOSTREMA XANTUSI. *a*, TOP VIEW; *b*, SIDE VIEW; *c*, BASAL VIEW.

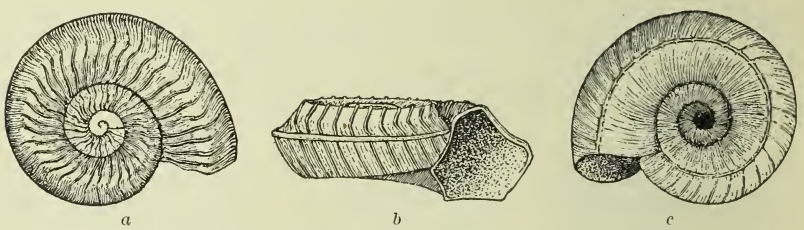
a little nearer the summit than the periphery of the whorls. In addition to this spiral sculpture there are many (about 48 on the last turn) regular, equally spaced, low riblets, which coincide with the lines of growth and are about one-third as wide as the spaces that separate them. Periphery of the last whorl strongly angulated by the spiral cord. The base is marked by three spiral keels—one at the edge of the umbilicus, the other two divide the space between this and the peripheral keel into three equal parts. The riblets of the upper surface continue equally strong over the space between the peripheral and the first basal keels, but between this and the second basal keel they become decidedly enfeebled, while they are almost absent between the second keel and the one that bounds the umbilicus. Umbilicus broadly open. Columellar wall of the last whorl well rounded and marked by three equally spaced spiral threads, the inner one of which is decidedly

weaker than the rest. Aperture decidedly oblique, polygonal, the angles being formed by the spiral keels, the posterior angle of the aperture, and the insertion of the stout and strongly curved columella.

The unique type, Cat. No. 4035, U.S.N.M., was collected by J. Xantus at Cape St. Lucas, Lower California. It has little more than four whorls and measures: Greater diameter 1.4 mm.; lesser diameter 1.15 mm.; altitude 0.5 mm.

CYCLOSTREMA DIEGENSIS, new species.

Shell exceedingly small, thin, planorboid, with a prominent, compressed peripheral keel, translucent, yellow horn-colored. Nepionic whorls 1½, moderately rounded, not elevated, smooth. The succeeding turns have their highest elevation at about one-third of the distance from the suture to the periphery, at which place they are raised into a broad, well-rounded ridge from which they slope abruptly, convexly rounded, to the suture and more gently concavely to the angulated periphery. On the upper surface the whorls are ornamented with slender, regularly spaced, oblique riblets, which are



a *b* *c*

FIG. 7.—CYCLOSTREMA DIEGENSIS. *a*, TOP VIEW; *b*, SIDE VIEW; *c*, BASAL VIEW.

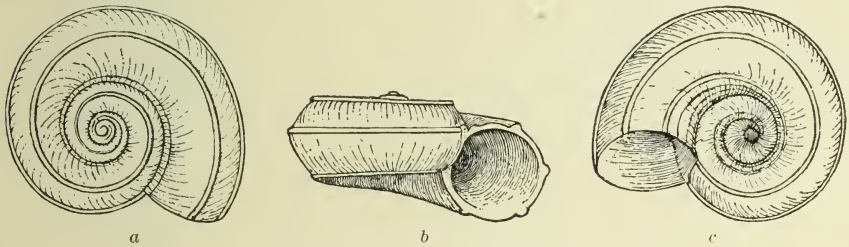
best developed on the elevated ridge, where they are about one-fourth as wide as the spaces that separate them. Sutures strongly marked. Periphery with a compressed, obtuse angle. Base moderately rounded, broadly openly umbilicated, with a slender thread bounding the outer edge of the umbilicus and a slender spiral cord situated about halfway between the umbilical thread and the periphery. The riblets seen on the upper surface extend feebly beyond the peripheral keel to the first basal cord but are reduced to simple incremental lines between this and the umbilical thread; columellar wall well rounded, marked by incremental lines only. Aperture oblique, irregularly pentagonal, one blunt angle being formed by the elevated part of the whorl, another equally obtuse one by the periphery, the third by the basal keel, the fourth by the umbilical angle, and the fifth by the junction of the columella with the parietal wall. Outer lip thin, showing the sculpture of the shell within. Columella straight and very obliquely placed. Parietal wall covered by a thin callus.

There are five specimens of this species in the collection of the U. S. National Museum, Cat. No. 105488, all from San Diego, California.

The type, which is one of these specimens, has $3\frac{2}{3}$ whorls and measures: Greater diameter 1.0 mm.; lesser diameter 0.8 mm.; altitude about 0.25 mm.

CIRCULUS COSMIUS, new species.

Shell decidedly depressed, planorboid, creamy white, shining. Nepionic whorls 2, well rounded, helicoid, polished. Succeeding turns marked by a low, rather broad spiral thread at the summit and a strong, acute, lamellar ridge at the periphery, and another equally strong halfway between the periphery and the summit. The last has the free edge pointing outward, forming an angle of 45° with the peripheral lamella. The spaces between these keels are gently rounded and marked by incremental lines only. The middle keel forms the most elevated portion on each whorl, the summit of the whorl at the suture being considerably lower. Base very broadly umbilicated, marked by a spiral, lamellar carina, which is as strong as the peripheral one and is situated halfway between this and the umbilical angle. In addition to this carina the entire base shows fine incremental lines.



a *b* *c*

FIG. 8.—CIRCULUS COSMIUS. *a*, TOP VIEW; *b*, SIDE VIEW; *c*, BASAL VIEW.

Umbilicus limited by an obtuse angle; columellar wall almost vertical, marked by three slender, equally spaced, spiral lirations. Aperture decidedly oblique, pentagonal, the angles being formed by the three carinæ, the posterior angle of the aperture, and the umbilical angle; outer lip thin; columella decidedly curved; parietal wall covered by a strong callus, which renders the peritreme almost continuous.

There are two specimens in the collection of the U. S. National Museum, Cat. No. 192708, both dredged by the U. S. Bureau of Fisheries steamer *Albatross*, at Station 2799, near Atacames, Ecuador, in $29\frac{1}{2}$ fathoms of water. The type, which is one of these two specimens, has $4\frac{1}{2}$ whorls and measures: Greater diameter, 2.5 mm.; lesser diameter, 2.1 mm.; altitude, 1 mm.

CIRCULUS CERROSENSIS, new species.

Shell decidedly depressed, planorboid, semitransparent, yellowish horn colored. Nepionic whorls 2, moderately elevated, polished. Succeeding turns marked by a feeble spiral thread at the summit and a strong, acute spiral lamella at the periphery and another equally strong

about halfway between the two. In addition to these keels the surface on the upper side is marked by many fine incremental lines and numerous equally fine spiral striations. The greatest elevation of the whorls falls in the region of the middle keel, from there they slope roundedly downward to the sutural thread. Base very broadly umbilicated, showing all the whorls within the umbilicus to the very apex. A strong spiral keel, somewhat stronger than the peripheral one, is situated almost halfway between the umbilical edge and the periphery. In addition the base is marked by fine incremental lines and scarcely perceptible spiral striations. The umbilical edge is marked by a moderately strong carina and the columellar wall, which is moderately rounded, bears immediately below this three equally spaced threads, the outer two of which are as strong as the carina at the edge, while the inner one is only feebly developed. Aperture extremely oblique, pentagonal, the angles being formed by the keels, the posterior angle of the aperture and the umbilical carina; outer lip thin; columella strongly curved; parietal wall with a faint callus.

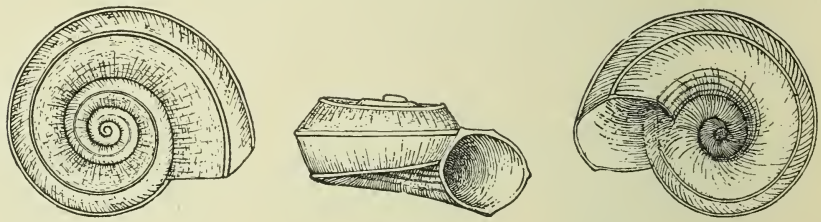


FIG. 9.—CIRCULUS CERROSENSIS. *a*, TOP VIEW; *b*, SIDE VIEW; *c*, BASAL VIEW.

The type and only specimen known, Cat. No. 151942, U.S.N.M., was dredged by the U. S. Bureau of Fisheries Steamer *Albatross* at Station 2827 off Cerros Island, Lower California, in 10 fathoms of water. It has 5 whorls and measures: Greater diameter, 2.5 mm.; lesser diameter, 2.1 mm.; altitude, 1.1 mm.

While this specimen resembles *C. cosmius* closely in general outline, it can nevertheless be distinguished quite readily by the fine spiral sculpture between the keels on the upper surface, which is absent in *C. cosmius* and by the much more strongly developed spiral cords on the columellar wall of the umbilicus.

CYCLOSTREMELLA CALIFORNICA, new species.

Shell small, planorboid, semitransparent, closely spirally striated. Nepionic whorls 1¼, moderately rounded, smooth and shining. Succeeding turns increasing regularly in size like Planorbis, rendering the apex considerably lower than any of the succeeding turns, the last being the most elevated. Whorls well rounded, separated by strongly impressed sutures and marked by many equally strong and equally

spaced, somewhat wavy, incised spiral lines and fine incremental lines. At more or less regular intervals there appear slight constrictions which coincide with the lines of growth. Periphery of the last whorl well rounded. Base well rounded, very broadly and openly umbilicate to the very apex, marked like the upper surface. Aperture oblique, suboval; outer lip thin; columella short, forming almost a straight line with the faint callus of the parietal wall. The type has a little more than three and a half whorls and measures. Greater diameter, 2.3 mm.; lesser diameter, 1.8 mm.; altitude, 0.8 mm.

The type and another specimen were collected by Mrs. Oldroyd at Long Beach, California, and are entered under Cat. No. 125537, U.S.N.M.

There are five additional lots in the collection: Cat. No. 192709, one specimen collected by Mr. S. S. Berry in 12 fathoms off Del Monte, Monterey, California; Cat. No. 127561 U.S.N.M., three specimens

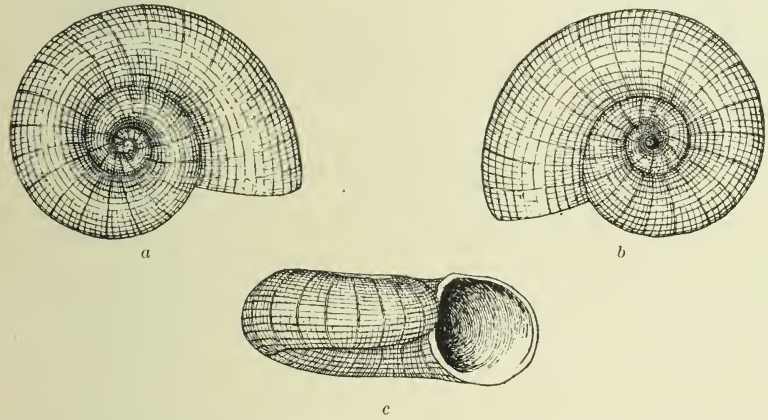


FIG. 10.—CYCLOSTREMELLA CALIFORNICA. *a*, TOP VIEW; *b*, BASAL VIEW; *c*, SIDE VIEW.

from San Pedro, California, collected by Mrs. Oldroyd; Cat. No. 192710, U.S.N.M., 25 specimens dredged at Terminal Island by Mrs. W. H. Eshnaur, and 50 additional specimens from the same place are in the collection of Mrs. Eshnaur; Cat. No. 192711, U.S.N.M., three specimens collected by Mrs. Oldroyd at San Diego, California; and lastly Cat. No. 7963, six fossil specimens collected by Mr. Henry Hemphill in the Postpliocene beds of San Diego, California.

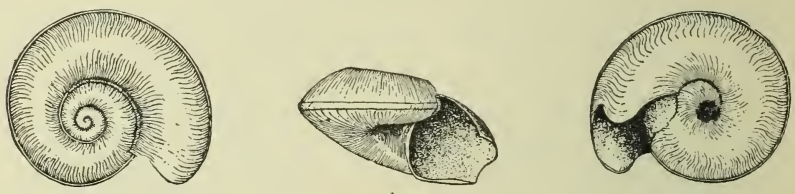
SCISSILABRA, new genus.

Vitrinella-like shells with the middle of the outer lip deeply and broadly notched, the center of the notch coinciding with the periphery of the shell.

Type.—Scissilabra dalli.

SCISSILABRA DALLI, new species.

Shell small, depressed, lenticular, with acutely angulated periphery, having $3\frac{1}{2}$ transparent, vitreous whorls which are separated by well-marked sutures. The nepionic portion consists of the first $1\frac{2}{3}$ turns and is scarcely differentiated from the rest of the shell. The upper surface is evenly and gently rounded from the summit to the periphery, which is strongly and sharply carinated. Under side openly umbilicated, much less convex than the upper. The umbilical edge is marked by an acute carina from which the columellar wall in the last whorl extends almost vertically to where it joins the preceding turn. This carina and vertical umbilical wall are characteristic of the last turn only; in all the others which are visible in the umbilicus it appears



a *b* *c*

FIG. 11.—SCISSILABRA DALLI. *a*, TOP VIEW; *b*, SIDE VIEW; *c*, BASAL VIEW.

evenly rounded. Aperture very large, decidedly oblique; outer lip very broadly and strongly notched, the blunt angle of the notch coinciding with the periphery of the shell; the portion of the lip posterior to the sinus and its basal part somewhat sinuous; columella vertical and slightly concave; parietal wall covered by a thick callus which renders the peritreme almost continuous.

The type, Cat. No. 192712 U.S.N.M., was collected in the beach drift, San Diego, California. It measures: Greater diameter, 2 mm.; lesser diameter, 1.5 mm.; altitude about 0.75 mm.

Another specimen, Cat. No. 127562, U.S.N.M., comes from San Pedro, California. A third specimen, Cat. No. 192713, U.S.N.M., was dredged in 12 fathoms, blue mud bottom, at Monterey Bay by Mr. S. S. Berry, and an additional specimen from the same locality is in Mr. Berry's collection.

12

NOTES ON THE FRESH-WATER MOLLUSK PLANORBIS MAGNIFICUS AND DESCRIPTIONS OF TWO NEW FORMS OF THE SAME GENUS FROM THE SOUTHERN STATES

BY

PAUL BARTSCH

Assistant Curator, Division of Mollusks, U. S. National Museum

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No. 1587.—From the Proceedings of the United States National Museum, Vol. XXXIII, pages 697–700, with Plate LVII

Published March 4, 1908

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Early in November, 1906, the writer made a trip to Wilmington, North Carolina, in quest of that magnificent member of the genus *Planorbis*, *Planorbis* (*Pierosoma*) *magnificus*; which was described by Dr. H. A. Pilsbry in the Nautilus.[a]

The locality cited was lower Cape Fear River. An examination of the type lot at the Philadelphia Academy of Sciences created some doubt in my mind about this being a fluviatile species. The thin texture of the large shell appeared to me as indicating evidence of a lacustrine form.

Inquiry as to the larger lakes about Wilmington resulted in the location of Greenfield Pond, about a mile and a half south of the city. This pond is formed by a broad earthen milldam, about 20 feet high, which banks up the water between sand dunes, inundating the low-lying ground, and transforming it into a lake, the digitations of which extend back for some 3 miles. Its greatest width probably does not exceed 400 feet. A large portion is fringed with cypress trees, and there are several cypress-covered islands in it. The trees are not large, hardly more than a foot in diameter, and are all draped with large festoons of Spanish moss. The water of the lake comes from springs, is unpolluted, and contains an interesting fauna and flora. Conspicuous among the plants were long strings of *Potamogeton* and several species of pond lilies, the leaves of which extend over the surface of the water. After a half hour's sifting of bottom material and vegetation, I succeeded in finding many small mollusks and the first fragment of the desired *Planorbis*. The sieve was discarded for a time and a systematic search among the heavier aquatic vegetation begun, which resulted shortly in discovering the first perfect living *magnificus*. The search continued all day, when, gathering

[a] November, 1903, XVII, p. 75.

the results of my labor, I found myself the possessor of 29 fine *Planorbis*. These were carefully packed in Spanish moss to prevent injuring their delicate edges and taken to the hotel. The following day was spent in further searching, and ended by increasing the number of specimens found to 46.

Most of the specimens of *Planorbis magnificus* found were attached to the underside of the expanded leaves of the larger species of the white pond lily, probably a *Castalia*, though many were obtained from the heavy banks of *Potamogeton* growing in dense masses a short distance offshore. By pulling these masses and shaking them the mollusks were dislodged and rose to the surface for a moment before sinking to the bottom. I was able to find them only along the border of the south side of the lake, the shore line of which consists of a series of loops, and then only off the west side of the extreme points of each loop. It is quite possible that the shells live in greater numbers in deeper parts of the lake, and that they are driven inshore with dislodged vegetation by northwest winds. (See Plate LVII, figs. 7–9.)

Other lakes about Wilmington, as well as the river, were explored during my visit, but none yielded this large shell nor the new species described below, which so far confines the distribution of the two to this lake.

There are many interesting features about the very profuse molluscan life of this lake. I found among other forms a new *Liogyra* and probably also a new *Limosina*, the latter, I believe to be the most northern record for that genus. I observed also a curious habit of the white pond lily of forming a circlet of fleshy roots on the stem, about a foot below the expanded leaves. Many of these were floating free near the edge of the pond, where they undoubtedly become anchored and start a new plant by this natural slipping process.

The specimens collected were brought home alive; some were preserved in alcohol, but the greater number were placed in aquaria, where it was soon discovered that *Planorbis magnificus* had other interesting features besides being our largest form. They were entirely blind. Not one of the lot showed even the trace of an eye. Rudiments of this organ, however, may be seen in miscroscopic sections, where it appears as if it had been covered by the thickened cuticle.

I was anxious to note if the species would reproduce itself in captivity. Up to June 15, 1907, when I left on my vacation, this had not taken place. Large appetite, slow growth, and a great mortality sum up the events to that time. The mortality appears to have continued until only a few of the mollusks remained. When I returned to Washington in September and examined the aquaria, I found several young specimens of one and a half whorls which had been

born during my absence, and these, like well-behaved *Planorbis*, have small but well-defined eyes on the inner side, at the base of the tentacles.

Figures 7, 8, and 9 represent three views, profile, bottom and top, of the largest specimen, all natural size. This shell (Cat. No. 193321, U.S.N.M.) measures: Greatest diameter, 37 mm.; lesser diameter, 26 mm.; altitude, 25 mm., and is the largest specimen on record up to date.

PLANORBIS EUCOSMIUS, new species.

Plate LVII, figs. 1–3.

Shell resembling *Planorbis bicarinatus* Say in outline but much smaller than that species, of yellowish horn color with two rather broad, bright chestnut bands.

Shell biconcave. Entire surface marked by very strong lines of growth and numerous fine spiral lirations. Upper surface strongly umbilicated, showing a little more than three and one-half whorls. A moderately strong carina is situated about halfway between the periphery and the suture. The upper surface is marked by the two chestnut bands which are of about equal width, a little more than one-third as wide as the space between the dorsal carina and the suture. The posterior of these bands is a little nearer the suture than the carina, and the anterior one is about as far anterior to the carina as the other is posterior to it. Periphery well rounded. Base broadly umbilicated, showing a little more than three and one-half turns. Outer limiting angle of the umbilicus marked by an obtuse carina. Aperture decidedly oblique, with somewhat expanded, black edged peristome; slightly angulated at the posterior carina and more strongly so at the basal one; outer lip reenforced within by a moderately thick white callus. Parietal wall covered with a thin callus.

The type (Cat. No. 193890*a*, U.S.N.M.) measures: Greater diameter, 6.6 mm.; lesser diameter, 5.1 mm.; altitude, 3.1 mm.

The type and 46 specimens (Cat. No. 193890, U.S.N.M.) were collected by the author in Greenfield Pond, near Wilmington, North Carolina.

PLANORBIS EUCOSMIUS VAUGHANI, new subspecies.

Plate LVII, figs. 4–6.

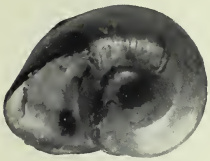
Similar to *Planorbis eucosmius*, but with much narrower and deeper basal umbilicus, with the basal carina much stronger and with the last whorl considerably more expanded toward the aperture. The spiral sculpture and the lines of growth are less strongly developed than in *eucosmius*. The present form is also considerably higher than *Planorbis eucosmius*. Three specimens of this subspecies (Cat. No.

125719, U.S.N.M.), were collected by Dr. T. Wayland Vaughan, at Burkes Place, Louisiana. The type shows three and one-half whorls in the umbilicus and measures: Greater diameter, 6.7 mm.; least diameter, 5.1 mm.: altitude, 3.3 mm.

EXPLANATION OF PLATE LVII.

FIGS. 1–6 are enlarged four diameters; figs. 7–9 are natural size.

FIG. 1. *Planorbis cucosmius*, top view. Type. Page 699.
2. *Planorbis cucosmius*, bottom view. Type.
3. *Planorbis cucosmius*, profile. Type.
4. *Planorbis cucosmius vaughani*, top view. Type. Page 699.
5. *Planorbis cucosmius vaughani*, bottom view. Type.
6. *Planorbis cucosmius vaughani*, profile. Type.
7. *Planorbis magnificus*, profile. Page 698.
8. *Planorbis magnificus*, bottom view.
9. *Planorbis magnificus*, top view.



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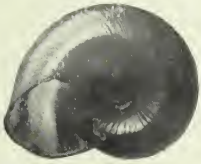

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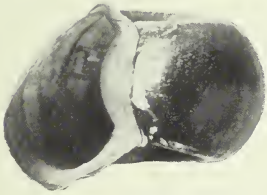

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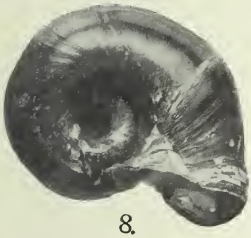

8.

9.

SPECIES OF PLANORBIS FROM NORTH CAROLINA AND LOUISIANA.

FOR EXPLANATION OF PLATE SEE PAGE 700.

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SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM

Bulletin 100
VOLUME 1, PART 1

CONTRIBUTIONS TO THE BIOLOGY OF THE PHILIPPINE ARCHIPELAGO AND ADJACENT REGIONS

THE PHILIPPINE LAND SHELLS OF THE GENUS AMPHIDROMUS

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WASHINGTON
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PHILIPPINE AMPHIDROMUS

THE PHILIPPINE LAND SHELLS OF THE GENUS AMPHIDROMUS.

By Paul Bartsch,

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INTRODUCTION.

George Brettingham Sowerby, jr., in his Conchological Illustrations, published between 1832 and 1841, gives the first record of *Amphidromus* in the Philippine Islands. On plate 145 he reproduces a front and back view (fig. 100) of *Bulinus maculiferus*, stating that the specimens are in Lady Harvey's collection. This plate, we are told by Mr. Sherborn [1] was published in 1836. A description of this species was furnished five years later by William John Broderip.[2] Here Broderip describes not only the typical form of *Bulinus maculiferus* Sowerby, but varieties A–F.

The material reported upon in this paper was collected by Hugh Cuming, who writes: "All the varieties, except variety C, were found in the Province of Misamis, in the islands of Mindanao. Variety C was found at Gindulman in the isle of Bohol. All were taken on trunks of trees."

In 1848 the greater part of Lovell Augustus Reeve's monograph of the genus *Bulimus* [3] appeared, and in it we find the following figures and descriptions of Philippine *Amphidromi*.

Plate 6, figures 26*a* and 26*b*, *Bulimus maculiferus* Sowerby from the Province of Misamis, collected by Cuming. These two figures represent 26*a*, *A. maculiferus maculiferus*, and 26*b*, *A. maculiferus cataganensis*, of the present text.

Plate 37, figure 223, represents and the text describes *Bulimus chloris* Reeve. "Eastern Island," the locality from whish this specimen is said to have come, is rather vague, but later references place it in our domain.

[1] Proc. Malac. Soc., vol. 8, 1909, p. 33[illegible].
[2] Proc. Zool. Soc. London, vol. 9, 1841, pp. 14–15.
[3] Conchologia Iconica, vol. 5.

Ludwig Pfeiffer, in the second volume of his Monographia Heliceorum Viventium [1] assigns *Bulinus maculiferus* Sowerby to *Bulimus perversus* Linnaeus, as variety E, but a year later [2] changed his opinion and considered it a valid species. In the above work he gives a full description of this species (p. 134), and *Bulimus chloris* Reeve (p. 137), citing a variety B of the latter, and giving the Philippine Islands with Cuming as authority for the habitat of *A. chloris* Reeve.

In the part on Mollusca, of the Zoology of the Voyage of H. M. S. *Samarang*, 1850, by Arthur Adams and Lovell Reeve, the following statement is found (p. 58): "The animal of *Bulimus chloris* is of a pale brown color, always differing in this respect from that of *B. citrinus*, and of extremely vivacious habits. A bushel of them, collected on the mountains of Mindanao, soon dispersed themselves all over the cabin in which the basket was deposited. The shell was of the same elongated form and deep yellow color throughout, with no indication of bands or markings."

The same year Johan Christian Albers erected the genus *Amphidromus* [3] placing in it, among others, the two species *A. maculiferus* Sowerby and *A. chloris* Reeve., heretofore referred to.

Pfeiffer, in 1853,[4] retains *Bulimus* for the group. He redescribes (p. 319), *B. maculiferus* Reeve and adds a description of var. β, which in the present effort is referred to as *A. maculiferus gracilior* Fulton, and another form γ, which we consider synonymous with *A. maculiferus* as from Mindanao. He also relists *Bulimus chloris* Reeve as in volume 2.

In 1854 Jacques Bernard Hombron and Honore Jacquinot published the Molluscan part of the Voyage au Pole Sud et Dans L'Oceanie of the *Astrolabe* and *Velee*.[5] On page 29 of this work *Bulimus sulphuratus* is described from Samboanga. It is figured on plate 8, figures 10–12. This has since been placed in the synonomy of *Amphidromus chloris* Reeve.

In 1855, Pfeiffer's Monograph on the genus *Bulimus* was published.[6] In it, on pages 117–118, *Bulimus maculiferus* is described, and figured on plate 36, figures 1 and 2, and a variety β on plate 40, figure 9, which has since been described as *Amphidromus maculiferus gracilior* by Fulton.

In the same volume (p. 183), *Bulimus chloris* Reeve, is described and figured on plate 49, figures 7 and 8, and *Bulimus sulphuratus*, Hombron and Jacquinot is placed in the synonomy of it.

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[1] Page 38, 1848.
[2] Zeitschr. f. Malak., 1849, pp. 134, 137.
[3] Die Heliceen, Berlin, 1850, pp. 138–140.
[4] Monographia Helicorum Viventium, vol. 3.
[5] Zool., vol. 5.
[6] Martini-Chemnitz Conchylien Cabinet, vol. 1, pt. 13, p. 1.

The same year he published his Versucheiner Anordung der Heliceen nach naturlichen Gruppen.[1] In this he recognized *Amphidromus* as a subdivision of *Bulimus* (pp. 146–147), and referred the above-mentioned species to it. Here he also assigned a lot of *Helicostyla* erroneously to this group.

Henry and Arthur Adams in 1858 referred[2] *Bulimus chloris* Reeve, and *B. maculiferus* Sowerby, to the subgenus *Canistrum* Klein, which they considered synonymous with *Amphidromus* Albers and *Balea* of Blainville.

In the fourth volume of Pfeiffer's *Monographia Heliceorum Viventium* published in 1859, we find on pages 381 and 382 the references to *Bulimus maculiferus* Sowerby and *Bulimus chloris* Reeve, given in his third volume, and in the publications in which these species have been alluded to since that volume was issued, *Bulimus sulphuratus* is lisited under *B. chloris.*

In 1867 the volume on Mollusca of Die Preussische Expedition nach Ost.-Asien, by Edward von Martens, appeared. In this[3] (p. 351), *Bulimus sulphuratus* of Hombron and Jacquinot is made a subspecies of *Bulimus perversus* Linnaeus, and considered quite distinct from *Bulimus chloris* Reeve.

The sixth volume of Pfeiffer's Monographia Heliceorum Viventium, 1868 (pp. 25–26), cites references to the previous volume and gives the notations listed in our remarks since its publication in 1859.

Carl Semper, in his Reisen im Archipel der Philippinen[4] describes the anatomic characters for the genus *Amphidromus*, giving the anatomy of *Amphidromus maculiferus* Sowerby (p. 146), and illustrating it on plate 14, fig. 1; and on pages 141–149 he cites the places in Mindanao and Bohol from which he has seen specimens. He describes three yellow shells with a single or double varix, which had been given to him and were said to have come from Cebu, but does not bestow a name upon them.

He also lists *Amphidromus chloris* Reeve (p. 148), from Zamboanga, and considers *A. sulphuratus* Hombron and Jacquinot synonymous with it.

In 1877 Pfeiffer's eighth volume of his Monographia Heliceorum Viventium was published, and here, as in the previous volumes, he gives the additional references which have been occasioned since the publication of volume 6, in 1868.

In the same year Joaquin G. Hidalgo published a small paper entitled Description d'un Amphidromus et d'un Cyclophorus nou-

[1] Malak Blat., vol. 2, 1855.
[2] Genera of Recent Mollusca, vol. 2, p. 143.
[3] Zoologischer Theil, vol. 2.
[4] Zweiter Theil, Wiss. Res., vol. 3, 1873.

veaux provenant les isles Philippines.[1] In this, *Amphidromus quadrasi* is described and figured (pl. 2, fig. 2), from Caramandanes Island.

The following year the same author reached the present genus in his series of papers entitled Recherches conchyliologiques de M. Quadras aux iles Philippines.[2] He discusses these Philippine forms (pp. 31–34).

He figures (pl. 6, fig. 1) the variety of *Amphidromus maculiferus* which is now named *A. philippinensis.* He assigns the yellow and pale form of what was later described as *A. entobaptus* Dohrn to *Amphidromus perversus* Linnaeus and refers at length to *A. chloris* and corrects the locality name given in the previous volume for *Amphidromus quadrasi* from Caramandanes to Candaramanes Island, a member of the Balabac group.

He also lists *Amphidromus contrarius* Muller from Balabac and Luzon. The second citation is undoubtedly due to a market specimen, as *Amphidromus* does not occur on Luzon, and the first may also be a market shell or else a form of the *A. quadrasi* group. *A. contrarius* Muller belongs to Timor.

In 1889 Dr. Heinrich Dohrn's Beitrag zur Conchylienfauna der Philippinischen Insel Palawan appeared.[3] In this the yellow *Amphidromus* from the region of Puerto Princesa is described as *Amphidromus entobaptus.* The next year the first part of Joaquin Gonzalez Hildago's Obros Malacologicos[4] appeared. On pages 17–18 the description of *A. quadrasi* Hidalgo is published.

In 1893 Edgar A. Smith published his report On a Small Collection of Land Shells from Palawan and Balabac, Philippine Islands.[5]

Here four figures (10–13, pl. 18) are given of *Amphidromus quadrasi* and forms *a—f*, described from a series of a hundred specimens from Balabac. The same year Otto Franz von Möllendorff's Materialien zur Fauna der Philippinen XI Die Insel Leyte appeared.[6] In this *Amphidromus maculiferus multicolor* is described from Leyte and Camotes.

The following year Edgar Albert Smith published his report On the Land Shells of the Zulu Archipelago.[7] In this (p. 55) he describes and figures (pl. 4, figs. 9, 9*a*) a variety of *Amphidromus maculiferus* from Bilitan Island, which is now named *A. philippinensis* Fulton.

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[1] Journ. d. Conch. Paris, vol. 35, 1887, pp. 36–37.
[2] Idem, vol. 36, 1888.
[3] Nachr. Deut. Malak. Ges., vol. 20, pp. 53–63.
[4] Mem. Real Acad. Clen., Madrid, vol. 14.
[5] Ann. Mag. Nat. Hist. London, ser. 6, vol. 11, 1893, pp. 347–353.
[6] Bericht, Senck. Natuz. Ges. Frankfurt am Main, 1893.
[7] Ann. Mag. Nat. Hist., ser. 6, vol. 13, 1894.

The same year Zur Mollusken Fauna der Sulu Inseln, by Otto Franz von Möllendorff, was published.[1] On pages 210 and 211 *Amphidromus roeseleri* is described from Sulu Island, and the variety of *A. maculiferus* mentioned, described, and figured by Smith from Bilitan Island, mentioned in the last reference, is described on page 211.

A year later Edgar Albert Smith's paper On a Collection of Land Shells from Sarawak, British North Borneo, Palawan, and other Neighboring Islands[2] appeared. In this he lists *Amphidromus quadrasi* Hidalgo (on pp. 98–99) from Candaraman, and *A. entobaptus* Dohrn (on p. 99) from Palawan.

In 1896 the genus *Amphidromus* was subjected to a critical revision by Hugh Fulton in A List of the Species of Amphidromus Albers, with Critical Notes and Descriptions of some Hitherto Undescribed Species and Varieties.[3] In this (p. 67) he refers *Amphidromus chloris* Reeve to *A. perversus* Linnaeus or a subspecies, and *A. entobaptus* Dohrn is also considered a subspecies of *A. perversus* Linnaeus. *Amphidromus maculiferus* and varieties *gracilior* Fulton, *strigata* v. Möllendorff, and *obscura* Fulton are described from Mindanao; while variety *inflata* Fulton is referred to Philippine Islands without specific locality. Variety *multicolor* Möllendorff is listed from the island of Leyte (pp. 74 and 75), and *Amphidromus roescleri* Möllendorff described (p. 75) from Bilitan Island.

Amphidromus quadrasi Hidalgo is reported from Balabac Island (p. 85), and *A. q.*, variety *solida* Fulton, is described (p. 86) and figured (pl. 5, fig. 16).

Amphidromus versicolor Fulton, described (p. 86), embraces part of the complex referred to by Smith[4] as varieties of *A. quadrasi*. *Amphidromus dubius* Fulton is diagnosed (pp. 86 and 87) and figured (pl. 6, figs. 1, 1*a*) and comes from Balabac Island, while *Amphidromus everetti* Fulton, also a member of the *A. quadrasi* complex described as a variety of that species by Smith[5] as coming from Palawan, is given specific rank on page 87.

In the same year R. P. Fr. Casto de Elera published the third volume of his Catalogo Sistematico de toda la Fauna de Filipinas. On pages 617 and 618 he lists *A. chloris* Reeve from Mindanao, Basilan, and Mindoro; *A. maculiferus* Sowerby from Bohol, Camotes, Leyte, Maasin, Bato, and Mindanao, and *Amphidromus* variety *multicolor* Möllendorff from Leyte, Maasin, Bato, and Camotes.

To *Amphidromus contrarius* Muller the rather large range of Luzon, Balabac, and Timor is assigned.

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[1] Nachr. Deut. Malak. Ges., vol. 26, pp. 205–215.
[2] Proc. Zool. Soc. London for 1895.
[3] Ann. Mag. Nat. Hist., ser. 6, vol. 17.
[4] Idem, vol. 11, 1893, p. 351, pl. 18, figs. 11–13.
[5] Idem, p. 350, pl. 18, fig. 12.

A. entobaptus is reported from Porto Princesa, Paragua (=Palawan); *A. perversus* Linnaeus variety from Busuanga, Mindanao, and Zamboanga, and *A. quadrasi* Hidalgo from Candaramanes.

A. cosmandanus Crosse is erroneously listed (p. 618) as *Amphidromus.* This, we learn later from Pilsbry,[1] is *Helicostyla crossmanniana* Crosse.

Joaquin Gonzales Hidalgo, in his beautiful Atlas Obras Malacologicas[1] reached Amphidromus in 1898. He devoted three plates to the Philippine forms, 99–101. On plate 99, figures 1 and 2 represent a large inflated yellow shell with a whitish band at the summit of its whorls, and a dark varix on the last turn, which is listed under the designation of *A. maculiferus* Sowerby var. This we learn from correspondence with Señor Hidalgo, comes from Dapitan, Mindanao. It is our *Amphidromus hidalgoi.* Figures 3 and 4 represent *A. chloris* Reeve, and 5–8, *A. entobaptus* Dohrn.

Plate 100 has 6 figures showing races of *A. maculiferus* Sowerby. Of these, figures 1, 4, 5, and 6 represent my *Amphidromus maculiferus cotabatoensis*, and figures 2 and 3 appear referable to my *Amphidromus maculiferus cataganensis.*

Plate 101, figures 1–4, are said to represent *A. nigrofilosus* Rochebrune. They are in reality *A. maculiferus gracilior* Fulton. Figures 5 and 6 illustrate *A. quadasi* Hidalgo and 7 and 8 *A. dubius* Fulton.

In his Verzeichness der auf Philippinen Lebenden Landmollusken,[2] Dr. Otto von Möllendorff lists on pages 148–150 the following: *A. entobaptus* Dohrn, from Paragua, with subspecies *gracilis* Möllendorff from Linapakan and Busuanga, and subspecies *contracta* Möllendorff from Koron and Kalamianes. These two names are *nomena nuda* and have no status. *Amphidromus chloris* Reeve is listed from Mindanao (Samboanga), *A. maculiferus* Sowerby from western Mindanao. Of this he lists subspecies *strigata* Möllendorff (="*Amph. mac.* var. *gracilior* et *strigata*, Fulton") from eastern Mindanao and Bohol. Subspecies *multicolor* Möllendorff, from Leyte and Camotes; subspecies *obscurus* Fulton from Mindanao and subspecies *inflatus* Fulton.

Amphidromus quadrasi Hidalgo is credited to Balabac and subspecies *solidus* Fulton to Paragua. *A. versicolor* Fulton and *A. dubius* Fulton are both listed from Balabac, and *A. everetti* Fulton from Paragua.

The last to give these shells consideration was Dr. Henry A. Pilsbry, who monographed the genus in 1900.[3] In this he recognizes

[1] Mem. de la Real Acad. de Sci. Madrid, 1890–1904.
[2] Abhand. Narturf. Ges. Gorlitz, vol. 22, 1898.
[3] Man. Conch., vol. 13, pp. 127–234.

(pp. 130–133) *Amphidromus maculiferus* Sowerby with variety *obscurus* Fulton; subspecies *multicolor* Möllendorff; subspecies *gracilior* Fulton; variety *strigata* Möllendorff; subspecies *inflatus* Fulton, *Amphidromus chloris* Reeve (pp. 143–144) with variety *pallidulus* Pilsbry from Zamboanga and varieties *purissimus* Pilsbry and *rosa* Pilsbry from Basilan Island.

A. roeseleri Möllendorff is listed on pages 144–145—*A. entobaptus* Dohrn on pages 145–147. *A. lindstedti* Pfeiffer is referred to as coming from Balabac according to Fulton (pp. 228–229). As we have said before, the Balabac specimens cited probably refer to some of the forms of *A. quadrasi* Hidalgo. *A. lindstedti* Pfeiffer comes from Malacca.

Amphidromus quadrasi Hidalgo is treated (pp. 229–230) and *solidus*, *versicolor*, *dubius*, and *everetti* of Fulton are recognized.

GEOGRAPHIC DISTRIBUTION.

The genus *Amphidromus* presents some very fascinating zoogeographic problems in the Philippine Islands, and, when fully studied, will undoubtedly throw considerable light on the derivation and dispersal of the Philippine land shells. At present the available information is fragmentary, and more material with specific locality notes is badly needed.

There are several distinct groups which show a northward migration from Borneo into the Philippine Archipelago. One of these is the group of *Amphidromus quadrasi*, which has undoubtedly come from some Bornean stock and is extending its range northward into Palawan. At the present time it is distributed over Balabac and the adjacent islands.

Then there is the group of *Amphidromus entobaptus*, which extends over Palawan and the Calamianes group, apparently splitting up into races in the islands of the latter group, and a generic label "Calamianes," which was applied by the older collectors to material from this group, is absolutely insufficient to enable one to understand the complex or the conditions and causes for the variations presented by a mixture of forms assembled from the various places within the group. This is well shown by the specimens which we have had for examination which have enabled us to recognize a number of races, each practically confined to a separate island. The northernmost extension of the yellow *Amphidromus* is found in Mindoro in the large inflated species now described as *A. mindoroensis*.

No *Amphidromus* has been reported from Luzon (the term "Manila" seen at times on old labels simply means that they were purchased in the Manila markets and not that they occur at or about Manila), nor do any *Amphidromi* occur on any of the smaller

islands, as far as known, intervening between Mindoro and Luzon or Panay.

The group of *A. chloris*, embracing *roeseleri* and *suluenis*, extends over the Sulu Archipelago and Zamboanga, Mindanao, and it appears as if it had been derived from Borneo and had reached Mindanao through the chain of islands which extend from Borneo to Mindanao, through Tawi Tawi, Jolo, etc.

Amphidromus inflatus, *pallidulus*, *mearnsi*, and *calista* are yellow forms which, though the last is at times variously marked with red, combine the yellow coloration of the *chloris* group with the black filations of *maculiferus*.

By far the most satisfactory lot of material which we have had for our study belongs to the group of *Amphidromus maculiferus*, which divides up into a series of geographic races, beautifully accounted for by the separate habitats which they occupy. A full discussion of this group will be found preceding the description of this species and its races.

I wish to acknowledge my deep appreciation of the courtesies extended to me by the authorities of the United States Bureau of Fisheries and the United States National Museum, in assigning the collection of mollusks made by the Fisheries steamer *Albatross* in the Philippines, to me for report. Also to the Philippine Bureau of Sciences for material sent for report, and to Dr. H. A. Pilsbry, of the Philadelphia Academy of Natural Sciences, for the loan of the Philippine Amphidromi in the collection of the academy, and to Dr. Frank C. Baker, of the Chicago Academy of Sciences, and Walter F. Webb, of Rochester, New York, for similar reasons. I wish also to express my sincere thanks to Dr. William H. Dall, honorary curator of the Section of Mollusks, United States National Museum, for his counsel and many suggestions.

The photographs used in the illustrations were made by the Division of Photography, United States National Museum, and were retouched by Mrs. E. B. Decker.

GROUP OF AMPHIDROMUS MACULIFERUS.

The group of *Amphidromus maculiferus* extends over the southeastern islands of the archipelago, its chief center being Mindanao. When one looks at a topographic or relief map of the Philippine Islands, particularly Mindanao, one sees that this island is composed of a series of smaller islands which have been fused into the large territory by a comparatively moderate raising of that part of the ocean floor, and the *Amphidromi* reflect this state of affairs beautifully.

Amphidromus maculiferus Sowerby ss. was described from material collected by Hugh Cuming in Misamis Province, Mindanao,

and is undoubtedly a coastal race. The material before us agrees well with Sowerby's figure, which represents an elongate-ovate, spotted form without varices.

On the slopes of Mount Malindang another form occurs, which is decidedly shorter, more chubby, more brightly colored, with a few faint indications of varices. To this race I have given the subspecific name *cataganensis*.

In the Cotabato region, or, in other words, the lower Rio Grande Valley, we find another race which is profusely spotted and provided with very strong, dark, varicial bands. To this race I have applied the name *cotabatensis*.

In the upper regions of the Rio Grande, about Lake Buluan, we find another race, which lacks the spotting altogether, but has strong, brown varices, which I have called *buluanensis*.

On the southeast coast of Mindanao, along the shores of the Gulf of Davao, another race occurs, which is very elongate-ovate, has alternating pale-brown and hydrophanous axial bands and a general rosy suffusion on the surface. This is von Möllendorff's *strigatus*.

On northeastern Mindanao still another race is found, which is nearest allied to *strigatus*, but is always pale, lacking the rosy suffusion and also the dark varicial bands. This is *gracilior* Fulton.

North of Mindanao, the islands of Bohol, Leyte, and Samar each contain a race of *maculiferus*. That in Bohol is smaller than *strigatus* and *gracilior*, and is provided with alternating bands of pale brown and dingy white. This I shall term *boholensis*. On the island of Leyte we have the race named *multicolor* by von Möllendorff. It is an exceedingly dark-colored race, by far the most marked of all the forms so far mentioned. The race living on the island of Samar is more nearly related to that of Bohol than to that of Leyte. It is of darker color and stouter form than the Bohol race, and may be known as *samarensis* Bartsch.

South of Mindanao we have the race now described as *cosmius* Bartsch, occurring on Basilan Island. This race is the smallest of the entire group. It has the general form and markings of *gracilior* Fulton, but differs from it by its diminutive size and a much lesser number of hydrophanous bands and in being suffused with faint yellow.

An additional race from the island of Cebu is indicated by Semper, who is quoted on page 18.

As derived from the group of *maculiferus* may be considered the mountain species occurring on Mount Malindang and Mount Apo in Mindanao. Both of these forms have the dark filations on the early whorls, which indicate relationship to *maculiferus*, but the rest of the characters are sufficient in my estimation to entitle them to full specific rank, and so I have called them *malindangensis* and

apoensis. These two forms have developed along parallel lines, but are quite distinct.

The little race of *Amphidromus* occurring on the island of Basilan, which I have called *basilanensis*, is related to these last two forms, as is the shell from Lampinigan Island, which is too poor to serve for diagnosis.

There remains but one shell of the group of *maculiferus* which is to be considered in this monograph and that is *Amphidromus floresi*. This form has indications of the black filations on the early whorls which would ally it to *maculiferus*, but it differs markedly in form from any of these and also in its sculpture, the surface being ornamented with numerous, slender, thread-like riblets. This shell comes from southeastern Mindanao.

DESCRIPTIONS OF SPECIES.

AMPHIDROMUS MACULIFERUS MACULIFERUS Sowerby.

Plate 2, figs. 1–5.

Bulinus maculiferus SOWERBY, Conch. Ill., 1838, pl. 145, fig. 100.
Bulinus maculiferus BRODERIP, Proc. Zool. Soc. London, vol. 9, 1841, pp. 14–15.
Bulimus maculiferus REEVE, Conch. Icon., vol. 5, 1848, pl. 6, fig. 26*a*.
Bulimus perversus LINNAEUS, var *E*. PFEIFFER, Mon. Hel. Viv., vol. 2, 1848, p. 38.
Bulimus maculiferus PFEIFFER, Zeitschr. f. Malak., 1849, p. 134.
Amphidromus maculiferus ALBERS, Heliceen, 1850, pp. 138–140.
Bulimus maculiferus PFEIFFER, Mon. Hel. Viv., vol. 3, 1853, p. 319.
Bulimus maculiferus, var PFEIFFER, Mon. Hel. Viv., vol. 3, 1853, p. 319.
Bulimus maculiferus PFEIFFER, Mart. Chem. Conch. Cab., vol. 1, pt. 13, 1855, pp. 117–118, pl. 36, figs. 1–2.
Bulimus (*Amphidromus*) *maculiferus* PFEIFFER, Malak. Blät., 1855, vol. 2, p. 147.
Bulimus (*Canistrum*) *maculiferus* H. and A. ADAMS, Gen. Rec. Moll., 1858, p. 143.
Bulimus maculiferus PFEIFFER, Mon. Hel. Viv., vol. 4, 1859, p. 381.
Bulimus maculiferus PFEIFFER, Mon. Hel. Viv., vol. 6, 1868, p. 25.
Amphidromus maculiferus SEMPER, Reis. Arch. Phil., vol. 3, 1873, p. 146, pl. 14, fig. 18.
Bulimus maculiferus PFEIFFER, Mon. Hel. Viv., vol. 8, 1877, p. 39.
Amphidromus maculiferus HIDALGO, Journ. de Conch., vol. 36, 1888, p. 31.
Amphidromus maculiferus ELERA, Cat. Sist. Faun. Filip., 1896, p. 617.
Amphidromus maculiferus obscura FULTON, Ann. Mag. Nat. Hist., ser. 6, vol. 17, 1896, p. 75.
Amphidromus maculiferus von MÖLLENDORFF, Abhand. Naturf. Ges. Görlitz, vol. 22, 1898, p. 149.
Amphidromus maculiferus obscura von MÖLLENDORFF, Abhand. Naturf. Ges. Görlitz, vol. 22, 1898, p. 149.
Amphidromus maculiferus PILSBRY, Man. Conch., vol. 13, 1900, pp. 130–131, pl. 49, figs. 19–21.
Amphidromus maculiferus obscura PILSBRY, Man. Conch., vol. 13, 1900, p. 131.

Shell elongate-ovate, whorls moderately rounded, marked by incremental lines only. The first three whorls have a narrow, black band appearing above the suture, while the rest is white. The remaining turns are yellowish white, profusely spotted with irregularly shaped blotches of chestnut brown, which are bordered by a lighter area and usually preceded by a white area. There are no strongly developed varicial streaks; if shown at all they are indicated as mere faint lines.

The type of *A. maculiferus* was collected by Hugh Cuming in Misamis Province, Mindanao. The material which I have examined comes from the same region. The following table gives additional data as to number of whorls and measurements:

Cat. No. U.S.N.M.	Number of whorls.	Length in mm.	Diameter in mm.	Locality.	Collector.
244668	7	70	32.7	Camp Overton, Mindanao	E. A. Mearns.
244668	6	59	32.7	do	Do.
244669	7	66.5	31.6	do	J. Clemens.
244670	6	60.5	32.8	Camp Pantar, Angus. R. 4 miles from Lake Lanao, Mindanao.	E. A. Mearns.
244671	.....	.....	.....	Tangob, Misamis, Mindanao; a young individual.	
99567	6	62.3	32.2	P. I., without specific locality	

AMPHIDROMUS MACULIFERUS CATAGANENSIS, new subspecies.

Plate 3, figs. 1–5.

Bulimus maculiferus REEVE, Conch. Icon., vol. 5, 1848, pl. 6, fig. 26*b*.
Amphidromus maculiferus HIDALGO, Mem. Real Acad. Sci. Madrid, 1896, pl. 100, figs. 2–3.

Shell ovate, dextral, or sinistral. Whorls well rounded, appressed at the summit and marked by lines of growth only. Sutures strongly constricted. Aperture moderately large; outer lip expanded and reflected; inner lip almost vertical, slightly twisted and reflected over the narrow umbilicus; parietal wall covered with a moderately thick callus. The first two volutions are bordered with a narrow black band at the suture, the rest being white; the next two are yellowish white, while the succeeding may have the same ground color or they may be suffused with a rosy blush and are marked by irregular, wavy, somewhat protractive, brown axial bands and a few irregularly placed, scattered spots of brown which are usually preceded by a lighter area.

The type and two specimens of this species were collected by Lieut. Col. Edgar A. Mearns at Catagan, Mindanao, on the Mount Mal-

indang Expedition, at 1,100 feet altitude. The type, Cat. No. 244672, U.S.N.M., has six whorls and measures—length, 52 mm.; diameter, 31 mm. The following additional specimens have been examined:

Cat. No., U.S.N.M.	Number of whorls.	Length in mm.	Diameter in mm.	Locality.	Collector.
244672[1]	6	52	31	Catagan, Mindanao, 1100 feet.....	E. A. Mearns.
244672	6	56	31.2	.....do	Do.
244672	6.2	56.6	30	.....do	Do.
244673	6.2	55.5	29	Mount Malindang, 3500 to 9200 feet (fragment).	Do.
244274	.....	.....	29	.....do.....	Do.

[1] Type.

AMPHIDROMUS MACULIFERUS COTABATENSIS, new subspecies.

Plate 1, fig. 1; plate 4, figs. 1–8.

Amphidromus maculiferus FULTON, Ann. Mag. Nat. Hist., ser. 6, vol. 17, p. 74, 1896.

Amphidromus maculiferus HIDALGO, Mem. Real Acad. Sci., Madrid, pl. 100, figs. 1, 4, 5, 6, 1898.

Shell elongate-ovate with the whorls well rounded, appressed at the summit, with the sutures moderately constricted; lip normal. First two whorls white, excepting a narrow, black band immediately above the suture. The succeeding two are dingy white, and the remainder yellowish white, in places suffused with pale brown. The first one succeeding the dingy white turns bears a number of zigzag, axial bands of brown with a few spots of the same color, while the rest are marked with numerous, more or less elongate dots of brown, which are preceded by a whitish area. In addition to the above, the whorls are also crossed by a number of strong, dark brown varices.

The type (Cat. No. 244676 U.S.N.M.) comes from Cotabato, Mindanao. It has 6.2 whorls and measures—length 57 mm.; diameter 31.5 mm. The following specimens have been examined:

Cat. No. U.S.N.M.	Number whorls.	Length in mm.	Diameter in mm.	Locality.	Collector.
244676[1]	6. 2	57	31. 5	Cotabato, Mindanao	E. A. Mearns.
244676	6. 3	60. 5	32. 1	do	Do.
244676	6. 5	59. 5	31	do	Do.
244676	6. 7	61	31	do	Do.
244676	.....	.....	.....	Cotabato, Mindanao, one young specimen.	Do.
244677	6. 6	60. 3	30. 3	Cotabato, Mindanao, five additional young specimens.	Do.
184564	6. 5	57. 4	30	Cotabato, Mindanao	von Möllendorff.
244678	6. 5	61. 7	33	do	E. A. Mearns.
244678[2]	6. 7	57. 6	30. 5	do	Do.
244679	6. 6	54	31	Libungan River and La'bas River, Rio Grande Valley, Mindanao.	Do.
244679	.....	.....	33. 6	Libungan River and La'bas River, Rio Grande Valley, Mindanao, young individual, dextral.	Do.
105023	.....	.....	33. 5	Loc.?	
215578	7. 2	66. 5	35. 4	Kidapawan, Cotabato	Webb.
302840	6. 3	58. 2	32. 8	Kidapawan, Cotabato, Mindanao.	Henderson.

[1] Type. [2] Dextral.

AMPHIDROMUS MACULIFERUS BULUANENSIS, new subspecies.

Plate 5, figs. 1–6.

Shell elongate-conic, with the whorls moderately rounded and appressed at the summit and the sutures moderately constricted, the first two whorls bearing the dark filation in the suture, the succeeding ones pale brown with an occasional retractive streak of light brown or dingy white. These varicial streaks become much intensified on the last two volutions. The spotting is entirely absent. Aperture normal.

The type (Cat. No. 244688, U.S.N.M.) was collected with two other specimens on the trail between Simpitan and Buluan, Mindanao, by Lieut. Col. Edgar A. Mearns. The type has seven whorls and measures—length, 66.2 mm.; diameter, 33.4 mm. Some of the specimens have the whorls a yellowish white instead of light brown. These are dead specimens and have probably been bleached. The following material has been examined:

Cat. No. U.S.N.M.	Number whorls.	Length in mm.	Diameter in mm.	Locality.	Collector.
244680	7.2	65.5	32.7	Trail from Simpitan to Buluan, Mindanao.	E. A. Mearns.
244680	7.1	64	32.8	.....do.....	Do.
244680	7	59.8	30.3	.....do.....	Do.
244680	.....	.....	.....	Trail from Simpitan to Buluan, Mindanao, young individual.	Do.
244683	7	65	34	Trail from Simpitan to Buluan, Mindanao.	Do.
244683	7	60.7	32.3	.....do.....	Do.
244683	7	59.7	29.5	.....do.....	Do.
244683	.....	.....	.....	Trail from Simpitan to Buluan, Mindanao, young.	Do.
244686	7	63.5	34	Trail from Simpitan to Buluan, Mindanao.	Do.
244686	6.8	59	32	.....do.....	Do.
244686	7	58	29.4	.....do.....	Do.
244686	.....	.....	.....	Trail from Simpitan to Buluan, Mindanao, two young.	Do.
244688[1]	7	66.2	33.4	Trail from Simpitan to Buluan, Mindanao.	Do.
244688	7	58.6	30.8	.....do.....	Do.
244688	6.5	56.6	30	.....do.....	Do.
244687	6.5	59.5	33	Lake Buluan, Mindanao.....	Do.
105023a	.....	.....	.....	Young individual without locality..	Do.
244685	6.5	60	33.2	Buluan, Mindanao.....	Do.
244685	7	62.6	31.5	.....do.....	Do.
244685	7	64.9	31.7	.....do.....	Do.
244685	7	65.3	32.5	.....do.....	Do.
244682	7	62.5	33	.....do.....	Do.
244682	6.5	60	30.5	.....do.....	Do.
244682	6	63.5	32.2	.....do.....	Do.
244682	.....	.....	33	Buluan, Mindanao, fragment.....	Do.
244684	7	60.2	31.2	Buluan, Mindanao.....	Do.
244684	.....	.....	.....	Buluan, Mindanao, one young individual.	Do.

[1] Type.

AMPHIDROMUS MACULIFERUS STRIGATUS (von Möllendorff) Fulton.

Plate 6, figs. 1–5.

Amphidromus maculiferus Hidalgo, Journ. de Conch., vol. 36, 1888, p. 31.

Amphidromus maculiferus, var. *strigata* Fulton, Ann. Mag. Nat. Hist., ser. 6, vol. 17, 1896, p. 75.

Amphidromus maculiferus Elera, Cat. Sist. Faun. Filip., 1896, p. 617.

Amphidromus maculiferus strigatus (von Möllendorf) Fulton, Ann. Mag. Nat. Hist., ser. 6, vol. 17, 1896, p. 75.

Amphidromus maculiferus strigatus von Möllendorff, Abhand. Naturf. Ges. Görlitz, vol. 22, 1898, p. 149.

Amphidromus maculiferus gracilior Pilsbry, Man. Conch., vol. 13, 1900, p. 132.

Amphidromus maculiferus gracilior, var. *strigata* Pilsbry, Man. Conch., vol. 13, 1900, p. 132.

Shell very elongate-ovate. The first two whorls have the narrow dark band in the suture, the rest are white. The succeeding turns are flesh colored, with very retractively slanting dark brown varices and similarly disposed light hydrophanous bands. Some scattered, elongate dots are also present. Aperture normal.

This race is said by von Möllendorff to occur in Eastern Mindanao. Six specimens from the von Möllendorff collection, from Davao, Mindanao, are in the United States National Museum. The following material has been examined:

Cat. No.	Collection.	Number whorls.	Length in mm.	Diameter in mm.	Locality.	Collector.
184565	U.S.N.M.....	6.5	67.5	33.5	Davao, Mindanao..	von Möllendorff.
184565	.....do.....	7	67.5	32.3	.....do.....	Do.
195849	.....do.....	7.1	70.5	32.4	.....do.....	Do.
195849	.....do.....	7	67.3	31.4	.....do.....	Do.
195849	.....do.....	7	69.7	34.5	.....do.....	Do.
195849	.....do.....	6.5	60	32.3	.....do.....	Do.
	Webb.....	7	66	30.2	.....do.....	Quadras.

AMPHIDROMUS MACULIFERUS GRACILIOR Fulton.

Plate 7, figs. 5–6.

Bulimus maculiferus, var. β Pfeiffer, Mon. Hel. Viv., vol. 3, 1853, p. 319.

Bulimus maculiferus, var. β Pfeiffer, Mart. Chem. Conch. Cab., vol. 1, 1855, pl. 40, fig. 9.

Amphidromus maculiferus, var. β Semper, Reis. Arch. Phil., vol. 3, 1873, p. 149.

Amphidromus maculiferus, var. *gracilior* Fulton, Ann. Mag. Nat. Hist., ser. 6, vol. 17, 1896, p. 74.

Amphidromus maculiferus Elera, Cat. Sist. Faun. Filip., 1896, p. 617.

Amphidromus nigrofilosus Hidalgo, Mem. Real Acad. Sci. Madrid, 1898, pl. 100, figs. 1–4.

Amphidromus maculiferus gracilior Pilsbry, Man. Conch., vol. 13, 1900, p. 132.

Shell very elongate-ovate; the first two whorls have a very broad, black band which frequently covers half of the turns, the rest of the early whorls being white. The whorls succeeding are yellowish white with numerous, retractively slanting hydrophanous bands, which are of irregular width and distribution. There are no dark varices. The whorls are rather high between the sutures, strongly appressed at the summit, and well rounded. The aperture is normal. The following material has been examined.

Cat. No.	Collection.	Number whorls.	Length in mm.	Diameter in mm.	Locality.	Collector.
184566	U. S. N. M.	7.3	72	32.8	Mindanao	von Möllendorff.
	Chicago Acad. Sci.	7	69.2	33	Mainit, Mindanao	Quadras.
	Webb	6.5	58.7	28.6	do	Do.
	do	6.5	64.5	29.5	do	Do.
	do	6.8	60	28.5	do	Do.

AMPHIDROMUS MACULIFERUS BOHOLENSIS, new subspecies.

Plate 1, fig. 2; plate 7, figs. 1–3.

Bulimus maculiferus, var. C. Broderip, Proc. Zool. Soc. London, vol. 9, 1841, pp. 14–15.
Amphidromus maculiferus Semper, Reis. Arch. Phil., vol. 3, 1873, p. 149.
Amphidromus maculiferus Elera, Cat. Sist. Faun. Filip., 1896, p. 617.

Shell elongate-ovate. Whorls moderately well rounded and appressed at the summit; sutures moderately constricted; aperture normal. The first two turns show a faint, black band in the suture, the rest being white. The succeeding turns are marked by alternate retractively slanting bands of pale brown and dingy white, the latter usually a little broader than the brown areas. There are no distinct dark varices.

The type and nine specimens of this species were collected by A. Celestino, at Sevilla, Bohol. The type (Cat. No. 245563, U.S.N.M.) has six and a half whorls and measures—length, 57 mm.; diameter, 27.5 mm. The following specimens have been examined:

Cat. No.	Collection.	Number whorls.	Length in mm.	Diameter in mm.	Locality.	Collector.
245563[1]	U. S. N. M.	6.5	57	27.5	Sevilla, Bohol	A. Celestino.
245563	do	6.5	57.5	28	do	Do.
245563	do	6.3	56.5	28.4	do	Do.
245563	do	6.1	51.3	27	do	Do.
215577	do	6.5	58.5	30.2	Belar	Webb.
	Phil. Bur. Sci.	6.5	55.5	28	Sevilla	A. Celestino.
	do	6.5	59.5	29.2	do	Do.
	do	6.1	55.3	28.6	do	Do.
	do	6.3	60.5	30.5	do	Do.
	do				Sevilla, Young	Do.
	Chicago Acad. Sci.	6.5	55	26.5	Bohol	Quadras.
	Webb	6.5	62.2	30	do	Do.
	do	6.3	55.4	28.5	Belar, Bohol	Webb.

[1] Type.

AMPHIDROMUS MACULIFERUS MULTICOLOR von Möllendorff.

Plate 8, figs. 1, 2, 4, 5.

Amphidromus maculiferus Semper, Reis. Arch. Phil., vol. 3, 1873, p. 149. 1893, p. 99.

Amphidromus maculiferus, var. *multicolor* Fulton, Ann. Mag. Nat. Hist., ser. 6, vol. 17, 1896, p. 74.

Amphidromus maculiferus Elera, Cat. Sist. Faun. Filip., 1896, p. 617.

Amphidromus maculiferus multicolor von Möllendorff, Abhand. Naturf. Ges. Görlitz, vol. 22, 1898, p. 149.

Amphidromus maculiferus multicolor Pilsbry, Man. Conch., vol. 13, 1900, pp. 131–132.

Shell elongate-ovate; the first two whorls with the usual narrow black band at the suture, the rest with alternating, retractive bands of yellowish white and brown, the brown bands on the last whorl following a somewhat zigzag course and being more closely spaced on the last turn than on those preceding. The white bands between the darker appear as if superimposed upon a dark ground. The inside of the lip is of a purplish blue color, while the peristome is white. The shell in its entirety is much darker than any of the other races of *A. maculiferus*. One of the specimens in the Webb collection has a tendency toward spiral lines of brown on the last volution. We have seen the following specimens:

Cat. No.	Collection.	Number whorls.	Length in mm.	Diameter in mm.	Locality.	Collector.
184562	U. S. N. M. Chicago	6. 4	56. 5	26	Leyte	von Möllendorff.
	Acad. Sci.....	6. 2	60	29	Matalon, Leyte..	Quadras.
	.....do.....	6. 3	59. 5	29. 9	Sitio Busay, Massin, Leyte	Do.
	Webb.....	6. 5	58. 5	28. 5	Sitio, Jonas, Bato, Leyte.	Do.

AMPHIDROMUS MACULIFERUS SAMARENSIS, new subspecies.

Plate 7, fig. 4.

Shell very similar in outline to *boholensis*, but stouter, with the brown bands much darker. The narrow black band on the first two whorls is very faint. The lines of growth are also a little stronger in this than in *boholensis*. The type (Cat. No. 215579, U.S.N.M.) was collected by Quadras on the island of Samar. It has 6.5 whorls and measures—length, 56.4 mm.; diameter, 29 mm.—and was presented to the Museum by Mr. Webb.

AMPHIDROMUS MACULIFERUS, subspecies?

Semper, in his Reisen im Archipel der Philippinen (vol. 3, p. 149), 1873, writes:

> Finally, I have in my possession three examples of a form which were presented to me in Cebu, of which the specific locality in which they were found was unknown. The shell is much more inflated than in the named varieties of *maculiferus*, of a beautiful yellow color, with a simple or double brown varix. The apex is edged with black, and in two of the examples a few brown spots are present under the suture. The dimensions of the two extreme forms are:
>
> Long. 57, diam. maj. 35, min. 28; apert. alt. 29, lat. 15 mm.
>
> Long. 64, diam. maj. 31, min. 26; apert. alt. 30, lat. 14 mm.
>
> This probably is nearest related to *Amphidromus palaceus* var. *sulfureus*, but I dare not take the responsibility for deciding whether that should be placed here or not. I am equally reluctant to describe it as a new species, since I do not consider that I have sufficient material.

I have not seen specimens from the island of Cebu, and therefore simply call attention to the fact that these three specimens which Semper had seen may have come from that island; and if so, it is quite likely that they represent something different from any of the forms that are mentioned in this paper.

AMPHIDROMUS MACULIFERUS, subspecies?

From Lampinigan Island I have a shell which is badly worn, Cat. No. 244692, U.S.N.M., collected by Lieut. Col. Edgar A. Mearns, which differs from any of the described forms. There are traces of brown markings on the badly worn white surface which indicate that it probably belongs near *A. basilanensis*.

AMPHIDROMUS MACULIFERUS COSMIUS, new subspecies.

Plate 9, fig. 4.

Shell elongate-ovate, very thin, yellowish white, with the whorls moderately rounded and the summit of the whorls appressed. The first two whorls show the narrow, faint dark band immediately above the suture. The succeeding turns are marked by irregularly disposed, hydrophanous axial bands of variable width, which are most pronounced on the third and fourth turns. The last whorl is marked by weak axial threads, the remainder being marked by mere incremental lines. Aperture oval; outer lip somewhat expanded and reflected, thin and white at the edge; inner lip short, somewhat twisted, broadened at the base, and reflected partly over the narrow umbilicus; parietal wall covered by a thin callus, which is of pale rust color.

The type (Cat. No. 245562, U.S.N.M.) was collected by Lieut. Col. Edgar A. Mearns on Basilan Island. It has 6.2 whorls and measures—length, 52 mm.; diameter, 25.5 mm.

This shell somewhat resembles *Amphidromus maculiferus gracilior* Fulton, but the hydrophanous markings are considerably less strong in the present form, and it is much smaller and has a faint yellowish suffusion.

AMPHIDROMUS MALINDANGENSIS, new species.

Plate 9, figs. 1, 2.

Shell of medium size, elongate-ovate, dextral or sinistral, yellow with bands of brown. The suture of the first two whorls is bordered by a narrow black zone. The brown markings consist of rather irregularly placed longitudinal bands which extend only over the anterior two-thirds of the whorls between the sutures on the first two and a half whorls. These bands are of quite regular widths and about half as wide as the spaces that separate them. On the last turn the brown bands are irregular in width and assume a decidedly zigzag form, but not a regular definite pattern. They extend over the base to the umbilical area. The whorls are evenly rounded, separated by a moderately constricted suture, and are marked by exceedingly fine lines of growth. Aperture moderately large; outer lip thickened and reflected; inner lip somewhat curved, strong, and slightly twisted, reflected over the narrow umbilicus; parietal wall covered with a moderately thick callus; inside of shell, lip and callus white.

Two specimens of this species are before us, Cat. No. 244689, U.S.N.M. They were collected by Lieut. Col. Edgar A. Mearns at Mount Malindang, Mindanao, at an altitude of between 3,500 and 9,200 feet. Both have six whorls, the sinistral specimen, the type, measures—length, 48.5 mm.; greater diameter, 25 mm. The dextral—length, 46.8 mm.; greater diameter, 27.5 mm.

AMPHIDROMUS APOENSIS, new species.

Plate 9, figs. 5, 6.

Shell elongate-ovate, with the whorls moderately rounded and appressed at the summit, marked by fine lines of growth only. The first two volutions show the narrow black band in the suture, the remainder of these whorls being yellowish-white. The next turn is plain white. Beginning with the third, a series of closely spaced, somewhat retractively slanting zigzag markings of alternating brown and yellowish-white bands, the latter a little wider than the brown elements, make their appearance. These brown bands become a little more closely spaced on the last volution, particularly so on the base. Aperture moderately large; outer lip thin, showing the external markings within, thickened at the edge, which is reflected

and slightly expanded; inner lip almost vertical, expanding at the base into a callus which fuses with the thin callus that covers the parietal wall; partly reflected over the narrow umbilicus.

The type, Cat. No. 244690, U.S.N.M., was collected by Lieut. Col. Edgar A. Mearns on Mount Apo, Mindanao. It has 6.5 whorls and measures—length, 59 mm.; diameter, 28.3 mm.

AMPHIDROMUS BASILANENSIS, new species.

Plate 9, fig. 3.

Shell of medium size; elongate-ovate. The first three whorls dingy white with a satiny luster, the remaining of the same ground color, marked at irregular intervals by more or less interrupted axial zigzag lines of light brown which have no definite form of disposition. The brown markings become more abundant on the last whorl. The whorls are moderately well rounded, appressed at the summit, and crossed by fine, very retractive axial lines of growth and exceedingly fine spiral striations. Sutures moderately constricted. Aperture moderately large, oval; outer lip thickened and reflected; inner lip thickened, somewhat sinuous and reflected over the umbilical chink; parietal wall covered with a moderately thick callus. The inside of the aperture shows the same coloration as the exterior, the brown markings extending through the shell. The outer edge of the peristome is white, while its inner border is of the same brown as the longitudinal bands.

Two specimens of this species were collected by Mr. McGregor, of the Philippine Bureau of Sciences, on Basilan Island. One of these, the type, is in the United States National Museum, Cat. No. 244691; the other is in the Philippine Bureau of Sciences. The type has six post-nuclear whorls and measures—length, 45.8 mm.; greater diameter, 24.2 mm.

AMPHIDROMUS FLORESI, new species.

Plate 8, fig. 3.

Shell ovate, sinistral. Early whorls well rounded, with a narrow band of gray immediately above the suture, the rest white. The succeeding turns are evenly rounded, appressed at the summit, and very feebly constricted at the sutures. All but the last one and a half turns are marked by faint lines of growth and exceedingly fine, spiral striations. On the last turn and a half, the axial sculpture becomes much strengthened, forming regular threadlike riblets. The shell is of bluish white ground color, marked with irregularly distributed, somewhat wavy, narrow, brown axial bands. These may be continuous from the summit to the umbilical region or interrupted. In-

side of the aperture and peristome bluish white; outer lip reflected, and slightly expanded; inner lip broadened at its insertion, which fuses with the thin callus that covers the parietal wall, and reflected over the narrow umbilicus.

The type, Cat. No. 215580, U.S.N.M., was collected for Mr. Walter F. Webb by Mr. I. Flores in southeastern Mindanao. I have named it in honor of Mr. Flores at Mr. Webb's request.

GROUP OF AMPHIDROMUS INFLATUS.

The group of *Amphidromus inflatus* at present embraces six species: *A. inflatus* Fulton, *A. mearnsi* Bartsch, *A. pallidulus* Pilsbry, *A. hidalgoi* Bartsch, *A. bilatanensis* Bartsch, and *A. calista* Pilsbry. The type-locality of the first is not known. *A. pallidulus* comes from Zamboanga, *Amphidromus mearnsi* and *calista* from Basilan, *A. hidalgoi* from Dapitan, Mindanao, and *A. bilatanensis* from Bilatan Island. All of these forms have the narrow black band in the suture on the early turns. All but *calista* Pilsbry are yellow; this may be white, yellow, or streaked with red or rose pink. It is evidently the black, suprasutural band of the early whorls, which caused Fulton and subsequent writers to ally the described forms with *maculiferus*, but when one views the various races of *maculiferus* one sees readily that it would require considerable stretching of the imagination to believe these shells mere races of that species.

AMPHIDROMUS INFLATUS Fulton.

Plate 1, fig. 3; plate 10, figs. 6, 7.

Amphidromus maculiferus, var. HIDALGO, Journ. de Conch., vol. 36, 1888. p. 31, pl. 6, fig. 1.

Amphidromus maculiferus SMITH, Ann. Mag. Nat. Hist., ser. 6, vol. 13, 1894, p. 55, in part.

Amphidromus maculiferus inflatus FULTON, Ann. Mag. Nat. Hist., ser. 6, vol. 17, 1896, p. 75.

Amphidromus maculiferus inflatus VON MÖLLENDORFF, Abhand. Naturf. Ges. Görlitz, vol. 22, 1898, p. 149.

Amphidromus maculiferus inflatus PILSBRY, Man. Conch., vol. 13, 1900, p. 133.

Shell ovate; pale yellow; outer edge of the reflected lip sometimes pale orange; the first three whorls have the narrow black band immediately above the suture. All the whorls are well rounded, appressed at the summit, marked by very strong, retractively slanting lines of growth and very fine, weakly impressed, spiral striations. Sutures feebly constricted. Aperture large, yellow within; the slightly expanded and reflected outer, as well as the inner lip is white; inner lip somewhat twisted, expanded at the base, and re-

flected over the narrow umbilicus which is sometimes closed by the reflected callus; parietal wall covered with a thin callus.

Two specimens of this species (Cat. No. 99568 U.S.N.M.) bear the label "Philippine Islands," without specific locality. They have six whorls each, and measure—length, 58.6 mm.; diameter, 31.4 mm.: and length, 55.5 mm.; diameter, 30.2 mm., respectively.

Fulton cites[1] Baranda, Philippine Islands, as the type-locality.

AMPHIDROMUS MEARNSI, new species.

Plate 10, figs. 1, 2.

Shell ovate, canary yellow, excepting the narrow dark band immediately above the suture on the first three whorls and a narrow band of white, which is separated from the summit by a band equaling the white band in width, which agrees with the general coloration of the surface. The whorls are well rounded, appressed at the summit, and marked by well-expressed lines of growth, which almost suggest rib striations and exceedingly fine spiral striations. Sutures moderately constricted. Aperture quite large, oval; outer lip expanded and reflected; inner lip expanded at its insertion and reflected over the narrow umbilicus; parietal wall covered by a moderately thick callus; inside of the aperture and peristome white.

The type (Cat. No. 245565, U.S.N.M.) was collected by Lieut. Col. Edgar A. Mearns, at Atingating, northwest coast of Basilan Island. It has six whorls and measures—length, 47 mm.; diameter, 25.5 mm. Cat. No. 245566, U.S.N.M., contains an adult specimen and a young individual, also from Basilan. The adult has 6.5 whorls and measures—length, 55 mm.; diameter, 28.7 mm.

AMPHIDROMUS PALLIDULUS Pilsbry.

Plate 10, figs. 3, 8.

Amphidromus chloris ELERA, Cat. Sist. Faun. Filip., 1896, p. 617,
Amphidromus chloris, var. *pallidulus* PILSBRY, Man. Conch., vol. 13, 1900, pp. 143, 144, pl. 50, figs. 33, 34.

Shell stout, sinistral, straw colored, with a narrow white zone a little anterior to the suture. The nuclear whorls are marked with a narrow dark zone at the suture. The succeeding turns are well rounded, marked by numerous retractive lines of growth and very fine spiral striations. Aperture large; outer lip provided with a strong white peristome. Columella moderately long, expanded at the base, the outer edge extending over the base and fusing with the parietal callus.

This description is based upon Doctor Pilsbry's cotypes, which were collected by the Steere Expedition at Zamboanga, Mindanao. They both have six whorls and measure—length, 45 mm.; diameter,

[1] Am. Mag. Nat. Hist., ser. 6, vol. 17, 1896, p. 75.

28 mm.; and length, 46.4 mm.; diameter, 25.5 mm., respectively. They form Cat. No. 106459 of the collection of the Philadelphia Academy of Natural Sciences.

AMPHIDROMUS BILATANENSIS, new species.

Plate 10, figs. 4, 5.

Amphidromus maculiferus, var. SMITH, Ann. Mag. Nat. Hist., ser. 6, vol. 13, 1894, p. 55, pl. 4, figs. 9, 9*a*.

Amphidromus maculiferus VON MÖLLENDORFF, Nachr. Deut. Malak. Ges., vol. 26, 1894, p. 211.

I have not seen specimens of this species, but base my conclusions of its distinctiveness upon Mr. Smith's figures and remarks and the geographical isolation from any of the other forms of the group. I quote Mr. Smith's remarks:

The specimens from Bilatan present but the faintest trace of oblique strigation, like some of the Philippine examples. They more resemble the variety figured by Hidalgo, being either pale lemon-yellow or pinkish white. They are rather smaller than normal specimens, having an average length of about 50 to 55 millimeters. All as yet examined are sinistral.

Hab., Bilatan Island.

AMPHIDROMUS HIDALGOI, new species.

Plate 11, figs. 4, 6.

Amphidromus maculiferus SOWERBY, var. HIDALGO, Mem. Real Acad. Sci. Madrid, 1898, pl. 99, figs. 1, 2.

Shell large, inflated, the early whorls with the usual narrow black band immediately above the suture. The succeeding ones inflated, appressed at the summit, lemon-yellow with a narrow whitish band at the summit, and irregularly distributed markings of dark rust brown. A varicial streak of the same color marks the last turn. Aperture broad, flaring, strongly reflected; dark within, white at the edge.

I have based my description upon Señor Hidalgo's figures,[1] which measure—length, 60 mm.; diameter, 35.5 mm. Señor Hidalgo informs me that the specimen came from Dapitan, Mindanao.

AMPHIDROMUS CALISTA Pilsbry.

Plate 11, figs. 1–3.

Amphidromus chloris, col. var. *purissimus* PILSBRY, Man. Conch., vol. 13, 1900, p. 144, pl. 50, fig. 32.

Amphidromus chloris, col. var. *calista* PILSBRY, Man. Conch., vol. 13, 1900, p. 144, pl. 50, fig. 36.

Amphidromus chloris, col. var. *rosa* PILSBRY, Man. Conch., vol. 13, 1900, p. 144, pl. 50, fig. 38.

[1] Mem. Real Acad. Sci. Madrid, 1898, pl. 99, figs. 1, 2.

The coloration of this species varies from pure white to pale yellow with reddish brown streaks on the spire, or it may be rose-pink throughout. The three specimens above cited are in the collection of the Philadelphia Academy of Natural Sciences. They have a very dark fillet in the suture of the early whorls, which places them in the *Amphidromus inflatus* group, of which they form the smallest known member. Only two of the three shells are adult and these yield the following measurements, respectively: Number of whorls, 6, and 5.6. Length, 42.4 mm., 39 mm.; diameter, 23 mm., 21.5 mm.

GROUP OF AMPHIDROMUS CHLORIS.

The group of *Amphidromus chloris* will probably be found to extend from Mindanao southward over the Sulu Archipelago. From the material examined it is possible to recognize three species—namely, *A. chloris*, *A. roeseleri*, and *A. suluensis;* the first coming from Zamboanga, Mindanao, the second from Jolo, while the material of the third one examined was listed as coming from the islands of the Sulu Sea. It is quite possible that when a complete exploration of the Sulu Archipelago will be completed that more island races of this group will be discovered.

AMPHIDROMUS CHLORIS Reeve.

Plate 1, fig. 4; plate 12, figs. 1–6, 8.

Bulimus chloris Reeve, Conch. Icon., 1848, pl. 37, p. 223.
Bulimus chloris Pfeiffer, Zeitschr. f. Malak., 1849, p. 137.
Bulimus chloris Pfeiffer, var. Zeitschr. f. Malak., 1849, p. 137.
Bulimus chloris Reeve, Zool. Voy. Samarang, 1850, p. 58, pl. 14, fig. 10.
Amphidromus chloris Albers, Heliceen, 1850, pp. 138–140.
Bulimus sulphuratus Hombron and Jacquinot, Voy. Ast. and Zelee, Zool., vol. 5, 1854, p. 29.
Bulimus chloris Pfeiffer, Conch. Cab. Mart. Chem., vol. 1, pt. 13, 1855, p. 183, pl. 49, figs. 7, 8.
Bulimus (*Amphidromus*) *chloris* Pfeiffer, Malak. Blat., vol. 2, 1855, p. 147.
Bulimus (*Canistrum*) *chloris*, A. and H. Adams, Gen. Rec. Shells, 1858, p. 143.
Bulimus chloris Pfeiffer, Mon. Hel. Viv., vol. 4, 1859, p. 382.
Bulimus sulphuratus Pfeiffer, Mon. Hel. Viv., vol. 4, 1859, p. 382.
Bulimus chloris von Martens, Preus. Exp. Ost. Asien, Zool., vol. 2, 1867, p. 351.
Bulimus sulphuratus Pfeiffer, Mon. Hel. Viv., vol. 6, 1868, p. 26.
Bulimus chloris Pfeiffer, Mon. Hel. Viv., vol. 6, 1868, p. 26.
Amphidromus chloris Semper, Reis. Arch. Phil., vol. 3, 1873, p. 148.
Amphidromus sulphuratus Semper, Reis. Arch. Phil., vol. 3, 1873, p. 148.
Amphidromus chloris Pfeiffer, Mon. Hel. Viv., vol. 8, 1877, p. 42.
Amphidromus chloris Hidalgo, Journ. de Conch., vol. 36, 1888, p. 32.
Amphidromus perversus chloris Fulton, Ann. Mag. Nat. Hist., ser. 6, vol. 17, 1896, p. 67.
Amphidromus chloris Elera, Cat. Sist. Faun. Filip., vol. 3, 1896, p. 617.

Amphidromus chloris HIDALGO, Mem. Real Acad. Sci., Madrid, 1898, pl. 99, figs. 3–4.

Amphidromus chloris PILSBRY, Man. Conch., vol. 13, 1900, pp. 142–144.

Shell very elongate-ovate, pale canary yellow with a narrow white band at the summit. Peristome and aperture white. Whorls well rounded, somewhat constricted at the suture, marked by fine lines of growth only. Aperture elongate, oval; outer lip reflected and thickened; inner lip expanded at the base, partly reflected over the umbilicus where it joins the moderately thick callus of the parietal wall.

A specimen belonging to the Chicago Academy of Sciences, collected by Quadras at Zamboanga, Mindanao, has 6.5 whorls and measures—length, 44.7 mm.; diameter, 22.5 mm. This specimen might have served for Reeve's figure cited above, so perfectly does it agree with it in every feature.

Adams and Reeve state, locality cited, that the animal of *Bulimus chloris* is of pale brown color * * * and of extremely vivacious habits. A bushel of them, collected on the mountains of Mindanao, soon dispersed themselves all over the cabin in which the basket was deposited. The shell was of elongate form and deep yellow color throughout, with no indications of bands or markings. The figure, however, shows the pale sutural band of white.

Thanks to the kindness of Mr. Walter F. Webb, I have had the opportunity of examining 393 specimens of this species collected at Talantalan, Zamboanga, Mindanao. These give the following measurements:

	No. of whorls.	Altitude, mm.	Diameter, mm.
Average	6.198+	39.851	22.266+
Greatest	7	48.2	25
Least	5.5	34	18.8

The extremes represented by the seven specimens, Cat. No. 215641, U.S.N.M., which are figured, yield measurements as follows:

No. of whorls.	Length, mm.	Diameter, mm.	Remarks.
6.25	40	22.3	Norm.—i. e., typical average specimen.
7	45.1	23.2	Greatest number of whorls.
5.5	36.8	20.8	Least number of whorls.
6.75	48.2	24.3	Greatest length.
5.75	34	20.2	Least length.
6.5	45.5	25	Greatest diameter.
6.23	38.7	18.8	Least diameter.

Doctor Pilsbry, in the Manual of Conchology (p. 144), makes the following statement:

Basilan.—The Steere Expedition also collected examples of *chloris* on Basilian Island (figs. 32, 35, 36–38), where Semper did not find it. They are identical in form with Samboanga shells, but vary in color as follows: (*a*) Color of the typical yellow tint, but rapidly fading to white on the spire (pl. 50, fig. 35). (*b*) Pale citron or greenish-yellow, the spire white (fig. 37). (*c*) Similar to color-var. *pallidulus*, but with a slightly darker sutural border and no white band. (*d*) Pure white throughout, color-var. *purissimus* (fig. 32). (*e*) Pale yellow or rufous, with oblique reddish-brown streaks on the spire or throughout, the suture narrowly marked with the same, color-var. *calista* (fig. 36). (*f*) Brilliant rose-pink, with white subsutural band and darker sutural line to the apex, color-var. *rosa* (fig. 38).

From a very careful examination of these shells I am led to believe that a mix-up has occurred in handling collections and that two of the specimens referred to, namely, those represented by figures 35 and 37, are true *chloris* which I am inclined to believe came from Zamboanga, Mindanao. This is all the more probable since Professor Steere's expedition also collected in this place. The other three are sufficiently distinct to merit separation. They belong to the *inflata* group. I have listed them under the name *Amphidromus calista* Pilsbry.

AMPHIDROMUS SULUENSIS, new species.

Plate 1, fig. 5; plate 11, figs. 5, 7–9; plate 12, figs. 7 and 9.

Shell elongate-ovate, dextral or sinistral, sulphur yellow, with occasional, bluish gray varicial streaks. Aperture and peristome white. Whorls rather inflated, appressed at the summit, marked by very fine lines of growth and rather conspicuous varices; sutures moderately constricted. Aperture small, broadly oval; outer lip reflected and thickened; inner lip somewhat twisted and reflected over the umbilicus, which is covered in almost all the specimens, broadly expanded at its insertion, where it joins the thick parietal callus.

The type (Cat. No. 99564, U.S.N.M.) and five specimens bear the label "Islands of the Sulu Sea." The type has 6.5 whorls and measures—length, 45.5 mm.; diameter, 23.8 mm. The following specimens were examined:

Cat. No. U.S.N.M.	Number whorls.	Length in mm.	Diameter in mm.	Locality.	Remarks.
99564[1]	6.5	45.5	23.8	Islands of Sulu Sea....	(Sinistral).
99564	6.5	39	22	.....do.....	Do.
99564	6.5	44.5	23.8	.....do.....	Do.
99564	6.4	41.8	22.3	.....do.....	Do.
99564	6.1	37.4	22	.....do.....	Do.
99564	.....	.....	.....	.....do.....	(Sinistral) young individual.
99565	6.5	39.5	23.4	.....do.....	(Dextral).
99565	6.5	42.4	23.5	.....do.....	Do.
99565	6.5	44.3	29.6	.....do.....	Do.

[1] Type.

This species is at once distinguished from all the other Philippine *Amphidromi* by its sulphur yellow color and by the fact that it is variced.

AMPHIDROMUS ROESELERI Möllendorff.

Plate 13, figs. 1–3.

Amphidromus roeseleri von Möllendorff, Nachr. Deut. Malak. Ges., vol. 26, 1894, pp. 210–211.

Amphidromus roeseleri Fulton, Ann. Mag. Nat. Hist., ser. 6, vol. 17, 1896, p. 75.

Amphidromus roeseleri Pilsbry, Man. Conch., vol. 13, 1900, p. 144.

Shell elongate-ovate, white with a satiny luster. Whorls well rounded, appressed at the summit, marked by numerous, very retractive lines of growth and exceedingly fine, spiral striations. Sutures moderately impressed. Aperture auricular; outer lip expanded, reflected and thickened at the edge; inner lip twisted and expanded at its insertion where it joins the rather thick parietal callus and is reflected over the narrow umbilicus. Inside of aperture and peristome white.

There are three specimens of this species Cat. No. 215576, U.S. N.M., which were collected on Jolo Island, Philippines, by Lieut. Col. Edgar A. Mearns. All of them have six whorls. They measure—length, 46 mm.; diameter, 25 mm.; length, 47 mm.; diameter, 25.2 mm.; and length, 48 mm.; diameter, 28 mm., respectively. Von Möllendorff's type comes from Sulu (=Jolo) Island.

AMPHIDROMUS, species ?

The United States National Museum contains a specimen, Cat. No. 215638, collected by Lieut. Col. Edgar A. Mearns, on Loran Island, opposite the southern end of Ubian Island. This specimen is a dead, badly worn individual, which without question belongs to the group of *chloris*, but it is too poor to serve as the type of a distinct species.

GROUP OF AMPHIDROMUS ENTOBAPTUS.

The yellow *Amphidromi* of the Western Philippine Islands belong to a distinct group, of which we may take the oldest described species, *Amphidromus entobaptus* Dohrn, as the typical figure. This group is distributed over Palawan, the *Cuyos* group, the *Calamianes* to Mindoro, splitting up into races on the various islands. I have recognized *A. entobaptus*, *A. e. viridoflavus*, *A. e. linapancensis*, *A. e. culionensis*, *A. e. coronensis*, *A. e. busuangensis*, and *A. mindoroensis*. *Amphidromus entobaptus* s. s. comes from Palawan, and *A. viridoflavus* from Malubutglubut Island, while the location of the rest will easily be noted from the name, which is based upon the island of the type-locality.

AMPHIDROMUS ENTOBAPTUS ENTOBAPTUS Dohrn.

Plate 13, figs. 4–9.

Amphidromus perversus Hidalgo, Journ. de Conch., vol. 35, 1888, p. 32.
Amphidromus entobaptus Dohrn, Nach. Malak. Gesel., vol. 22, 1889, p. 62,
Amphidromus entobaptus Smith, Proc. Zool. Soc. London, 1895, pp. 98–99.
Amphidromus perversus entobapta Fulton, Ann. Mag. Nat. Hist., ser. 6, vol. 17, 1896, p. 67.
Amphidromus contrarius Elera, Cat. Sist. Faun. Filip., 1896, p. 617.
Amphidromus entobaptus Elera, Cat. Sist. Faun. Filip., 1896, p. 618.
Amphidromus entobaptus Hidalgo, Mem. Real Acad. Sci. Madrid, 1898, pl. 99, figs. 5–8.
Amphidromus entobaptus von Möllendorff, Abhand. Naturf. Ges. Görlitz, vol. 22, 1898, p. 148.
Amphidromus entobaptus Pilsbry, Man. Conch., vol. 13, 1900, pp. 145–6, pl. 51, figs. 42–6.

Shell sinistral, stout, elongate-ovate to ovate, varying in color from almost white to pinkish buff on the outside; inside, light orange buff or buffish yellow. The early whorls are usually soiled white, with a narrow ashy band immediately above the suture. All the whorls are decidedly appressed at the summit, strongly rounded, and marked by decidedly retractive lines of growth. Aperture large; outer lip reflected to form a thickened peristome, the edge of the lip being almost white; columella somewhat sigmoid, reflected over the base in the shape of a callus; parietal wall covered with a thick callus connecting with the columella; columella and the parietal callus of the same color as the edge of the outer lip.

Eighty-five specimens of this species were collected by the U. S. Fisheries steamer *Albatross* Philippine expedition, Cat. No. 254917, U.S.N.M., at Ulugan Bay, Palawan, which is a short distance to the north and across the island from the type-locality, Puerto Princesa. Twenty-five of these taken at random give the following measurements and data:

Number of whorls.	Length in mm.	Diameter in mm.
6	52	28.7
6	51.5	29
6	55.2	32.4
6	51.3	30
6	49.2	29
6	48.5	29
6	52	30
6.2	54.2	30.1
6.1	51.2	29.2
6	49.6	27.3
5.8	49.6	28.3
5.8	48	29.2
6	50.2	29
6.2	48.2	28
6	49.3	27
6	49.1	28
6.2	51.3	27.3
6	48.6	28.2
6	46.2	26.2
6.5	50.3	27.4
6	51.6	29
6.5	55	29.2
6	47.7	28
6	48	25.6
6.5	48.3	27
[1] 6.5	[1] 55.2	[1] 38.3
[2] 5.8	[2] 46.2	[2] 25.6
[3] 6.07	[3] 50.25	[3] 28.95

[1] Largest. [2] Smallest. [3] Average.

Two additional specimens, Cat. No. 254918, U.S.N.M., were collected at Poncal, Palawan, by the U. S. Bureau of Fisheries steamer *Albatross.*

AMPHIDROMUS ENTOBAPTUS VIRIDOFLAVUS, new subspecies.

Plate 14, figs. 1–3.

This race of *A. entobaptus* is of medium size. It is distinguished from the shells so far seen from other islands by the green coloration of the early whorls. In some specimens this reaches a depth of lettuce green. On the last turn the coloration usually corresponds with that of *Amphidromus entobaptus entobaptus.*

I have seen 17 specimens of the race, Cat. No. 215600, U.S.N.M., collected at the observatory on Malubutglubut Island. Only six of these are mature, and these yield the following data:

Number of whorls.	Length in mm.	Diameter in mm.
6	45.2	25.7
6.1	45	23.4
6	44	23.8
[1] 6	46.5	25.8
6.1	46	25.6
5.8	41.7	23.2

[1] Type.

AMPHIDROMUS ENTOBAPTUS LINAPACENSIS, new subspecies.

Plate 16, figs. 1–3.

Amphidromus entobaptus gracilis VON MÖLLENDORFF, Abhand, Nat. Gesel. Görlitz, vol. 22, 1898, p. 148, *nomen nudum*.

Shell elongate-ovate, varying in color from oil green through Naples yellow, through canary yellow to almost white. The greenish tints are usually confined to the early portion of the shell, the later turns being yellow. The inside is always of a deeper shade than the exterior. The peristome is white. The whorls are closely appressed at the summit, marked by decidedly protractively slanting lines of growth and exceedingly fine spiral striations.

We have seen 142 specimens of this race, Cat. No. 215599, U.S.N.M., from Malcochin Harbor, 450 feet altitude, on Linapacan Island, 25 of which taken at random give the following measurements:

Number of whorls.	Length in mm.	Diameter in mm.
6	42.6	23.3
5.5	42.4	23.1
6.2	47.5	25.8
5.7	41.2	23.4
6	47	23.6
6.1	43.2	22.6
6	43.6	24.5
6	43.4	24
6.1	46	25.1
5.5	39.2	22.5
6.2	45	25
6	45.1	25.6
6.1	42	23.3
6.2	45.6	25.6
5.7	45.7	24.1
5.6	41.6	23
6.3	49.9	25.2
5.7	41	23.5
6	41.3	22.5
5.8	41.3	21.3
5.6	39.2	22
6.3	47.2	24.4
6	44.6	22.8
[1]6.3	49.2	25.1
5.5	40.4	24.2
[2]6.3	49.9	25.8
[3]5.5	39.2	21.3
[4]5.93	43.8	23.82

[1] Type. [2] Largest. [3] Smallest. [4] Average.

This race seems nearest to typical *A. entobaptus*, but is uniformly more slender, and a greenish tint is much more apparent.

AMPHIDROMUS ENTOBAPTUS CULIONENSIS, new subspecies.

Plate 1, fig. 6; plate 14, figs. 4–9; plate 15, figs. 1–3.

Shell much smaller than typical *Amphidromus entobaptus entobaptus*, and much less inflated than *Amphidromus entobaptus busuangensis.* In general shape it resembles *Amphidromus entobaptus gracilis*, but is of a more uniform paler coloration than that race.

We have seen 21 specimens which were collected by Dr. D. C. Worcester on the Menage Scientific Expedition on Culion Island. These yield the following data:

Number of whorls.	Length in mm.	Diameter in mm.
6. 1	44. 7	24. 8
6. 2	44. 6	24. 4
5. 7	42. 6	23. 4
6. 1	46	25. 7
[1]5. 8	45. 8	[1]25. 6
5. 7	41. 2	23. 7
5. 5	40	24
6	44. 9	25. 5
6	38. 9	22. 6
6. 1	47. 8	27. 1
5. 7	48	25. 7
5. 6	40. 5	24. 1
5. 6	45. 6	26. 8
5. 8	46. 3	26. 1
5. 7	40. 6	24. 7
5. 5	38. 6	23. 2
6	43. 5	24. 8
5. 6	41. 6	24
6	48. 2	27
6. 1	46. 1	24. 7
5. 2	36. 4	23. 7
[2]5. 8	[2]43. 42	[2]24. 83
[3]6. 2	[3]48. 2	[3]27. 1
[4]5. 2	[4]36. 4	[4]22. 6

[1] Type. [2] Average. [3] Greatest. [4] Least.

The type is Cat. No. 215642, U.S.N.M.

AMPHIDROMUS ENTOBAPTUS CORONENSIS, new subspecies.

Plate 15, figs. 6–8.

Amphidromus entobaptus contractus VON MÖLLENDORFF, Abhand. Nat. Gesel. Görlitz, vol. 22, 1898, p. 148, *nomen nudum.*

The shells from Coron Island of the Calamianes Group have the shape of *Amphidromus chloris* Reeve; that is, they are very much more slender than typical *Amphidromus entobaptus.* Of course the typical deep coloration at once proclaims them members of the *Amphidromus entobaptus* complex.

The three specimens in the collection of the U.S.N.M. Cat. No. 195848*a* come from the von Möllendorff collection. They present the following data:

Cat. No. U.S.N.M.	Number of whorls.	Length in mm.	Diameter in mm.	Locality.
195848*a*	5.8	43	24	Coron.
195848*a*	6.4[1]	47.5	22.2	Do.
195848*a*	5.8	41.3	23	Do.

[1] Type.

AMPHIDROMUS ENTOBAPTUS BUSUANGENSIS, new subspecies.

Plate 16, figs. 4–9.

Amphidromus perversus LINNAEUS, var., ELERA, Cat. Sist. Faun. Filip., 1896, p. 618.

Amphidromus entobaptus PILSBRY, Man. Conch., vol. 13, p. 146, 1900, pl. 51, figs. 42–44.

Shell elongate-ovate to ovate; cream colored to Naples yellow, usually darker within. Whorls well rounded, appressed at the summit, marked by fine, retractive lines of growth and exceedingly fine spiral striations. The aperture is broadly oval; outer lip thick, expanded and reflected; inner lip expanded at the base where it fuses with the rather thick callus of the parietal wall; peristome white. The following specimens have been examined:

Cat. No.	Collection.	Num- of whorls.	Length in mm.	Diam- eter in mm.	Locality.	Collector.
184559	U.S.N.M.	6	43.3	23.1	Busuanga	Von Möllendorff.
302841	do.	5.5	40	23.2	do.	Henderson.
302841	do.	6	43.3	24.4	do.	Do.
	do.	5.6	43	23	Malbato Busuanga	Quadras.
	do.	6	45.5	25	do.	Do.
	do.	5.4	41.5	24	do.	Do.
	do.	6	47.8	24	do.	Do.
215643	do.	5.4	40.3	25.5	do.	Do.
215643[1]	do.	5.7	46.5	27.3	do.	Do.
	Webb.	5.4	40.6	24.2	do.	Do.
	do.	5.8	41.6	24.5	do.	Do.
	do.	5.8	44	25	do.	Do.
	do.	5.7	38.8	23	do.	Do.
	do.	5.9	40.2	22	do.	Do.
	Chicago Acad. Sci.	5.8	41.5	25	do.	Do.
	do.	5.8	45	25.3	do.	Do.
Largest		6	47.8	27.3		
Smallest		5.4	38.8	22		
Average		5.73	42.6	24.2		

[1] Type.

AMPHIDROMUS MINDOROENSIS, new species.

Plate 15, figs. 4, 5.

Shell inflated, ovate. The first whorl and a half white, the rest canary yellow excepting a very narrow band at the summit and the peristome, which are white. The whorls are inflated, well rounded, appressed at the summit, and marked by very retractive lines of growth and exceedingly fine spiral striations. Aperture rather large, oval; outer lip thick, somewhat expanded and reflected; inner lip twisted, expanded at the base; parietal wall covered with a thin callus. The inside of the aperture is colored like the exterior.

The type (Cat. No. 245564, U.S.N.M.) was collected by Mr. Weber, of the Philippine Bureau of Sciences, in Mindoro. It has six whorls and measures—length, 53.2 mm.; diameter, 29.2 mm.

GROUP OF AMPHIDROMUS QUADRASI.

I am quite perplexed by the following species and feel at a loss as to the treatment that should be accorded to it. My own collecting in the Philippines has taught me that specific locality data are absolutely necessary. Many forms, having a somewhat extended distribution, break up into distinct and easily recognizable races on the various islands. Not only is this true, but they may even become differentiated into several forms in one island; for example, *Cochlostyla ovoidea* on Masbate. In Cataingan Bay we find an extremely large, light-colored form on the hillsides of the west shore, while across the bay on Dumurug Point, in the somewhat swampy lowlands, we find a much smaller race which is always darker colored, while at the town of Masbate we find a third equally distinct race.

The perfectly uniform development at each place of these three lots of mollusks would incline one to consider them as three distinct species. It is only when one has made collections over the entire range of *Cochlostyla ovoidea* and has obtained good series of specimens from each locality that one sees that these races can be arranged in such a way as to show complete gradation from one extreme to another.

The old collections made in the Philippines consisted chiefly of purchased material collected by natives, frequently in widely separate localities, dumped together without any data regarding its source. This material has furnished little aid to the student of geographic distribution. It is a stumbling block and the workers who have amused themselves by describing *unicolor*, *unicincta*, *bicincta*, *tricincta*, and *quadricincta* of certain species would have saved time and trouble for their successors if they had chosen a different field for amusement, because these forms occur in varying numbers in a single brood of one parent.

Looking over the material of *Amphidromus quadrasi* Hidalgo before me, and all the printed matter relating to it, I am strongly inclined to believe that a large amount of the material which has found its way into collections consists of shells purchased from natives at Balabac. It is equally probable that these may have come from many of the smaller islands surrounding Balabac Island and that when careful collecting has been done in these places we may find constant races of *Amphidromus quadrasi* on them just as in the case of *Cochlostyla ovoidea* in other parts of the islands.

My belief in this is strengthened by the fact that the 86 specimens collected by the *Albatross* expedition at Caxisigan Island; also the 107 from Bekin, as well as the 41 from Candaraman Island, are of perfectly uniform shape and coloration. This is also true of the 50 specimens labeled Southern Palawan without specific locality.

AMPHIDROMUS QUADRASI QUADRASI Hidalgo.

Plate 1, fig. 11; plate 17, figs. 1–11.

Amphidromus quadrasi HIDALGO, Journ. de Conch., vol. 35, 1887, p. 36, pl. 2, fig. 2.

Amphidromus quadrasi HIDALGO, Journ. de Conch., vol. 36, 1888, pp. 33–34.

Amphidromus quadrasi HIDALGO, Mem. Real Acad. Sci. Madrid, vol. 14, 1889, pp. 17–18.

Amphidromus quadrasi, var. *a.b.d.* SMITH, Ann Mag. Nat. Hist., ser. 6, vol. 11, 1893, p. 351, pl. 18, fig. 10.

Amphidromus quadrasi FULTON, Ann. Mag. Nat. Hist., ser. 6, vol. 17, 1896, p. 85.

Amphidromus quadrasi ELERA, Cat. Sist. Faun. Filip, 1896, p. 618.

Amphidromus quadrasi VON MÖLLENDORFF, Abhand. Naturf. Ges. Gorlitz, vol. 22, 1898, p. 149.

Amphidromus quadrasi HIDALGO, Mem. Real Acad. Sci. Madrid, 1898, pl. 100, figs. 5–6.

Shell sinistral, regular, elongate-conic. Early whorls white, nuclear whorls two, well rounded, marked with numerous very fine, evenly scattered granules, post-nuclear whorls appressed at the summit, smooth, excepting very fine, decidedly retractive lines of growth and numerous exceedingly fine spiral striations. Sutures only slightly constricted. Periphery of the last whorl angulated in young shells, and very feebly angulated in the adult; base well rounded, marked like the spire. Aperture moderately large, oblique; outer lip reflected; inner lip moderately reflected. Parietal wall glazed with a thin callus. The coloration of typical *quadrasi* is as follows: Early whorls white, without dark spot at tip of the nucleus; the rest yellow marked with numerous fine, decidedly retractive green lines which tend to become fused toward the latter part of the shell and give this a green aspect. These green lines do not quite extend to the summit. The summit is marked by a very slender yellowish-white line. This is followed by a moderately broad red band which,

in turn, is followed by a narrow yellow zone anteriorly; a red area surrounds the umbilical area and this is followed at its posterior edge by a moderately broad yellow zone. The inside of the aperture and lip are white.

Cat. No. 66188, Philadelphia Academy of Natural Sciences, figured in Tryon's Manual of Conchology (vol. 13, pl. 71, fig. 78), is typical *quadrasi*, it is my figure 3, on plate 12. This comes from Balabac Island. It has a little more than six whorls and measures—length, 34 mm.; diameter, 17.8 mm. Another specimen in Mr. Webb's collection, which I have likewise figured (pl. 12, fig. 1), is also typical *quadrasi* and comes from the same island. It has $6\frac{1}{2}$ whorls and measures—length, 36 mm.; diameter, 18.2 mm.

The United States National Museum has several lots of this form, all obtained by the United States Bureau of Fisheries' Expedition to the Philippine Islands, which I shall list in detail below. All of these are remarkably uniform in coloration, the green streaks being reduced to a minimum, the yellow predominating in every instance. They all have white tips.

Eighty-six specimens, Cat. No. 215603, U.S.N.M., were obtained at Caxisigan Island, near Balabac Island. Twenty-five of these, taken at random, give the following measurements:

Number of whorls.	Length in mm.	Diameter in mm.
6.5	38	20.2
6	37.3	20.2
6.5	30.3	15.2
7	36.5	18.3
6.5	34.5	16
6.5	32.3	16
6.3	31.6	16.2
6.7	34	16.7
6	30.6	15.7
6	33.5	15.5
6.5	35	16.5
6.5	34.5	17.2
6.5	37.5	17.5
7	41.2	19.8
6	28.2	15.3
6	35.8	17.7
7	42.3	22
7	41.5	21
7	36.2	17.2
6.5	34.6	18.5
6.5	37.7	19
6.5	39.6	20
6	22.5	14.5
6	29	15
6	28.6	15
[1] 6.4	34.5	17.4
[2] 7	42.3	22
[3] 6	22.5	15

[1] Average. [2] Greatest. [3] Least.

One hundred and seven specimens, Cat. No. 215606, U.S.N.M. come from Bekin; 25 of these, taken at random, give the following measurements:

Number of whorls.	Length in mm.	Diameter in mm.
6.5	37.8	17.3
6.5	38	18.5
6	27.8	15.2
6.5	32.3	16
6	28	17.5
6	28.2	15.5
5.8	30.7	16.5
6	30.2	15.2
6	28.3	17
6	30.5	15.3
6	31.3	17
6	30	15.5
6.3	35.5	18.2
5.5	25.4	14.5
5.5	28	15
6	30	15.6
6	31	16.6
6	32.5	17
6.5	34	17
6	31.5	16.2
6	30	15.5
6	26.6	15
5.5	27.5	15
6	26.6	14.2
6	29.3	16.7
[1] 6	31.11	16.2
[2] 6.5	38	18.5
[3] 5.5	26.6	14.2

[1] Average. [2] Greatest. [3] Least.

Forty-one specimens, Cat. No. 215605, U.S.N.M., were obtained from Candaraman Island, off Balabac Island; 10 of these, taken at random, measure:

Number of whorls.	Length in mm.	Diameter in mm.
7	40.7	19.2
7	37.2	18
6.5	36.7	18.4
7	43.5	19
6.5	35.6	18.4
6.5	35	18.2
6.5	35	17.5
6	32.7	18
6.5	35	17.5
7	39	18.5
[1] 6.65	37.04	18.27
[2] 7	43.5	19.2
[3] 6	32.7	17.5

1 Average. 2 Greatest. 3 Least.

Another lot of 50 specimens, Cat. No. 215604, is labeled "Southern Palawan region," without specific locality.

A specimen in Mr. Webb's collection from Balabac is figured on plate 12, figure 11. This has the whorls considerably more convex than any we have seen.

Plate 12, figures 4, 5, are specimens from Caxisigan Island and figures from Candaraman Island.

Another specimen in the Philadelphia Academy of Natural Sciences is entered as Cat. No. 95172 and comes from the Quadras collection from Balabac.

AMPHIDROMUS QUADRASI VERSICOLOR Fulton.

Plate 1, fig. 7; plate 18, figs. 1–10.

Amphidromus quadrasi, var. *c*. Smith, Ann. Mag. Nat. Hist., ser. 6, vol. 11, 1893, p. 351, pl. 18, fig. 11.

Amphidromus versicolor Fulton, Ann. Mag. Nat. Hist., ser. 6, vol. 17, 1896, p. 86.

Amphidromus quadrasi versicolor Von Möllendorff, Abhand. Naturf. Ges. Görlitz, vol. 22, 1898, p. 150.

Amphidromus quadrasi versicolor Pilsbry, Man. Conch., vol. 13, 1900, pp. 230–231, pl. 71, figs. 84, 87, and 90–91.

The present form agrees in general shape and size fairly well with typical *quadrasi*. All of the specimens, however, have the extreme tip black, and none show the strong red girdle immediately below the summit, although this is faintly indicated in one of the specimens in the Philadelphia Academy of Natural Sciences. The main coloration is pale yellow, the last whorl being frequently streaked with axial lines of green, which, in some instances, become so concentrated as to form broad green spiral bands. Some specimens have several narrow spiral bands. The aperture varies from white to rose-purple. This is also true of the outer lip and the umbilical area. Of the specimens which we would refer to this form we have seen the following:

Cat. No.	Collection.	Number of whorls.	Length in mm.	Diameter in mm.	Locality.
302844	U. S. N. M.	7.1	41.4	20.5	Balabac Island.
215639	do.	7.2	44.7	21	Balabac, Balabac Island.
215639	do.	7.1	43.3	22.2	Do.
95173	Phila. Acad. Nat. Sci.	7	40.3	19	Cabo, Melbile, Balabac.
98852	do.				Do.
79483	do.	7	39	19.3	Balabac Island.
79483	do.	6.5	34.7	19.7	Do.
79483	do.	6	34	17.7	Do.
95172	do.	6	31.5	15.5	Do.
	Webb.	6.5	36.6	18.1	Do.
	do.	6	35	19.2	Do.

AMPHIDROMUS QUADRASI SOLIDUS Fulton.

Plate 1, figs. 8, 9, 12, 13, 14; plate 19, figs. 1, 3, 7; and plate 20, figs. 3, 5.

Amphidromus quadrasi, var. *c*, Smith, Ann. Mag. Nat. Hist., ser. 6, vol. 11, 1893, p. 351, pl. 18, fig. 13.

Amphidromus quadrasi, var *solida* Fulton, Ann. Mag. Nat. Hist., ser. 6, vol. 17, 1896, p. 86, pl. 5, fig. 16.

Amphidromus quadrasi solidus von Möllendorff, Abhand. Naturf. Ges. Gorlitz, vol. 22, 1898, p. 149.

Amphidromus quadasi solidus Pilsbry, Man. Conch., vol. 13, 1900, p. 230, pl. 66, figs. 47, 48, and pl. 71, figs. 72–76.

In the present form the conspicuous bands of the base are practically absent. If present at all, they are a mere suggestion. The coloration of the early whorls is blotched and streaked with brown, like that of *dubius*. The extreme apex also is black. The red subsutural band may or may not be present. The last whorl may be streaked with green as in typical *quadrasi*, or may be orange-yellow or white or even suffused with "Spinel red." Of this form, we have seen the following material:

Cat. No.	Collection.	Number of whorls.	Length in mm.	Diameter in mm.	Locality.
215608	U.S.N.M.	7	42.3	19.5	Balabac (U.S.B.F.) *Albatross*.
215608	.....do.	6.5	38.8	18.4	Do.
215608	.....do.	6.5	40.5	20	Do.
215608	2 immature.	.....	.....	.....	Do.
302844	.....do.	6.9	38.6	20.9	Balabac Id.
215607	.....do.	6.5	40.5	19	Port Ciego, Balabac.
215607	.....do.	6	34.8	17.8	Do.
215607	.....do.	6	35.8	18.5	Do.
215607	.....do.	6.2	32.3	16	Do.
215607	8 immature.	.....	.....	.....	Do.
215640	U.S.N.M.	7.3	43.0	20.4	Balabac, Balabac Id.
215640	.....do.	7.2	47.5	23.0	Do.
215640	.....do.	7.5	46.0	21.6	Do.
215640	.....do.	7.2	44.3	21.2	Do.
215640	.....do.	6.9	41.2	20.5	Do.
215640	U.S.N.M., young.	.....	.....	.....	Do.
98853	Phila. Acad. Nat. Sci.	6	32.7	17	Balabac (Steere Exp.).
98851	.....do.	6.5	38.6	19	Do.
98851	.....do.	6	33.5	19.1	Do.
.....	Philippine Bur. Sci.	6.7	39.2	20.1	Do.
.....	Webb.	7	39.2	20.2	Do.

AMPHIDROMUS QUADRASI DUBIUS Fulton.

Plate 1, fig. 10; plate 19, figs. 2, 4, 5, 6, 8, 9; plate 20, fig. 2.

Amphidromus quadrasi, var. *f* Smith, Ann. Mag. Nat. Hist., ser. 6, vol. 11, 1893, p. 351, pl. 18, fig. 12.

Amphidromus dubius Fulton, Ann. Mag. Nat. Hist., ser. 6, vol. 17, 1896, p. 86, pl. 6, figs. 1, 1*a*.

Amphidromus everetti Fulton, Ann. Mag. Nat. Hist., ser. 6, vol. 17, 1896, p. 87.

Amphidromus dubius HIDALGO, Mem. Acad. Real Sci., Madrid, 1898, pl. 101, figs. 7–8.

Amphidromus quadrasi dubius VON MÖLLENDORFF, Abhand. Naturf. Ges. Gorlitz, vol. 22, 1898, p. 150.

Amphidromus quadrasi everetti VON MÖLLENDORFF, Abhand. Naturf. Ges. Gorlitz, vol. 22, 1898, p. 150.

Amphidromus quadrasi dubius and *everetti* PILSBRY, Man. Conch., vol. 13, 1900, p. 231, pl. 71, figs. 79–83, and pl. 70, figs. 65–68.

In the present form the early extreme apex is dark. In every specimen before us the succeeding turn or turn and a half is white. Following this, we have axial, retractive, broad bands of brown separated by narrow bands of light yellow or white. At times these bands become forked and variously diversified, in some instances ending in a number of fine streaks on the upper half of the whorl. There may be or may not be a red subsutural band present as in typical *quadrasi.* On the last whorl the axial banding in all our specimens becomes very much enfeebled and in some has disappeared entirely. The base may be plain yellow or banded with spiral bands of brown and yellow. The umbilical area is usually red, bordered with a yellow band posteriorly, though in several of the specimens the red is entirely wanting, the yellow covering the entire area. The aperture may be pale purple, the yellow spiral bands appearing white within, or it may be white with the number of bands appearing paler on the inside. The lip may be white or purple. This form is distinguished from the next chiefly by the conspicuous coloring of the base, the spiral bands being practically absent in *solida.* I have seen the following specimens:

Cat. No.	Collection.	Number of whorls.	Length in mm.	Diameter in mm.	Locality.
215609	U.S.N.M.	6.3	36.5	20.3	Balabac Id.
215610	U.S.N.M., 6 immature.	.....	.....	.....	Pt. Ciego, Balabac.
79485	Phila. Acad. Nat. Sci.	6.5	40.5	21.5	Palawan (Fulton).
79485	.....do.....	6	30.5	16.3	Do.
79480	.....do.....	6	33.7	18	Balabac Id.
79480	.....do.....	6.5	35.2	17	Do.
79480	.....do.....	6	30.2	16.5	Do.
.....	Webb.....	7	39.5	20.6	Do.
.....	.....do.....	(?)	(?)	19.2	Do.
.....	Chicago Acad. Sci...	6	33.4	16.5	Do.
.....	Webb.....	6	35.6	18	Do.

AMPHIDROMUS QUADRASI PALAWANENSIS, new subspecies.

Plate 1, fig. 15; plate 20, figs. 1, 4, 6–9.

Shell more elongate than typical *quadrasi.* Apex black, the succeeding turn white, and all but the last turn or turn and a half are marked with axial bands of brown which usually break up into finer branches on the posterior half of the whorls. The last portion of the

shells lacks this brown banding and is unicolor, excepting the spiral bands of yellow on the base. The entire surface of the shell is suffused with a brownish wash which gives the whole a dusky aspect. Aperture pale purple within, lip dark brown. In all but one specimen the middle of the base is encircled by a moderately broad yellow band. The columellar area also shows indications of a second yellow band surrounding it, though the portion immediately adjoining the columella is purplish brown. All of the shells have a subsutural red band which is toned down strongly by the brownish suffusion.

The specimens examined yield the following data:

Cat. No.	Collection.	Number of whorls.	Length in mm.	Diameter in mm.	Locality.
99570	U.S.N.M.	7.3	44	21.8	Palawan Passage.
99570	do	6.5	38	19.5	Do.
99570	do	7	37.6	18.5	Do.
302843	do	6.4	32.7	17.5	Do.
302843	do	6.3	32.6	17.7	Do.
.....	Webb	7	43.5	20.4	Palawan.
.....	do	7	38.3	19	Do.

EXPLANATION OF PLATES.

Plate 1.

Fig. 1. *Amphidromus maculiferus cotabatensis* Bartsch.
2. *Amphidromus maculiferus boholensis* Bartsch.
3. *Amphidromus inflatus* Fulton.
4. *Amphidromus chloris* Reeve.
5. *Amphidromus suluensis* Bartsch.
6. *Amphidromus entobaptus culionensis* Bartsch.
7. *Amphidromus quadrasi versicolor* Fulton.
8. *Amphidromus quadrasi solidus* Fulton.
9. *Amphidromus quadrasi solidus* Fulton.
10. *Amphidromus quadrasi dubius* Fulton.
11. *Amphidromus quadrasi quadrasi* Hidalgo.
12. *Amphidromus quadrasi solidus* Fulton.
13. *Amphidromus quadrasi solidus* Fulton.
14. *Amphidromus quadrasi solidus* Fulton.
15. *Amphidromus quadrasi palawanensis* Bartsch.

Plate 2.

Fig. 1. *Amphidromus maculiferus maculiferus* Sowerby, Camp Overton, Mindanao, Cat. No. 244668, U.S.N.M.
2. *Amphidromus maculiferus maculiferus* Sowerby, Camp Pantar, Mindanao, Cat. No. 24467, U.S.N.M.
3. *Amphidromus maculiferus maculiferus* Sowerby, Camp Overton, Mindanao, Cat. No. 244668, U.S.N.M.
4. *Amphidromus maculiferus maculiferus* Sowerby, Philippine Islands, Cat. No. 99567, U.S.N.M.
5. *Amphidromus maculiferus maculiferus* Sowerby, Camp Overton, Mindanao, Cat. No. 244669, U.S.N.M.

Plate 3.

Fig. 1. *Amphidromus maculiferus cataganensis* Bartsch, Mt. Malindang, Mindanao, Cat. No. 244672, U.S.N.M.
2. *Amphidromus maculiferus cataganensis* Bartsch, Mt. Malindang, Mindanao, Cat. No. 244672, U.S.N.M.
3. *Amphidromus maculiferus cataganensis* Bartsch, Mindanao, Cat. No. 244274, U.S.N.M.
4. *Amphidromus maculiferus cataganensis* Bartsch, Mt. Malindang, Mindanao, Cat. No. 244673, U.S.N.M.
5. *Amphidromus maculiferus cataganensis* Bartsch, Mt. Malindang, Mindanao, Cat. No. 244673, type.

Plate 4.

Fig. 1. *Amphidromus maculiferus cotabatensis* Bartsch, Cotabato, Mindanao, Cat. No. 244676, U.S.N.M.
2. *Amphidromus maculiferus cotabatensis* Bartsch, Cotabato, Mindanao, Cat. No. 244676, U.S.N.M.
3. *Amphidromus maculiferus cotabatensis* Bartsch, Cotabato, Mindanao, Cat. No. 244678, U.S.N.M.
4. *Amphidromus maculiferus cotabatensis* Bartsch, Cotabato, Mindanao, Cat. No. 244677, U.S.N.M.
5. *Amphidromus maculiferus cotabatensis* Bartsch, Cotabato, Mindanao, Cat. No. 244677, U.S.N.M.
6. *Amphidromus maculiferus cotabatensis* Bartsch, Cotabato, Mindanao, Cat. No. 184564, U.S.N.M.
7. *Amphidromus maculiferus cotabatensis* Bartsch, Cotabato, Mindanao, Cat. No. 244676, U.S.N.M.
8. *Amphidromus maculiferus cotabatensis* Bartsch, Cotabato, Mindanao, Cat. No. 244676, U.S.N.M., type.

Plate 5.

Fig. 1. *Amphidromus maculiferus buluanensis* Bartsch, near Lake Buluan, Mindanao, Cat. No. 244687, U.S.N.M.
2. *Amphidromus maculiferus buluanensis* Bartsch, Buluan to Simpitan, Mindanao, Cat. No. 244688, U.S.N.M.
3. *Amphidromus maculiferus buluanensis* Bartsch, Buluan to Simpitan, Mindanao, Cat. No. 244686, U.S.N.M.
4. *Amphidromus maculiferus buluanensis* Bartsch, Buluan to Simpitan, Mindanao, Cat. No. 244688, U.S.N.M., type.
5. *Amphidromus maculiferus buluanensis* Bartsch, Buluan to Simpitan, Mindanao, Cat. No. 244688, U.S.N.M.
6. *Amphidromus maculiferus buluanensis* Bartsch, Buluan to Simpitan, Mindanao, Cat. No. 244686, U.S.N.M.

Plate 6.

Fig. 1. *Amphidromus maculiferus strigatus* Möllendorff, Davao, Mindanao, Cat. No. 195849, U.S.N.M.
2. *Amphidromus maculiferus strigatus* Möllendorff, Davao, Mindanao, Cat. No. 195849, U.S.N.M.

FIG. 3. *Amphidromus maculiferus strigatus* Möllendorff, Davao, Mindanao, Cat. No. 184565, U.S.N.M.

4. *Amphidromus maculiferus strigatus* Möllendorff, Davao, Mindanao, Cat. No. 184565, U.S.N.M.

5. *Amphidromus maculiferus strigatus* Möllendorff, Mindanao, Cat. No. 185849, U.S.N.M.

PLATE 7.

FIG. 1. *Amphidromus maculiferus boholensis* Bartsch, Sevilla, Bohol, Cat. No. 245563, U.S.N.M.

2. *Amphidromus maculiferus boholensis* Bartsch, Sevilla, Bohol, Cat. No. 245563, U.S.N.M.

3. *Amphidromus maculiferus boholensis* Bartsch, Sevilla, Bohol, Cat. No. 245563, U.S.N.M., type.

4. *Amphidromus maculiferus samarensis* Bartsch, Samar, Cat. No. 215579, U.S.N.M., type.

5. *Amphidromus maculiferus gracilior* Fulton, Mainit, Mindanao, Chicago Acad. Sci.

6. *Amphidromus maculiferus gracilior* Fulton (no specific locality), Mindanao, Cat. No. 184566, U.S.N.M.

PLATE 8.

FIG. 1. *Amphidromus maculiferus multicolor* Möllendorff, Matalon, Leyte, Chicago Academy Sciences.

2. *Amphidromus maculiferus multicolor* Möllendorff, Maasin Leyte, Chicago Academy Sciences.

3. *Amphidromus floresi* Bartsch, Mindanao, Cat. No. 215580, U.S.N.M., type.

4. *Amphidromus maculiferus multicolor* Möllendorff, Leyte, Cat. No. 184562, U.S.N.M.

5. *Amphidromus maculiferus multicolor* Möllendorff, Bato, Leyte, Webb Coll.

PLATE 9.

FIG. 1. *Amphidromus malindangensis* Bartsch, Mount Malindang, Mindanao, Cat. No. 244689, U.S.N.M.

2. *Amphidromus malindangensis* Bartsch, Mount Malindang, Mindanao, Cat. No. 244689, U.S.N.M., type.

3. *Amphidromus basilanensis* Basilan Island, Cat. No. 244691, U.S.N.M., type.

4. *Amphidromus maculiferus cosmius* Bartsch, Basilan Island, Cat. No. 245562, U.S.N.M., type.

5. *Amphidromus apoensis* Bartsch, Mount Apo, Mindanao, Cat. No. 244690, U.S.N.M., type.

6. *Amphidromus apoensis* Bartsch, Mount Apo, Mindanao, Cat. No. 244690, U.S.N.M.

PLATE 10.

FIG. 1. *Amphidromus mearnsi* Bartsch, Basilan, Cat. No. 245566, U.S.N.M.

2. *Amphidromus mearnsi* Bartsch, Basilan, Cat. No. 245565, U.S.N.M. type.

3. *Amphidromus pallidulus* Pilsbry, Zamboanga, Mindanao, Cat. No. 106459, Phila. Acad. Nat. Sci., cotype.

4. *Amphidromus bilatanensis* Bartsch, Bilatan Island. British Museum, type.

FIG. 5. *Amphidromus bilatanensis* Bartsch, Bilatan Island, British Museum, type.
6. *Amphidromus inflatus* Fulton, Philippine Islands, Cat. No. 99568, U.S.N.M.
7. *Amphidromus inflatus* Fulton, Philippine Islands, Cat. No. 99568, U.S.N.M.
8. *Amphidromus pallidulus* Pilsbry, Zamboanga, Mindanao, Cat. No. 106459, Phila. Acad. Nat. Sci., cotype.

PLATE 11.

FIG. 1. *Amphidromus calista* Pilsbry, Basilan, Cat. No. 106458, Phila. Acad. Nat. Sci., cotype.
2. *Amphidromus calista* Pilsbry, Basilan, Cat. No. 106458, Phila. Acad. Nat. Sci., cotype.
3. *Amphidromus calista* Pilsbry, Basilan, Cat. No. 106458, Phila. Acad. Nat. Sci., cotype.
4. *Amphidromus hidalgoi* Bartsch, Dapitan, Mindanao, type. Hidalgo collection.
5. *Amphidromus suluensis* Bartsch, Islands of the Sulu Sea, Cat. No. 99564, U.S.N.M.
6. *Amphidromus hidalgoi* Bartsch, Dapitan, Mindanao, type. Hidalgo collection.
7. *Amphidromus suluensis* Bartsch, Islands of the Sulu Sea, Cat. No. 99564, U.S.N.M.
8. *Amphidromus suluensis* Bartsch, Islands of the Sulu Sea, Cat. No. 99565, type.
9. *Amphidromus suluensis* Bartsch, Islands of the Sulu Sea, Cat. No. 99565.

PLATE 12.

FIG. 1. *Amphidromus chloris* Reeve, Talantalan, Zamboanga, Mindanao, Cat. No. 215641, U.S.N.M.
2. *Amphidromus chloris* Reeve, Talantalan, Zamboanga, Mindanao, Cat. No. 215641, U.S.N.M.
3. *Amphidromus chloris* Reeve, Talantalan, Zamboanga, Mindanao, Cat. No. 215641, U.S.N.M.
4. *Amphidromus chloris* Reeve, Talantalan, Zamboanga, Mindanao, Cat. No. 215641, U.S.N.M.
5. *Amphidromus chloris* Reeve, Talantalan, Zamboanga, Mindanao, Cat. No. 215641, U.S.N.M.
6. *Amphidromus chloris* Reeve, Talantalan, Zamboanga, Mindanao, Cat. No. 215641, U.S.N.M.
7. *Amphidromus suluensis* Bartsch, Islands of the Sulu Sea, Cat. No. 99565, U.S.N.M.
8. *Amphidromus chloris* Reeve, Talantalan, Zamboanga, Mindanao, Cat. No. 215641, U.S.N.M.
9. *Amphidromus suluensis* Bartsch, Islands of the Sulu Sea, Cat. No. 99564, U.S.N.M.

PLATE 13.

FIG. 1. *Amphidromus roeseleri* Möllendorff, Jolo Island, Cat. No. 215576, U.S.N.M.
2. *Amphidromus roeseleri* Möllendorff, Jolo Island, Cat. No. 215576, U.S.N.M.
3. *Amphidromus roeseleri* Möllendorff, Jolo Island, Cat. No. 215576, U.S.N.M.
4. *Amphidromus entobaptus* Dohrn, Puerto Princesa, Palawan, Cat. No. 254917, U.S.N.M.

FIG. 5. *Amphidromus entobaptus* Dohrn, Puerto Princesa, Palawan, Cat. No. 254917, U.S.N.M.

6. *Amphidromus entobaptus* Dohrn, Puerto Princesa, Palawan, Cat. No. 254917, U.S.N.M.

7. *Amphidromus entobaptus* Dohrn, Puerto Princesa, Palawan, Cat. No. 254917, U.S.N.M.

8. *Amphidromus entobaptus* Dohrn, Puerto Princesa, Palawan, Cat. No. 254917, U.S.N.M.

9. *Amphidromus entobaptus* Dohrn, Puerto Princesa, Palawan, Cat. No. 254917, U.S.N.M.

PLATE 14.

FIG. 1. *Amphidromus entobaptus viridoflavus* Bartsch, Malubutglubut Island, Cat. No. 215600, U.S.N.M.

2. *Amphidromus entobaptus viridoflavus* Bartsch, Malubutglubut Island, Cat. No. 215600, U.S.N.M.

3. *Amphidromus entobaptus viridoflavus* Bartsch, Malubutglubut Island, Cat. No. 215600, U.S.N.M., type.

4. *Amphidromus entobaptus culionensis* Bartsch, Culion Island, Cat. No. 215642, U.S.N.M.

5. *Amphidromus entobaptus culionensis* Bartsch, Culion Island, Cat. No. 215642, U.S.N.M.

6. *Amphidromus entobaptus culionensis* Bartsch, Culion Island, Cat. No. 215642, U.S.N.M.

7. *Amphidromus entobaptus culionensis* Bartsch, Culion Island, Cat. No. 215642, U.S.N.M.

8. *Amphidromus entobaptus culionensis* Bartsch, Culion Island, Cat. No. 215642, U.S.N.M., type.

9. *Amphidromus entobaptus culionensis* Bartsch, Culion Island, Cat. No. 215642, U.S.N.M.

PLATE 15.

FIG. 1. *Amphidromus entobaptus culionensis* Bartsch, Culion Island, Cat. No. 215642, U.S.N.M.

2. *Amphidromus entobaptus culionensis* Bartsch, Culion Island, Cat. No. 215642, U.S.N.M.

3. *Amphidromus entobaptus culionensis* Bartsch, Culion Island, Cat. No. 215642, U.S.N.M.

4. *Amphidromus mindorocnsis* Bartsch, Mindoro, Cat. No. 245564, U.S.N.M., type.

5. *Amphidromus mindoroensis* Bartsch, Mindoro, Cat. No. 245564, U.S.N.M., type.

6. *Amphidromus entobaptus coronensis* Bartsch, Coron Island, Cat. No. 195848*a*, U.S.N.M.

7. *Amphidromus entobaptus coronensis* Bartsch, Coron Island, Cat. No. 195848*a*, U.S.N.M., type.

8. *Amphidromus entobaptus coronensis* Bartsch, Coron Island, Cat. No. 195848*a*, U.S.N.M.

PLATE 16.

FIG. 1. *Amphidromus entobaptus linapacensis* Bartsch, Linapacan Island, Cat. No. 215599, U.S.N.M.

2. *Amphidromus entobaptus linapacensis* Bartsch, Linapacan Island, Cat. No. 215599, U.S.N.M., type.

Fig. 3. *Amphidromus entobaptus linapacensis* Bartsch, Linapacan Island, Cat. No. 215599, U.S.N.M.

4. *Amphidromus entobaptus busuangensis* Bartsch, Malbato, Busuanga, Cat. No. 215643, U.S.N.M.

5. *Amphidromus entobaptus busuangensis* Bartsch, Malbato, Busuanga, Webb Collection.

6. *Amphidromus entobaptus busuangensis* Bartsch, Malbato, Busuanga, Webb Collection.

7. *Amphidromus entobaptus busuangensis* Bartsch, Malbato, Busuanga, Cat. No. 215643, U.S.N.M., type.

8. *Amphidromus entobaptus busuangensis* Bartsch, Malbato, Busuanga, Webb Collection.

9. *Amphidromus entobaptus busuangensis* Bartsch, Malbato, Busuanga, Webb Collection.

Plate 17.

Fig. 1. *Amphidromus quadrasi quadrasi* Hidalgo, Balabac Island, Webb Collection.

2. *Amphidromus quadrasi quadrasi* Hidalgo, Candaraman Island, Cat. No. 215605, U.S.N.M.

3. *Amphidromus quadrasi quadrasi* Hidalgo, Balabac Island, Cat. No. 66188, Phila. Acad. Nat. Sci.

4. *Amphidromus quadrasi quadrasi* Hidalgo, Caxisigan Island, Cat. No. 215603, U.S.N.M.

5. *Amphidromus quadrasi quadrasi* Hidalgo, Caxisigan Island, Cat. No. 215603, U.S.N.M.

6. *Amphidromus quadrasi quadrasi* Hidalgo, Candaraman Island, Cat. No. 215605, U.S.N.M.

7. *Amphidromus quadrasi quadrasi* Hidalgo, Candaraman Island, Cat. No. 215605, U.S.N.M.

8. *Amphidromus quadrasi quadrasi* Hidalgo, Candaraman Island, Cat. No. 215605, U.S.N.M.

9. *Amphidromus quadrasi quadrasi* Hidalgo, Caxisigan Island, Cat. No. 215603, U.S.N.M.

10. *Amphidromus quadrasi quadrasi* Hidalgo, Candaraman Island, Cat. No. 215605, U.S.N.M.

11. *Amphidromus quadrasi quadrasi* Hidalgo, Balabac Island, Webb Collection.

Plate 18.

Fig. 1. *Amphidromus quadrasi versicolor* Fulton, Balabac, Cat. No. 79483, Phila. Acad. Nat. Sci.

2. *Amphidromus quadrasi versicolor* Fulton, Balabac, Cat. No. 98852, Phila. Acad. Nat. Sci.

3. *Amphidromus quadrasi versicolor* Fulton, Webb Collection.

4. *Amphidromus quadrasi versicolor* Fulton, Balabac, Cat. No. 95152, Phila. Acad. Nat. Sci.

5. *Amphidromus quadrasi versicolor* Fulton, Webb Collection.

6. *Amphidromus quadrasi versicolor* Fulton, Cat. No. 79483, Phila. Acad. Nat. Sci.

7. *Amphidromus quadrasi versicolor* Fulton, Cat. No. 98852, Phila. Acad. Nat. Sci.

FIG. 8. *Amphidromus quadrasi versicolor* Fulton, Cat. No. 79483, Phila. Acad. Nat. Sci.
9. *Amphidromus quadrasi versicolor* Fulton, Cat. No. 95172, Phila. Acad. Nat. Sci.
10. *Amphidromus quadrasi versicolor* Fulton, Cat. No. 95173, Phila. Acad. Nat. Sci.

PLATE 19.

FIG. 1. *Amphidromus quadrasi solidus* Fulton, Balabac, Cat. No. 98851, Phila, Acad. Nat. Sci.
2. *Amphidromus quadrasi dubius* Fulton, Balabac, Cat. No. 79480, Phila. Acad. Nat. Sci.
3. *Amphidromus quadrasi solidus* Fulton, Balabac, Cat. No. 98851, Phila. Acad. Nat. Sci.
4. *Amphidromus quadrasi dubius* Fulton, Balabac, Cat. No. 79480, Phila. Acad. Nat. Sci.
5. *Amphidromus quadrasi dubius* Fulton, Balabac, Cat. No. 79480, Phila. Acad. Nat. Sci.
6. *Amphidromus quadrasi dubius* Fulton, Balabac, Webb Collection.
7. *Amphidromus quadrasi solidus* Fulton, Balabac, Cat. No. 79483, Phila. Acad. Nat. Sci.
8. *Amphidromus quadrasi dubius* Fulton, Balabac, Chicago Acad. Sci.
9. *Amphidromus quadrasi dubius* Fulton, Palawan, Cat. No. 79485, Phila. Acad. Nat. Sci.

PLATE 20.

FIG. 1. *Amphidromus quadrasi palawanensis* Bartsch, Palawan, Cat. No. 302843, U.S.N.M.
2. *Amphidromus quadrasi dubius* Fulton, Palawan, Cat. No. 79485, Phila. Acad. Nat. Sci.
3. *Amphidromus quadrasi solidus* Fulton, Balabac, Cat. No. 98853, Phila. Acad. Nat. Sci.
4. *Amphidromus quadrasi palawanensis* Fulton, Palawan Passage, Cat. No. 99570, U.S.N.M.
5. *Amphidromus quadrasi solidus* Fulton, Balabac Island, Cat. No. 302844*a*, U.S.N.M.
6. *Amphidromus quadrasi palawanensis* Fulton, Palawan, Webb Collection.
7. *Amphidromus quadrasi palawanensis* Fulton, Palawan Passage, Cat. No. 99570, U.S.N.M.
8. *Amphidromus quadrasi palawanensis* Fulton, Palawan Passage, Cat. No. 99570, U.S.N.M.
9. *Amphidromus quadrasi palawanensis* Fulton, Palawan, Webb Collection.

PLATE 21.

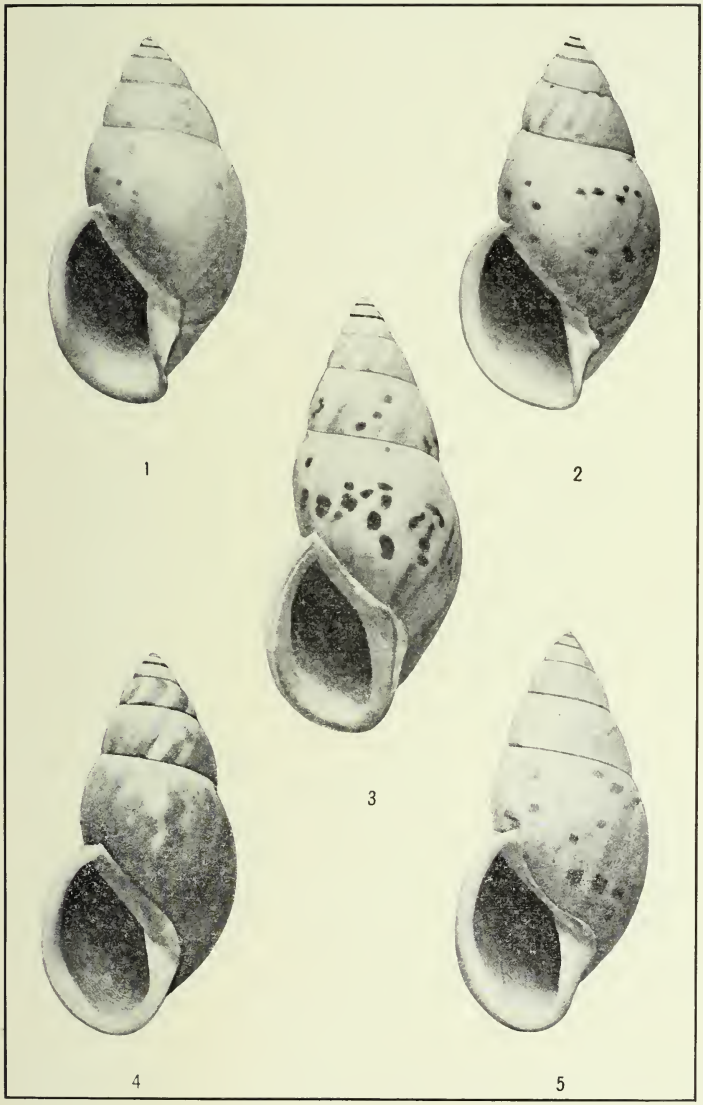
Relief map showing the distribution of the *Amphidromus maculiferus* group, numbers 1 to 16, and *Amphidromus hidalgoi*, number 21.

1. *maculiferus.*
2. *cataganensis.*
3. *cotabatensis.*
4. *buluanensis.*
5. *strigatus.*
6. *gracilior.*
7. *boholensis.*
8. *multicolor.*
9. *samarensis.*
10. (?).
11. (?).
12. *cosmius.*
13. *malindangensis.*
14. *apoensis.*
15. *basilanensis.*
16. *floresi.*

PLATE 22.

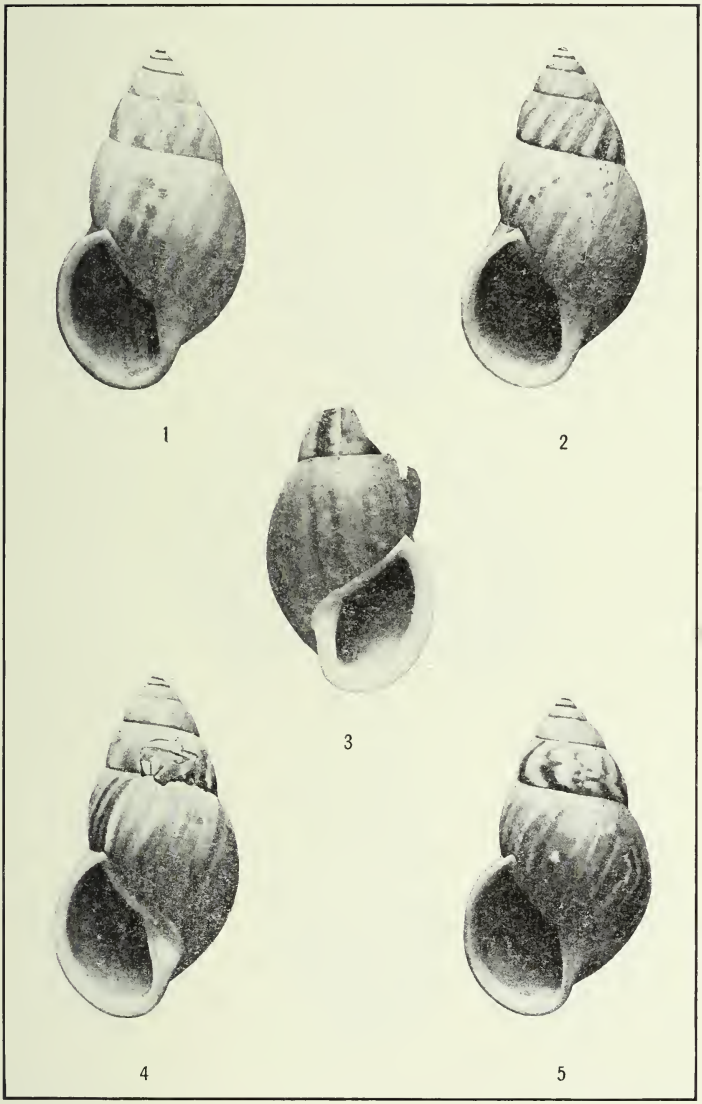
Relief map showing the distribution of the group of *Amphidromus inflatus*, numbers 17–22; the group of *Amphidromus chloris*, numbers 23–25; the group of *Amphidromus entobaptus*, numbers 27–33; and the group of *Amphidromus quadrasi*, numbers 34–38:

17. *inflatus*.
18. *mearnsi*.
19. *pallidulus*.
20. *bilatanensis*.
21. *hidalgoi*.
22. *calista*.
23. *chloris* .
24. *roeseleri*.
25. *suluensis*.
26. species (?).
27. *entobaptus*.
28. *viridoflavus*.
29. *linapacensis*.
30. *culionensis*.
31. *coronensis*.
32. *busuangensis*.
33. *mindoroensis*.
34. *quadrasi*.
35. *versicolor*.
36. *solidus*.
37. *dubius*.
38. *palawanensis*.



PHILIPPINE AMPHIDROMUS.

FOR EXPLANATION OF PLATE SEE PAGE 40.



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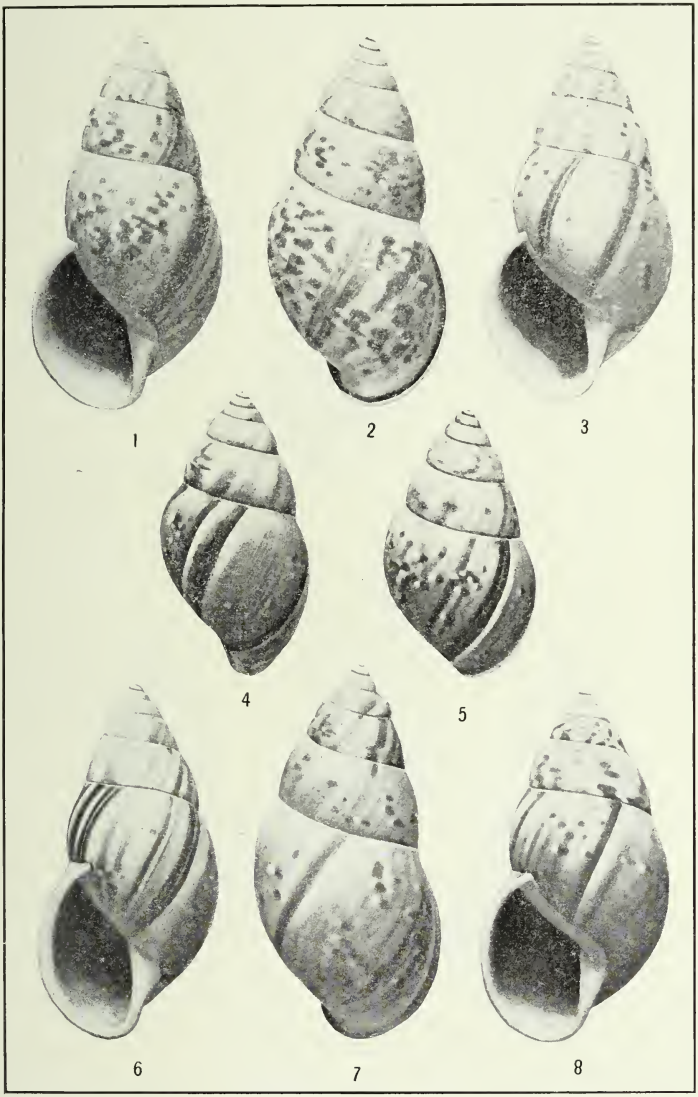

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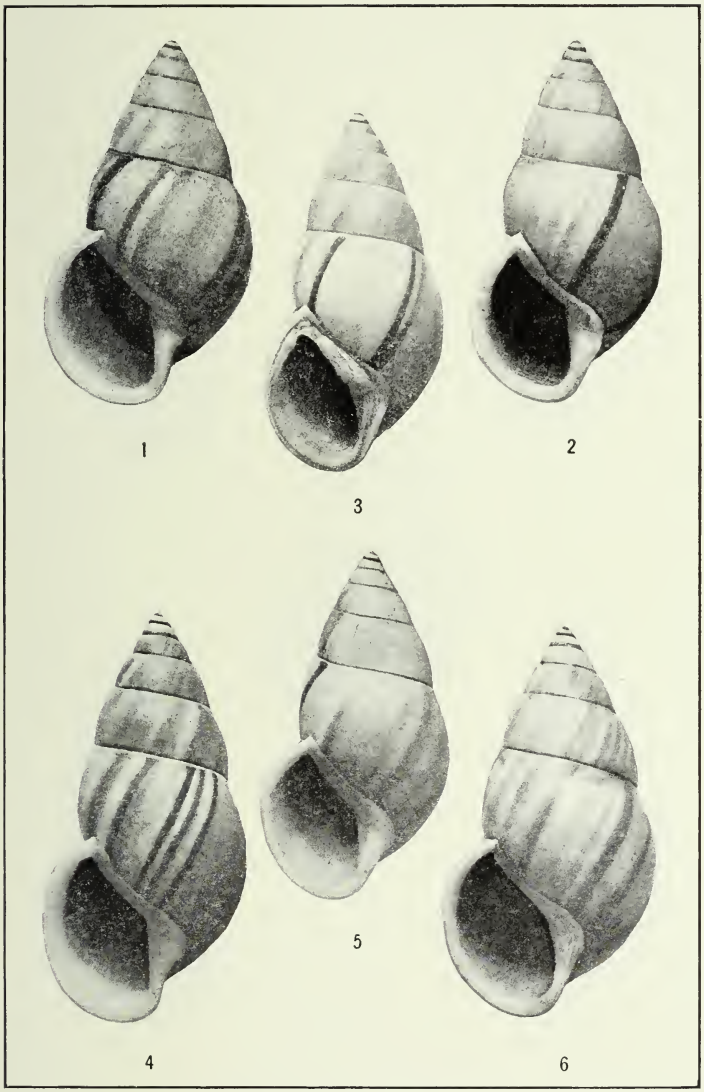

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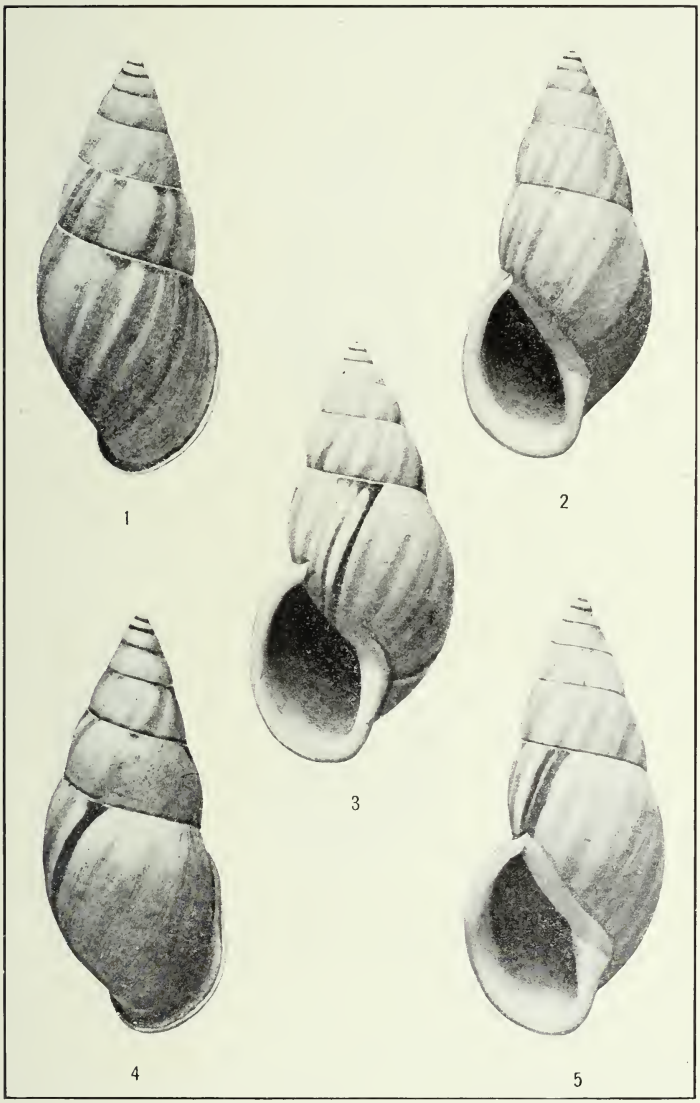

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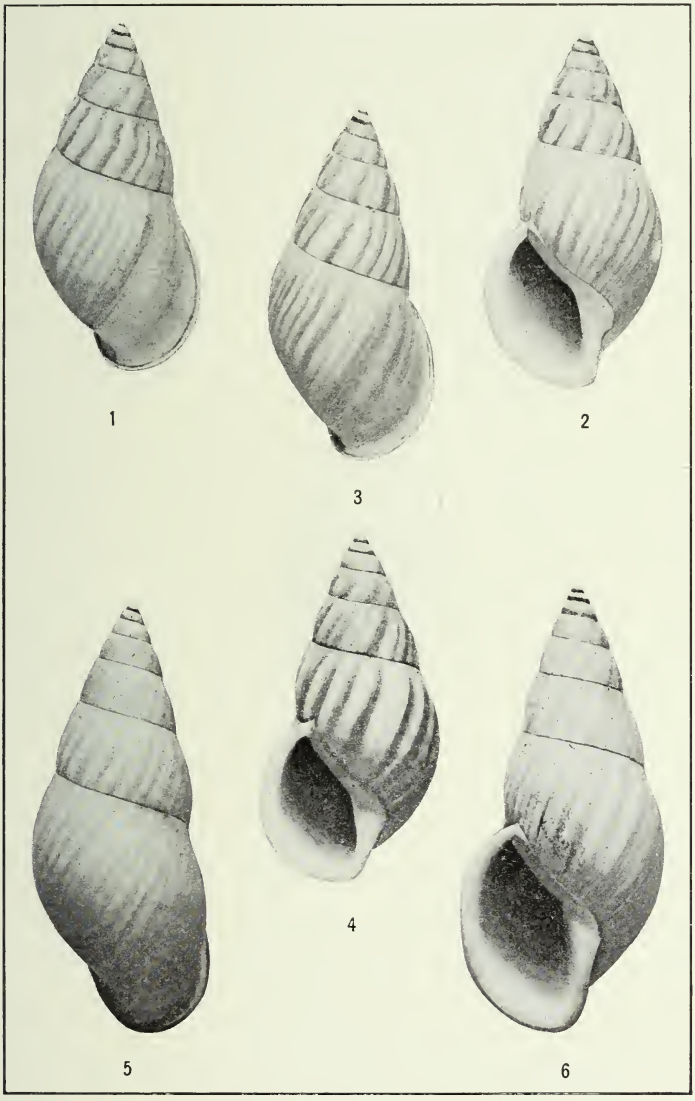

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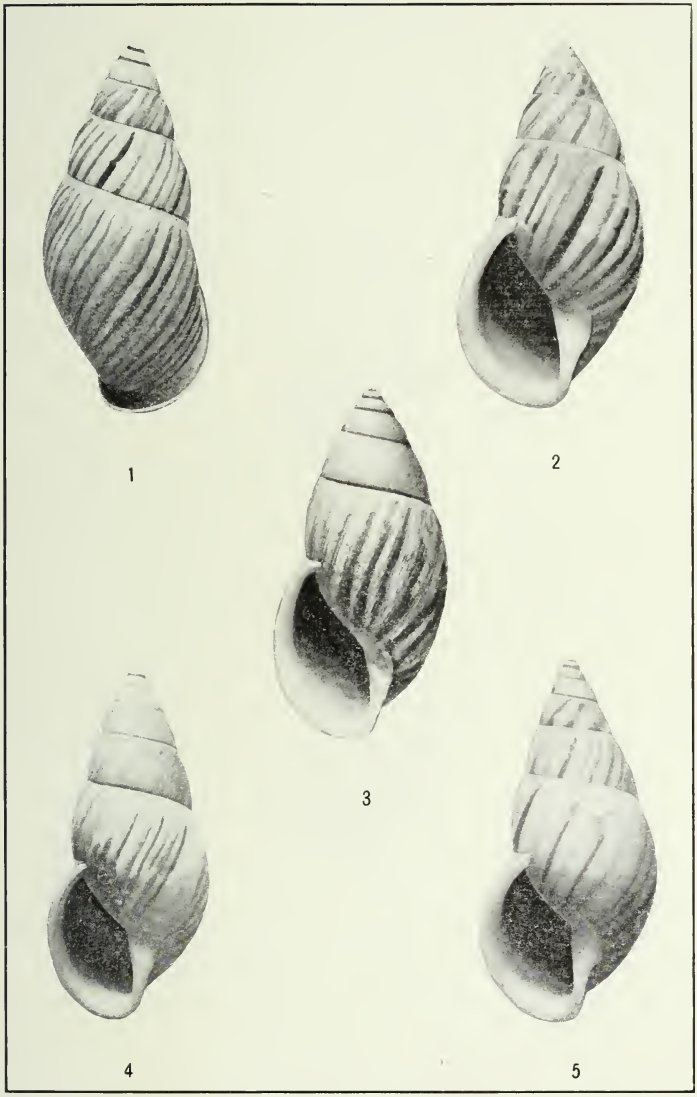

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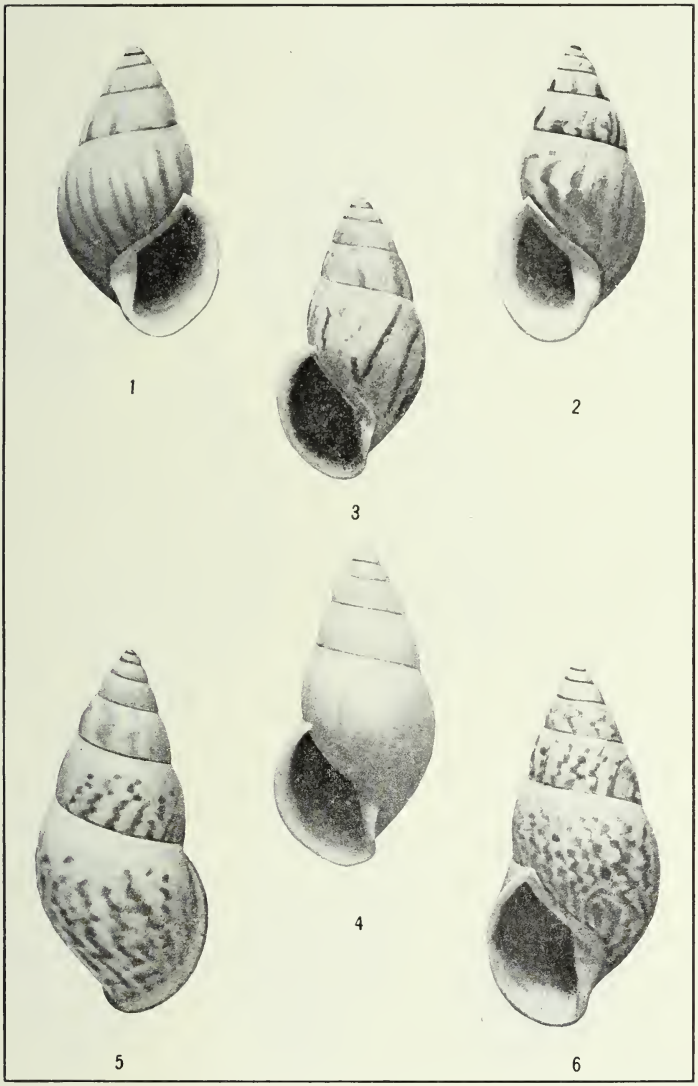

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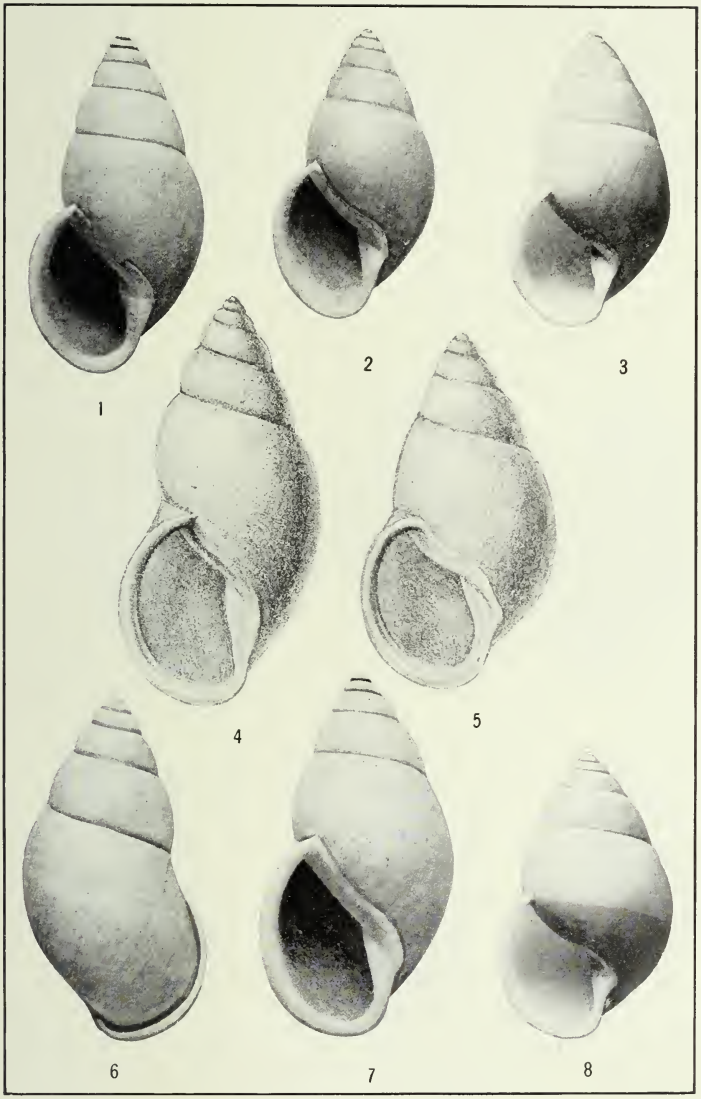

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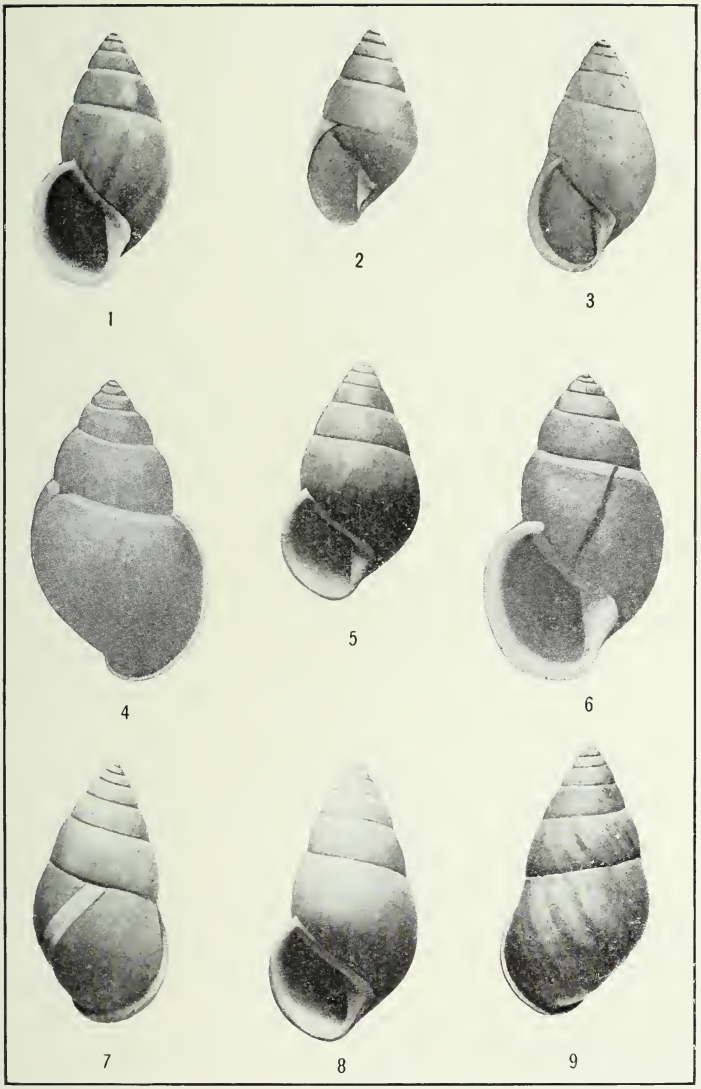

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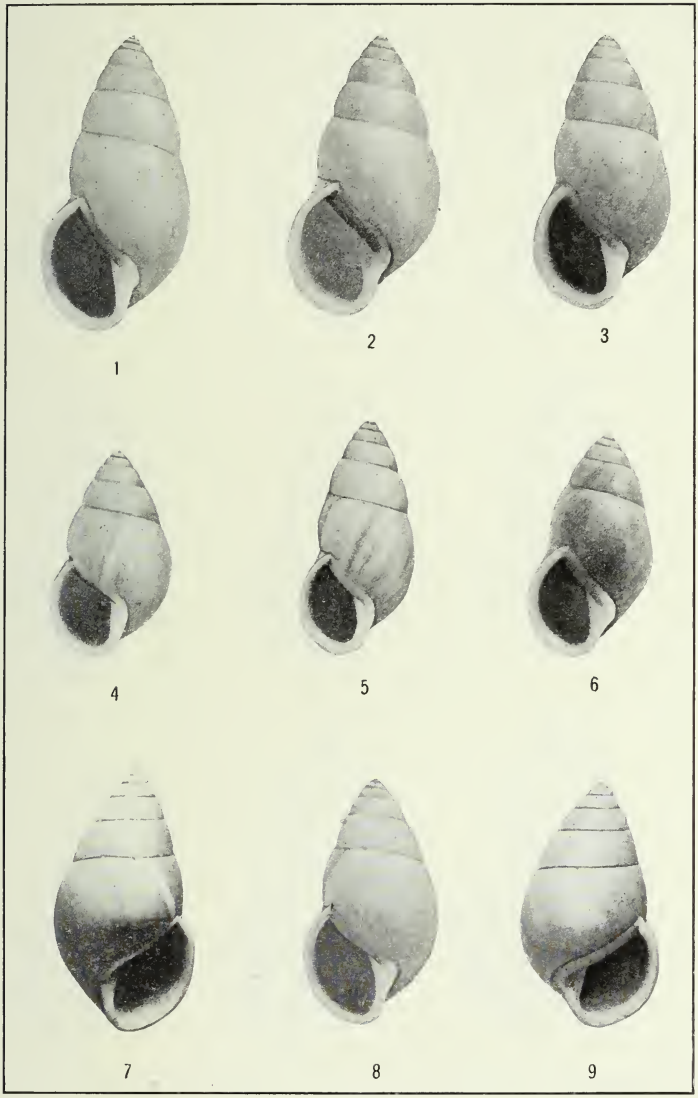

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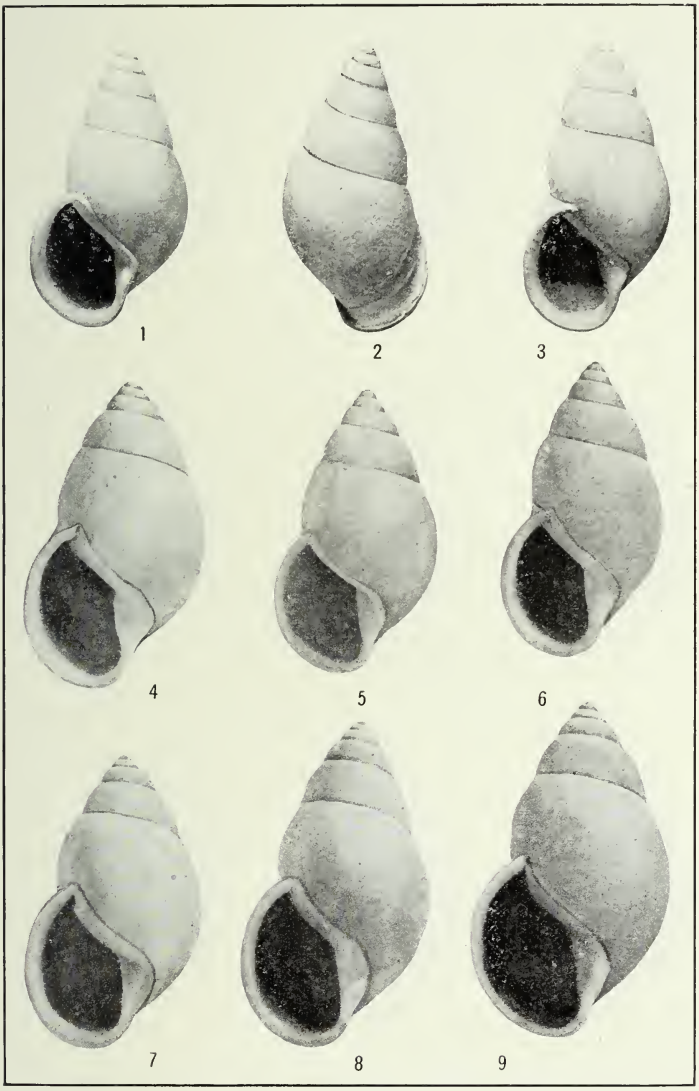

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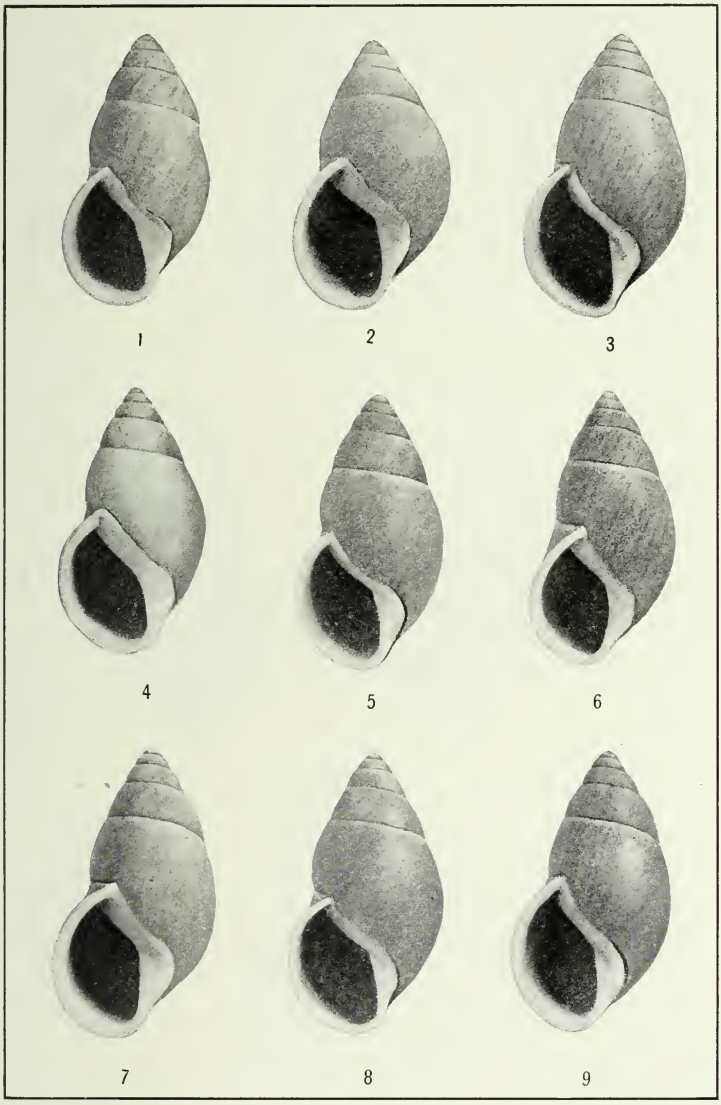
FOR EXPLANATION OF PLATE SEE PAGES 43 AND 44.



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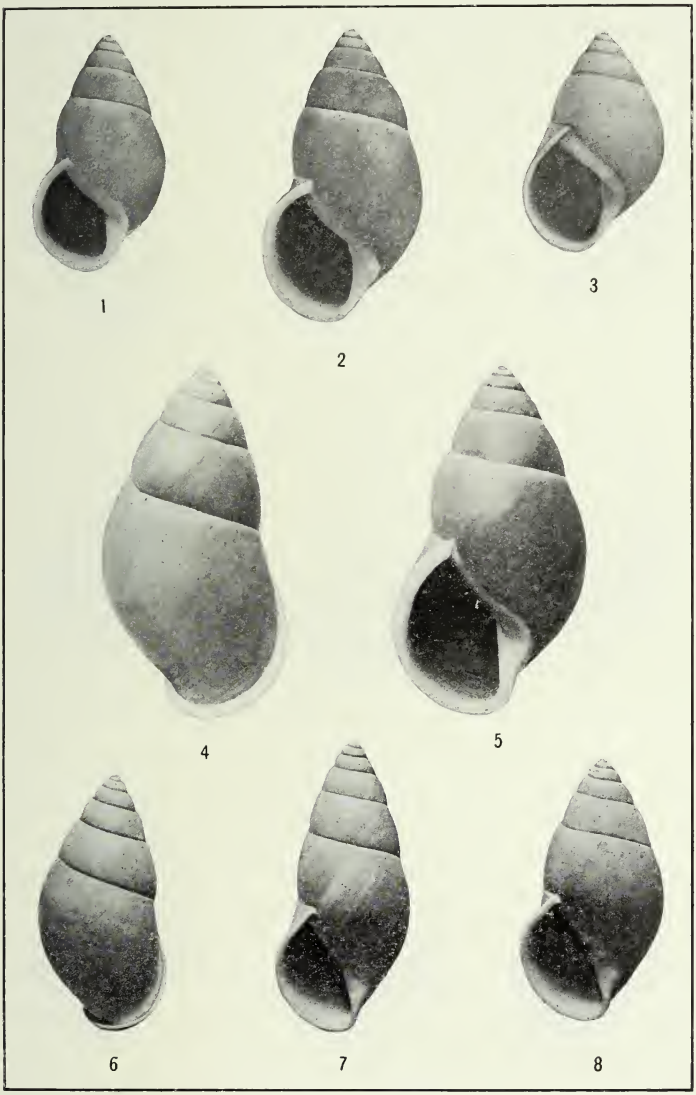

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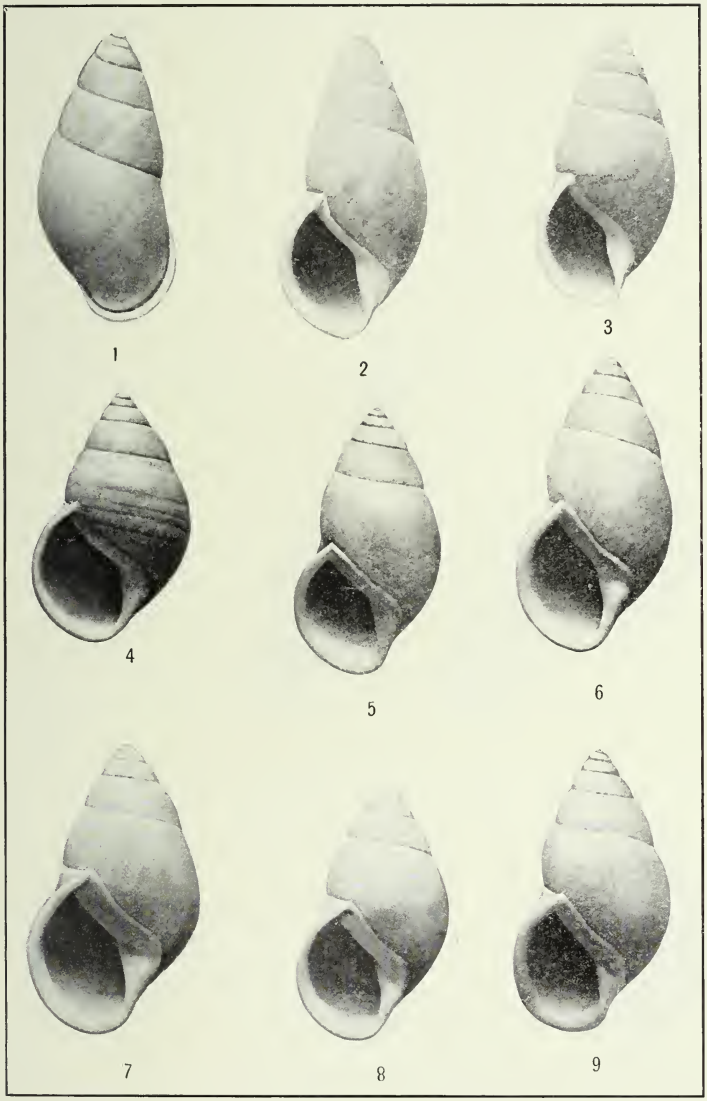
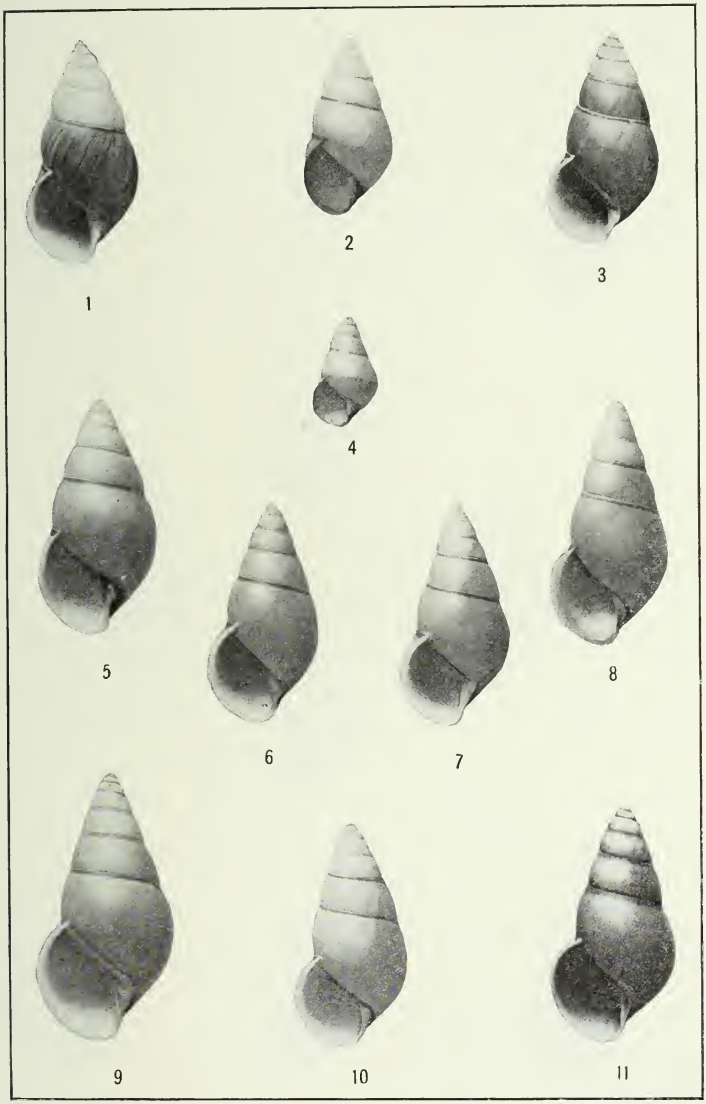


PHILIPPINE AMPHIDROMUS.

FOR EXPLANATION OF PLATE SEE PAGES 44 AND 45



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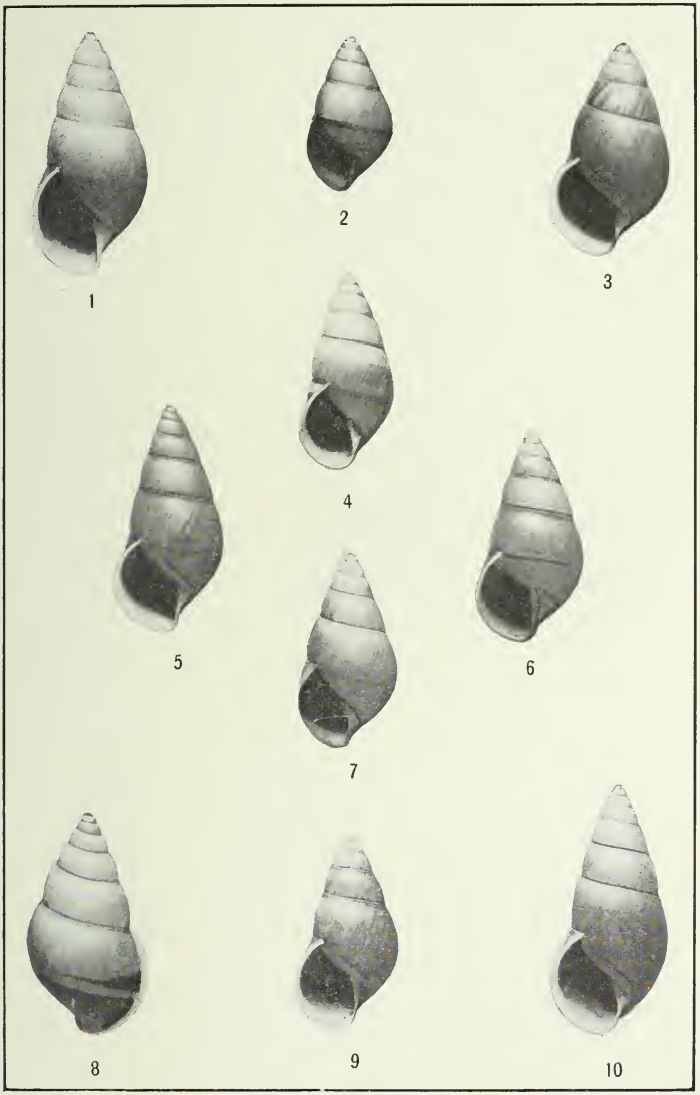
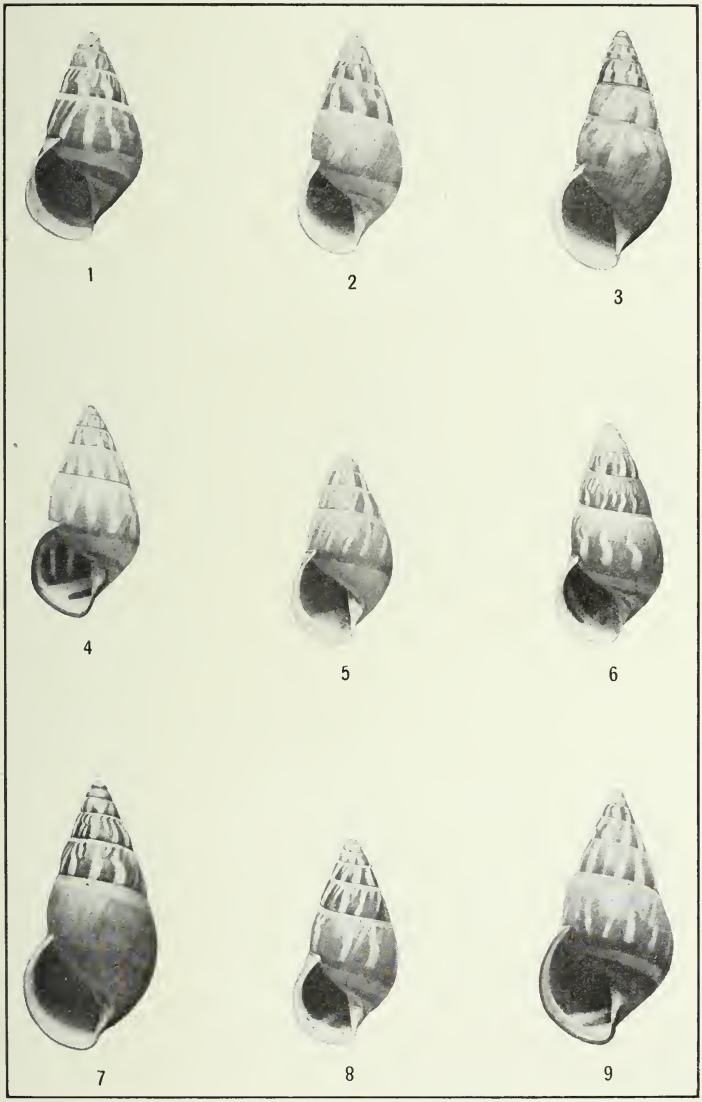


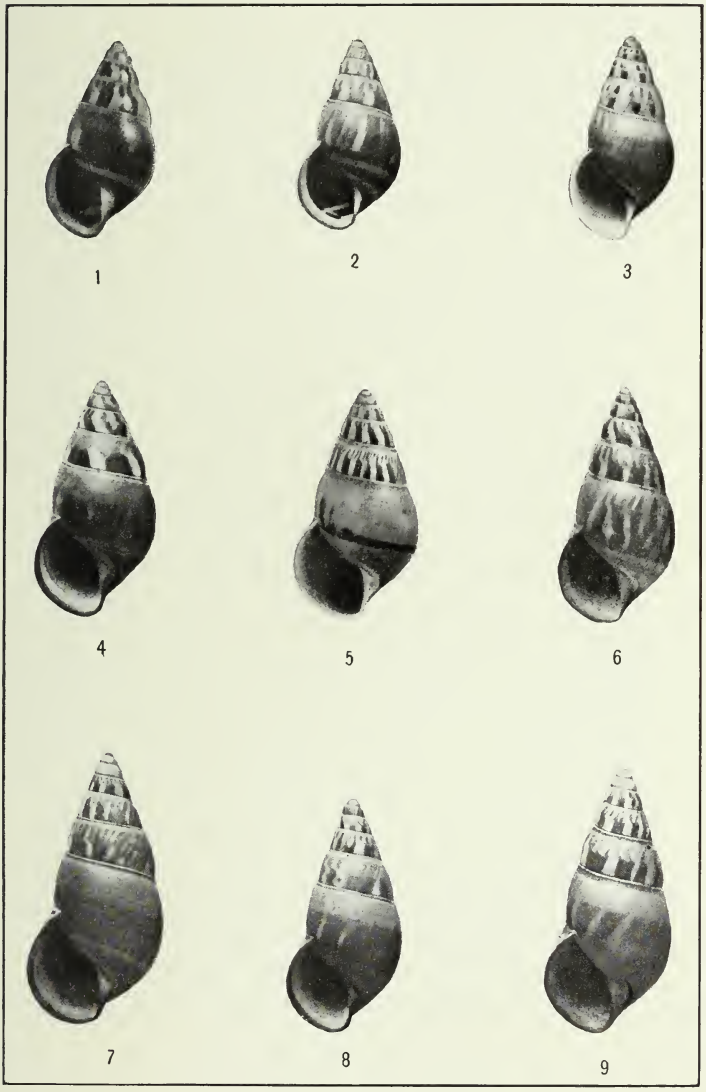
PHILIPPINE AMPHIDROMUS.

FOR EXPLANATION OF PLATE SEE PAGES 45 AND 46



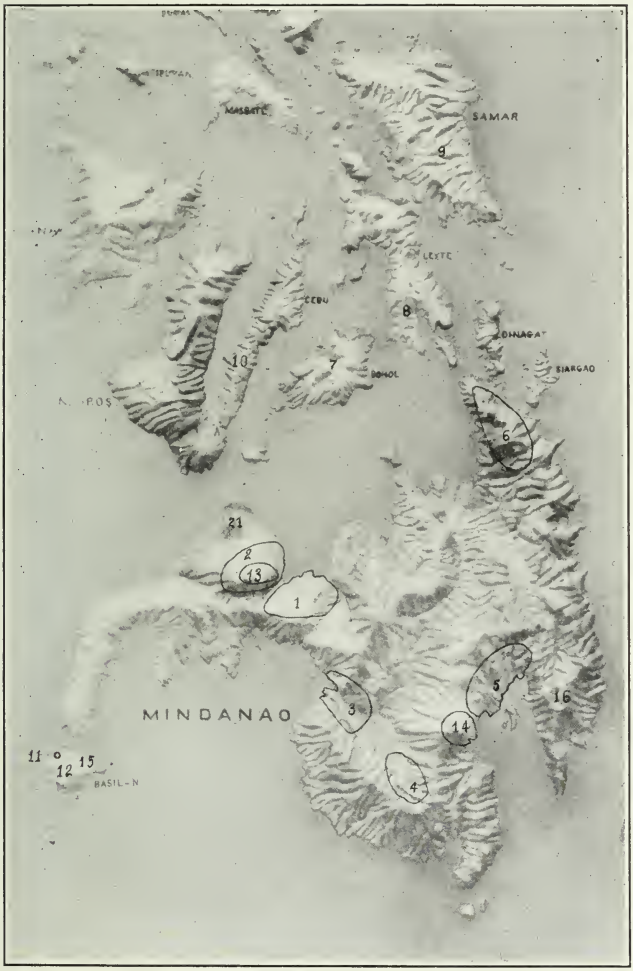
PHILIPPINE AMPHIDROMUS.

FOR EXPLANATION OF PLATE SEE PAGE 46.



PHILIPPINE AMPHIDROMUS.

FOR EXPLANATION OF PLATE SEE PAGE 46.



PHILIPPINE AMPHIDROMUS.

FOR EXPLANATION OF PLATE SEE PAGE 46

PHILIPPINE AMPHIDROMUS.

FOR EXPLANATION OF PLATE SEE PAGE 47.

THE PHILIPPINE MOLLUSKS OF THE GENUS DIMYA

[SCIENTIFIC RESULTS OF THE PHILIPPINE CRUISE OF THE FISHERIES STEAMER "ALBATROSS," 1907–1910.—No. 27]

BY

PAUL BARTSCH

Assistant Curator, Division of Mollusks, United States National Museum

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No. 1983.—From the Proceedings of the United States National Museum, Vol. 45, pages 305–307, with Plates 27–28.

Published June 13, 1913

Washington
Government Printing Office
1913

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THE PHILIPPINE MOLLUSKS OF THE GENUS DIMYA.

By Paul Bartsch,

Assistant Curator, Division of Mollusks, United States National Museum.

During the cruise of the United States Fisheries steamer *Albatross* in the Philippines a number of mollusks belonging to the genus *Dimya* were obtained at several of the deep-sea stations which are here described.

Most of the known members of this genus are fossils, only two having been described as now existing species. These are *Dimya argentea* Dall[1] from the West Indies and *Dimya corrugata* Hedley[2] dredged off New South Wales.

To these two additional species are now added.

DIMYA FILIPINA, new species.

Plate 28, figs. 1–4.

Shell heavy, inequivalve, of variable outline, depending upon the nature of the support to which the basal valve is attached. Outside of upper valve brown, marked by strong closely spaced overlapping concentric laminations which are free at their edges. These laminations are present on the prodissoconch and increase steadily in size from this to the edge of the adult shell. Radiating sculpture entirely wanting. In the lower valve which is much stronger than the upper, the laminations assume the form of moderately strong corrugations. In this the external surface is marked with radiating zones of chestnut brown which are about one-third as wide as the light area that separates them. The interior of the shell is pale buff; the material of this color forms a thin layer in the dorsal valve which readily flakes away, exposing a chestnut colored basal layer. Resilium resting in a strongly excavated pit in the dorsal valve, bending under a little shelf

[1] Bull. Mus. Comp. Zoöl., vol. 12, 1886, p. 228. [2] Mem. Austr. Mus. Sydney, vol. 4, 1902, pp. 308–309.

in the ventral valve. On each side of the resilium, bending outward and downward, is the provincular area, which in the ventral valve is lightly raised and transversely feebly notched; in the dorsal it is impressed, bearing slender cross bars. Muscular scars very large. Edge of shell outside of pallial line roughened on the dorsal third.

The type and about 68 loose valves, mostly upper, Cat. No. 246281, U.S.N.M., were dredged at station 5217, in 105 fathoms, off Anima Sola Island (lat. 13° 20′ N.; long. 123° 14′ 15″ E.), on coarse gray sand bottom; bottom temperature, 63.1°; density at bottom, 1.02496. The measurements of the type are as follows: Lower valve, altitude 11 mm., latitude 12 mm.; diameter at ventral edge 5 mm.; dorsal valve, altitude 9 mm., latitude 10 mm., thickness probably 1 mm.

DIMYA LIMA, new species.

Plate 27; Plate 28, figs. 5 and 6.

Shell large but much thinner than *Dimya filipina*, white with a silvery nacreous suffusion. In adult shells the edge beyond the pallial ridge curves up and lends the shell a dished appearance. Lower valve very thin at the point of attachment, where it is quite translucent; the rest of its exterior, excepting the extreme edge, which is hyaline, is milk white and polished, showing fine, irregular lines of growth. The exterior of the upper valve is almost smooth during the early stages, but sculptured with roughened irregular flake-like squamations (not strong laminations as in *filipina*), and a few well incised, irregularly spaced, radiating lines on the latter two thirds. Interior bluish white, the edge outside of the pallial line nacreous. Resilium resting in a small pit, which is partly roofed over by a thin shelf, dorsally, in both valves. Radiating outward and downward on each side of the resiliar pit is the provincular area, which appears in both valves as a transversely roughened ridge, fusing ventrally with the considerably thickened pallial border. The latter is crossed by strongly impressed radiating grooves in the upper valve, that correspond to an equal number of raised threads in the lower valve.

The type and many other specimens were dredged at station 5533, off Balicasag Island (lat. 9° 27′ 15″ N.; long. 123° 31′ 48″ E.), in 432 fathoms, on green mud and sand bottom; bottom temperature 53°.3. All of these were attached to shells of *Lima* (*Callolima*) *smithi* Bartsch. The type, Cat. No. 256977, U.S.N.M., measures: Altitude 13.5 mm., latitude 15.5 mm.

Additional specimens were obtained at the following stations:

On LIMA (CALLOLIMA) SMITHI Bartsch.

Station 5124, off Point Origon (lat. 12° 52′ 00″ N.; long. 121° 48′ 30″ E.), in 281 fathoms, on soft green mud bottom. Cat. No. 256978, U.S.N.M.

On LIMA (CALLOLIMA) DALLI Bartsch.

Station 5135, off Jolo Light (lat. 6° 11′ 50″ N.; long. 121° 08′ 20″ E.), in 161, fathoms on fine coral sand bottom; bottom temperature 57°.4. Cat. No. 254980, U.S.N.M.

Station 5198, off Baliscasag Island (lat. 9° 31′ 50″ N.; long. 123° 39′ 45″ E.), in 220 fathoms, on green mud bottom; bottom temperature 53°.9; density of water at bottom 1.02500. Cat. No. 256975, U.S.N.M.

Station 5371, off outer Tayabas Light (lat. 13° 49′ 40″ N.; long. 121° 40′ 15″ E.). Sounding not made; depth taken from chart which says 83 fathoms. (This is probably incorrect, for all the other Giant Limas were taken at much greater depth.) Bottom, green mud. Cat. No. 254978, U.S.N.M.

Station 5503, off Macubalan Point Light, Mindanao (lat. 8° 36′ 26″ N.; long. 124° 36′ 08″ E.), in 226 fathoms, on green mud bottom; bottom temperature 53° .3. Cat. No. 254976, U.S.N.M.

Station 5516, off Point Tagolo Light, Mindanao (lat. 8° 46′ 00″ N.; long. 123° 32′ 30″ E.), in 175 fathoms, on globigerina bottom; bottom temperature 54°.3. Cat. No. 254974, U.S.N.M.

Station 5519, off Point Tagolo Light, Mindanao (lat. 8° 47′ 00″ N.; long. 123° 31′ 15″ E.), in 182 fathoms, on globigerina and sand bottom; bottom temperature 54°.3. Cat. No. 254979, U.S.N.M.

On cinders and empty bottom.

Station 5243, off Uvian Island (lat. 6° 50′ 55″ N.; long. 126° 14′ 35″ E.), in 281 fathoms, on gray mud bottom; bottom temperature 63°.6; density at bottom, 1.02468. Cat. No. 229321, U.S.N.M.

Station 5282 yielded some loose valves, off Malavatuan Island (lat. 13° 53′ 00″ N.; long. 120° 26′ 45″ E.), in 248 fathoms, on dark gray sand; bottom temperature 47°.4; density at bottom, 1.02517. Cat. No. 230109, U.S.N.M.

EXPLANATION OF PLATES.

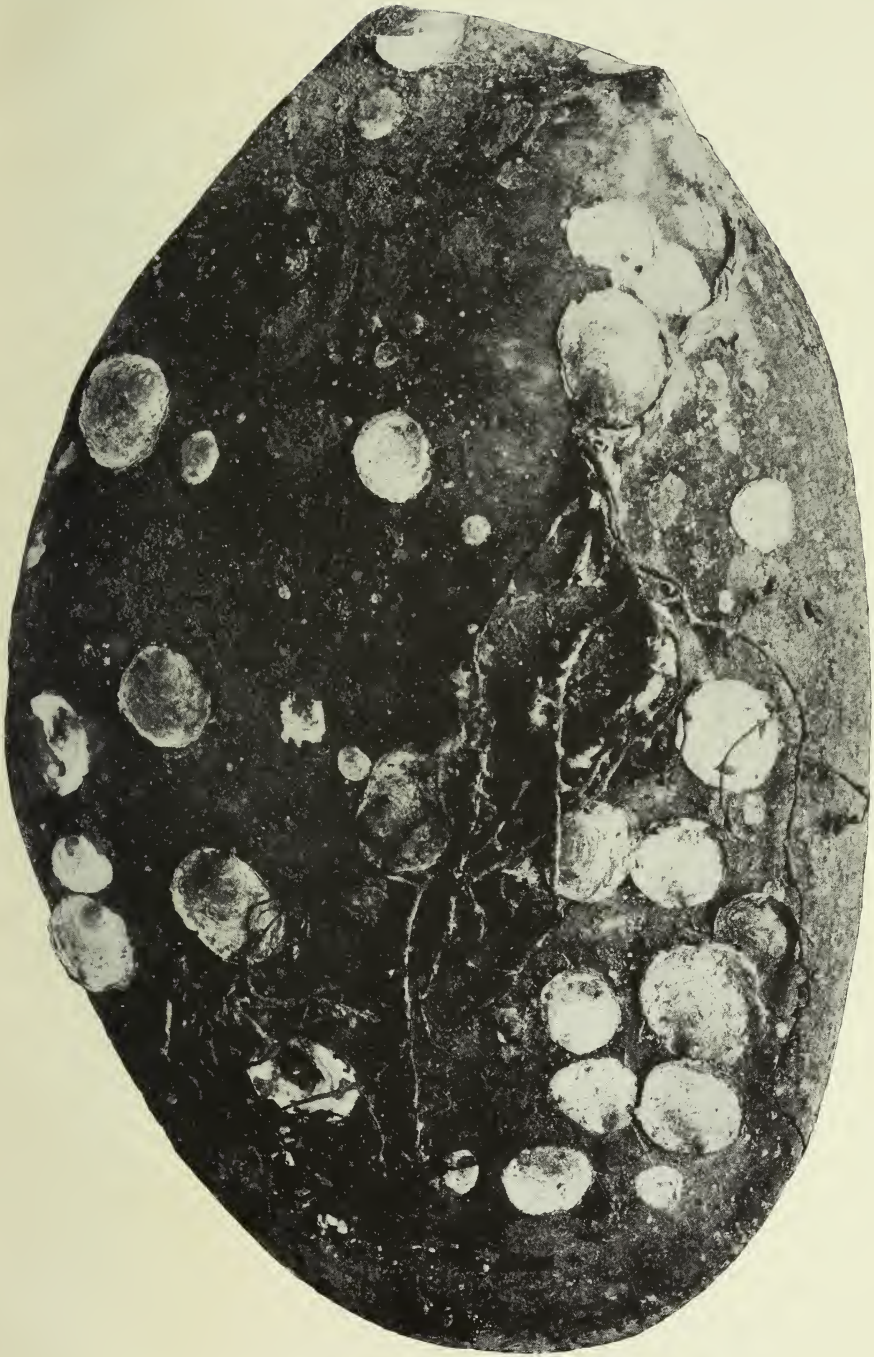
PLATE 27.

Dimya lima Bartsch on *Lima* (*Callolima*) *smithi* Bartsch. The specimen with the arrow is the type.

PLATE 28.

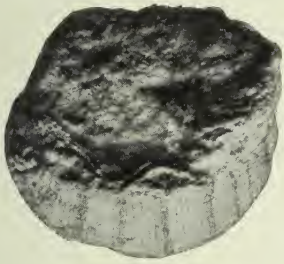
All figures enlarged three diameters.

Fig. 1. *Dimya filipina*, external view of lower valve.
2. *Dimya filipina*, external view of upper valve.
3. *Dimya filipina*, internal view of upper valve.
4. *Dimya filipina*, internal view of lower valve.
5. *Dimya lima*, internal view of upper valve.
6. *Dimya lima*, internal view of lower valve.



DIMYA LIMA ON LIMA SMITHI.

FOR EXPLANATION OF PLATE SEE PAGE 307.



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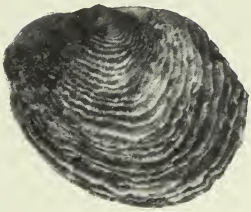

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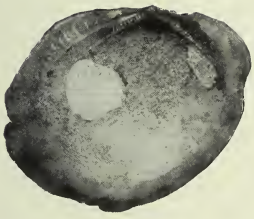

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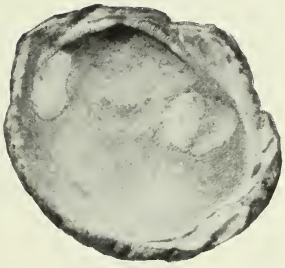

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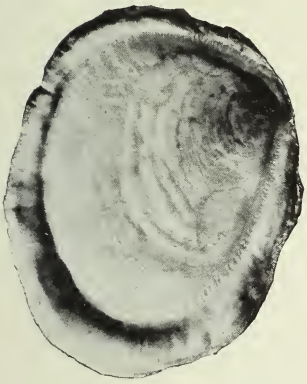

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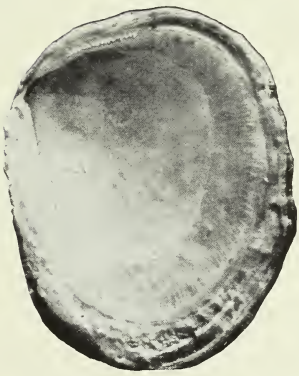

6

NEW DIMYAS FROM THE PHILIPPINES.

FOR EXPLANATION OF PLATE SEE PAGE 307.

15

THE PHILIPPINE MOLLUSKS OF THE GENUS PLANORBIS

BY

PAUL BARTSCH

Assistant Curator, Division of Mollusks, U. S. National Museum

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No. 1512.—From the Proceedings of the United States National Museum, Vol. XXXII, pages 83–85

Washington
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1907

THE PHILIPPINE MOLLUSKS OF THE GENUS PLANORBIS

BY

PAUL BARTSCH

Assistant Curator, Division of Mollusks, U. S. National Museum

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Vol. XXXII, pages 83–85

Washington
Government Printing Office
1907

THE PHILIPPINE MOLLUSKS OF THE GENUS PLANORBIS.

By Paul Bartsch,

Assistant Curator, Division of Mollusks, U. S. National Museum.

Up to date only two species of *Planorbis* have been known from the Philippines. To these Maj. E. A. Mearns's explorations in Mindanao have added two new forms, which are described and figured in the present paper.

PLANORBIS (GYRAULUS) QUADRASI Möllendorff.

Planorbis (*Gyraulus*) *quadrasi* Möllendorff, Bericht. Senck. Nat. Ges., 1903, p. 115, pl. III, figs. 11, 11a–11c.

The type locality for this species is Montalban, Luzon. The type is said to have three whorls and measures: Greater diameter, 3.5 mm.; altitude, 1 mm. Von Möllendorff also reports it in the same publication from the island of Leyte. His figure shows almost four instead of three whorls as cited in the description.

PLANORBIS (GYRAULUS) MINDANENSIS, new species.

Shell lenticular, biconcave, thin, semitransparent, corneous. Upper surface decidedly more concave than the lower, showing all the whorls, which increase evenly and rapidly in size. The entire upper surface

Fig. 1.—Planorbis (Gyraulus) mindanensis.

is marked by numerous, quite prominent, irregularly developed lines of growth. Periphery of the last whorl marked by a slender keel. The basal parts of the whorls are a little more convex than the upper sides, with the incremental lines less strongly developed. The center

of the base is only slightly depressed below the plane of the last whorl; in fact the most convex part of all of the whorls on the base falls almost in an even plane. The turns are separated above and below by well-impressed sutures. Aperture quite large, suboval, decidedly oblique, angulated at the middle of the outer lip by the slender keel. Columella practically absent; parietal wall covered with a thin callus.

The type has four and one-fourth whorls and measures: Greater diameter, 6.7 mm.; lesser diameter, 5.7 mm.; altitude, 1.7 mm.

The type and 196 specimens, Cat. No. 192982, U.S.N.M., were collected in Lake Buluan, Rio Grande Valley, province of Cotabato, Mindanao.

PLANORBIS (HELICORBIS) LUZONICUS Möllendorff.

Planorbis (*Hippeutis*) *luzonicus* MÖLLENDORFF, Nachr. Mal. Ges., XXVII, 1895, p. 120.

The shells described were collected by natives near the village Libmanan, in the province Camarines, Luzon. The measurements given for the type, which has five whorls, are: Greater diameter, 10.5 mm.; lesser diameter, 9 mm.; altitude, 3 mm.

PLANORBIS (HELICORBIS) MEARNSI, new species.

Shell lenticular, vitreous, horn color. Whorls increasing regularly in size, the last enveloping the greater part of the previous turns. All of the whorls show evenly coiled on the dorsal surface in the

FIG. 2.—PLANORBIS (HELICORBIS) MEARNSI.

extremely regularly conically depressed apex. The last half turn only, deviates from the regular spiral in having the summit gradually deflected until it falls about halfway between the summit and periphery on the preceding turn, at the aperture. The angle at the junction of the outer wall and the parietal wall is filled up for a short distance, and this shows through the shell as a moderately broad solid band, and makes the whorls appear as if they had a double suture. The whorls are evenly rounded on the dorsal surface and marked by moderately strong incremental lines only. Sutures lightly impressed. Periphery of the last whorl bluntly but strongly angulated. Base almost flat, with a moderately broad umbilicus, in which the whorls can be seen regularly and evenly coiled, but here also the last half of the last one becomes more and more openly coiled until it reaches

a point at the aperture, about one-third of the distance toward the periphery from the umbilicus to the periphery. The base, like the upper surface, is marked by numerous incremental lines. Aperture decidedly oblique, arrow shaped, the apex falling at the periphery, and the two barbs above and below the periphery of the preceding turn. Outer lip thin, somewhat sinuous; basal lip almost straight; columella exceedingly short, represented by the mere upward turn of the basal lip; parietal wall covered by a thin callus.

The type has almost five whorls and measures: Altitude, 1.5 mm.; greater diameter, 5 mm.; lesser diameter, 4.4 mm. The type and seven specimens, Cat. No. 192981, U.S.N.M., were collected by Maj. E. A. Mearns in Lake Buluan, Rio Grande Valley, Mindanao.

The only other *Helicorbis* reported from the islands is *P.* (*H.*) *luzonicus* Möllendorff. The much larger size—altitude, 3 mm.; greater diameter, 10.5 mm.; lesser diameter, 9 mm.—is sufficient to distinguish it from the present species.

THE PHILIPPINE POND SNAILS OF THE GENUS VIVIPARA

BY

PAUL BARTSCH

Assistant Curator, Division of Mollusks, U. S. National Museum

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No. 1518.—From the Proceedings of the United States National Museum, Vol. XXXII, pages 135–150, with Plates X–XI

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THE PHILIPPINE POND SNAILS OF THE GENUS VIVIPARA

BY

PAUL BARTSCH

Assistant Curator, Division of Mollusks, U. S. National Museum

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1907

THE PHILIPPINE POND SNAILS OF THE GENUS VIVIPARA.

By Paul Bartsch,
Assistant Curator, Division of Mollusks, U. S. National Museum.

In the present paper all of the species of this genus heretofore known from the Philippine Islands have been considered, as well as a host of new forms which were collected by Maj. Edgar A. Mearns, U. S. Army, and presented by him to the U. S. National Museum.

VIVIPARA ANGULARIS Müller.

Plate X, fig. 1.

Helix angularis Müller, Hist. Verm., Pt. 2, 1774, p. 187.

Shell quite large, conic, light to dark olive green. Whorls increasing very regularly in size. The first and second rather loosely coiled, marked by faint spiral lirations. On the third the keels characteristic of the adult shell make their appearance; in addition to the keels there are many fine spiral lirations. The adult shell is marked by three spiral keels between the sutures, of which the peripheral one is by far the strongest. The two supra-peripheral keels divide the space between the sutures into three areas, of which the one immediately below the summit is a little wider than the other two, which are equal in width. The space between the summit and the first keel forms a sloping shoulder. In addition to the three keels, the whorls are marked by numerous microscopic, minutely granulose spiral lirations and moderately strong incremental lines between the sutures. Periphery of the last whorl angulated. Base well arched, narrowly umbilicated, marked by lines of growth and many fine, wavy, equally developed, and equally spaced finely wrinkled spiral lirations. In some specimens the area adjoining the umbilicus is moderately excavated, in others it is almost closed. Aperture suboval, bluish white within, edged with a dark-brown border; outer lip thin, rendered slightly sinuous by the keels; columella moderately strong, concave, and slightly reflected; parietal wall covered with a thick callus in adult shells, which is bluish white, with a dark border, and lends the peritreme a complete aspect.

In adult shells the last whorl is usually somewhat deflected below the peripheral keel of the preceding turn, and the keel is thus exposed above the suture. Operculum reddish brown, with scarcely depressed eccentric nucleus and many fine lines of growth.

The specimen figured probably had seven and a half whorls (the early ones being somewhat eroded) and measures: Altitude, 32 mm.; greater diameter, 24.5 mm.; lesser diameter, 21.1 mm.; aperture, altitude (from the posterior angle to the base of the columella), 17.4 mm.; diameter (at right angles to the last from the middle keel of the outer lip), 13 mm. There are eight specimens of this species in the collection of the U. S. National Museum—three, Cat. No. 103669, from Luzon, Philippine Islands, of which one has served for our description and figure; Cat. No. 104056b, one specimen, collected by Rich in Luzon; one, Cat. No. 47996, collected by Hungerford at St. Cruz Bay Lake, Luzon, and three specimens, Cat. No. 19985, obtained by the North Pacific Exploring Expedition at Manila, Luzon, Philippine Islands.

VIVIPARA ANGULARIS BURROUGHIANA Lea.

Plate X, figs. 3, 4.

Paludina burroughiana LEA, Trans. Am. Phil. Soc., V, 1837, p. 113, pl. XIX, fig. 80.

There are three specimens in the Lea collection, Cat. No. 105640, U. S. National Museum, which were collected by Doctor Burroughs at Manila, Philippine Islands. Since the types were collected by Doctor Burroughs at Manila, it is quite likely that these specimens represent the cotypes upon which Doctor Lea based his description. This appears all the more probable, as one of the three shells agrees in every respect with the figure cited above. *V. a. burroughiana* represents a strongly sculptured form of *angularis*. In this, the spaces between the keels on the spire are marked with a number of slender subgranose lirations. In some individuals these lirations attain almost half the size of the middle keel. The sculpture of the base also is much stronger than in *V. angularis* proper. There are five lots in the collection, the one cited above, of which one specimen is figured, Plate X, fig. 4, which measures: Altitude, 39.2 mm.; greater diameter, 28.2 mm. Cat. No. 19984, U.S.N.M., fifteen specimens, collected by Wilsoup at Manila. Of these eight are nepionic shells. Cat. No. 90477, one specimen, from Manila, the strongest sculptured individual, here figured. Plate X, fig. 3. Cat. No. 104056, U.S.N.M., one specimen, collected by Rich, in Luzon, Philippine Islands. Cat. No. 192975, U.S.N.M., four individuals, collected by Maj. Edgar A. Mearns, at Pasay Beach, Manila, Luzon, Philippine Islands.

VIVIPARA ANGULARIS PHILIPPINENSIS Nevill.

Plate X, fig. 2.

Paludina philippinensis Nevill, Hand List Moll. Ind. Mus., 1884, p. 24. ?
Viripara hanleyi Frauenfeld, Verz. Paludina, 1864, p. 618, for *P. intermedia*, Hanley, Ms., Reeve, fig. 57, 1863, Loc. ? (not of Deshayes).

Long. 23, diam. 19 mm. This is a very closely allied form to *P. javanica;* indeed, probably only a geographical race and perhaps would be better classed as a variety of it. It can nevertheless be readily distinguished by the keel on the last whorls, giving the suture a canaliculate appearance by the less developed spiral structure, by the presence of longitudinal, subobsolete plications, as also by its shorter and more decollated form, more convex whorls, the last one subangulate, darker and duller epidermis and blacker peristome, which is more or less angulate below.

Von Martens would not appear to have met with it, as it can not surely be the form he mentions, Mal. Blatt. 1865, p. 148, as a rounded keelless, extreme variety of *P. burroughiana*. One of my specimens approaches Reeve's fig. 53 (*P. carinata*), in the more rounded peristome and less distinct subangulation of the last whorl. Seven specimens, Majajay, Luzon; coll. R. Hungerford, esq.

The above are Nevill's remarks upon this form. Three specimens, Cat. No. 104056, U.S.N.M., one of which is here figured, agree with Reeve's figure 57 and also with the above remarks. *V. a. philippinensis* represents a form of *V. angularis*, in which the two supra-peripheral keels have become obsolete; the peripheral one alone remains, forming the peripheral angle. Its chief marks of distinction, however, lie in alternating narrow dark and light longitudinal bands, the first, the narrower, probably represent resting stages and are usually a trifle more elevated than the broader light areas, and lend the shell an obsoletely ribbed appearance. The spiral sculpture, consisting of fine granose spiral lines in *V. angularis*, is in the present form reduced to mere indications of microscopic spiral lines, the surface having a polished appearance. The color in the three specimens varies from light yellowish-green to dark olive-green ground, with narrow longitudinal brown bands. The specimens at hand, which also come from Luzon, force me to assign this form a place under *V. angularis*. The one figured measures: Altitude, 21 mm.; greater diameter, 17 mm.

VIVIPARA ZAMBOANGENSIS, new species.

Plate XI, fig. 19.

Shell conic, thin, dark olive green. Nepionic whorls one and one-half, well rounded, smooth. Succeeding turns somewhat inflated, marked between the sutures by three spiral keels, of which the basal one, which is a little stronger than the other two, marks the periphery. The two post-peripheral keels divide the space between the summit and the periphery of the whorls into three equal, almost flattened areas, which are marked by many very fine and somewhat wavy, spiral lines, that lend the surface a silky luster. The summit of the whorls falls immediately below the peripheral keel in all but the last turn; in this it is

deflected toward the base and a narrow band becomes apparent between it and the peripheral keel. Base rather short, well arched, narrowly umbilicated, marked by numerous fine, wavy, spiral striations as on the spire. Aperture small, subcircular; black edged, bluish white within; outer lip thin, faintly angled at the keels, columella thin, strongly concave and somewhat reflected over the slitlike umbilicus; parietal wall covered with a thick callus which renders the peristome practically continuous. Operculum reddish brown with depressed eccentric nucleus, marked by many incremental lines.

The type and fifty-four specimens, Cat. No. 192956, U.S.N.M., were collected by Maj. Edgar A. Mearns, at Zamboanga, Mindanao, Philippine Islands. The type has five whorls (the nucleus being eroded) and measures: Altitude, 25.9 mm.; greater diameter, 20.2 mm.; lesser diameter, 18.8 mm; aperture, altitude (from the posterior angle to the base of the columella), 13.1 mm.; diameter (at right angles to the last, from the middle keel of the outer lip), 11.5 mm.

A single much-worn individual, which is a little more slender than the shells from the type locality, was collected by Major Mearns in Libungan River at Labas, Rio Grande Valley, Mindanao, Philippine Islands.

VIVIPARA ZAMBOANGENSIS TUBAYENSIS, new subspecies.

Plate XI, fig. 16.

Shell similar to *V. zamboangensis*, but subglobose, with the whorl more inflated and with the secondary sculpture much more strongly developed. The six slender keels above the stronger peripheral one are of almost equal strength and the spaces between them are occupied by spiral lirations as in *V. zamboangensis*. The base also is more inflated than in *V. zamboangensis* and the umbilicus is completely closed. In color it is also entirely different, being light brown or yellowish brown. The sculpture of the present form bears the same relation to *V. zamboangensis* that *V. a. burroughiana* bears to *V. angularis*. The type, which has five whorls remaining (part of the nucleus being lost), measures: Altitude, 22.7 mm.; greater diameter, 20.1 mm.; lesser diameter, 18 mm.

The type and two specimens, Cat. No. 192974 U.S.N.M., were collected by Maj. Edgar A. Mearns in Tubay River at Santiago, Mindanao, Philippine Islands.

VIVIPARA ZAMBOANGENSIS DAVAOENSIS, new subspecies.

Plate XI, fig. 17.

This form resembles *V. z. tubayensis* in contour, but is much more delicate. It is flesh colored. The periphery is marked by a weak liration, while the rest of the surface is marked by many ill-defined,

closely spaced, fine, wavy, spiral lirations on the spire and the base. A few of these lirations are a little stronger and visible to the unaided eye. The sutures are strongly impressed and the well-rounded base is openly, narrowly umbilicated.

The type, Cat. No. 192976, was collected by Maj. E. A. Mearns at Davao, Mindanao, Philippine Islands. It has five and seven-eighths whorls and measures: Altitude, 21 mm.; greater diameter, 17.6 mm.; lesser diameter, 14.1 mm.; aperture, altitude (from the posterior angle to the middle of the base), 12 mm.; diameter (at right angles to the last, from the middle of the outer lip), 9.5 mm.

VIVIPARA ZAMBOANGENSIS SURIGENSIS, new subspecies.

Plate XI, fig. 18.

Shell resembling *V. z. davaoensis* in outline, but polished, periphery obsoletely angulated. The shell is of light olive green color, with a few narrow longitudinal brown bands at irregular intervals. Base well rounded, narrowly umbilicated. Under high magnification the surface of the spire and base show many very fine, quite closely spaced, wavy lirations, which are scarcely perceptible to the naked eye.

The type, Cat. No. 192977, U.S.N.M., was collected by Maj. Edgar A. Mearns in Baganga River, Surigao, Mindanao, Philippine Islands. It has five whorls and measures: Altitude, 16.4 mm.; major diameter, 15.3 mm.; lesser diameter, 13.4 mm.; aperture, altitude (from the posterior angle to the middle of the base), 10.4 mm.; diameter (at right angles to the last, at the middle of the outer lip), 8.5 mm.

VIVIPARA MINDANENSIS, new species.

Plate XI, fig. 11.

Shell subturreted, light olive green. The early whorls of the type are eroded, but it contained nine nepionic shells, one of which will serve for the description of the early turns. The largest nepionic shell has three and one-half volutions, the first two of which are more loosely coiled and more rounded than those that follow. They are all marked by exceedingly fine spiral striations. The periphery of the last whorl of the nepionic shell is strongly angulated, while the base is rounded like the spaces between the sutures and narrowly umbilicated. The adult whorls are inflated, evenly rounded at the side, but abruptly so near the summit, which renders this roundly tabulated. The periphery of the last whorl is marked by a moderately strong keel, while the space between it and the summit is crossed by six slender threads, which are not regularly spaced. In addition to these threads there are many exceedingly fine interrupted wavy spiral lirations between them. The summit of the whorls falls considerably below the peripheral keels and exposes this above the suture in all the

whorls. The summits of the whorls and the rounded shoulders are marked in addition to the above-mentioned sculpture with oblique wrinkles, which give this part of the whorls a quite strongly malleated appearance. Periphery of the last whorl angulated. Base short, somewhat inflated, well arched, excavated about the narrow open umbilicus and marked by ten subequal and irregularly spaced slender spiral lirations, between which there are many exceedingly fine interrupted papillose spiral lines. Aperture oval, bluish white within, bordered by a very narrow black edge on the outside; outer lip thin; columella concave, slender, somewhat expanded at the base and slightly reflected over the umbilicus; parietal wall covered with a thin callus; operculum orange, with depressed eccentric nucleus marked by many lines of growth. The type and seven specimens, Cat. No. 192559, U.S.N.M., were collected by Major Mearns in Lake Lanao, Mindanao. It has lost the first two nuclear whorls. The five which remain measure: Altitude, 31.1 mm.; greater diameter, 24.1 mm.; lesser diameter, 22 mm.; aperture, altitude (from the posterior angle to the middle of the base), 15.3 mm.; diameter (at right angles to the last, from the middle of the outer lip), 12.5 mm.

VIVIPARA MINDANENSIS BAGANGENSIS, new subspecies.

Plate XI, fig. 12.

Shell much more globose than *V. mindanensis*, dark olive green, with a reddish tinge. Interior of aperture reddish brown. Spire and base marked by more or less equally spaced fine spiral lirations and weakly developed obliquely forward slanting folds, which lend the last two turns a malleated appearance. In addition to the spiral lirations visible to the unaided eye there are many closely spaced, more or less interrupted, very fine, wavy lines which can be seen under the microscope. Base well rounded and narrowly umbilicated.

The type, Cat. No. 192979, U.S.N.M., was collected by Maj. E. A. Mearns in Baganga River, Surigao, Mindanao. It has six whorls (the first being decidedly worn) and measures: Altitude, 22.8 mm.; greater diameter, 19.3 mm.; lesser diameter, 17 mm.; aperture (from the posterior angle to the base of the columella), 18.8 mm.; diameter (at right angles to the last, at the middle of the outer lip), 10.3 mm.

VIVIPARA BULUANENSIS, new species.

Plate XI, fig. 15.

Shell thin, subturreted, broadly conic, light brown, shining. All the whorls inflated and well rounded, with a broad rounded shoulder at the summit. Sutures strongly impressed. Periphery of the last whorl with a mere indication of an angulation. Base short, well rounded, rather broadly openly umbilicated. The entire surface, both on the spire and on the base, marked by many moderately strong lines of growth, and many fine equally developed and subequally spaced

wavy spiral lirations. The crossing of these two elements lend the shell a finely reticulated sculpture. Aperture, moderately large, oval, white, with a brownish tinge within; outer lip, thin; columella very slender, somewhat expanded at base and slightly reflected; parietal wall covered with a short, thin, semitransparent callus. Operculum reddish orange, with but slightly depressed eccentric nucleus and many lines of growth.

The type and 136 specimens, Cat. No. 192978, U.S.N.M., were collected at Lake Buluan, Mindanao, Philippine Islands, by Maj. Edgar A. Mearns. The type has six and one-half whorls and measures: Altitude, 30.8 mm.; greater diameter, 23.3 mm.; lesser diameter, 28.8 mm.; aperture (from the posterior angle to the middle of the base), 15.2 mm.; diameter (at right angles to the last from the middle of the outer lip), 12 mm.

This entire lot is remarkably uniform in shape and sculpture, differing only in color, in which there is a variation from light olive green to reddish brown.

VIVIPARA CARINATA Reeve.

Plate XI, fig. 14.

Paludina carinata Reeve, Conch. Icon., XIV, 1863, no. 53, fig. 53.

The name of the present shell is somewhat misleading, since the carination is restricted to the periphery of the early whorls. In the adult turns it is quite obsolete.

The shell is conic and of olive-green color, with an occasional narrow, dark, longitudinal stripe. The early whorls are eroded in all of our specimens. The later ones are evenly rounded between the sutures, marked by lines of growth and exceedingly fine, closely spaced, obsolete, spiral lirations. Sutures strongly impressed. Periphery of the last turn obsoletely angulated. Base well rounded, with a narrow umbilicus, which is almost completely covered by the somewhat reflected columella, marked as the spire. Aperture moderately large, bluish white within, outer lip thin. Columella slender, concave, and somewhat reflected; parietal wall covered by a thin callus. Operculum reddish, with slightly depressed eccentric nucleus and many lines of growth. The specimen described and figured, Cat. No. 103666, U.S.N.M., has the apex badly worn. The six remaining turns measure: Altitude, 31.8 mm.; greater diameter, 25.2 mm.; lesser diameter, 23.4 mm.; aperture, altitude (from the posterior angle to the middle of the base), 18.6 mm.; diameter (at right angles to the last from the middle of the outer lip), 14 mm. Another specimen, belonging to the same lot, with worn nucleus and five whorls remaining, measures: Altitude, 22 mm.; greater diameter, 18 mm.; lesser diameter, 15 mm. These two individuals are marked Philippine Islands, without nearer designation of locality. Three additional specimens, Cat. No. 47995, U.S.N.M., were collected in Luzon, Philippine Islands, by Hungerford.

VIVIPARA CUMINGI (Hanley) Reeve.

Plate X, Fig. 7.

Paludina cumingi (Hanley) Reeve, Conch. Icon., XIV, 1863, no. 11, figs. 11, 11*a*.

Shell subglobose, of light olive green color. The early whorls are but little elevated, well rounded, marked by lines of growth and a few exceedingly fine interrupted spiral lirations. From the third whorl on the turns are decidedly inflated and strongly roundly shouldered at the summits, the shoulder being almost tabulated. These whorls are marked by faint lines of growth and exceedingly closely spaced, fine, wavy lirations. In additions to this sculpture a number of moderately strong, low, oblique, raised ridges make their appearance on the last two turns, which, in connection with the above-mentioned sculpture, give these whorls a weakly malleated aspect. Sutures strongly impressed. Periphery of the last whorl rounded. Base well rounded, narrowly unbilicated, marked by the lines of growth and obsolete spiral lirations as on the spire. Aperture moderately large, oval, bluish white, with a narrow dark-colored border; outer lip thin; columella slender, concave, somewhat reflected over the umbilicus; parietal wall covered with a thick, bluish white, dark-edged callus, which gives the peristome a complete aspect.

The specimen described and figured, Cat. no. 105658, was donated by C. M. Wheatley and comes from Luzon, Philippine Islands. It has five and one-half whorls and measures: Altitude, 17.1 mm.; greater diameter, 14.8 mm.; lesser diameter, 12.6 mm., aperture, altitude (from the posterior angle to the middle of the base), 10.2 mm.; diameter (at right angles to the last from the middle of the outer lip), 7.8 mm. Another specimen, Cat. No. 98070, U.S.N.M., was collected at Manila, Luzon, Philippine Islands, by W. W. Walpole.

VIVIPARA MEARNSI, new species.

Plate X, fig. 6.

Shell thin, polished, conic, strongly keeled at periphery, greenish-yellow, with irregularly disposed, narrow, dark, longitudinal bands, which appear to mark resting stages. The entire shell on the spire and base is marked by fine incremental lines and very fine, closely spaced, spiral striations, which lend the surface a finely reticulated aspect when viewed under high magnification. (Nuclear whorls decollated.) Succeeding turns well but not evenly rounded, the posterior half between the summit and the periphery being decidedly more convex than the anterior. Periphery of the whorls bearing a strong narrow compressed keel, which is apparent above the suture in all the volutions. On the earlier ones it is appressed quite closely to the summit of the succeeding turn, while in the last two volutions the

summit falls somewhat below the keel and makes this appear all the more prominent. Base short, evenly and strongly arched, with a narrow perforate umbilicus. Aperture ovate, rather large, the outer lip thin, rendered }-shaped by the keel in the middle; columella slender, concavely curved; parietal wall covered by a thick callus which joins the columella and the posterior angle of the aperture, rendering the peristome complete. Operculum thin, translucent, reddish-brown, with depressed eccentric nucleus and well-marked incremental lines, the outer edge bearing a slight projection which fits into the angle of the peripheral keel.

The type and 58 specimens Cat. No. 192957, U. S. N. M., were collected by Maj. Edgar A. Mearns, at Lake Lanao, Mindanao, Philippine Islands. The type has five whorls (the nepionic part of the spire being lost) and measures: Altitude, 43.8 mm.; greater diameter, 36.3 mm.; lesser diameter, 32.5 mm. Aperture: Altitude (from the posterior angle to the middle of the base), 21.5 mm.; diameter (taken at right angles to the altitude at the keel of the outer lip), 17.2 mm.

Occasionally there appear one or more very slight spiral lirations on the surface of the spire; these, however, are not constant, even on the same shell, and therefore unimportant in the specific diagnosis.

This species is remarkably distinct from any of the recent Viviparas. It resembles V. yukotinovici Frauenfeld figured Plate 5, figs. 7, 8, in the Verh. Zool. Bot. Ges. Wien. XIV, 1864, which comes from the Neogentertiary of West Slavonia.

VIVIPARA MEARNSI MISAMISENSIS new subspecies.

Plate X, fig. 5.

Shell large, thin, subturreted, light olive green with many narrow dark brown bands, which coincide with the lines of growth and probably mark resting stages. Entire surface marked by rather strong incremental lines. Nuclear whorls wanting. Succeeding turns inflated, shouldered at the submit and marked by three prominent spiral ridges and two less conspicuous intermediate ones, between the sutures. The most strongly developed of these ridges is at the periphery, the next strongly developed one is located about two-fifths of the distance anterior to the summit, between the summit and the periphery, while the third is about halfway between these two keels. Of the two weaker cords, one stands halfway between the middle and posterior keel, while the other encircles the shoulder, about as far posterior to the first keel as the other intermediate cord is anterior to it. The spaces between these keels appear flattened and lend the outline of the whorls a polygonal appearance. Periphery of the last whorl strongly keeled. Base short, well arched, not umbilicated, marked by many fine rather closely spaced spiral lirations. Aperture suboval, white within, edged with black; outer lip thin, rendered

somewhat polygonal on its posterior half by the spiral cords; columella slender, decidedly concave and slightly reflected; parietal wall covered with a thick white callus which is black-edged like the lip and renderes the peristome continuous.

The type, Cat. No. 192960, U.S.N.M., was collected by Maj. Edgar A. Mearns in Lake Lanao, Mindanao, Philippine Islands. It lacks the nucleus and some of the earlier whorls, the last four only remain and these measure: Altitude, 31.7 mm.; greater diameter, 27.4 mm.; lesser diameter, 25.4 mm. Aperture: Altitude (from the posterior angle to the base of the columella), 18.5 mm.; diameter (at right angles to the last from the middle keel), 14.9 mm.

VIVIPARA PAGODULA, new species.

Plate X, fig. 8.

Shell thin, broadly conic, turreted, greenish yellow with irregularly disposed, narrow, dark bands coinciding with the lines of growth. Nepionic whorls decollated. Succeeding turns rather depressed, with a broad sloping shoulder above, which extends from the summit to the strongly keeled periphery. This shoulder is marked by two spiral lirations, which are placed a little to each side of the middle of the upper surface. The periphery is marked by a very strong, hollow keel, which falls about one-third of the distance anterior to the summit, from the summit to the base of the columella in the last turn. The space between the periphery and the summit of the succeeding turn is marked by two equally developed spiral keels, which are placed on the vertical side. The lower one of these is immediately above the suture, while the upper one is at some little distance below the periphery, which projects considerably beyond them. Base of the last whorl rather short, marked by the two strong spiral keels, which are rather closely spaced and enclose a narrow channel between them. The space between the posterior keel and the periphery is quite strongly concave. The space between the basal keel and the narrow, almost covered, umbilicus is well arched and marked by eight slender lirations, which are less strongly developed and more closely spaced about the umbilical area than at the keel. These lirations as well as the two basal keels are rendered faintly crenulate by the incremental lines. The spaces between the spiral keels and the lirations are marked by many exceedingly fine incised spiral striations, both on the spire and the base. Aperture slightly effuse basally, irregular in outline, the peripheral keel marking a deep acute angle and the two basal ones shallow rounded channels in the thin outer lip; columella slender, concave, and somewhat reflected over the umbilical opening; parietal wall covered with a thin callus.

The type, Cat. no. 192858, U.S.N.M., was collected in Lake Lanao, Mindanao, Philippine Islands, by Maj. Edgar A. Mearns, and has five and

one-fourth turns (the nucleus being lost), which measure: Altitude, 30 mm.; greater diameter, 26.5 mm.; lesser diameter, 22.4 m.; Aperture, altitude (from the posterior angle to the base of the columella), 15.9 mm.; diameter (at right angles to the last measurement at the basal keel of the outer lip), 13.3 mm.

VIVIPARA GILLIANA, new species.

Plate X, fig. 12.

Shell large, broadly conic, reddish brown. (First one and one-half whorls worn.) The second part of the second whorl shows the beginning of the sculpture of the adult turns, which consists of three poorly developed keels, of which one appears at the periphery and the other two between it and the summit. The space between the peripheral keel and the next one is a little narrower than the space between the median and posterior keel, while the space between the summit and the posterior keel is considerably wider still. The space between the summit and the posterior keel is moderately rounded and forms the shoulder of the whorl. The spaces between the other keels are flattened. The greatest convexity of the whorls is marked by the median keel. Periphery of the last whorl angulated. Base moderately long, strongly arched. The entire surface of the spire and base is marked by rather strongly expressed, incremental lines and many closely placed, microscopic spiral lirations. Aperture large, subcircular, reddish brown within; outer lip thin, rendered slightly angular by the keels; columella slender, concave, somewhat reflected over the umbilical area; parietal wall covered with a moderately thick dark colored callus. Operculum thin, yellowish, with decidedly depressed eccentric nucleus, marked by many lines of growth.

The type and five additional specimens (three of which are nepionic shells having the same sculpture as the adult turns), Cat. No. 192972, U.S.N.M., were collected by Maj. Edgar A. Mearns, in Lake Lanao, Mindanao, Philippine Islands. The type has five and one-half whorls and measures: Altitude, 37.4 mm.; greater diameter, 27.7 mm.; lesser diameter, 23.5 mm. Aperture, altitude (from the posterior angle to the middle of the base), 21.1 mm.; diameter (at right angles to the last, at the middle keel), 17.3 mm.

VIVIPARA LANAONIS, new species.

Plate XI, fig. 7.

Shell of medium size, decidedly turreted, olive-green with many narrow dark-brown bands which coincide with the rather strongly developed lines of growth. The largest young shell, taken from a specimen before birth, has four whorls, the first two of which are helicoid, well rounded, and marked by a few faint spiral striations,

while the two which follow bear the same sculpture as the adult shell, though less strongly developed. The whorls of the adult shell are very strongly tabulately shouldered, the shoulder terminating in a prominent compressed keel, which is located at about one-third of the distance between the summit and the base of the columella, anterior to the summit. This keel, which may be known as the peripheral keel, marks the widest part of the turn and overarches the rest. Between this keel and the summit of the succeeding whorl there are two additional keels which are a little less strongly developed. The basal one of these (the suprasutural keel) is immediately above the suture, while the other (the median keel) lies half-way between it and the peripheral keel. A fourth keel, which is considerably less developed than any of the three others, is situated on the shoulder, about as far posterior to the peripheral keel as the first one below the peripheral keel is anterior to it. Base of the last whorl rather short, well arched, marked by about eight subequal spiral lirations, which are a little more closely spaced and less strongly developed near the umbilical chink than away from it. Aperture irregular, bluish white within, with dark border; outer lip thin, rendered sinuous by the keels; columella slender, concavely curved; parietal wall covered with a moderately thick, bluish white callus, which is dark edged and gives the peritreme a complete aspect. Operculum thin, orange colored, with depressed eccentric nucleus and many lines of growth.

The type, which has lost the first two nepionic turns, has five whorls left, which measure: Altitude, 24.5 mm.; greater diameter, 17.4 mm.; lesser diameter, 15.4 mm.; aperture, altitude (from the posterior angle to the base of the columella), 11.6 mm.; diameter (at right angles to the last, from the middle keel of the outer lip), 9 mm.

The present species, while fairly constant as far as general outline is concerned, nevertheless presents considerable variations in sculpture. These variations appear to follow certain definite lines, which will be noted below. It is an interesting fact that in all the gravid specimens examined, the nepionic shells taken from the parent, always had the sculpture of the parent. There are 104 shells which belong to this species, all collected by Major Mearns, in Lake Lanao, Mindanao, Philippine Islands. Eleven of these belong to the typical form, which is entered as Cat. No. 192363, U.S.N.M.

Form alpha (Plate XI, fig. 8).—Differs from typical *lanaonis* in having the base smooth. There are six specimens of this form. Cat. No. 192364, U.S.N.M.

Form beta (Plate XI, fig. 2).—Has two slender cords between the peripheral and suprasutural keel, instead of a single median one. There are only two specimens of this type. Cat. No. 192365, U.S.N.M.

Form gamma (Plate XI, fig. 4).—This lacks the keel on the shoul-

der. There are eleven specimens of this form. Cat. No. 192366, U.S.N.M.

Form delta (Plate XI, fig. 10).—This lacks the median keel. There are four specimens of this form. Cat. No. 192367, U.S.N.M.

Form eta (Plate XI, fig. 9).—This lacks the median and shoulder keel. There are thirty-two specimens in the lot. Cat. No. 192368, U.S.N.M.

Form theta (Plate XI, fig. 1).—Has same number and arrangement of the keels as in the typical form, but they are only weakly developed; the peripheral one is not stronger than the rest and does not overhang them. There are twelve specimens of this form. Cat. No. 192369, U.S.N.M.

Form iota (Plate XI, fig. 5).—Like theta, but lacking the cord on the shoulder. There are seven specimens in the lot. Cat. No. 192370, U.S.N.M.

Form kappa (Plate XI, fig. 3).—All the cords lost, except faint angles marking the peripheral and suprasutural keels. Nineteen specimens. Cat. No. 192371, U.S.N.M.

Form lambda (Plate XI, fig. 6).—In this form the periphery is angulated and the two supraperipheral keels are merely indicated; base smooth. One specimen. Cat. No. 192973, U.S.N.M.

VIVIPARA POLYZONATA Frauenfeld.

Plate XI, fig. 13.

Vivipara polyzonata Frauenfeld, K. K. Zool. Bot. Ges. Wien, 1862, p. 2.

Shell conic, thin, with the apex flesh colored, the ground color of the rest olive green, while the spiral keels are dark brown. The first three whorls are helicoid and smooth excepting a few spiral striations. With the beginning of the fourth, the characteristic sculpture of the adult whorls makes its appearance, though at first this is merely indicated. The adult whorls are encircled between the sutures by three equally strong, well-rounded dark-brown cords of which the third is at the periphery and is just covered by the summit of the succeeding turns, though in the last half of the last turn it is left exposed. The other two keels divide the space between the peripheral keel and the summit into three equal spaces. The first of these spaces forms a moderate shoulder. An additional slender brown spiral cord, which is only about one-fifth as strong as the others is located a little nearer the first keel than the suture. Base of the last whorl rather short, well arched, without umbilicus, marked by a number of spiral keels which gradually diminish in size and become closer spaced from the periphery toward the umbilicus chink. One of the specimens has seven quite regularly spaced basal cords. Another has five less regularly dis-

tributed, while a third has only four cords. The entire surface of the shell, in addition to the keels is marked with fine lines of growth and many exceedingly fine spiral striations, the latter occurring between the keels. Aperture suboval, bluish white within, edged with dark brown; outer lip thin, rendered sinuous by the spiral keels; columella moderately thick, glazing the umbilical area; parietal wall covered with a moderately thick bluish white callus, which is edged with dark brown and lends the peritreme a complete appearance. Operculum light orange, thin, with depressed, eccentric nucleus, marked by many lines of growth.

The three specimens before me agree in size and sculpture, two, Cat. No. 105636, U.S.N.M., come from Manila, Luzon. One of these has seven whorls and measures, altitude, 19.9 mm.; greater diameter, 9 mm.; lesser diameter, 12.7 mm. Aperture, altitude (from the posterior angle to the base of the columella), 11 mm.; diameter (at right angles to the last, from the middle keel of the outer lip), 6.4 mm. The third specimen, Cat. No. 41125, U.S.N.M., was collected by Benson and donated by McAndrew. It bears the locality label, Philippines, and probably comes from Luzon, the type locality of the species.

VIVIPARA MAINITENSIS, new species.

Plate X, figs. 9, 10, 11.

While the collection contains no less than forty-three specimens of this species, there is not one of the adult shells which is perfect. It has been deemed advisable therefore to base the specific diagnosis upon several cotypes rather than a single imperfect individual.

Shell subglobose, with multisulcate spire and of light brown color. (The description of the first four whorls is based upon the juvenile specimen.) The first two and a half whorls helicoid, well rounded, rather loosely coiled. The first one marked by a few transverse wrinkles only. On the second one a few faint spiral lirations are apparent as well as weak lines of growth. On the first half of the third turn these lirations become stronger and are granulose, while on the second half of the same turn three conspicuous spiral keels make their appearance. These keels and the spaces between them are marked by many closely-spaced, fine, finely papillose lirations. The fourth whorl bears five very strong rounded keels above the periphery which are equally well developed and equally spaced. Periphery marked by a depressed sulcus, which bears a low, well-rounded keel in the middle, which is about one-half as wide as the first supra and infra peripheral keel. The peripheral sulcus in reality is not a sulcus but a keel less raised than the two which bound it. The base of the fourth whorl is well rounded and marked by low, almost flattened, closely spaced cords, of which there are two kinds, narrow and broad, the latter about three times as wide as the former and alternating with

them. There are about twenty-four cords on the base; they gradually become narrower from the periphery to the umbilical chink. These cords are marked by spiral lines of very minute papillæ.

Second cotype.—Fifth and sixth whorls inflated, marked by six strong, moderately rounded cords between the summits and the peripheral sulcus. The first of these, at the suture, is considerably broader than the rest, and somewhat flattened, forming a narrow shoulder. The sutural keel is very low and ill-defined, in places bifed. Base not perforated; inflated and well rounded, marked by irregularly developed keels, which become quite obsolete from the middle of the base to the umbilical region. Aperture rather small, suboval, bluish white within; outer lip thin, faintly wavy, columella moderately thick, concave; parietal wall covered with a thin callus. Operculum reddish yellow, with slightly depressed eccentric nucleus, marked by numerous lines of growth.

Third cotype.—This is a badly eroded and fragmentary shell. It has at least one whorl more than the second cotype, i. e., about seven. This last turn has a decidedly tabulated shoulder and six rather rugose spiral keels between the shoulder and the obsolete peripheral sulcus. The base is likewise marked by rugose spiral keels. The keels are rendered rugose by the strong almost riblike incremental lines, which grow stronger as the shell increases with age.

The three cotypes have the following number of whorls and measure: First, young, has a little more than four turns, nucleus complete; altitude, 9.2 mm.; greater diameter, 8.4 mm.; lesser diameter, 7.8 mm.

The second cotype has five whorls (it has lost probably one and one-half), and measures: Altitude, 29.6 mm.; greater diameter, 24.5 mm.; lesser diameter, 21.3 mm. Aperture, altitude (from the posterior angle to the base of the columella), 16.8 mm.; diameter (at right angles to the last, from the insertion of the columella), 13.3 mm. The third cotype must have had about seven and a half whorls, six of which are still visible; it measures: Altitude, 37.1 mm.; greater diameter, 31.5 mm.; lesser diameter, 28.4 mm.

All of the specimens, 42, Cat. No. 192962, U.S.N.M., were collected by Maj. E. A. Mearns in Lake Mainit, northeastern Mindanao, Philippine Islands. One, Cat. No. 192961, U.S.N.M., comes from Baganga River, southeastern Mindanao, Philippine Islands.

There are two young individuals in the collection, Cat. No. 192980 U.S.N.M., collected by Maj. E. A. Mearns at Lake Mainit, Mindanao, Philippine Islands, which do not belong to any of the species of which we have adults from that locality. They are broadly conic, with the first one and one-half turns cylindrical, forming a mucronate apex. The periphery is strongly keeled and the shining surface marked by exceedingly fine closely spaced spiral lirations.

EXPLANATION OF PLATES.

[All figures are natural size.]

PLATE X.

FIG. 1. *Vivipara angularis* Müller, p. 135.
2. *Vivipara angularis philippinensis* Nevill, p. 137.
3. *Vivipara angularis burroughiana* Lea, p. 136.
4. *Vivipara angularis burroughiana* Lea, p. 136.
5. *Vivipara mearnsi misamisensis* Bartsch, p. 143.
6. *Vivipara mearnsi* Bartsch, p. 142.
7. *Vivipara cumingi* (Hanley) Reeve, p. 142.
8. *Vivipara pagodula* Bartsch, p. 144.
9. *Vivipara mainitensis* Bartsch, p. 148.
10. *Vivipara mainitensis* Bartsch, p. 148.
11. *Vivipara mainitensis* Bartsch, p. 148.
12. *Vivipara gilliana* Bartsch, p. 145.

PLATE XI.

FIG. 1. *Vivipara lanaonis* form *theta* Bartsch, p. 147.
2. *Vivipara lanaonis* form *beta* Bartsch, p. 146.
3. *Vivipara lanaonis* form *kappa* Bartsch, p. 147.
4. *Vivipara lanaonis* form *gamma* Bartsch, p. 146.
5. *Vivipara lanaonis* form *iota* Bartsch, p. 147.
6. *Vivipara lanaonis* form *lambda* Bartsch, p. 147.
7. *Vivipara lanaonis* Bartsch, p. 145.
8. *Vivipara lanaonis* form *alpha* Bartsch, p. 146.
9. *Vivipara lanaonis* form *eta* Bartsch, p. 147.
10. *Vivipara lanaonis* form *delta* Bartsch, p. 147.
11. *Vivipara mindanensis* Bartsch, p. 139.
12. *Vivipara mindanensis bagangensis* Bartsch, p. 140.
13. *Vivipara polyzonata* Frauenfeld, p. 147.
14. *Vivipara carinata* Reeve, p. 141.
15. *Vivipara buluanensis* Bartsch, p. 140.
16. *Vivipara zamboangensis tubayensis* Bartsch, p. 138.
17. *Vivipara zamboangensis davaoensis* Bartsch, p. 138.
18. *Vivipara zamboangensis suriganensis* Bartsch, p. 139.
19. *Vivipara zamboangensis* Bartsch, p. 137.

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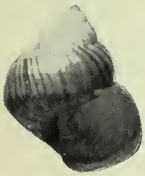

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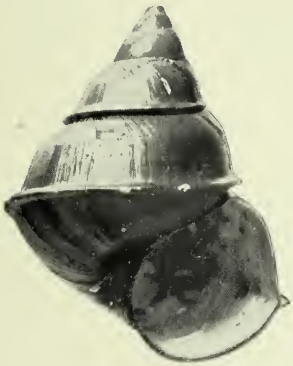

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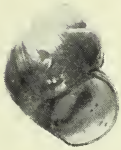

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PHILIPPINE ISLAND VIVIPARIDÆ.

FOR EXPLANATION OF PLATE SEE PAGE 150.

TWO NEW LAND SHELLS FROM THE WESTERN STATES

BY

PAUL BARTSCH

Curator, Division of Marine Invertebrates, United States National Museum

No. 2155.—From the Proceedings of the United States National Museum, Vol. 51, pages 331–333, with Plate 31

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TWO NEW LAND SHELLS FROM THE WESTERN STATES

BY

PAUL BARTSCH

Curator, Division of Marine Invertebrates, United States National Museum

No. 2155.—From the Proceedings of the United States National Museum, Vol. 51, pages 331–333, with Plate 31

Published November 24, 1916

Washington
Government Printing Office
1916

TWO NEW LAND SHELLS FROM THE WESTERN STATES.

By Paul Bartsch,

Curator, Division of Marine Invertebrates, United States National Museum.

While accompanying her husband, the Secretary of the Smithsonian Institution, on a collecting trip through the Northwest, Mrs. Walcott gathered some specimens of *Oreohelix* in Montana. These belong to an undescribed race which I take pleasure in naming for the discoverer.

The second subspecies, *Oreohelix idahoensis baileyi*, here described was collected by Mr. Vernon Bailey of the Biological Survey, in 1896, on a limestone ridge, at an altitude of 700 feet, in the Seven Devils Mountains of Idaho.

OREOHELIX YAVAPAI MARIAE, new subspecies.

Plate 31, figs. 1–3.

Shell decidedly depressed helicoid, almost lenticular, flesh colored, with a narrow brown band on the upper surface, which is a little nearer the peripheral cord than the suture, and a second even narrower one bordering the peripheral cord on the lower surface. Nuclear whorls scarcely differentiated from the succeeding turns, bearing the same sculpture as the adult whorls, but a little less strongly expressed. Periphery of the whorls provided with a cord-like keel, which becomes somewhat weakened on the last quarter of the last turn. Entire surface both above and below marked by slender thread-like incremental lines and fine spiral striations; last whorl slightly descending near the aperture. Base broadly, openly umbilicated, well rounded; a little more convex at the umbilical wall than at the lateral margin. Aperture very oblique, oval; peristome neither thickened nor reflected at the edge; parietal wall strong, rendering the peristome complete.

The type and eight specimens of this subspecies (Cat. No. 215132, U.S.N.M.), were collected by Mrs. Mary Walcott on Squaw Creek near the mouth of Gallatin Canyon, Montana. The type has 5.6

whorls and measures: Altitude, 10.0 mm.; greatest diameter, 22.5 mm.; least diameter, 19.6 mm.

The other specimens yield the following additional measurements

Number of whorls.		Altitude.	Greatest diameter.	Least diameter.
Type	5.6	10.0	22.5	19.6
	5.4	9.3	21.2	18.0
	5.5	9.1	21.1	18.4
	5.3	9.0	20.0	17.3
	5.6	10.0	22.4	18.7
	5.6	8.6	20.5	18.0
	5.6	9.1	20.7	18.5
	5.2	8.2	18.3	15.6
	5.4	9.9	19.5	17.3
Largest	5.6	10.0	22.5	19.6
Least	5.2	8.2	18.3	15.6
Average	5.47	9.24	20.69	17.93

This race of *Oreohelix yavapai* Pilsbry is the most northern one so far reported. It differs from the typical form, which comes from "Purtyman's Ranch on Oak Creek, Yavapai County, about 40 miles from Jerome, Arizona," in being larger, more solid and more acutely keeled. Dr. Henry A. Pilsbry gives the following measurements of his *O. yavapai:* Altitude 8.7–9.5 mm.; greatest diameter 15.2–16.6.

Our race appears nearest related to *Oreohelix yavapai angelica* Pilsbry and Ferriss, which was collected by these authors near the base of the Crossbed Sandstone, Bright Angel Trail, Grand Canyon, Colorado. Of this Doctor Pilsbry has kindly sent me eight specimens for the collection of the United States National Museum (Cat. No. 215085), which yield the following measurements:

Number of whorls.		Altitude.	Greatest diameter.	Least diameter.
Type	4.6	8.0	18.0	15.2
	4.7	7.6	17.4	15.0
	5.0	7.3	17.0	14.6
	4.9	8.0	17.3	14.1
	4.9	8.0	16.9	14.6
	4.8	8.0	17.5	14.5
	4.8	8.0	17.6	14.6
	5.0	8.3	16.4	14.0
Largest	5.0	8.3	18.0	15.2
Least	4.6	7.3	16.4	14.0
Average	4.83	7.9	17.26	14.57

In addition to the differences expressed by the measurements, our shell has the peripheral keel even more compressed than *Oreohelix yavapai angelica* Pilsbry and Ferriss.

OREOHELIX IDAHOENSIS BAILEYI, new subspecies.

Plate 31, figs. 4–6.

Shell depressed, helicoid. Nuclear whorls 2½, marked by somewhat irregularly disposed, crude, axial ridges, and fine spiral striations. The postnuclear whorls are well rounded, marked by very coarse, broad and strong, decidedly retractively slanting axial ribs, of which 23 occur upon the last whorl of the type. These ribs and the spaces between them are crossed by strong incremental lines. In addition to the axial sculpture the whorls are marked by fine closely spaced spiral striations which are best developed in the intercostal spaces of the last whorl. Periphery of the last whorl with a slender keel. Base broadly openly umbilicated, marked by the continuations of the axial ribs which extend well within the umbilicus, and spiral sculpture like the upper surface. Aperture oblique, subcircular, peristome not reflected.

The type and two additional specimens (Cat. No. 133221, U.S.N.M.) were collected on a limestone ridge on the side of a rapid creek, at an altitude of 3,700 feet, in the Seven Devils Mountains, Idaho, by Mr. Vernon Bailey of the United States Biological Survey. This shell is at once distinguished from *Oreohelix idahoensis idahoensis* Newcomb by its much smaller size, more depressed form, decidedly open, funnel shaped umbilicus, and the presence of a slender peripheral keel.

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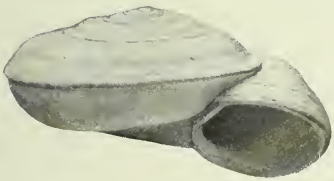

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TWO NEW LAND SHELLS FROM THE WESTERN STATES.

FOR DESCRIPTION SEE PAGES 331 AND 333.

18

TWO NEW LAND SHELLS OF THE EPIPHRAGMOPHORA TRASKII GROUP

BY

PAUL BARTSCH

Curator, Division of Marine Invertebrates, United States National Museum

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1918

TWO NEW LAND SHELLS OF THE EPIPHRAGMOPHORA TRASKII GROUP

BY

PAUL BARTSCH

Curator, Division of Marine Invertebrates, United States National Museum

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No. 2246.—From the Proceedings of the United States National Museum, Vol. 54, pages 523–524, with Plate 83

Washington
Government Printing Office
1918

TWO NEW LAND SHELLS OF THE EPIPHRAGMOPHORA TRASKII GROUP.

By Paul Bartsch,

Curator, Division of Marine Invertebrates, United States National Museum.

My short paper on the Californian land shells of the *Epiphragmophora traskii* group [1] resulted in having a lot of land shells sent to me by west American collectors for classification.

Among these are two lots which represent races not heretofore described. They were collected by Mr. Herbert N. Lowe, of Long Beach, California, in mountains from which no material was available at the time the paper mentioned above was prepared. It is quite possible that careful collecting in the higher altitudes of other isolated peaks in Southern California and adjacent Mexican territory will bring additional forms to our attention.

Mr. Lowe has kindly donated both types to the United States National Museum, and I take great pleasure in bestowing the name *Epiphragmophora cuyamacensis lowei* on the new form from Palomar Mountain.

EPIPHRAGMOPHORA CUYAMACENSIS LOWEI, new subspecies.

Plate 83, figs. 1, 2, 3.

Shell very large, depressed, helicoid, broadly, openly umbilicated, horn colored, with a chestnut band at the periphery which is flanked on each side by a narrow zone, a little lighter than the general color of the shell. Nuclear whorls one and a half, moderately rounded, marked by retractively curved, incremental lines and scattered papillae. Postnuclear whorls marked by somewhat irregularly spaced and irregularly developed, retractively slanting, depressed lirations, which give to the surface a somewhat roughened aspect, and rather strongly developed, elongated papillae which are arranged in series that form curves, slanting in just the opposite direction from the incremental lines. These papillae are rather regularly developed and quite evenly distributed on the upper surface; on the lower surface they are shorter and inclined to be hemispherical.

[1] Proc. U. S. Nat. Mus., vol. 51, pp. 609–619, pls. 114–117, 1916.

Here, too, they are quite regularly distributed, but a little more densely spaced immediately behind the aperture than on the rest of the shell. Aperture large; outer lip very slightly reflected; inner lip expanded at the base and slightly reflected over the umbilicus; parietal wall covered by a thin callus.

The type (Cat. No. 216906, U.S.N.M.) has six whorls and measures—altitude, 15.9 mm.; greater diameter, 26.7 mm.; lesser diameter, 21.2 mm. It comes from Palomar Mountain, which Mr. Lowe informs me is sometimes called Smith Mountain. He states further that this is a detached mountain midway between the San Jacintos on the north and the Cuyamacas on the south. He says that it is about 5,700 feet at the highest peak, and that the shell was obtained at an altitude of 5,000 feet.

EPIPHRAGMOPHORA TRASKII ISIDROENSIS, new subspecies.

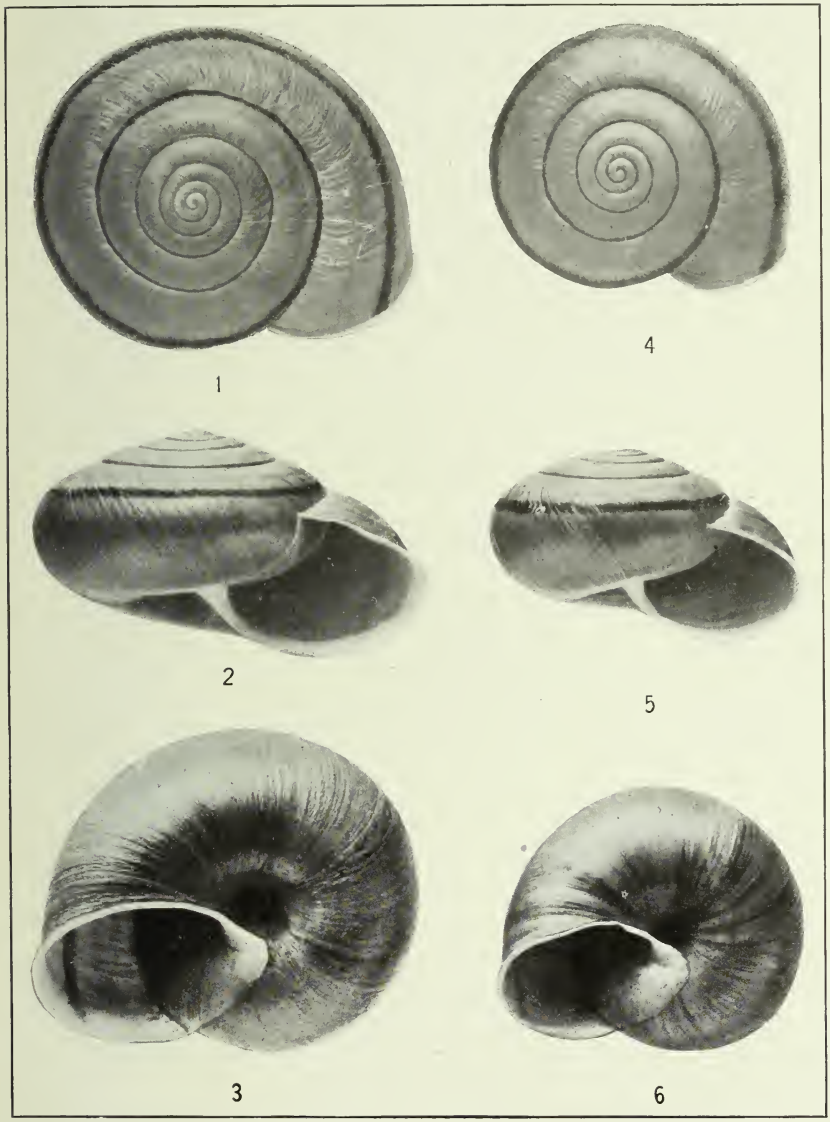
Plate 83, figs. 4, 5, 6.

Shell depressed, helicoid, horn-colored, with a broad chestnut band at the periphery, that is edged on either side by a somewhat lighter zone than the general tint of the shell, which is almost as wide as the brown band. Nuclear whorls one and three-quarters, moderately rounded, densely covered with small papillae, which gives the entire surface a granulose appearance. The succeeding whorls are marked by decidedly, obliquely curved, retractive lines of growth and rows of well rounded, small papillae which form lines practically at right angles to the lines of growth. In addition to this sculpture the last two whorls are marked by rather distantly spaced, somewhat interrupted, feebly incised spiral lines. Base well rounded, with a moderately broad umbilicus, which is almost half covered by the reflected inner lip, marked by strong incremental lines and the weakly incised spiral striations which equal those on the upper surface. The general papillation is absent on the lower surface excepting immediately behind the aperture where there is a dense massing of very fine granules, which is also the case on the upper surface. Aperture large, subcircular; outer lip very slightly reflected; inner lip broadly expanded at the base and reflected to half cover the umbilicus.

The type and another specimen were collected by Mr. H. N. Lowe on Campo San Isidro Mountain on the Mexican border. The type (Cat. No. 216907, U.S.N.M.) has 5.5 whorls and measures—altitude, 13.5 mm.; greater diameter, 21.3 mm.; lesser diameter, 17.6 mm. The other specimen, which is in Mr. Lowe's collection, is not quite mature.

EXPLANATION OF PLATE 83.

FIGS. 1, 2, and 3. *Epiphragmophora cuyamacensis lowei.*
4, 5, and 6. *Epiphragmophora traskii isidroensis.*



NEW LAND SHELLS FROM CALIFORNIA

FOR EXPLANATION OF PLATE SEE PAGE 524

19

NOTES ON AN UNUSUALLY FINE SLAB OF FOSSIL CRINOIDS

BY

R. S. BASSLER

Curator, Division of Paleontology, United States National Museum

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No. 2009.—From the Proceedings of the United States National Museum, Vol. 46, pages 57–59, with Plates 1–2

Published November 29, 1913

Washington
Government Printing Office
1913

NOTES ON AN UNUSUALLY FINE SLAB OF FOSSIL CRINOIDS

BY

R. S. BASSLER

Curator, Division of Paleontology, United States National Museum

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Published November 29, 1913

Washington
Government Printing Office
1913

NOTES ON AN UNUSUALLY FINE SLAB OF FOSSIL CRINOIDS.

By R. S. Bassler.

Curator, Division of Paleontology, United States National Museum.

A large slab of fossil crinoids just prepared for the exhibition collections in the Division of Paleontology of the United States National Museum is so unique and of such interest that it seemed to the writer worthy of some special notice. This slab belongs to the unrivaled collection of fossil echinoderms deposited in the National collections by Mr. Frank Springer, who is preparing a monograph upon *Scyphocrinus*, the genus to which the crinoids represented on the slab belong. Mr. Springer has very kindly allowed the writer free use of his notes upon this genus in preparation of the present article.

For over 50 years paleontologists have known of certain bulblike crinoidal or cystoidal bodies in late Silurian and early Devonian rocks. American specimens were described by Hall in 1879 as *Camarocrinus*, but some years before Barrande applied the name *Lobolithus* to similar objects in the Silurian rocks of Bohemia. A large number of these bodies having been accumulated in the collections of the United States National Museum, Prof. Charles Schuchert in 1904 published a full account of them in his paper on "Siluric and Devonic Cystoidea and Camarocrinus." [1] Hall regarded *Camarocrinus* as a large chambered bulb to which was attached a column bearing at its distal extremity a large crinoidal calyx with unknown characters. Schuchert arrived at substantially the same conclusion, believing that "*Camarocrinus* thus appears to be the float of an unknown crinoid that was held together after the death of the individual by the firmly interlocked double walls of the exterior and interior while the crown and stalk dropped away. Under this hypothesis the float drifted with the sea currents, was finally filled with water, and the attenuated end being heavier sank in that position to the sea bottom." Although realizing that the last word had not been said in regard to *Camarocrinus*, this author believed that the supposition that these bodies were anchored in the mud with the stalk directed upward was not in accord with the facts. In Bohemia

[1] Smiths. Misc. Coll., vol. 47, 1904, pt. 2, pp. 201–272, 11 pls., 24 figs. No. 1482.

Camarocrinus (*Lobolithus*) is found associated with calices of the crinoid *Scyphocrinus*, and in 1900, Dr. F. A. Bather definitely associated these two genera as parts of one and the same organism.

No association of *Camarocrinus* and *Scyphocrinus* in America had ever been noted, although the *Camarocrinus* occurred frequently in such large numbers as to make up entire limestone layers. In Oklahoma, where these layers sometimes outcrop at the surface, cobblestone-like masses frequently strew the ground in great profusion. Since 1904 Mr. Springer has directed his efforts toward the discovery of new evidence upon *Camarocrinus*, with the result, as announced at the 1912 meeting of the Paleontological Society in New Haven, Connecticut, that he is now able to show, first, that the genus *Scyphocrinus* occurs at several horizons in the late Silurian and early Devonian of America; second, that the *Camarocrinus* bulbs are frequently connected at the distal end of the stem with crinoids belonging to the genus *Scyphocrinus;* and third, that these bulbs usually occur with the stalk end upward and not downward as before supposed. Mr. Springer will publish the evidence for these conclusions later, but a few notes regarding the slab which is the subject of the present article are in order.

During the summer of 1904, as recorded in Schuchert's paper, the present writer observed *Camarocrinus* in the bluffs along the Mississippi River a few miles north of Cape Girardeau, Missouri, in the outcropping edge of a layer with numerous large crinoid stems. In 1911 Dr. E. O. Ulrich found a detached mass of crinoidal limestone from the same layer in which was embedded the well-preserved calyx of a large *Scyphocrinus*. These discoveries were so promising of favorable results that Mr. Springer asked his private collector, Mr. Frederick Braun, to carefully examine this general area in the hope of finding the fossiliferous bed at some place sufficiently exposed for careful collecting. After a protracted search along the bluffs facing the Mississippi River, Mr. Braun finally succeeded in locating the crinoidal layer at a point where he could carry on quarrying operations. Here several weeks' work resulted not only in some most remarkable specimens of crinoid, but in settling finally the facts upon which the interpretation of *Camarocrinus* must depend. The work was of no small difficulty, as the physical obstacles were formidable. The layer could be readily traced but it was not everywhere fossiliferous, and as the crinoids occurred only on the lower side a place had to be found where there was a soft seam underneath along which the fossiliferous stratum would readily separate from the one next below. The fossiliferous part of the layer proved to be limited to a small area which contained the remains of a thickly crowded crinoid colony suddenly killed by some change in the water and embedded in the soft muddy sea bottom without material disturbance by currents.

Four large slabs ranging from 500 to 1,500 pounds weight each and a number of smaller pieces were selected, the whole weighing 4,500 pounds. Two of the slabs fit together, forming a single one of about 4 by 7 feet, containing the most important specimens. This is the slab now on exhibition in the United States National Museum. The remaining specimens have been prepared and form a part of the study series.

The locality was a number of miles distant from any station or landing, and it was necessary to transport lumber to make strong packing cases for the slabs, embedding them in plaster to insure the specimens from injury in handling. A chute was then constructed to slide the cases down with ropes and tackle from a rock levee to the water's edge, about 35 feet distant, where they were shipped on a passing river steamboat. Upon their arrival at the National Museum it was necessary to clear away the adherent clay with fine tools before the specimens could be seen or studied. In addition a large amount of time was consumed in removing the more or less hard calcareous matrix composed of innumerable arm and pinnule joints forced down between the arms of the specimens and firmly cemented by pressure.

The principal slab, of which a portion, one-sixth natural size, is shown on plate 1, contains 18 complete crowns, several of them with the stem attached for part of its length. Some have the calyx fairly rotund, but most of them are considerably flattened and often much distorted by contact with the *Camarocrinus* bulbs noted below. All have the strong, many-branched arms intact and often upward of 12 inches long. Two of the smaller but more complete calices, one-half natural size, are shown on plate 2. Besides these crowns several sets of arms are partly visible, belonging to calices which are entirely buried, either under other individuals or in the limestone matrix, which becomes firm and hard a short distance inward. Some parts of the slab are covered with a dense mass of stems lying parallel like stalks of grain in a sheaf, and many of the crowns lie with their arms pointing in the same direction, as if they had fallen over in the mud at the same time under the common impulse of a gentle current. Intermingled with the crowns and stems forming the chief remaining portion of the crowded surface are numerous *Camarocrinus* bulbs; some of them are well exposed and appear of good size, while in many cases only a part can be seen protruding among the other objects. All of them are considerably flattened and some much fractured from the pressure of the overlying mass of arms of the compact limestone deposit forming the main thickness of the heavy layer.

This slab has been mounted on a flat-topped glass-covered base and has been installed at the west end of the hall of Invertebrate Paleontology. Here the specimen serves a twofold purpose—first, in showing one method of fossilization, and, second, as an introduction to the biologic exhibit of fossil crinoids.

SLAB OF SCYPHOCRINUS. (ONE-SIXTH NATURAL SIZE.)

FOR EXPLANATION OF PLATE SEE PAGE 59.

TWO COMPLETE CALICES OF SCYPHOCRINUS. (ONE-HALF NATURAL SIZE.)

FOR EXPLANATION OF PLATE SEE PAGE 59.

20

CHITONS TAKEN BY THE UNITED STATES FISHERIES STEAMER "ALBATROSS" IN THE NORTHWEST PACIFIC IN 1906

BY

S. STILLMAN BERRY

Scripps Institution for Biological Research, La Jolla, California

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No. 2223.—From the Proceedings of the United States National Museum, Vol. 54, pages 1–18, with Plates 1–10

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By S. Stillman Berry,

Scripps Institution for Biological Research, La Jolla, California.

A small series of chitons taken in the course of the Northwest Pacific Expedition of the United States Fisheries Steamer *Albatross* during the summer of 1906 was kindly transferred to the writer by Dr. Harold Heath, of Stanford University, for study and report, and forms the subject matter of the present paper. Though rich neither in species nor in individuals, the fact that our knowledge of the chiton fauna of this region is slight and the fortunate circumstance that the specimens were kept in alcohol render the material noteworthy. The collection comprises in all some 45 specimens. These are referable to 11 species, of which the 4 named below are described as new:

Leptochiton diomedeae, new species.
Ischnochiton (*Lepidozona*) *amabilis*, new species.
Ischnochiton (*Lepidozona*) *interfossa*, new species.
Ischnochiton (*Lepidozona*) *pilsbryanus*, new species.

Family LEPIDOPLEURIDAE.

Genus LEPTOCHITON Gray 1847.

LEPTOCHITON DIOMEDEAE, new species.

Plate 1, figs. 1–3; plate 2.

Description.—Shell rather small, elliptical, the shell and girdle together approximately twice as long as broad. Insertion plates lacking. Valves moderately elevated, sharply arcuate. Anterior valve with a concave anterior slope due to the apical region rising more abruptly than the slightly flaring marginal region; posterior margin broadly ∧-shaped in outline when the valve lies in its normal position. Median valves with small but sharp and rather prominent beaks, their anterior margins only slightly arcuate except the second

valve, where the tegmentum extends well forward mesially. Tail valve lower and a trifle narrower than the head valve, the flaring margin rendering the posterior slope distinctly concave; central area mildly convex, the anterior margin arcuate; mucro a little in front of the center.

Anterior valve with a sculpture comprising a large number of small, sharp, conical granules of ovate outline, very closely placed with a greater or less quincuncial arrangement, so that there often appear evidences of a secondary ranking of the granules in series oblique to the lines of growth. Intermediate valves with distinct lateral areas, the mesial regions of the latter somewhat sunken, but their anterior margins raised to form a pseudo-rib; finer sculpture of lateral areas very similar to that of the head valve; central areas everywhere except in the immediate vicinity of the beaks covered with a copious fine file-like sculpture of crowded, but distinct and rarely overlapping pustules like those described except that toward the sides they show a quite definite arrangement in longitudinal lines (these lines being roughly continuous with the less definite and more oblique series of the lateral areas in a manner not brought out in the drawing). The posterior valve corresponds in sculpture to the remainder of the shell (pl. 1, fig. 1).

Interior of head valve simple, but quite heavily calloused near the margin. Intermediate valves with sutural laminae well separated, broadly triangular, acute in front, and attached beneath the tegmentum in such a way that the latter projects over somewhat at the base and there is a notch giving a false appearance of slitting at the sides; anterior sinus broad at the base, not quite as wide as the adjoining laminae. Posterior valve with a rather heavy callus at the margin and another supporting the sutural laminae which are shorter and have more rounded margins than those of the intermediate valves (pl. 2, fig. 2).

Girdle with a dorsal armature of small, close-set spines, usually very even in size, but occasionally both at the margin and elsewhere a few scattered dagger-like spines, two or three times the length of the commoner ones, may be noted (pl. 1, fig. 3; pl. 2, fig. 5). With rather frequent exceptions all the spines show an outward trend. No striation can be detected with such magnification as I have been able to use. The spinelets of the ventral surface differ in their close palisading, smaller size, more conical outline, and even greater uniformity for any given region of the girdle (pl. 2, fig. 4).

Radula with large, strongly bidentate second laterals, medians small and mushroom-like in outline, first laterals small. My preparation of the radula did not prove satsfactory and the drawing merely serves to indicate the main features (pl. 2, fig. 6).

Color (in alcohol) a light yellowish brown without mottlings, Interior of valves white.

The ctenidia are posterior in position and number about 12 on each side.

Maximum length of type, 15 mm.; width, 8 mm.

Type.—Cat. No. 215625, U.S.N.M. [S. S. B. 95].

Type-locality.—Station 4967, 244–253 fathoms, brown mud, etc., bottom temperature 45.9° F., off Shio Misaki Light, Japan.

Remarks.—This little species is fairly large for a *Lepidopleurus*, but offers no particularly striking characters. The three recognizable Japanese members of the genus, *L. hakodatensis* Thiele, *L. japonica* Thiele, and *L. assimilis* Thiele, are all from much shallower water and differ entirely in the possession of broad, striated girdle scales little resembling the smooth, narrow spinelets of the present form. The radula of the latter is also distinctive, possibly showing most resemblance to that of *L. hakodatensis* as figured by Thiele.

Family CALLOCHITONIDAE.

Genus TONICELLA Carpenter, 1873.

TONICELLA SUBMARMOREA (Middendorff, 1846).

1846. *Chiton submarmoreus* Middendorff, Bull. Phys.-Math., Acad. Sci. Petersburg, vol. 6, No. 8.
1848. *Chiton submarmoreus* Middendorff, Mem. Acad. Sci. St. Petersburg, vol. 6, p. 98.
1886. *Tonicella submarmorea* Dall, Proc. U. S. Nat. Mus., vol. 9, p. 210.
1892. *Tonicella submarmorea* Pilsbry, Man. Conch. (1), vol. 14, p. 42, pl. 10, figs. 16–24.

Three specimens were taken between tides at Nikolski, Bering Island, June 15, 1906 [S. S. B. 116]. Two of these are entered as Cat. No. 215626, U.S.N.M.

The species has already been recorded from Bering Island by Dall.

Genus SCHIZOPLAX Dall 1879.

SCHIZOPLAX BRANDTII (Middendorff, 1847).

1848. *Chiton Brandtii* Middendorff, Mem. Acad. Sci. St. Petersburg, vol. 6, p. 128.
1848. *Chiton Brandtii* Middendorff, Bull. Phys.-Math., Acad. Sci. St. Petersburg, vol. 6, No. 8, pp. 117–118.
1879. *Schizoplax Brandtii* Dall, Proc. U. S. Nat. Mus., vol. 1, pp. 2, 296, 328, pl. 1, fig. 8 (dentition).
1884. *Schizoplax brandtii* Dall, Proc. U. S. Nat. Mus., vol. 7, p. 344.
1892. *Schizoplax brandtii* Pilsbry, Man. Conch. (1), vol. 14, p. 47, pl. 11, figs. 32–37.

One specimen taken between tides at Nikolski, Bering Island, June 15, 1906 [S. S. B. 117].

The species has already been listed from Bering Island by Dall.

Family ISCHNOCHITONIDAE.

Genus ISCHNOCHITON Gray, 1847.

Subgenus ISCHNORADSIA Shuttleworth, 1853.

ISCHNOCHITON (ISCHNORADSIA) ALBRECHTI (Schrenck, 1863).

Plate 1, figs. 4–5; plate 3, figs. 1–2.

1863. *Chiton Albrechti* SCHRENCK, Bull. Phys.-Math., Acad. Sci. St. Petersburg, vol. 5, p. 511.

1867. *Chiton Albrechti* SCHRENCK, Reisen u. Forsch. Amur-Lande, vol. 2, Zool., p. 283, pl. 13, figs. 7–17.

1892. *Ischnochiton* (*Ischnoradsia*) *albrechti* PILSBRY, Man. Conch. (1), vol. 14, p. 147, pl. 19, figs. 70–74.

Material.—This fine chiton is represented in the collection by two large alcoholic specimens [S. S. B. 83], taken at Mororan, Island of Yesso, Japan, July 6, 1906, during one of the shore expeditions. One of these is entered as Cat. No. 215627, U.S.N.M.

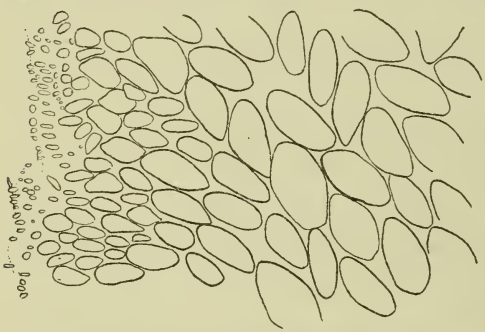


FIG. 1—ISCHNOCHITON ALBRECHTI [83], PORTION OF GIRDLE SEEN FROM ABOVE; CAMERA DRAWING FROM A MOUNT IN BALSAM; × 28.

Remarks.—The shell and girdle characters have been well described by Pilsbry, but figures of the radula are now given for the first time (pl. 3, fig. 2). The latter is well developed in this species, the powerful second laterals being armed with a strong, long, entire cutting edge, and the third laterals having a conspicuous basal process.

Even in the valves of a single individual great variation appears in the number of insertion plates. The specimen dissected shows the following formula: Anterior valve, 17; intermediate valves, respectively, 2–3, 2–2, 1–2, 2–2, 2–3, 2–3; posterior valve, 13 slits.

The branchiae number 47–49 on each side, extending practically the entire length of the foot.

ISCHNOCHITON (ISCHNORADSIA) HAKODADENSIS Carpenter, 1892.

Plate 1, figs. 6–7; plate 3, figs. 3–5; plate 4, figs. 1–3.

1892. *Ischnochiton* (*Ischnoradsia*) *hakodadensis* PILSBRY, ex Carpenter MSS., Man. Conch. (1), vol. 14, p. 147, pl. 19, figs. 64–66.

?1910. *Ischnochiton hakodadensis* THIELE, Revis. Syst. Chitonen, vol. 2, pp. 111, 112, pl. 8, fig. 44 (dentition).

A medium-sized chiton offering several quite puzzling features was taken rather abundantly by the shore expeditions of the *Albatross* both at Hakodate, Japan, and at Mororan, a port somewhat farther to the north. The specimens exhibit great variability, not only in color, but in the number of radial riblets (from 5 to 11) and marginal slits, but after much study I am unable to do otherwise than refer the

entire series to *I. hakodadensis*. Not only was Carpenter's original material from Hakodate, but a considerable degree of variation similar in character to that remarked upon is recognized in the excellent description by Pilsbry, while furthermore the mounted radulae taken at random from the material before me show very little variation.

Superficially the shell of *I. hakodadensis* is so generally similar to that of *I. albrechti* that I was not prepared for the striking differences to be found in their radulae. Although seemingly a much less powerful affair than the strong radula of *albrechti*, that of the present species is in many respects so much more complicated that I have not yet been able satisfactorily to elucidate all its details, nor can I secure preparations offering a reasonable coincidence with the sketches of two of the teeth given by Thiele. The latter divergence is possibly explicable on the assumption that the specimens which we have independently referred to the same species are not really conspecific. Here the major laterals are strongly bicuspid, with the inner cusp conspicuously the larger and longer, and bear a conspicuous wing-like expansion just below the crown but so narrowly attached at its base and hence so easily broken away that it is not always readily observable in dissected radulae and therefore does not show in most of my camera sketches (pl. 3, figs. 4, 5).

The valves of one of the specimens from Hakodate are slitted as follows: Anterior valve, 19; intermediate valves, respectively, 2–2, 3–3, 2–2, 2–2, 2–3, 2–2; posterior valve, 15 slits; interior bluish or brownish white. A Mororan specimen shows the formula: Anterior valve, 14; intermediate valves, 3–2, 2–3, 3–3, 3–3 (or 4?), 2–2, 2–3; posterior valve, 14 slits; interior deep slate blue.

The beautiful zigzag sculpture of flattened overlapping pointed pustules, which covers the central areas of young specimens, is usually eroded to the pitted appearance characteristic of the adults. It should be added that the girdle scales of my specimens seen *in situ* from above under a relatively high magnification are very weakly striate, not smooth, as described by Pilsbry, though in some of my mounted preparations the striae are almost impossible to distinguish (pl. 1, fig. 7; pl. 3, fig. 3).

The ctenidia number 28–32 on each side.

Material examined.

No. specimens.	Locality.	Collector.	Author's register.	Museum number.
11	Hakodate, Japan..	*Albatross*, 1906	[85]	Cat. No. 215629, U.S.N.M.
9	Mororan, Japan...	.....do.....	[84]	Cat. No. 215628, U.S.N.M.

Subgenus LEPIDOZONA Pilsbry, 1892.

Primarily because of certain differences observed in the radulae, Thiele removes the *Lepidozona* group of chitons from *Ischnochiton*, and this accomplished finds no recourse except to unite them bodily

with *Callistochiton*. With such a disposition of the group the investigations which I have thus far made do not lead me to concur, even though I can as yet suggest no better arrangement. It would not be surprising if *Lepidozona* should later on require elevation to generic rank, but for the present it is perhaps best to leave it where originally placed by Pilsbry.

ISCHNOCHITON (LEPIDOZONA) AMABILIS, new species.

Plate 3, figs. 6–7; plate 4, figs. 4–7; plate 5; figs. 1–4.

Description.—Animal small, elevated, rather elongate; maximum transverse diameter about three-fifths the length, or of shell alone about two-fifths the length.

Anterior valve rounded, conical; its frontal slope nearly straight, becoming slightly convex on the sides. Interior smooth, marked by about 12 sharp radial lines exactly corresponding to the slits at the margin; teeth slightly roughened at the edge and with rather coarse vertical striations on their outer surfaces (pl. 5, figs. 1–2).

Median valves elevated, beaked very slightly or even scarcely at all, the slopes distinctly convex. Sutural laminae short and broad, the shallow sinus bridged by a short, delicate, slightly concave plate, barely nicked at the margin to form about 8 very delicate squarish teeth; converging striations or lines corresponding in position to the slits continue back through the substance of the shell, the exact number of both slits and lines being often extremely difficult to determine, though the number appears to become considerably less in the more posterior valves. Eaves spongy and quite short (pl. 5, figs. 1–3).

Posterior valve with a rather depressed, yet conspicuous, mucro; posterior region flattened, its slope concave (pl. 5, fig. 4); side slopes convex; sutural plates and intermediate plate similar to those of the middle valves, except that there are only about half as many slits and lines as in the latter. The lines radiating from the mucro to the posterior slits are practically indistinguishable. The hinder margin is thickened and the central region shows a curious, much branched, triangular callus (pl. 5, fig. 2).

Anterior valve with 12, intermediate valves with 1–1, posterior valve with 11 slits.

Entire surface of shell closely and rather heavily granulose. Anterior valve otherwise smooth at the apex, but ornamented below by 33–40 low radial ribs having shallow, not sharply, incised grooves between; some ribs slightly bifurcating or otherwise rendered indistinct, but typically bearing a series of 5 or 6 separate sharply elevated pustules; the last series of pustules (4–8) on each side projecting like teeth from the valve margin. Intermediate valves with lateral areas sculptured like the anterior valve, the 6 or 7 low ribs usually bearing 3–8 pustules each, and the posterior series of 5–6

pustules projecting as dentations past the valve margin; central areas ornamented by some 22 (valve 7) to 26 (valve 4) nodulose ribs, for the most part slightly curved toward the jugum, connected by a series of much fainter and more irregular crossbars, the entire complex becoming reduced to a scarcely regular reticulum over the jugal tract. Posterior valve with central and posterior areas clearly marked, their sculpture closely similar to that of the intermediate valves; posterior area with some 18–24 pustulose radiating ribs, from which the pustules seem very often to be rubbed away (pl. 4, fig. 7).

Girdle wide, averaging about one-fourth the width of the median valves. Dorsal scales translucent, scarcely imbricating, strongly convex, the convexity directed obliquely outward and forward (except in the posterior region), and arranged with a fair degree of definiteness in oblique lines; variable in size, the largest occurring a short distance from the shell, the smallest at the margin; all distinctly ribbed-striate on the upper convexity, the number of striae being generally about 7 to 10 on the larger scales (pl. 4, figs. 5–6). Marginal scales minute, transparent, delicate, spiniform, finely striate, but a few smooth, needle-like spines now and then appearing among them. Ventral scales similar to the marginal, but elongate rectangular, and ranked in closely placed transverse series (pl. 3, fig. 6).

Color of shell in alcohol a warm orange brown, heavily mottled, and variegated with both darker and lighter tints. Girdle with alternate bands of orange brown and tan. Ventral surface a light pinkish tan. Interior of shell grayish pink with lavender clouding.

The radula has strong bidentate major laterals (pl. 3, fig. 7), but its further details have not yet been successfully worked out.

Ctenidia about 28 on each side, extending to a point nearly opposite the middle of the third valve.

Length of entire animal (type-specimen) 21, of shell 19 mm.; width of same 12.25, of shell 7.5 mm.; maximum width of girdle, 2.5 mm.

Type.—Cat. No. 215630, U.S.N.M. [S. S. B. 112].

Type-locality.—Station 4808,[1] 47 fathoms; bottom of sand, shells, and coarse gravel; off Cape Tsiuka, Japan; July 16, 1906 (three specimens).

Remarks.—This very attractive species seems chiefly characterized by the ruddy tones of its prettily maculated color scheme, the very weakly dentate sinus, the bidentate major laterals of the radula, and the small, little crowded, strongly ribbed girdle scales. The sculpturing of the central areas considerably resembles that of the following species, but here the longitudinal riblets are narrower, rougher, and have interspaces distinctly wider than the ribs, differences which are not shown well in the figures. A brief comparison

[1] The station number appearing on the original specimen label is 4708, but this seems clearly erroneous.

with such of the described forms as seem nearest allied is given in the course of our discussion of the next species.

ISCHNOCHITON (LEPIDOZONA) INTERFOSSA, new species.

Plate 3, figs. 8–9; plate 5, figs. 5–8; plate 6, figs. 1–4.

Description.—Animal small, elevated, rather elongate, the sides often nearly straight; maximum diameter about three-fifths the length, or of shell alone less than half the length.

Anterior valve rounded, conical, its slope very slightly convex. Interior smooth, marked by delicate lines radiating toward and in correspondence with the marginal slits; teeth slightly roughened at the edges, their outer surfaces faintly striate (pl. 5, figs. 5–6).

Median valves elevated, beaked, rather sharply carinate, their slopes very slightly convex. Sutural laminae broad; inner margins of same rather abrupt, anterior margins rounded and sloping off more gradually toward the sides; connected across the sinus by a short, delicate, weakly denticulate, concave plate, the minute slits separating the denticles continuing back into the shell as distinct incised lines, the number of these being uniformly 8. Eaves spongy and quite short (pl. 5, figs. 5–7).

Posterior valve with conspicuous mucro situated a little in front of the middle; posterior slope nearly straight (pl. 5, fig. 8). Sutural laminae and intermediate lamina similar to those of the preceding valves, except that there are 9 or 10 of the incised lines. Similar lines radiate from the region of the mucro to the posterior slits. There is a low, semicircular, rounded callus near the margin above the slightly roughened insertion teeth (pl. 5, fig. 6).

Anterior valve with 11, intermediate valves with 1–1, posterior valve with 10 slits.

Entire surface of shell very finely granulose. Anterior valve with immediate apex smooth; elsewhere with from 24–34 low, rounded, radial ribs, separated by shallow but rather sharply cut grooves; the ribs rarely showing a tendency to bifurcation, and typically ornamented with a series of some 6–8 separate, sharply elevated, round pustules, the posterior series on each side containing fewer pustules (4–6) a little larger than the others and projecting like denticles past the margin of the valve. Intermediate valves with lateral areas sculptured like the anterior valve, the 3–4 low ribs intergrooved as above, and bearing 2–3 pustules each, a series of 4–5 larger pustules occurring along the valve margin; central areas ornamented by some 20 (valve 7) to 24 (valve 4) straight or slightly curved, faintly nodulose, longitudinal riblets on each side, these riblets connected by slightly smaller and less regular transverse crossbars in such a manner that in some lights the surface appears reticulate, in others as though cut into lines of small square pits which become more irregu-

lar where the ribs curve over the jugal tract. Posterior valve with posterior and central areas very sharply delimited by a nearly straight line, the sculpture corresponding to that of the intermediate valves; posterior area with about 20–24 radiating pustulose ribs (pl. 6, fig. 2).

Girdle wide, averaging about a quarter the width of the median valves. Dorsal scales translucent, strongly convex, loosely imbricating, their convexities as a rule, except in the posterior region, directed obliquely outward and forward (pl. 6, fig. 4); variable in size, but largest near the shell, becoming exceedingly small at the outer margin, while a few scales larger than their immediate neighbors and of a more opaque whitish color occur scattered with no apparent regularity among the others. Mounted in balsam some of the smaller scales show a faint striation, but the larger appear almost perfectly smooth. Marginal armature comprising quite numerous, very minute, finely striate, conical, transparent spines, with a few scattered needle-like spines among them. Ventral scales minute, rectangular, rod-like, very closely ranked in transverse series (pl. 3, fig. 8).

Color of shell in alcohol a light grayish tan, faintly mottled with cloudings of a ruddier tone. Girdle pale above, with indistinct sutural bands of a darker shade. Entire ventral surface of animal and girdle a light pinkish tan. Interior of shell creamy, shading to warm tones of pink and salmon in the deeper regions.

Radula with strong, unicuspid major laterals, winged minor laterals, and well developed, fan-shaped rhachidian teeth (pl. 3, fig. 9).

Ctenidia about 28 on each side, extending forward to the second valve.

Length of entire animal (type-specimen) 21, of shell, 18.5 mm.; width of same 12.5, of shell 8 mm.; maximum width of girdle, 2.5 mm.

Type.—Cat. No. 215631, U.S.N.M. [S. S. B. 115].

Type-locality.—Station 4808,[1] 47 fathoms; bottom of sand, shells, and coarse gravel; off Cape Tsiuka, Japan; July 16, 1906 (three specimens).

Remarks.—*I. interfossa* is a very neat appearing little species and apparently a typical *Lepidozona*. Though much resembling the preceding species in form and sculpture, the color alone is sufficient for preliminary separation of the specimens, while a more minute examination reveals numerous differences. The special features are the large, smooth, whitish dorsal scales of the girdle; sharply angled jugum; beaked valves; sharply-cut grooves between the ribs of the anterior valve and lateral areas; the number of these ribs; and the very regular, basket-like sculpturing of the central areas, the longitudinal riblets being distinctly wider than the intervening spaces.

Of allied species *I. cultratus* Carpenter, according to Pilsbry's description, differs from both *I. amabilis* and *I. interfossa* in having

[1] These specimens were originally in the same vial as those of *I. amabilis*, so that here also the station number on the label requires correction.

but 4 ribs (separated by rather acute interstices, as in *interfossa*) on the lateral areas, 13 on the anterior valve, and but 16 narrow riblets on the central areas, the latter connected by irregular wrinkles rather than transverse bars. The anterior valve has only 8 slits, and the convex, *nondentate* sinus of the remaining valves is also distinctive if correctly observed. The dorsal girdle scales are said to be weakly striate.

I. craticulatus (Gould) differs from both the *Albatross* species in the far more numerous riblets of the lateral areas ("8–10"), and of the anterior valve ("about 50"), the minute latticing of the central areas, and the fact that the teeth of the head valve are said to be "distinctly notched or nicked at the edges and deeply, coarsely grooved outside." The girdle scales are described as striate.

I. coreanicus (Adams and Reeve) is insufficiently known and hence not liable to comparison with the above species in any certain fashion at the present time, though Pilsbry[1] has suggested a possible identity with *I. craticulatus*.

The only other *Lepidozona* which I can find to have been recorded from this region is *I. mertensii* (Middendorff), a much more coarsely sculptured species, with which none of the *Albatross* forms are likely to be confounded.

ISCHNOCHITON (LEPIDOZONA) PILSBRYANUS, new species.

Plate 6, figs. 5–9; plate 7.

Description.—Animal small, elevated, the sides only slightly convex; maximum transverse diameter a little less than half the length, or of shell alone about three-sevenths the length.

Anterior valve rounded, conical, its slope straight in front, becoming slightly convex on the sides (pl. 7, fig. 1). Interior smooth, marked with a series of about 13 delicate radiating lines corresponding to the marginal slits; teeth beveled, slightly rugose at the edges and obscurely and irregularly striate outside (pl. 7, fig. 2).

Median valves elevated, not beaked, high arched, sharply angled at the jugum, the side slopes nearly straight or very slightly convex. Sutural laminae short and broad; connected across the sinus by a delicate, scarcely projecting, very weakly dentate plate, the outline of the latter varying from strongly convex in the second valve to slightly concave in the more central valves, and showing apparently but about 8 slits, though there are some 10–12 of the incised lines which ordinarily correspond. Eaves short, relatively solid (pl. 7, figs. 1–4).

Posterior valve with mucro nearly median; posterior slope strongly concave; sutural laminae as described above, the minute slits and lines each about 8 in number; similar lines radiate from the mucro

[1] Man. Conch., vol. 15, p. 85.

region to the posterior slits, the concavity of the mucro forming the base of a low V-shaped callus extending forward; insertion teeth irregularly roughened at margin (pl. 7, figs 2, 5).

Anterior valve of paratype with 13 slits; intermediate valves with 2–2, 1–1, 1–1, 1–2, 2–2, 2–2 slits; posterior valve with 13 slits.

Entire surface of shell rather closely, heavily granulose. Anterior valve ornamented with many narrow radiating ribs, their total number about 55 at the margin, but becoming fewer and finally almost obsolete toward the apex, said ribs for the most part broken into a close set series of perhaps 20 low, distinct, rounded pustules, the latter often somewhat worn, and the posterior series larger and fewer (about 12) but so nearly obsolete as barely to dentate the margin; interspaces shallow and ungrooved. Intermediate valves with lateral areas slightly elevated and sculptured as above, the pustulose ribs 5–7 in number, and with a series of some 7–10 larger, but more obsolete, pustules bordering the posterior margin; central areas with 20 (valve 7) to 26 (valve 4) pustulose riblets on each side, usually a little narrower than their interspaces, the pustules small but distinct and coinciding with the lines of growth so as to appear grouped in squares, though usually the transverse connecting ridges are very faint if present at all; both ribs and pustules obsolete over the jugal tract. Posterior valve with posterior and central areas sharply delimited, the mucro forming an obtuse angle in their boundary; sculpture as above, the posterior area with 30–35 radiating pustulose ribs similar to those of the lateral areas (pl. 6, fig. 7).

Girdle wide, averaging about one-fourth the width of the median valves. Dorsal scales translucent, rather small, crowded, closely imbricate (pl. 6, fig. 8), their convex surfaces very finely ribbed-striate, the numerous (12–18) riblets being so delicate that the scales appear smooth under low magnifications (pl. 6, fig 9; pl. 7, fig. 6). Marginal scales small, partly needle-like, partly robust spiniform, the latter finely striate (pl. 7, fig. 6).

Color of shell in alcohol a light tan with scattered dark red-brown spots on the central areas and more numerously along the jugum, where they blend to form conspicuous triangular maculations. Girdle tan above, but darker and duller in tone than the groundwork of the shell and very indistinctly mottled with brown. Ventral surface of animal and girdle a light tan. Interior of shell a pale flesh color, some of the valves showing a narrow brownish ray on each side of the jugum.

The radula has strongly bicuspid major laterals, minutely winged minor laterals, and fan-shaped rhachidian teeth (pl. 7, fig. 7).

Ctenidia about 30 on each side, extending forward to the second valve.

Length of entire animal (type-specimen) 24, of shell 22 mm.; width of same 13, of shell 9 mm.; maximum width of girdle, 2.7 mm.

Type.—Cat. No. 215632, U.S.N.M. [S. S. B. 118].

Type-locality.—Station 4810; 195 fathoms; bottom of fine gray sand; bottom temperature 44.7° F.; off Cape Sirakami, Japan; July 16, 1906 (two specimens).

Remarks.—This handsome species is well characterized, the only one apparently requiring comparison with it being the *I. craticulatus* of Gould, but the latter is a more heavily granulose species and should be, according to the figures given by Pilsbry in his Manual, quite easy to distinguish. The special features of *I. pilsbryanus* seem to be in brief as follows:

1, the pale, tawny coloration.

2, the sharply arched, elevated shell.

3, the sculpture of numerous finely granulose riblets prevailing nearly all over the shell, and the arrangement of the pustules in squares without interlatticing on the central areas.

4, the reduplication of teeth and slits in many of the intermediate valves.

5, the numerous insertion slits (13) in each of the terminal valves.

6, the crowded, closely imbricating, very finely ribbed-striate dorsal scales.

The dedication of this species to Dr. Henry A. Pilsbry will require no apology to students of the group.

Family MOPALIIDAE.

Genus PLACIPHORELLA Carpenter, 1878.

PLACIPHORELLA STIMPSONI (Gould, 1859).

Plate 8, figs. 1–2; plate 9.

1859. *Chiton* (*Molpalia*) *stimpsoni* GOULD, Proc. Bost. Soc. Nat. Hist., vol. 7, p. 161.

1860. *Chiton* (*Molpalia*) *stimpsoni* GOULD, Otia Conch., p. 118, [fide Dall].

1886. *Placiphorella stimpsoni* DALL (part), Proc. U. S. Nat. Mus., vol. 9, p. 210.

1892. *Placiphorella stimpsonii* PILSBRY, Man. Conch. (1), vol. 14, p. 307, pl. 62, figs. 84–87.

Material.—The *Albatross* expedition took two specimens of this species between tides at Hakodate, Japan [S. S. B. 93].

Remarks.—I can add little to the excellent description given of the apparently somewhat variable shell characters by Pilsbry, but the preservation of the specimens in alcohol renders possible a few additional observations on the girdle. There is a series of large bristles near the middle of the girdle, one opposite each suture, and five or six continuing around the head valve. Other series of large bristles adorn the anterior lobe, more especially near the margin, in

addition to a number of smaller and less definitely arranged bristles and tufts of spines. The figure of one of the large bristles by Carpenter, which appears in the Manual (vol. 14, pl. 62, fig. 86) is very misleading, and I can only surmise that he must have mistaken the white or light-colored bands of spines, revealed by these specimens under a sufficiently high magnification, for spineless areas. When perfect the light and dark brown bands in alternation are a conspicuous feature of the bristles. An attempt is made to convey some idea of this in the accompanying drawing (pl. 9, fig. 4). Here it also appears that the spinose armature of all the larger bristles is exceedingly heavy, the spines being crowded upon one another in a fashion not conspicuously different from that observable in *P. velata* Carpenter. These two species are indeed exceedingly close and resemble one another much more nearly than either patterns the various Alaska-Bering Sea forms, with which they have at times been confounded.

In addition to those mentioned by Pilsbry, the following differences from California specimens of *P. velata* may be noted:

1, the shorter, wider valves.

2, the flatter outline.

3, the conspicuously marbled slate and buff coloration.

Outline drawings of the valves (pl. 9, figs. 1–3) and the typically Mopalioid radula (pl. 9, figs. 7–8) are here given, the latter for the first time.

The ctenidia number about 26 on each side.

PLACIPHORELLA BOREALIS Pilsbry, 1892.

Plate 8, figs. 3–5; plate 10.

1886. *Placiphorella stimpsoni* Dall (part), Proc. U. S. Nat. Mus., vol. 9, p. 210.
1892. *Placiphorella borealis* Pilsbry, Man. Conch. (1), vol. 14, p. 309, pl. 66 figs. 14–17.

Material.—Station 4803; 228 fathoms; bottom of black sand and gravel; bottom temperature 35.4° F.; off Cape Rollin, Simushir Island, Kuril Group; June 24, 1906 (seven specimens) [S. S. B. 94]. Four specimens are entered as Cat. No. 215633, U.S.N.M.

Remarks.—The shell of this species is the subject of a careful and detailed description by Pilsbry, but as the girdle characters have hitherto remained unknown it seems worth while to describe them in some detail. The dorsal surface of the entire girdle is covered with very minute pointed spinelets, rather heavily distributed. Among these one occasionally finds scattered spines or groups of spines slightly larger in size, a condition more evident near the margin than elsewhere. In addition occur the usual armored bristles characteristic of the genus, the most conspicuous being a fairly regular series bordering the entire anterior lobe a short dis-

tance within the margin, but inside of these only a few scattered bristles are evident, and taken as a whole the girdle is remarkably free of them. Most of them are quite broken away in my material, but a series of the stumps or "pores" can be made out running clear around the girdle, most of them corresponding to the sutures in position, though there are at least 6 or 7 behind the tail valve, and 2 in the same series on either side of the head valve. The extreme margin of the anterior lobe is decorated with a single series of short, very spinose bristles, between and beneath which occur a row of spines springing directly from the substance of the girdle itself (pl. 8, fig. 5). Toward the front of the lobe the spinose bristles are quite close together, but, although continued around the entire lobe, they become progressively smaller and more infrequent toward the sides and rear. The anterior margin frequently, if not always, exhibits a microscopic crenulation corresponding roughly to the bristles so that from certain aspects the latter appear as though borne upon small lobes. The contrast between the two types of bristles (i. e., marginal and dorsal) is very marked. The marginal bristles (pl. 10, fig. 6) have a bushy appearance, due to the very numerous spines, which, though not actually curved, often appear so because of the angle at which they project from the more or less twisted core. The dorsal bristles (pl. 10, fig. 4) are very narrow, trim, and slender, but larger, their long straight spinelets being much less crowded and closely applied to the core of the bristle for practically their entire length. Their arrangement is throughout very neat and regular. A cross section shows only about 8 spines to the tier on this type of bristle. The bristles do not appear to be banded, but are nearly uniform in color.

The radula (pl. 10, fig. 9) is of the same type as that of *P. stimpsoni* and *P. velata*, but the teeth show numerous differences in detail.

The ctenidia number 22–24 on each side.

The species has not been reported since its foundation by Pilsbry upon the valves of a single specimen obtained by Grebnitzki at Bering Island. The present record, therefore, constitutes a very appreciable extension of the known range. Despite his inadequate material, Pilsbry succeeded in acutely discriminating all the more important shell characters. *P. borealis* is, in fact, a very distinct species, and in the radiate sculpture of the anterior valve, complete sinus, and peculiar bristles, possesses features sufficient effectually to prevent confusion with any of the other described species, unless we consider the *Placophoropsis* group, the members of which are well separated by their subgeneric characters.

From *P. velata* and *P. stimpsoni* the more sparsely hairy girdle and much weaker armature of the bristles are striking differences.

Family CHITONIDAE.

Genus CHITON Linnaeus, 1758.

CHITON, species.

Plate 8, fig. 6.

A small specimen collected between tides at Aikawa, Rikuzen [S. S. B. 120], Cat. No. 215634, U.S.N.M., can not be identified with any of the described Japanese Chitonidae. It is quite likely new, and the accompaning illustration was prepared in the expectation of so treating it. Unfortunately the specimen seems at one time to have suffered immersion in formalin or some other decalcifying medium. At any rate, the valves proved so soft and subject to disintegration upon removal that their characters could not be made out with enough accuracy to justify naming the specimen. When the species is later rediscovered it may perhaps be recognized by the figure.

EXPLANATION OF PLATES.

PLATE 1.

FIG. 1. *Leptochiton diomedeae* Berry [95], dorsal aspect of first, third, and last valves of type specimen; × 8.

2. *Leptochiton diomedeae* Berry [95], entire animal in ventral aspect; × 3.
3. *Leptochiton diomedeae* Berry, dorsal view of portion of girdle of same specimen; drawn from a mount in balsam; × 28.
4. *Ischnochiton* (*Ischnoradsia*) *albrechti* Schrenck [83], dorsal view of portion of girdle; drawn from a mount in balsam; × 7½.
5. *Ischnochiton* (*Ischnoradsia*) *albrechti* Schrenck, a few scales from the same preparation as fig. 4 seen in greater magnification; × 27.
6. *Ischnochiton* (*Ischnoradsia*) *hakodadensis* Carpenter [85], dorsal view of portion of girdle of a specimen from Hakodate; drawn from a mount in balsam; × 10.
7. *Ischnochiton* (*Ischnoradsia*) *hakodadensis* Carpenter, a few scales from the same preparation as fig. 6 seen in greater magnification; × 27.

PLATE 2.

FIG. 1. *Leptochiton diomedeae* Berry [95], exterior view of first, third, and last valves of type; camera drawing; × 9.

2. Interior view of same, same scale.
3. Anterior view of third valve; same scale.
4. Isolated girdle scales from same specimen, the four larger from the dorsal, the four smaller from the ventral surface of the girdle; camera drawing from a mount in balsam; × 163.
5. Portion of girdle margin of same specimen, seen from above; camera outline from a mount in balsam; same scale as preceding.
6. Teeth from radula of same specimen; camera drawing from a mount in balsam; × 163.

PLATE 3.

FIG. 1. *Ischnochiton* (*Ischnoradsia*) *albrechti* Schrenck [83], isolated girdle scales drawn by camera from a mount in balsam; the largest scale shows radial striae, the others transverse color bands; × 31.
2. Isolated radula teeth from same specimen; camera drawing from a mount in balsam; × 31.
3. *Ischnochiton* (*Ischnoradsia*) *hakodadensis* Carpenter [84], isolated girdle scales of a specimen from Mororan; camera drawing from a mount in balsam; × 31.
4. Isolated radula teeth from same specimen; camera drawing from a mount in balsam; × 66.
5. *Ischnochiton* (*Ischnoradsia*) *hakodadensis* Carpenter [85], isolated radula teeth of a specimen from Hakodate; camera drawing from a mount in balsam; × 66.
6. *Ischnochiton* (*Lepidozona*) *amabilis* Berry [113], isolated girdle scales of paratype; camera drawing from a mount in balsam; × 31.
7. Two major lateral teeth from radula of same specimen, camera drawing from a mount in balsam; × 66.
8. *Ischnochiton* (*Lepidozona*) *interfossa* Berry [114], isolated girdle scales of paratype; camera drawing from a mount in balsam; × 31.
9. Isolated teeth from radula of same specimen; camera drawing from a mount in balsam; × 66.

PLATE 4.

FIG. 1. *Ischnochiton* (*Ischnoradsia*) *hakodadensis* Carpenter [85], dorsal aspect of a specimen from Hakodate; × $1\frac{1}{5}$.
2. Ventral aspect of same specimen; same scale.
3. Dorsal aspect of fourth valve of another specimen from the same lot; × 4.
4. *Ischnochiton* (*Lepidozona*) *amabilis* Berry [112], dorsal aspect of type; × 2.
5. Dorsal aspect of a portion of girdle of paratype [113]; camera drawing from a mount in balsam; × 11.
6. Portion of same preparation under greater magnification; × 50.
7. Dorsal aspect of first, fifth, and last valves of paratype [113]; × $6\frac{2}{3}$.

PLATE 5.

FIG. 1. *Ischnochiton* (*Lepidozona*) *amabilis* Berry [113], exterior view of first, fifth, and last valves of paratype; camera drawing; × $6\frac{1}{2}$.
2. Interior view of same; same scale.
3. Anterior view of fifth valve; same scale.
4. Profile of last valve; same scale.
5. *Ischnochiton* (*Lepidozona*) *interfossa* Berry [114], exterior view of first, fifth, and last valves of paratype; camera drawing; × 6.
6. Interior view of same; same scale.
7. Anterior view of fifth valve; same scale.
8. Profile of last valve; same scale.

PLATE 6.

FIG. 1. *Ischnochiton* (*Lepidozona*) *interfossa* Berry [115], dorsal aspect of type; × 2.
2. *Ischnochiton* (*Lepidozona*) *interfossa* Berry [114], dorsal aspect of first, fifth, and last valves of paratype; × 6.
3. Dorsal aspect of portion of girdle of same specimen; drawn from a mount in balsam; × 12.
4. Portion of same preparation under greater magnification; × 43. On the immediate area selected for illustration the scales are less crowded than is typically the case.
5. *Ischnochiton* (*Lepidozona*) *pilsbryanus* Berry [118], dorsal aspect of type; × 1½.
6. Ventral aspect of same; same scale.
7. *Ischnochiton* (*Lepidozona*) *pilsbryanus* Berry [119], dorsal aspect of first, third, and last valves of paratype; × 4.8.
8. Dorsal aspect of portion of girdle of same specimen; drawn from a mount in balsam; × 9½.
9. Portion of same preparation under greater magnification; × 27. The scales are typically much more crowded than appears in the drawing.

PLATE 7.

FIG. 1. *Ischnochiton* (*Lepidozona*) *pilsbryanus* Berry [119], exterior view of first, third, and last valves of paratype; part camera drawing; × 7.
2. Interior view of same; same scale.
3. Anterior view of third valve; same scale.
4. Interior view of left side of second valve; same scale.
5. Lateral view of tail valve; same scale.
6. Isolated girdle scales from same specimen; camera drawing from a mount in balsam; × 25.
7. Isolated teeth from radula of same specimen; camera drawing from a mount in balsam; × 52.

PLATE 8.

FIG. 1. *Placiphorella stimpsoni* (Gould) [93], dorsal aspect of a specimen from Hakodate; slightly magnified.
2. Ventral aspect of same; same scale.
3. *Placiphorella borealis* Pilsbry [94], dorsal aspect of a specimen from 228 fathoms, off Simushir Island; same scale.
4. Ventral aspect of same; same scale.
5. Portion of margin of anterior lobe of girdle of another specimen from the same lot; viewed ventrally from a preparation in balsam; × 18.
6. *Chiton* species [120], dorsal aspect of a specimen from Aikawa; × 2.4.

PLATE 9.

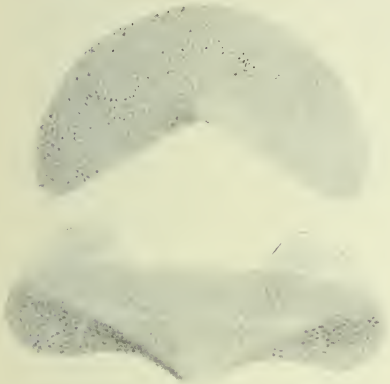
FIG. 1. *Placiphorella stimpsoni* (Gould) [93], exterior view of first, fourth, and last valves; camera drawing; × 2½.
2. Interior view of same; same scale.
3. Posterior view of sixth valve; same scale.
4. Basal portion of large spinose bristle from anterior lobe of girdle of same specimen; camera outline from a mount in balsam; × 65.
5. Isolated spine from large bristle; camera drawing; × 65.
6. Portion of margin of girdle near front of anterior lobe of same specimen; camera drawing from a mount in balsam; × 65.
7. Isolated teeth from radula of same specimen; camera drawing from a mount in balsam; × 65.
8. Series of teeth from one side of radula of same specimen; same scale as fig. 7.

PLATE 10.

FIG. 1. *Placiphorella borealis* Pilsbry [94], exterior view of first, third, and last valves; camera drawing; × 2¼.
2. Interior view of same; same scale.
3. Posterior view of fifth valve; same scale.
4. Basal portion of large spinose bristle from anterior lobe of girdle of same specimen; camera outline from a mount in balsam; × 60. On most bristles the spines appear to be more closely placed than is indicated in the drawing.
5. Portion of ventral surface of anterior lobe of same specimen, showing patches of spinelets; camera drawing from a mount in balsam; × 60.
6. Basal portion of marginal spinose bristle from anterior lobe of girdle of same specimen; camera drawing from a mount in balsam; × 60.
7. Isolated spines from ventral surface of anterior lobe of same specimen; camera drawing from a mount in balsam; × 150.
8. Isolated girdle and bristle spines from same specimen; camera drawing from a mount in balsam; × 150.
9. Isolated teeth from radula of same specimen; camera drawing from a mount in balsam; × 60.

NOTE.—The drawings on Plates 1, 4, 6, and 8 are from the brush of Mr. E. Russel Lord-Wood.

The majority of the figures as originally prepared were intended for plates of a larger size than those used in these Proceedings. Then again the plates first made were destroyed by fire and the make-up of several of them subsequently rearranged. This resulted in changes in the degree of magnification of the figures at a time when most of the specimens were no longer available for checking. There is therefore an unavoidable source of possible error in the magnifications as given.



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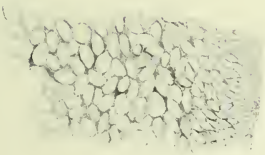

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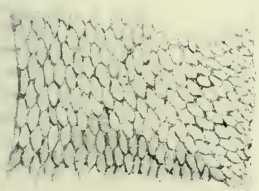

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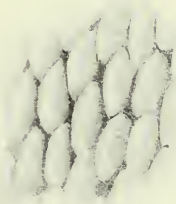

NORTHWEST PACIFIC CHITONS

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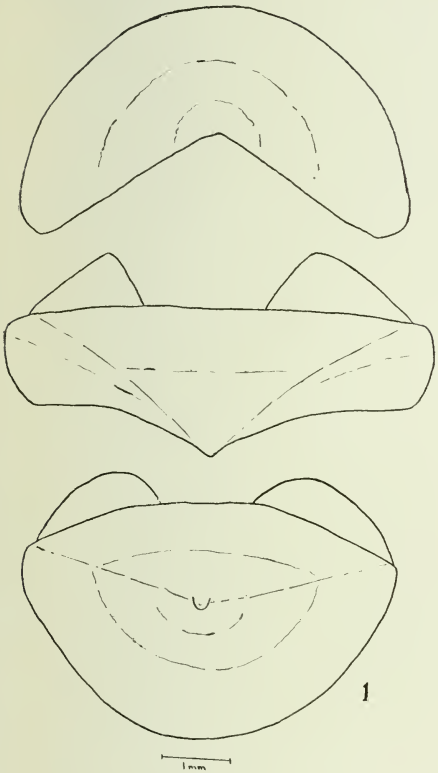

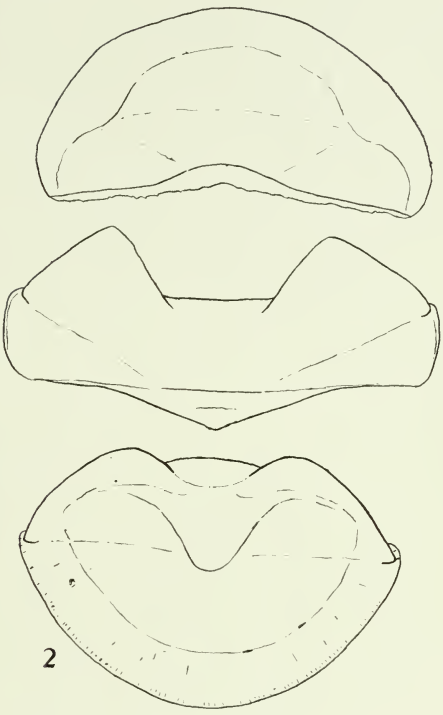

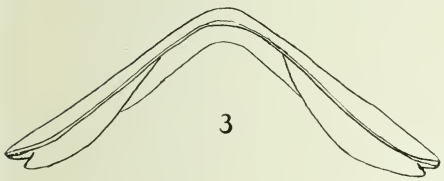

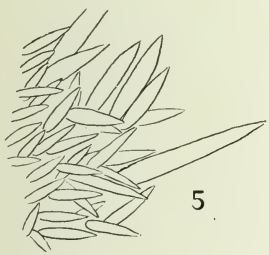

NORTHWEST PACIFIC CHITONS

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NORTHWEST PACIFIC CHITONS

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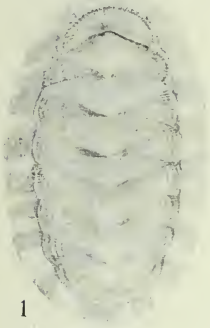

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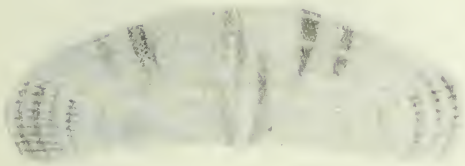

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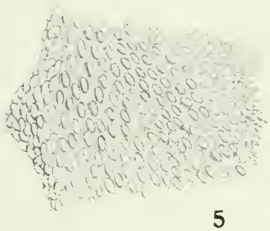

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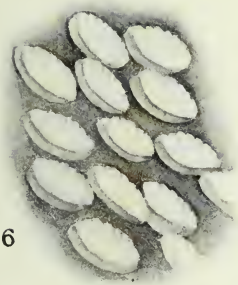

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NORTHWEST PACIFIC CHITONS

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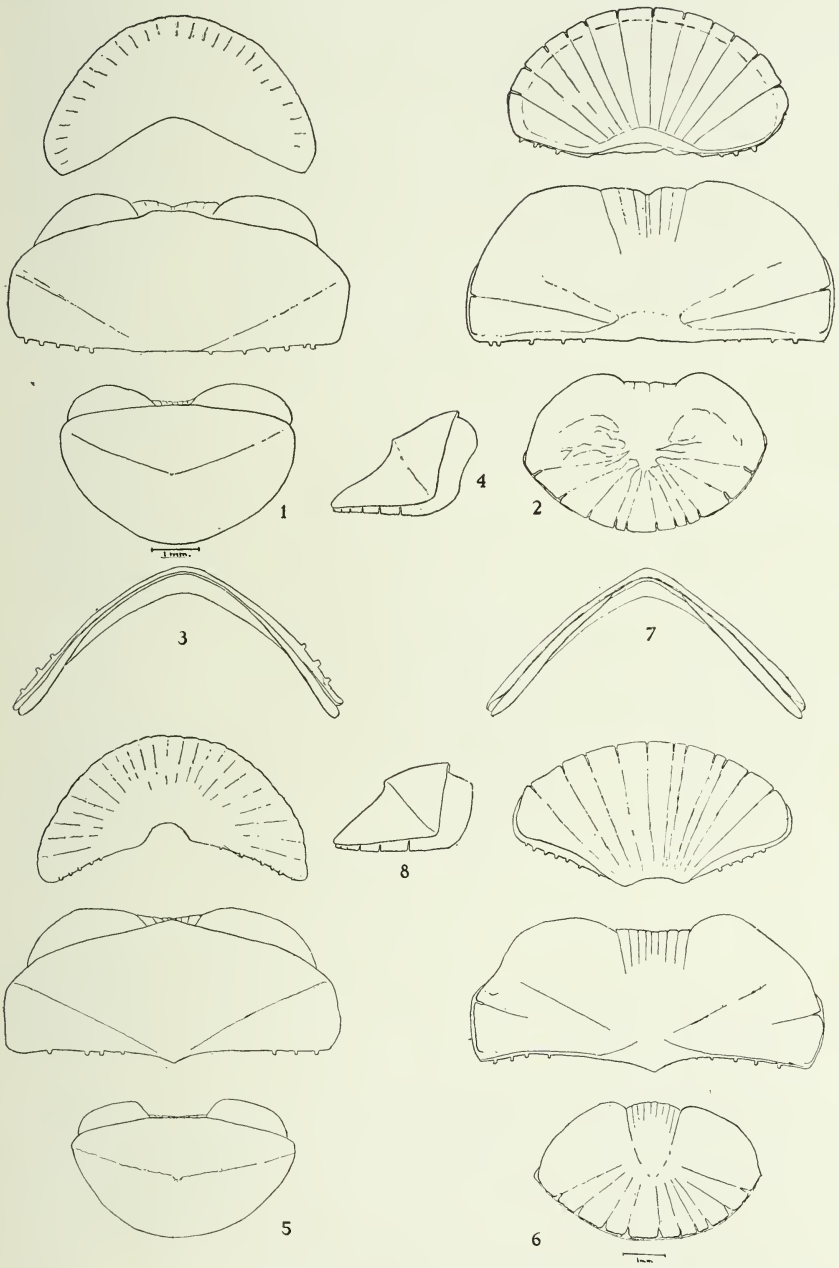

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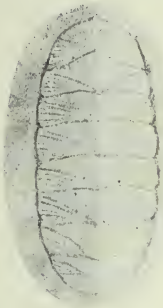

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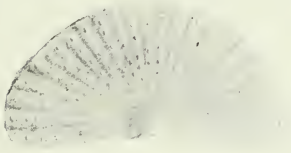

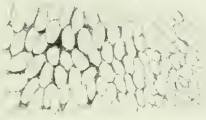

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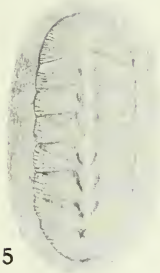

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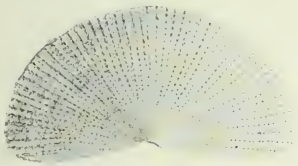

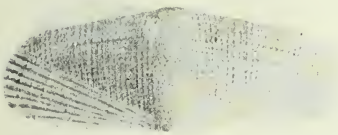

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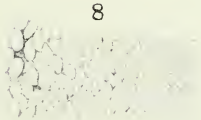

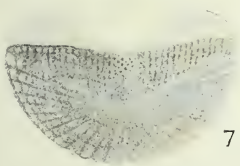

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NORTHWEST PACIFIC CHITONS

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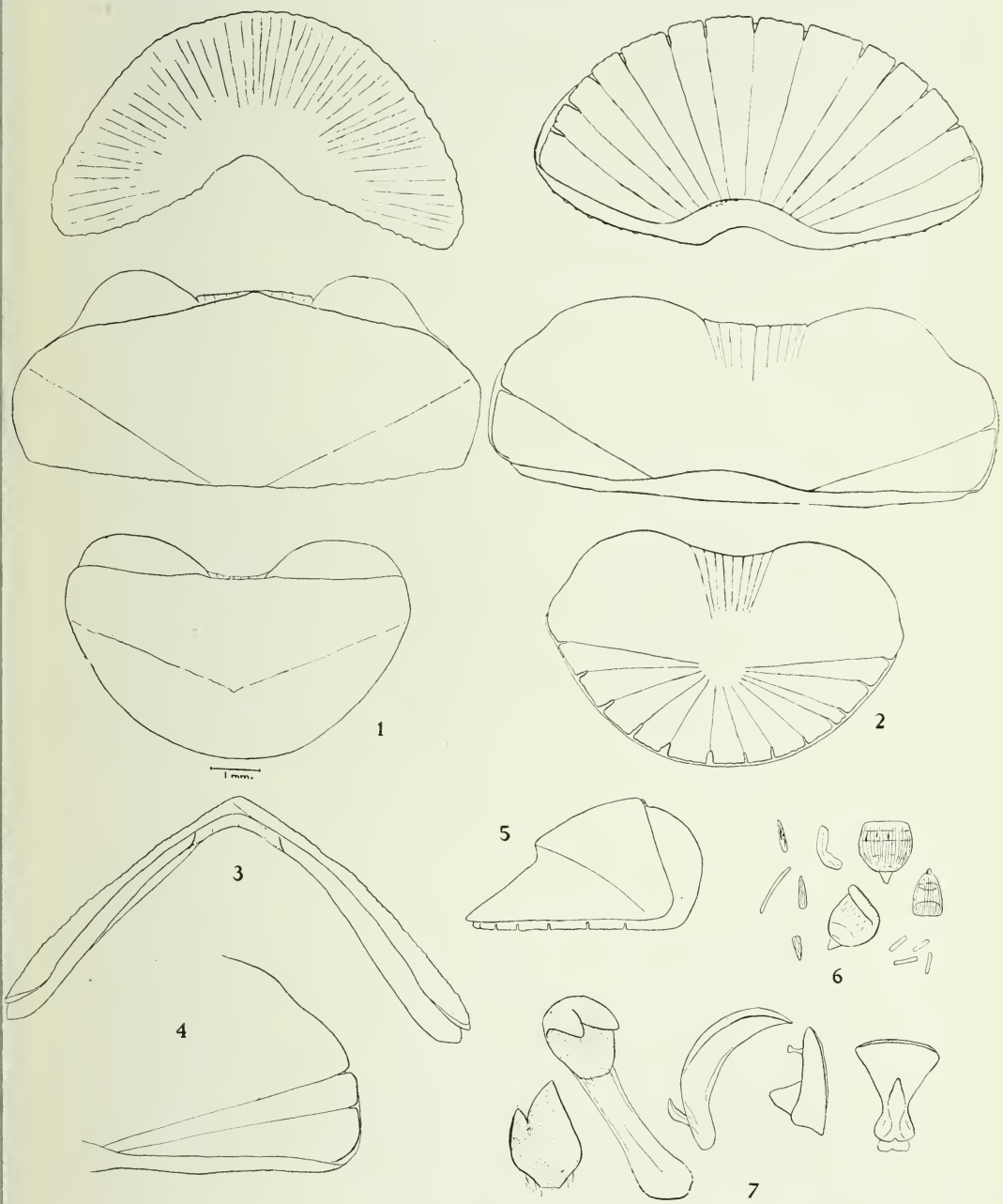

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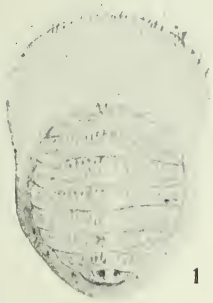
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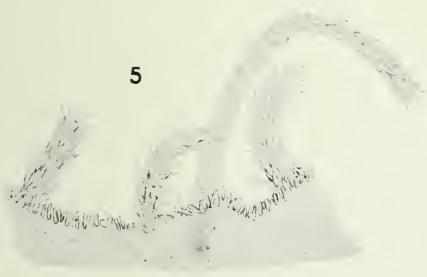
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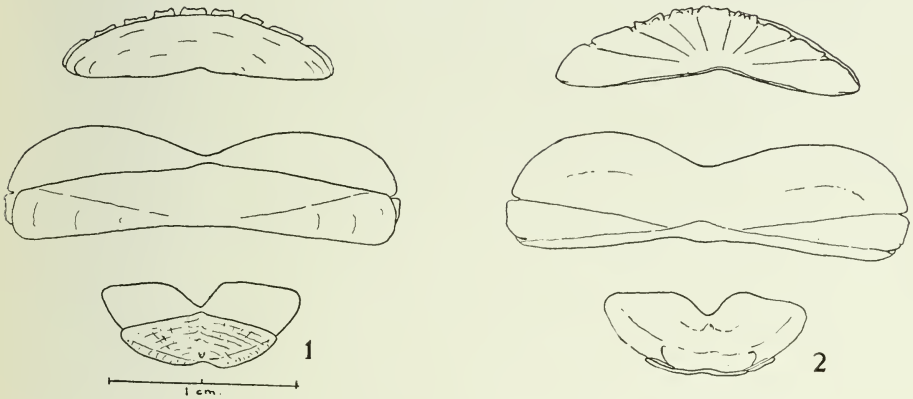

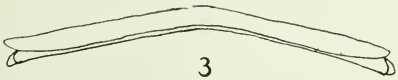

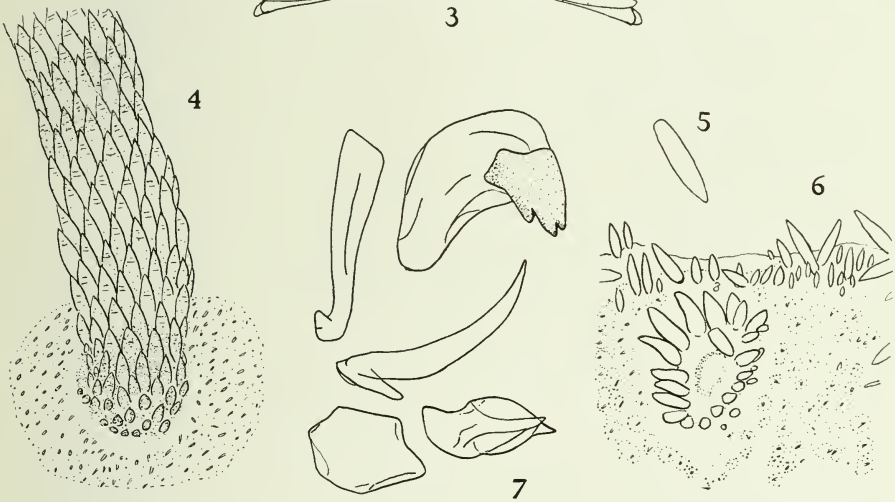

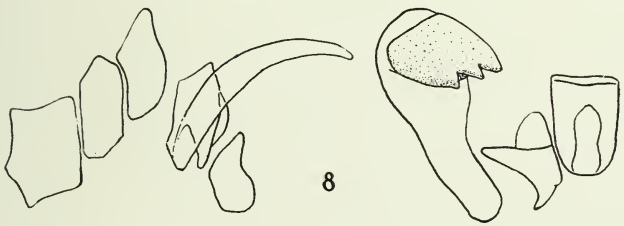

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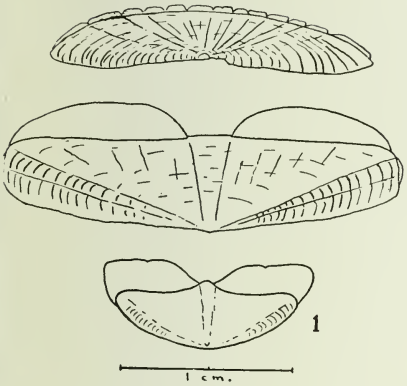

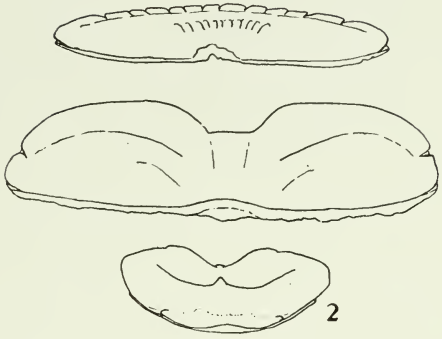

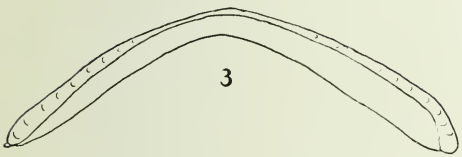

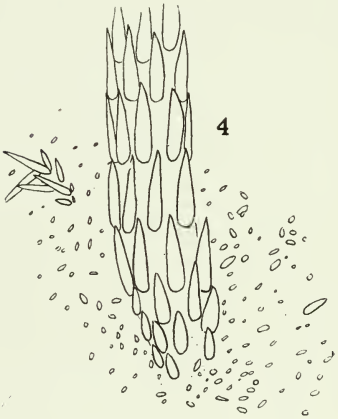

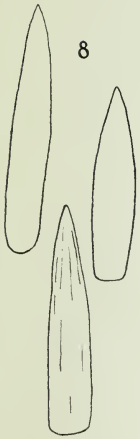

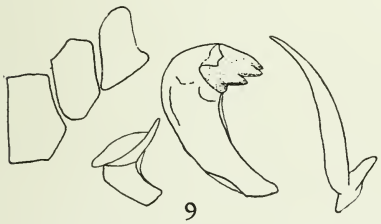

NORTHWEST PACIFIC CHITONS

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SOME NEW HAWAIIAN CEPHALOPODS

BY

S. STILLMAN BERRY

Of Redlands, California

No. 1996.—From the Proceedings of the United States National Museum,
Vol. 45, pages 563–566

Published June 4, 1913

Washington
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SOME NEW HAWAIIAN CEPHALOPODS.

By S. Stillman Berry,
Of Redlands, California.

The following brief notices of additional new forms of cephalopods from the United States Bureau of Fisheries steamer *Albatross* Hawaiian collections are offered in advance of the publication of the main report. A previous paper on the fauna has appeared in these Proceedings.[1]

LAETMOTEUTHIS, new genus.

Finned Octopods close to *Cirroteuthis*, but with the paired cirri apparently wanting. The well-developed radula has seven rows of teeth. The umbrella is ample as in *Cirroteuthis;* there is no "intermediate web."

Type.—*Laetmotheutis lugubris*, new species.

LAETMOTEUTHIS LUGUBRIS, new species.

Body large, rounded posteriorly; a pair of small, transversely elongate fins attached one at either side. Funnel very large.

Arms long, appearing merely as thickenings in the very extensive umbrella. Suckers large, flattened, distant; placed in a single somewhat zigzag series; paired cirri indistinguishable.

Beak large and powerful. Radula large and perfect, comprising seven rows of teeth, of which the tricuspid medians are conspicuously the largest.

Color a dark livid brown (chocolate colored when captured).

Type.—Cat. No. 214385, U.S.N.M. [S. S. B. 211]. From *Albatross* station 3904, off the north coast of Molokai.

Length of right dorsal arm, 430+mm.; of umbrella between dorsal arms, 300 mm.; of extracted radula, 22 mm.

This specimen is very fragmentary and was taken from the surface. A second similar specimen was taken at station 3898.

[1] Vol. 37, pp. 407–419, published December 30, 1909.

SCAEURGUS PATAGIATUS, new species.

Body small, short, rounded, compact; dorsal surface heavily tuberculate with small rounded papillæ which often coalesce to form longitudinal ridges, the arrangement of the latter showing a greater or less bilateral symmetry; a narrow keel bounds the periphery of the body on the sides but is discontinuous posteriorly; there is a large cirrus over each eye opening, with a smaller one just in front.

Head broad, but narrower than the body; eyes large. Funnel organ W-shaped.

Arms stout, somewhat over twice as long as the head and body taken together; subequal, the second pair slightly the longest. Umbrella well developed, especially between the dorsal arms. Third left arm in the male conspicuously hectocotylized; calamus very long and slender; the ligula spoon shaped, its inner face deeply excavated.

General color of living animal, pale green; of alcoholic specimens, a brownish buff marbled with chocolate.

Type.—Cat. No. 214379, U.S.N.M. [S. S. B. 204]. From *Albatross* station 4079, off the island of Maui.

Length (total), 152 mm.; posterior tip of body to base of dorsal arms, 46 mm.

EUPRYMNA SCOLOPES, new species.

Body small, sepioliform, of variable outline. Fins large, semicircular, attached in advance of the middle of the body. Nuchal commissure wide.

Head short, about the same width as the mantle; eyes large.

Arms short, stout, about as long as the mantle, their order of relative length 2, 3, 4, 1. Umbrella rudimentary between the dorsal arms and those of the ventral pair, but elsewhere better developed. Suckers on all the arms in four rows except at the extreme base and tip, where they are in two rows; pedicels short, stout; cups spherical, with small apertures; horny rings smooth. In the female the suckers on all the arms are relatively minute and subequal, but in the male some 6 to 10 suckers in each marginal row on the second, third, and fourth arms undergo a conspicuous enlargement; left dorsal arm of male hectocotylized—the first four pairs of suckers at the base in two rows, these succeeded by 10 quartets of small suckers, the two basalmost of the ventral row of which are reduced to slender papillæ; beyond its basal third the arm becomes much swollen, while the suckers of the two ventral rows are replaced by an irregular crowded series of transversely compressed papillæ, which continue to the tip, each bearing a minute aperture at its inner apex with a minutely toothed horny ring; the suckers of the two dorsal series undergo modification a little later than their ventral neighbors, finally appearing as a crowded double series of swollen tubercles which are neither so com-

pressed nor so closely palisaded as the latter. Tentacles of variable length; inner aspect of club of a villous appearance due to the exceeding minuteness of the numerous long-pediceled suckers which it bears.

Type.—Cat. No. 214380, U.S.N.M. [S. S. B. 320]. From *Albatross* station 3905, off the island of Molokai.

Length (total), 63 mm.; length of mantle (dorsal), 25 mm.

E. scolopes is a near ally of *E. stenodactyla* (Grant), but differs in the details of the hectocotylized arm and other secondary sexual characters in the male.

TELEOTEUTHIS COMPACTA, new species.

Small; mantle nearly cylindrical, ending posteriorly in an acute point. Fins enormous, broadly sagittate; their total width about equal to the length of the mantle; length a little more than half that of the mantle.

Head squarish, narrower than the body; eyes little prominent.

Arms short, stout, their order of length 3, 2, 4, 1; suckers in two widely interspaced rows; umbrella wanting. Tentacles little longer than the arms; clubs not thickened and bearing four series of acetabula, those of the medio-ventral series being transformed to hooks; the latter 10–11 in number, the first 5 quite small, next 3 larger, distal ones diminishing again; the two dorsal rows of suckers irregular, the first 5 pairs small and closely placed, the succeeding ones slightly larger and more distant, becoming smaller again distally; those of the inner dorsal row persist to the tip of the club, but the marginal series becomes obsolete distally and comprises only about 8 suckers; suckers of ventral row exceedingly minute, especially distally where they are placed very far apart; fixing apparatus well developed, comprising a quadruple series of small suckers and pads in alternation, about 12 of the former to 8 of the latter.

Type.—Cat. No. 214381, U.S.N.M. [S. S. B. 238]. From *Albatross* station 3989, vicinity of the island of Kauai.

ABRALIA TRIGONURA, new species.

Mantle short, wide and inflated in front, tapering to a point posteriorly. Fins large, a little over half as long as the mantle.

Head small; eyes large and prominent.

Arms over two-thirds as long as the body; nearly equal, but the dorsal pair distinctly the shortest; each bears two rows of small alternating hooks, succeeded by suckers at the extremities.

Structure of tentacles unknown.

Buccal membrane papillose and uniformly pale within; its outer surface dotted with small reddish chromatophores.

Photogenic organs of the ventral aspect of the head and mantle of two main types differing both in size and pigmentation; on the lower surface of the mantle the larger organs are arranged in longitudinal series, with the smaller organs irregularly scattered between them. The ventral surface of the funnel shows two large triangular groups of organs symmetrically disposed; four of these are of the larger type but do not lie in a single transverse series.

Type.—Cat. No. 214387, U.S.N.M. [S. S. B. 275]. From *Albatross* station 4087, northeast entrance to Pailolo Channel.

The single specimen seen is badly macerated, but does not seem to be conspecific with *A. andamanica* Goodrich, which it undoubtedly much resembles. The chief differences appear in the detailed distribution of the photogenic organs. In the present species the two median series of large organs which adorn the ventral aspect of the mantle are an especially conspicuous feature.

PTERYGIOTEUTHIS MICROLAMPAS, new species.

Body small, cylindro-conical, terminating posteriorly in a sharp spine-like process extending well past the rather large circular fins; fins attached along their inner margins for less than half their total length.

Head large, rounded; eyes large and prominent.

Arms short, nearly equal, their order 3, 2=4, 1; suckers in two rows, on the dorsal arms about 14 pairs, the ventral members of the eighth to tenth pairs transformed into hooks; second and third arms similar; ventral arms without hooks, their suckers very minute and confined to the more distal portion of the arm. Tentacles stout, but little longer than the arms; stalk thickened but constricted at base; club not expanded, bearing four series of minute suckers, of which the five proximal members of the dorsal row are distinctly the largest; two suckers and two pads in the fixing apparatus on the carpus. Subocular photogenic organs 14 in number; arrangement very similar to that described for *P. giardi* Fischer, but four instead of five small anterior organs, and the most anterior of these displaced laterally so that it is not in line with the others.

Type.—Cat. No. 214386, U.S.N.M. [S. S. B. 277]. From *Albatross* station 4105, in the Kaiwi Channel.

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(From the 27th Annual Report of the Department of Geology and Natural Resources of Indiana, 1902.)

ON SOME MOLLUSCA KNOWN TO OCCUR IN INDIANA.

A Supplementary Paper to Call's Catalogue.

By W. S. BLATCHLEY AND L. E. DANIELS.

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING.
1903.

With the compliments of
L E Daniels

On Some Mollusca Known to Occur in Indiana.

A SUPPLEMENTARY PAPER TO CALL'S CATALOGUE.

By W. S. Blatchley and L. E. Daniels.

INTRODUCTORY.

In the Twenty-fourth (1899) Annual Report of this Department, Dr. R. E. Call published an extensive paper entitled "A Descriptive, Illustrated Catalogue of the Mollusca of Indiana." In this paper he described, and for the most part figured, 184 species of land and fresh water shells from different parts of the State. During the past two years, Mr. L. E. Daniels, one of the authors of this paper, has spent the months from April to November in the field, collecting shells and other forms of life for the State Museum. As a result of his research, 91 species and varieties of mollusca not listed by Call have been taken in the State. In the present paper we publish descriptions of each of these and note the localities in which they have been taken. The descriptions are, for the most part, copied from the works of Binney, Say, Pilsbry, Baker, Sterki, and other special students of mollusca. The nomenclature and general arrangement of the land shells is that of Pilsbry's "Classified Catalogue with Localities of the Land Shells of America North of Mexico."

Our thanks are due Messrs. Bryant Walker, Detroit, Mich.; F. C. Baker, Chicago, Ill.; H. A. Pilsbry, Philadelphia, Pa.; Chas. T. Simpson, Washington, D. C.; A. C. Billups, Lawrenceburg, Ind., and Dr. V. Sterki, New Philadelphia, Ohio, for aid in determining and verifying specimens.

ON SOME MOLLUSCA KNOWN TO OCCUR IN INDIANA.

A Supplementary Paper to Call's Catalogue.

By W. S. Blatchley and L. E. Daniels.

Family HELICIDÆ.

1. Vallonia costata Muller.

"Small, depressed convex, rather solid, umbilicated; surface shining, with regular membranous ribs of good size, the intercostate spaces being finely striate; color reddish horn; periphery a trifle angled; sutures deeply impressed; whorls three and one-half, rapidly increasing, the last expanding and descending, somewhat angular on the periphery; spire flat, apex finely striate; aperture nearly circular, a little oblique, flattened above, angular below; peristome reflected, white, terminations approaching and connected by a thin callus; umbilicus open, large, spreading, exhibiting all the volutions. Greater diameter, 2.70 mm.; lesser, 2.25 mm.; height, 1.30 mm."—*Baker.*

Range.—Quebec to Washington, west to Colorado.

Indiana Localities.—A few specimens were taken beneath the bark of logs in a marsh at the south end of Lake Maxinkuckee, Marshall County. A number labeled "Indiana" are in the State Museum collection. This species is distinguished from *V. pulchella* by its numerous heavy ribs and darker color.

2. Polygyra leporina (Gould).

"Shell with a partially covered umbilicus, depressed, orbicular, thin, reddish horn-color, delicately striated, and, when fresh, having a delicate down on its surface; spire depressed, composed of five slightly convex whorls, the last of which is obtusely angular at its

upper portion; base convex, excavated at the umbilical region, with a minute, partially covered umbilicus; aperture oblique, lunate; peristome incumbent, rose-colored, reflexed, bearing on its dilated basal edge two expanded teeth, separated by a deep, narrow fissure, its terminations joined by a quadrate, erect, oblique lamella, whose upper edge is joined to the upper angle of the aperture by a thread-like callus; an internal, fulcrum-like tubercle, with uneven outer edge on the base of the shell. Greater diameter, 6 mm.; lesser, 5.5 mm.; height, 3 mm."—*Binney.*

Fig. 1. *Polygyra leporina* (Gould).

Range.—Southern Indiana through Kentucky and Tennessee to Georgia, Missouri and Texas.

Indiana Localities.—In this State *leporina* was first taken in Henry County by E. Pleas.* Mr. Daniels has taken it one-half mile east of New Harmony, Posey County, and near North Vernon, Jennings County. In both places it occurs in small numbers beneath logs, near the borders of woods.

3. Polygyra plicata Say.

"Shell rimately umbilicated, discoidal, depressed above, convex below, light horn-color, sparingly hirsute, with separated rib-like striæ; spire planulate; whorls five, gradually increasing, the upper ones rounded, smoother, the last convex, plane below, scrobiculated, and with an insulated, smooth, prominent bulge behind the peristome, deflected at the aperture; rimation level, at first grooved, showing one and a half whorls, and ending in a narrow umbilicus; aperture subreniform, very oblique, contracted; peristome white, thickened, not reflected, continuous, its terminations approached, joined by a prominent, excavated, heavy, somewhat flexuose, emarginate, tongue-like callus, projecting almost across the aperture; within the columellar margin of the peristome is an erect, blunt, stout denticle (its inner end continued back within the aperture into an erect lamella joining the inner wall), somewhat overlapping and thus partially concealing from view a smaller, more deeply seated, erect, obtuse, stout denticle on the right margin of the peristome; an internal transverse tubercle on the base of the shell. Greater diameter, 7 mm.; lesser, 6 mm.; height, 3 mm."—*Binney.*

Fig. 2. *Polygyra plicata* Say.

* The Nautilus, October, 1893, p. 68.

Range.—Alabama, Kentucky, Georgia and Tennessee.

Indiana Localities.—Beneath drift on the north bank of the Ohio River, near Clarksville, Floyd County.

4. Polygyra fraudulenta Pilsbry.

"Differs from *P. tridentata* in having a compact shell of a reddish brown color (varying to white in some localities); the spire is low—convex, composed of six closely coiled whorls, the last being notably deflexed in front and strongly constricted behind the lip. The aperture is strongly 'dished' or basin shaped; the outer lip bears a broad tongue-shaped, inflected tooth, situated at the position of the

a *b*

Fig. 3. Apertures of Polygyra. (After Pilsbry). *a*, *tridentata* Say; *b*, *fraudulenta* Pilsbry.

periphery of the shell. The middle part of the basal lip bears a small squarish tubercle, which is often laterally compressed. The parietal wall bears an elevated oblique blade which is typically almost straight and never much curved. Greater diameter, 15 mm.; lesser, 13.50 mm.; height, 8.50 mm."—*Pilsbry.*

Range. — Ontario, Canada, to Michigan and Illinois, south to Georgia.

Indiana Localities.—This is the species called *P. fallax* Say by Stein and Call. *Fallax* occurs only east of the Alleghanies. *P. fraudulenta* probably occurs throughout the State, having been taken in Posey, Lawrence, Tippecanoe, Marion and Laporte counties. It occurs beneath logs and flat stones in rather moist situations.

4a. Polygyra palliata-obstricta (Say).

The following remarks regarding the relation existing between the nominal species *P. palliata* and *P. obstricta* (Say) were prepared by Mr. H. A. Pilsbry, to whom a series of specimens collected in Posey County was submitted.

"A series of 18 specimens from Grand Chain, Posey County, taken by Mr. Daniels in bottom land near the Wabash River, and in its flood plain shows a complete series of transitions from *palliata* to *obstricta*. These supposed species have been separated not only on account of the acute keel of *obstricta*, and its absence in *palliata*,

but more because of the rough epidermis of the latter.* This series, so far as I can see, shows intergradation in the development of the cuticular processes, as well as in the contour of the shell.

a *b* *c*

Fig. 4. *Polygyra palliata-obstricta* (Say).

"A few of the specimens agree almost exactly with Say's type specimen of *palliata*, the periphery being moderately angular, the angle disappearing on the last third or fourth of the whorl; and the surface, besides having low, coarse striæ, bears numerous cuticular asperities, as though a loose cuticle had been pinched up into many little points, and more or less wrinkled in consequence between them. (See *a*, Fig. 4.)

"Most of the shells are decidedly more acutely angular at the periphery than typical *palliata*, but have essentially the same sculpture (*b*, Fig. 4). A few of the specimens (*c*, Fig. 4) have the peripheral keel acute, and reduced to an angle only on the latter part of the whorl, and there is a distinct tendency of the cuticle to pucker into spiral lines between the rib-striæ; such ill-developed spirals being characteristic of *P. obstricta*. In some of these specimens the keel projects a little above the sutures, as usual in *P. obstricta*. They are similar to shells of the latter species found in the hills, about half a mile distant from the locality of the *palliata-obstricta* series. No sharp line, however, can be drawn between the bluntly angular, the sharply angular and the strongly carinate shells; all intergradations occur, even in the small series.

"As only *obstricta* was found in the hills, the question naturally arises, whether *obstricta* is a form of *palliata* dependent upon station. This is apparently negatived by the wide distribution of *palliata* in the northern States, where it inhabits both lowland and mountains, in alluvial, limestone and sandstone tracts, and is not accompanied by *obstricta*, and indeed not varying toward strongly angular or carinate forms over most of its area. A simpler view seems to be that while *P. palliata* occupies an area generally north of that of *P. obstricta* there is a broad belt of territory common to the two, in some parts of which intergradation takes place, or, in other words, remnants of a variable, undifferentiated, parent race still exist.

* See Binney, Manual of American Land Shells, p. 285.

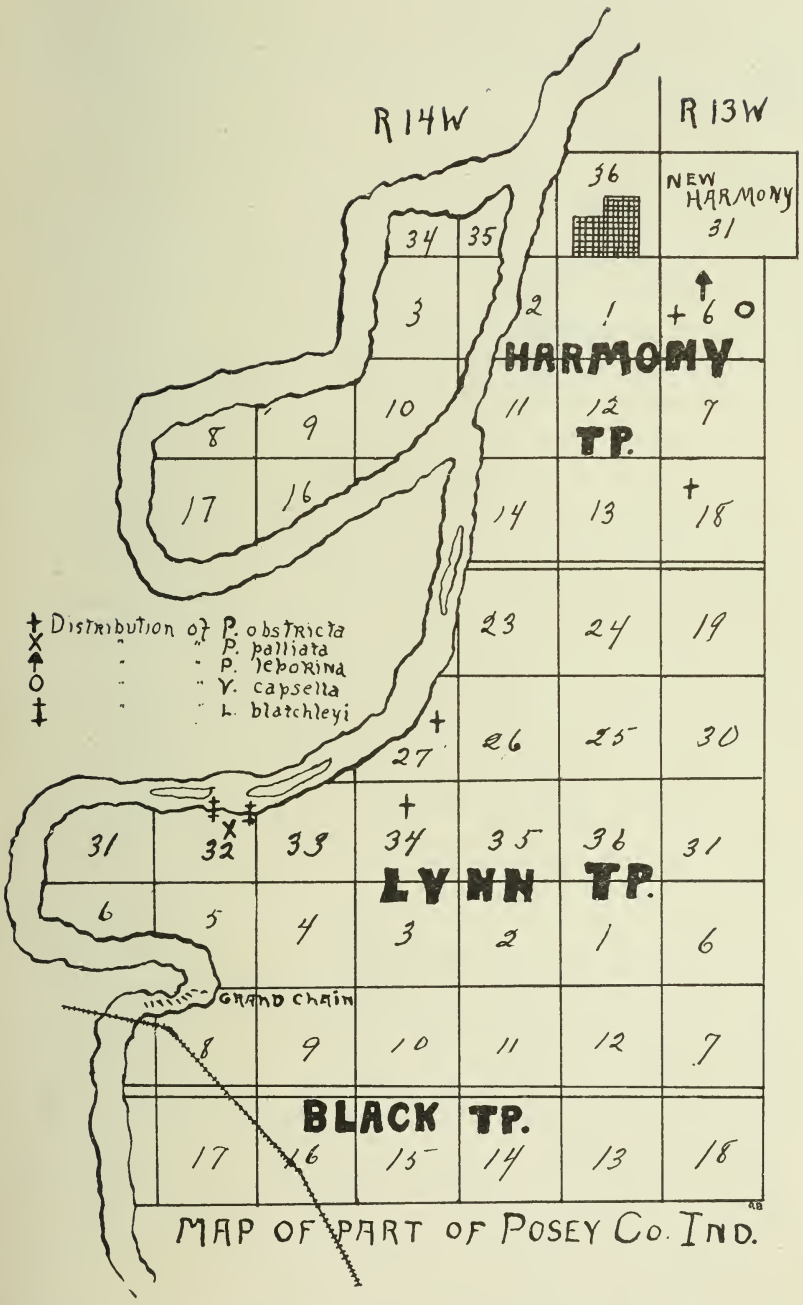


Fig. 4a. Showing distribution of certain species of Mollusca in Posey County.

"None of the Indiana shells I have seen are strictly referable to the variety *carolinensis* of Lea. That, in my opinion, is probably another remnant of the race ancestral to *obstricta*, but a little diversely modified.

"Further collections of the species under consideration should be made in as many localities as possible throughout the States where *palliata* and *obstricta* coexist, with full notes on the local conditions. It seems likely that more solid conclusions than those now attainable should result from the study of ample material."

5. POLYGYRA MONODON (Rackett). Plate I, Fig. 2.

"Subglobose, solid, umbilicate or imperforate; surface covered with very fine, oblique growth lines which are so minute as to be scarcely visible even when viewed with a powerful glass; the surface is also set with short hairs scattered over the whorls; nuclear whorls smooth; periphery rounded; sutures well impressed; color yellowish to reddish horn; whorls five to five and a half, closely coiled, flatly rounded, the last gibbous on the last half, and constricted behind the peristome; spire somewhat elevated in some specimens, but flat in others, convex; aperture narrowly lunate, no teeth or notches on the peristome; parietal wall with a long, narrow, more or less elevated tooth, which begins near the center of the parietal wall and extends generally to the umbilical region in a line parallel with the basal reflection of the peristome; peristome white, thick, reflected; umbilicus widely open, or wholly imperforate; the region strongly depressed; base of shell rounded, with a transverse internal tubercle. Greater diameter, 9 mm.; lesser, 8.25 mm.; height, 5.25 mm."—*Baker.*

This is the shell formerly known as *leaii* Ward. It was originally described from Alpena County, Michigan. The larger, more hirsute form, with umbilicus frequently partly closed or wholly imperforate and described by Call and others as *Stenotrema monodon*, has been shown by Pilsbry to be Say's *H. fraterna*, and it is now known as *P. monodon fraterna*. (Plate I, Fig. 1.) The range of *P. monodon* is from Minnesota and Michigan south and southwest to Tennessee and Kansas.

Indiana Localities.—Stein mentioned the present species under the name *leaii*, from Posey County. Mr. Daniels has found it to be quite common about the swamps bordering the larger lakes of northern Indiana, notably those near lakes Wawasee and Tippecanoe, Kosciusko County; Maxinkuckee, Marshall County; James, Steuben County, and Lake Manitou, Fulton County. It occurs beneath chips,

rubbish and fallen grasses and weeds, about the margins of the lakes. It has also been taken in grassy swales near Hammond and Pine, Lake County. It occurs in a semi-fossil state in thick loess deposits near New Harmony, Posey County.

Family PUPIDÆ.

6. STROBILOPS LABYRINTHICA (Say).

This species as described by Call (p. 382 of his Catalogue) included two others which had previously been separated by Pilsbry* chiefly by the number and length of the internal lamellæ of the basal and outer walls of the body whorl. His table used in their separation is as follows:

KEY TO THE SPECIES OF STROBILOPS.

a. Internal lamellæ on floor of body whorl two or three, short; color dark brown; one parietal fold conspicuously emerging from aperture. Form elevated conoidal.....*S. labyrinthica* Say.

aa. Internal lamellæ on floor and adjacent side walls of body whorl six or more.

b. Six long lamellæ; two parietal folds emerging; color white or pale brownish; form elevated.....*S. virgo* Pilsb.

bb. About eight short lamellæ arranged in a curved radial series; color dark brown; form elevated.....*S. affinis* Pilsb.

The description of *S. labyrinthica* as limited by Pilsbry is herewith included.

"Shell umbilicated, elevated conoidal; brownish horn-color with strong ribs above, below nearly smooth; spire obtuse; whorls wider than high, regularly increasing in size from apex to aperture; body whorl obtusely angulate at the periphery, flattened below, impressed around the narrow umbilicus; aperture rounded above, basal margin flattened; peristome narrowly reflected, thickened; parietal wall with three revolving, deeply entering parallel lamellæ, the central further within the aperture and less developed, one conspicuously emerging from the aperture; two or three short internal lamellæ on base of body whorl. Greater diameter, 2.25 mm.; height, 1.75 mm."—*Walker.*

7. STROBILOPS VIRGO Pilsbry.

"Shell umbilicated, globosely elevated; white or pale brownish in color; finely and closely ribbed above, ribs subobsolete on the base;

* The Nautilus, September, 1893, p. 57.

spire high, dome-shaped; whorls five and a half, narrow, almost as high as wide, body whorl somewhat angled at the periphery, rounded below, impressed around the umbilicus, which is a mere perforation; aperture lunately rounded; peristome narrow, thickened, reflected; two parietal folds conspicuously emerging; six long lamellæ on the base and outer wall of body whorl. Greater diameter, 2.25 mm.; height, 2 mm."—*Walker.*

S. virgo has been taken in small numbers from beneath logs and rubbish in ravines and moist places near Cannelton, Perry County; New Harmony, Posey County; Princeton, Gibson County; Wyandotte, Crawford County, and Lake Maxinkuckee, Marshall County.

8. Strobilops affinis Pilsbry.

"Shell umbilicated, obtusely elevated; dark brown; finely and closely ribbed above, ribs lighter below; spire obtusely elevated; whorls five and a half, rather narrow, higher than wide, body whorl obtusely angled at the periphery, somewhat flattened, but rounded below, impressed around the umbilicus, which is rounded and deep; aperture lunately rounded; peristome thickened, narrowly reflected; about eight short lamellæ arranged in a forwardly curved radial series from the axis across the base and up the outer wall of the body whorl. Greater diameter, 2⅞ mm.; height, 2.50 mm."—*Walker.*

In Indiana *S. affinis* has been found near Lake James, Steuben County; Tippecanoe Lake, Kosciusko County, and Mitchell, Lawrenceburg, Wyandotte and Huntingburg, in southern Indiana. It is said to be very abundant at many localities in New York and Ohio.

9. Bifidaria procera (Gould). Plate I, Fig. 3.

"Cylindrical, long, shining; surface covered with well marked, oblique lines of growth, the apex smooth; color brownish or chestnut horn; whorls six, convex, the last three about equal in size and the first three rapidly diminishing to the nucleus, making an obtuse apex; sutures deeply impressed; aperture ovate or semi-circular, higher than wide; there are generally five teeth placed as follows: One on the parietal wall, large and somewhat compressed, long and bifid at the end; one on the columella, near the upper third, short, conical; a third on the upper third of the outer lip, thick, conical, short; a fourth on the base of the peristome, long, sharp; and a fifth placed behind the columella tooth, large and massive; peristome rather widely reflected, thickened, bluish white; terminations approaching and joined by a callus; umbilicus small, open. Length, 2.50 mm.; diameter, 1.00 mm.; aperture length, 0.50 mm."—*Baker.*

Range.—Eastern United States west to Minnesota and south to Texas and South Carolina.

Indiana Localities.—This mollusk has been taken in this State only near Hamer's Cave, two miles east of Mitchell, Lawrence County, and near Connersville, Fayette County. At the former locality Mr. Daniels found a half dozen beneath flat stones, associated with *B. armifera, contracta* and *pentodon.*

10. VERTIGO MORSEI Sterki.

"Shell large (for the group), cylindrical-turriculate, with a rather acute apex, imperforate rimate, with few obsolete striæ of growth, shining, translucent; whorls six, rather slowly and regularly increasing, the last scarcely higher than the penultimate and rather narrower, somewhat sloping toward the base, slightly ascending at the aperture; suture deep; aperture lateral, scarcely oblique, comparatively small; inferior and palatal well rounded, the latter with an angular impression and slightly protracted in about its middle, the upper half more strongly curved, peristome everted; on the palatal wall, at some distance from and parallel with the margin, a moderate crest, behind it a deep and large impression over the palatal folds, and in front of it a groove corresponding with the impression at the auricle; inside the crest there is a distinct callus of the same color as the shell; apertural lamellæ and folds typically nine; three on the parietal wall (the same as in *V. ovata*) the largest whitish; two on the columella, the superior strong, vertical above, then in an angle turning horizontally, the inferior horizontal, lamelliform, thin, high and directed obliquely upward; basal small, sometimes double, rarely 0; palatals high, and rather long, curved and directed upward; suprapalatal small, nodule-like. Greater diameter, 1.3 mm.; lesser diameter, 0.8 mm.; height, 2.7 mm."*—*Sterki.*

Known heretofore only from Kent County, Michigan, and Sandusky, Ohio.

This handsome little mollusk occurs in numbers about the margins of Lakes James, Tippecanoe and Maxinkuckee; where it lives beneath rubbish, such as fallen weeds, grass stems, and pieces of wood. It is found associated with *Vertigo ovata, Polygyra monodon* and the two species of *Strobilops* above mentioned.

* The Nautilus, December, 1894, p. 89.

Family ZONITIDÆ.

11. OMPHALINA LÆVIGATA (Pfeiffer).

"Shell somewhat convex, oftener depressed; epidemris greenish horn-color, shining, thin; whorls five, rather flattened, rapidly enlarging, with beautiful and regular oblique striæ and revolving microscopic lines, the last whorl expanding toward the aperture, not descending; aperture transverse, broadly lunar, ample, with a testaceous deposit within; peristome thin, acute, straight, extremities approaching, its lower extremity inserted into the center of the base and somewhat reflected; base smooth, perforate. Greater diameter, 18 mm., lesser, 15 mm.; height, 9 mm."—*Binney.*

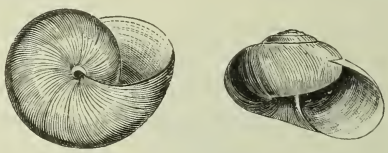


Fig. 5. *Omphalina lævigata* (Pfeiffer.)

A southern species whose range is given by Pilsbry as "North Carolina to St. John's Valley, Florida, west to Arkansas and western Louisiana."

In Indiana, Mr. Daniels found it in small numbers near Grand Chain, and Mt. Vernon, Posey County; Cannelton, Perry County, and Laurel, Franklin County. It occurs in dry upland woods beneath logs.

12. VITREA CELLARIA (Mull.).

"Shell very much depressed, thin, fragile, pellucid; epidermis light greenish-horn color, smooth, highly polished; whorls five, slightly rounded, with minute and almost imperceptible oblique striæ; aperture not dilated, its transverse diameter the greatest; umbilicus moderate, regularly rounded, deep; base rounded, thickened within by a testaceous deposit, bluish-white; peristome simple, acute. Greater diameter, 13 mm.; lesser diameter, 11.5 mm.; height, 5 mm."—*Binney.*

Fig. 6. *Vitrea cellaria* (Mull).

Introduced from Europe. Said to be quite common in the seaports of the Atlantic and Pacific coasts, and occasionally found inland in greenhouses.

In Indiana it has been noted only at Laporte, where it occurs in numbers beneath boards on the floor of a greenhouse. It does not seem to be harmful to the growing plants.

13. VITREA HAMMONIS (Ström). Plate I, Fig. 4.

"Small, depressed, thin, umbilicated; surface shining, the lines of growth well marked, impressed, more or less equidistant; color brownish-horn, transparent; periphery rounded; sutures well impressed; whorls four, rapidly enlarging, the last half of the last whorl

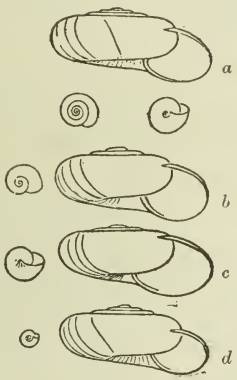


Fig. 7. Comparative figures of Vitrea and Zonitoides. (After Morse.) Enlarged. *a. Zonitoides arboreus* Say; *b, Vitrea hammonis* Ström; *c, Vitera indentata* Say; *d, Zonitoides minusculus* Binney.

very rapidly enlarging as it approaches the aperture; spire flat or a trifle convex; aperture large, transversely rounded, somewhat expanded; peristome simple, with thickened edge; umbilicus small, round, deep, showing several of the volutions, the umbilical region strongly concave; base of shell convex. Greater diameter, 4.25 mm.; lesser diameter, 3.75 mm.; height, 2.50 mm."—*Baker.*

Range.—North Carolina to Colorado, northwest through the northern States and British America.

Although not mentioned by Call, this is a rather common shell in Indiana, having been taken in a dozen or more localities. It occurs with *Zonitoides arboreus* (Say) under dead leaves and rotten logs, in open, usually moist woods. Specimens labeled "Indiana" were in the State Museum collection under the name of *Zonites viridulus* Menke. It was also listed by Pleas from Henry County.

14. VITREA WHEATLEYI (Bland).

"Shell umbilicated, depressed, thin, shining, pellucid, brownish horn-color, finely striated; spire subplanulate; suture slightly impressed; whorls little convex, the last more convex at the base, rapidly increasing, at the aperture scarcely descending; umbilicus pervious; aperture depressed, obliquely lunate; peristome simple, acute, the margins approximating, joined by a thin callus. Greater diameter, 5 mm.; lesser, 3.5 mm.; height, 2 mm."—*Binney.*

Fig. 8. *Vitrea wheatleyi* (Bland).

A southern species known chiefly from near Knoxville, Tennessee, and northern Alabama, though recorded by Sterki from Pennsylvania, Indiana and Michigan.

In the State Mr. Daniels has found it in small numbers associated with *Zonitoides arboreus*, the preceding and the next species, near New Harmony, Huntingburg, Brookville and Indianapolis.

15. VITREA INDENTATA (Say). Plate I, Fig. 5.

"Shell subperforated, flattened, thin, pellucid; epidermis highly polished, corneous; whorls rather more than four, rapidly enlarging, with regular, sub-equidistant, radiating, impressed lines, which on the body whorl extend to the center of the base, outer whorl expanding toward the aperture; suture well impressed; aperture rather large, transverse; peristome simple, acute, very thin, at its inferior extremity terminating at the center of the base of the shell; umbilicus none, but the umbilical region is indented. Greater diameter, 5 mm.; lesser diameter, 4.5 mm.; height, 2.5 mm."—*Binney.*

This species may be distinguished from *V. hammonis*, which it most resembles, by its subperforate umbilicus and peculiar equidistant impressed striæ. Its range as given by Pilsbry, is Dakota to New Mexico and Ontario to Florida.

It occurs in numbers throughout Indiana, in company with *Z. arboreus* and the two preceding species; having been taken at nearly every locality where collections were made.

16. VITREA CAPSELLA (Gould).

"Shell quite small, planorboid, pellucid, glistening, amber-colored; spire nearly plane, composed of about six and a half closely revolving, flattened whorls; surface with distant, impressed, radiating striæ; suture margined; aperture narrow, semilunar; peristome simple, not thickened by callus within; base perforated by a deep,

rather small, funnel-shaped umbilicus. Greater diameter, 5 mm.; height, 2.5 mm."—*Binney.*

This is another species of southern range which has been found near Huntingburg and New Harmony by Mr. Daniels, where it occurs sparingly under dead leaves in the edges of woods. It has not before been recorded north of the Ohio River, its range as given by Pilsbry being Virginia and Kentucky to Alabama. Dr. Sterki, who identified the species, states that the Indiana specimens "have a rather wide umbilicus."

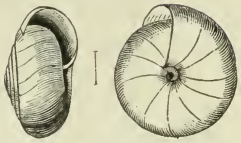


Fig. 9. *Vitrea capsella* (Gould).

17. Euconulus chersinus Say.

"Shell subglobose-conic, pale yellowish white, pellucid, convex beneath; volutions about six, wrinkles not distinct; spire convex-elevated; suture moderate; body whorl slightly carinated on the middle; mouth nearly transverse, unarmed, the two extremities nearly equal; labrum simple; umbilicus none."—*Say.* Pilsbry adds: "Outlines of spire quite convex; whorls six and a half, appearing very closely coiled, as seen from above, the last only faintly angular, though in immature shells it is carinated. The base is quite convex and the umbilical perforation very narrowly open. Greatest diameter, 2.8 mm.; height, 3 mm." Baker says that *E. chersinus* "is a shell with a much more turreted spire and more closely coiled whorls than *E. fulvus* (Mull.). The teeth of the two species are widely different, *fulvus* having the formula 21-1-28; while *chersinus* has 18-1-18."

Fig. 10. *Euconulus chersinus* Say.

Specimens of this little mollusk, identified by Sterki and verified by Pilsbry, were taken from beneath bark and leaves in moist places near New Harmony, Huntingburg and North Vernon; also in a cypress swamp in Knox County, and near Pine, Lake County. It has heretofore been known only from Georgia and Florida.

18. Zonitoides nitidus (Muller). Plate I, Fig. 6.

"Orbicularly depressed, thin, umbilicated; surface shining, covered with rather strong lines of growth; color smoky-horn; periphery rounded; sutures impressed; whorls five, convex, regularly increasing, except the last, which is very large in proportion, and obtusely

angled on the periphery as it approaches the aperture; spire rather elevated, convex; aperture lunate, oblique; peristome simple, acute, the basal margin bow-shaped; terminations of aperture not approaching; umbilicus round, broad, deep, exhibiting the volutions to the apex; base of shell concave about the umbilicus, convex on the last whorl. Greater diameter, 6 mm.; lesser diameter, 5 mm.; height, 4 mm."—*Baker.*

This is a common mollusk in northern Indiana, where it occurs about the margins of a number of the larger lakes, usually in company with *Polygyra monodon.* Its general range includes the northern United States and southern British America.

19. Zonitoides minusculus (Binney). Plate I, Fig. 7.

"Small, depressed, thin, umbilicated; surface shining, lines of growth strong; color white, periphery rounded; sutures deeply impressed; whorls four, convex, slowly and regularly increasing in size; spire almost flat, a trifle convex; aperture very nearly circular, not expanded; peristome simple, acute, the basal margin rounded; terminations of aperture not approaching; umbilicus very large, deep, exhibiting all the volutions to the apex; columella with a thin, testaceous deposit; base of shell convex. Greater diameter, 1.50 mm.; lesser diameter, 1.30 mm.; height, 0.75 mm."—*Baker.*

Occurs commonly in the State, having been taken in six widely separated localities. It is found in company with *Z. arboreus* and allied species beneath the bark of logs, and rubbish in damp woods.

20. Zonitoides læviusculus (Sterki).

"Of the size and general appearance of *Z. minusculus* but differs in being much depressed. The spire is entirely flat or very little elevated. The whorls are markedly wider, from the nucleus; in specimens of the same size one-half to one less in number, very gradually increasing, and flatter above and below. The surface appears smooth and polished, and only with a strong magnifier radiating lines are seen. The umbilicus is rather wider in the adult, and the curvature of the whorl to the umbilicus is quite abrupt, appearing almost angular. The shell is colorless, glassy while fresh, and when weathered appears more milky white, while *minusculus* then is more chalky."—*Sterki.*

Specimens from Dr. Sterki, collected by E. Pleas near Dunreith, Henry County, Indiana, are in the State Museum. It is known otherwise from two localities in Texas, and from northwestern Ohio.

21. Zonitoides milium (Morse).

"Shell widely umbilicated, depressed, transparent, shining, white, with a greenish tinge, marked with distinct and regular striæ of growth and microscopic revolving lines; the latter more conspicuous below; spire but slightly elevated; whorls three, rounded, rapidly increasing, the last planulate above, widely umbilicated below; aperture very oblique, subcircular, remote from the axis; peristome simple, acute, its terminations somewhat approached, that of the columella not reflected. Greater diameter, 1.5 mm.; height, 0.5 mm."—*Binney.*

Fig. 11. *Zonitoides milium* (Morse). Enlarged.

The range of this species is from Ontario to Florida and west to Kentucky and Indiana. In this State it has been taken only near Princeton, Gibson County, where a few specimens were secured.

Family LIMACIDÆ.

22. Agriolimax agrestis (L.).

"Color varying from whitish through every shade of cinereous and gray to black, and through various shades of yellowish or amber-color to brownish, and sometimes irregularly spotted with small black points or dots; eye peduncles and tentacles darker than the general surface, sometimes black; mantle sometimes mottled with a

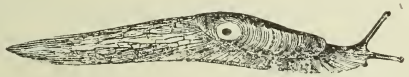


Fig. 12. *Agriolimax agrestis* (L.).

lighter color; base of foot sallow white; sheath of eye peduncles indicated by black lines extending backward from their base under the edge of the mantle. Body when in motion cylindrical, elongated, terminating acutely, the sides toward its posterior extremity compressed upwards, so as to form a short carina or keel; foot very narrow. Mantle oblong-oval, fleshy, convex, and prominent, rounded at both extremities, equaling in length one-third of the length of the body, its surface marked by prominent, irregularly waved, concentrical lines and furrows having their center on the posterior part, and its edges free throughout the whole circumference. Upper surface of the body marked with longitudinal lines or shallow furrows,

darker than the general surface, sometimes black, anastomosing with each other, and forming a sort of network; between the reticulated lines are narrow, irregular, oblong plates, or smooth, flattened tubercles, giving the surface the appearance of a mosaic work, with lines of dark cement; reticulations less distinct on the sides and disappearing toward the base; a prominent tubercular ridge extends from between the eye peduncles backward to the mantle, with a furrow on each side. Eye peduncles cylindrical, about one-eighth the length of the body, with small, black, ocular points on the superior part of the terminal bulb; tentacles immediately under, very short. Respiratory foramen near the posterior lateral edge of the mantle, large, surrounded with a whitish border. Orifice of rectum immediately adjacent, but a little above and anterior to the respiratory foramen. Foot narrow; locomotive band bounded by two distinct longitudinal furrows. Generally about 25 mm. in length, but when fully grown nearly 50 mm."—*Binney.*

This slug has been taken in numbers about Laporte, Indiana, where it occurs beneath logs, stones and rubbish in damp localities. It is an Old World species, introduced by commerce, and is common about Boston and other Atlantic seaports.

Family ENDODONTIDÆ.

23. PUNCTUM PYGMÆUM Drap. Plate I, Fig. 8.

"Subglobose, rather strong, umbilicated; surface dull or shining, marked by numerous strong, rounded, elevated striæ and very fine spiral lines, which are stronger on the base than elsewhere; color reddish or brownish; periphery rounded; sutures very deeply impressed, especially between the last two whorls; whorls four, convex, regularly and gradually increasing in size; spire elevated, convex; aperture somewhat oblique, crescentic, ample; peristome simple, rather solid; columella subreflected, the terminations of the aperture widely separated; umbilicus wide, deep, showing all the volutions to the apex. Greater diameter, 1 mm.; height, 0.50 mm."—*Baker.*

Range.—Northern United States and southern Canada, south to Texas and west to California. Taken near Seymour, Jackson County, and Vawter Park, Kosciusko County, beneath chips and chunks in open woods.

24. SPHYRADIUM EDENTULUM (Drap.)

"Shell minute, cylindrical, obtuse at apex, smooth, chestnut color; whorls five, well rounded, separated by a deep suture; aperture circular; the peristome nearly continuous, simple or scarcely everted, except at its columellar margin, where it partially conceals a small umbilicus; no trace of a tooth has been detected in any specimen. Length, 1.6 mm.; breadth, half as great." —*Binney.*

Fig 13. *Sphyradium edentulum* (Drap.).

This is a northern form whose range is given by Pilsbry as Ontario to Vancouver's Island. It was found in numbers on the leaves of the Ostrich fern in a dense marsh on the border of Clear Lake, Steuben County; and in a tamarack swamp near Vawter Park, Kosciusko County.

Family SUCCINIDÆ.

25. SUCCINEA CALUMETENSIS Calkins.

"Shell oblong, ovate, thin, shining, finely striate; color golden; whorls three, the last broad, dilated; aperture below expanded, stria of growth marked. Length, 12 to 13 mm."—*Calkins.*

Fig. 14. *Succinea calumetensis* Calkins.

This form was originally described from the banks of the Calumet River, Cook County, Illinois. Mr. Daniels found it common on aquatic grasses about the Half Moon Pond, Posey County, and the cypress swamp, Knox County, Indiana.

Family AURICULIDÆ.

26. CARYCHIUM EXILE H. C. Lea. Plate I, Fig. 9.

"Similar to *C. exiguum* (Say) but differing in the following particulars: the shell is elongated instead of cylindrical; there are five and a half whorls; the aperture is *just* one-third the length of the shell, instead of *over* one-third, and the surface is regularly and very distinctly striated. Length, 1.75 mm.; width, 0.75 mm.; aperture length, 0.50, width, 0.25 mm."—*Baker.*

This shell is by many conchologists considered a synonym of *C. exiguum* Say. Baker, however, regards them as probably distinct. In Indiana it has been taken near Vawter Park, Kosciusko County, and Berry Lake, Lake County.

Family LIMNÆIDÆ.

27. Limnæa stagnalis appressa Say. Plate I, Fig. 10.

"Elongated (or oval), ventricose at the anterior end, thin, color yellowish-horn to brownish-black; surface shining, growth lines numerous, crowded, more or less elevated, crossed by numerous fine, impressed spiral lines; apex smooth, brownish horn-color; whorls six and a half, rapidly increasing, all but the last two rather flat sided; last whorl very large, considerably dilated and inflated; spire long, pointed, acute, occupying about half the length of the entire shell (sometimes very short); sutures distinct, sometimes impressed; aperture large, broadly ovate, dilated, particularly at the upper part; peristome thin, acute, in some specimens thickened by an internal callus; lower part rounded; columella crossed in the middle by a heavy plait, which starts from the base of the aperture and runs obliquely into the aperture of the shell about 10 mm. from the junction of the peristome to the body whorl; there is a spreading callus on the columellæ and labrum, which completely covers the umbilicus. Length, 57 mm.; width, 24 mm.; aperture length, 31 mm., width, 14.50 mm."—*Baker.*

This large and handsome Limnæid ranges through North America from the Atlantic to the Pacific. It is found generally in stagnant ponds and rivers about decaying vegetation. In Indiana it has been taken at Turkey Lake, Kosciusko County; in the Kankakee River, Laporte County, and in a pond near Millers, Lake County.

28. Limnæa reflexa kirtlandiana Lea. Plate I, Fig. 11.

"Turreted, thin, irregularly striate, pale horn-color, imperforate; spire attenuated; sutures impressed; whorls six, slightly convex; aperture narrow-elliptical. Diameter, .26; length, .70 of an inch."—*Lea.*

This variety of *L. reflexa* has been taken by F. C. Baker near Roby, Lake County, Indiana.

29. Limnæa palustris michiganensis Walker. Plate I, Fig. 12.

"This form of L. palustris is characterized by the aperture being about one-half the total length, the outer lip is thickened within by a bluish white callus edged with brownish black; this shows as a white longitudinal band on the outside of the shell; spire acute, sutures impressed. Length, 17 mm.; width, 7 mm.; aperture length, 8.50 mm.; width, 4 mm."—*Baker.*

Occurs in numbers near Calumet Lake, Lake County, and Tippecanoe and Turkey lakes, Kosciusko County. Found in small streams

and rivers, ponds and lakes, attached to floating sticks and submerged water plants; often in low ground after the water has receded.

30. LIMNÆA CAPERATA UMBILICATA Adams. Plate I, Fig. 13.

"Ovate, solid, translucent; color yellowish or brownish horn; surface shining, growth lines fine and numerous; shell encircled by raised spiral lines; whorls five, very convex, the last whorl inflated, occupying from one-half to three-fifths of the total length of the shell; spire short, obtuse; conic, sutures much impressed; aperture roundly ovate, one-half to three-fifths the length of the shell, the terminations rounded; peristome thin, sharp, thickened inside by a reddish deposit; columella strong, reflected over the narrowly open umbilicus; columella with a small fold. Length, 6 mm.; width, 4 mm.; aperture length, 3.50 mm.; width 2 mm."—*Baker.*

This variety has been taken by Baker in a swale near Liverpool, Lake County, Indiana. He states that "*umbilicata* is doubtless a form of *caperata*, but seems distinct enough to constitute a separate variety characterized by a short spire and swollen whorls."

31. LIMNÆA CATASCOPIUM Say. Plate I, Fig. 14.

"Rather solid, ovate, inflated; color light horn to blackish; surface dull to shining, lines of growth numerous, fine, crowded, wavy, crossed by numerous impressed spiral lines; apex small, rounded, chestnut colored; whorls five, rounded, subinflated, the last large and somewhat inflated; spire sharp to obtuse, conic; sutures impressed; aperture roundly ovate, large, from half to three-fourths the length of the entire shell, rounded below; somewhat narrowed above; peristome thin, sharp, thickened by a light, whitish callus just within the edge; columella oblique, with a heavy plait across the middle; the lower part of the columella has a flexure caused by the heavy plait; the lower part of the peristome and the whole of the columella is sometimes covered with a heavy coating of white, testaceous material, which is reflected over the umbilicus, completely closing it. Length, 15 mm., width, 7.50 mm.; aperture length, 8 mm., width, 4.50 mm." —*Baker.*

This species ranges from New England to Utah, and British America to Virginia. In Indiana it has been taken in Calumet Lake, Lake County, by Baker, who also separated specimens from a large lot named *L. palustris* belonging to the State Museum. It has also been taken in Henry County by Pleas, and is listed by Stein as "not common."

32. LIMNÆA COLUMELLA Say. Plate I, Fig. 15.

"Ovate, somewhat pointed, thin, fragile, transparent; color light greenish or yellowish horn; surface shining, covered with rather coarse growth lines, and encircled by impressed spiral lines; whorls four, rounded, rapidly enlarging, the last one three times the size of the rest of the shell; spires sharply conic, rather short; apex small, very dark brown; sutures impressed; aperture oval, dilated, expanded at the lower part; the aperture varies from long and narrow to wide and somewhat expanded; peristome thin, acute; columella narrow, twisted; terminations of peristome connected by a thin callus; umbilicus generally closed but sometimes very narrowly perforate where the callus is not fully developed; the columella is so narrow that a view may be taken from the base nearly to the apex, as in *Succinea retusa*. Length, 16 mm.; width, 8.50 mm.; aperture length, 11.40 mm., width, 6 mm."—*Baker*.

Ranges from New England to Iowa and from Canada to Georgia. It occurs in small ponds and bays of lakes where the water is more or less stagnant and where water-lilies are abundant. In Indiana it has been taken at Bass Lake, Starke County, and in Grassy Creek, Kosciusko County.

33. LIMNÆA WOODRUFFI Baker. Plate I, Fig. 16.

"Ventricose, very much inflated, solid; color, greenish-horn or olivaceous; surface shining, growth lines distinct; rough in some specimens, crossed by numerous fine impressed spiral lines; apex small, rounded, light horn-colored; whorls three to four, rounded, inflated, the last occupying nearly the whole of the shell; spire depressed; sutures impressed; aperture very large, roundly ovate, occupying about four-fifths of the length of the entire shell, roundly shouldered at the upper part; peristome thin, sharp; columella thickened, spreading, with a plait or fold in the middle; the lower part of the aperture is expanded, the columella callus, making a ridge which is reflected over the umbilical region; umbilicus open, deep. Length, 11.50 mm., width, 8 mm.; aperture length, 8 mm., width, 4.75 mm." —*Baker*.

This mollusk occurs in abundance along the lower end of Lake Michigan, having been taken in numbers opposite Pine, Millers and Michigan City. It inhabits rather deep water. Its principal distinguishing characters "are its very short spire, rapidly increasing and swollen whorls, and its roundly oval aperture with its broad shoulder at the upper part."

34. PLANORBIS HIRSUTUS Gould.

"Shell small, somewhat transparent, of a brownish yellow color; both sides concave, the left rather more than the right, but the concavity is there more limited by the presence of a sub-angular ridge on the outer whorl; whorls three, the outer one rapidly increasing; surface exhibiting traces of revolving lines when denuded, but usually covered with a dark pigment or epidermis, bristling with rigid hairs which are arranged in close revolving lines; lines of growth very faint; aperture sub-oval, oblique, its diameter from side to side shorter than in the opposite direction; its plane very oblique. Long diameter, one-fifth inch, short diameter, one-fifteenth inch."—*W. G. Binney.*

This little fresh water univalve occurs in a number of the lakes of the northern third of the State and in their outlets; especially those which contain much aquatic vegetation. It is found attached to immersed stems and leaves of pond-weed (Potamogeton), water-lilies, cat-tails, etc. It is especially common in Grassy Creek, which connects Tippecanoe and the Barbee lakes, Kosciusko County.

Fig. 15. *Planorbis hirsutus* Gould.

35. PLANORBIS UMBILICATELLUS Cockerell.

"Shell somewhat flat above, but slightly sunk in the center, convex below, grayish white, somewhat glossy, closely and distinctly striate in the line of growth, with stronger ridges at intervals, most visible on the under side. Periphery rounded, but slightly compressed at each side. Suture rather deep. Aperture oblique and somewhat cardiform. Umbilicus deep and narrowly funnel-shaped. Whorls four and a half, compact, gradually increasing in size and faintly keeled or angulated on upper side. Diameter, 6.5 mm.; height, 2 mm."—*Cockerell.*

This little mollusk occurs with the above on aquatic vegetation. In Indiana it has as yet been taken only in Tippecanoe Lake. The specimens were identified by Sterki. It will probably be found in most, if not all, of the lakes of the State, its small size having caused it to be overlooked in the past.

36. SEGMENTINA ARMIGERA (Say).

"Dextral, flat, somewhat carinated above and below the periphery; color pearl white to reddish brown, sometimes black; surface smooth, shining, lines of growth very fine, oblique; apex sunken below the level of the whorls, very small and rounded; whorls four, regularly and

slowly increasing, obtusely carinated above and below the rounded periphery; spire concave, exhibiting all the whorls; sutures impressed; base of shell rounded; umbilicus round, deep, rather wide, concave, showing nearly all the volutions; aperture subovate, a trifle oblique, armed with five teeth, one on the parietal wall long, thin, S-shaped, extending in an oblique direction from a point near the upper carination of the body-whorl to a point near the lower carination; three on the peripheral wall, the two upper ones being prominent, short, thick and triangular, and the lower one more or less lamelliform and situated on the base of the aperture, and one small conic tooth near the superior junction of the peristome with the body-wall; peristome thin, acute, slightly thickened inside, the superior margin a trifle produced; interior of aperture pearly white, with a band of reddish just within the aperture extending parallel to the edge of the aperture. In some specimens there is a sixth tooth, small, acute, elevated, just below the large one on the parietal wall; this, however, is not always developed. Length, 2.75 mm., width, 6 mm.; aperture length, 2.25 mm., width, 1.50 mm."—*Baker.*

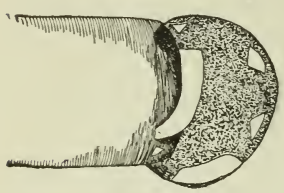


Fig. 16. *Segmentina armigera* (Say). Aperture, showing number and position of teeth. (After Baker.)

A common mollusk throughout the State; in the southern part occupying the smaller streams and swamps, especially those of the Wabash Valley; while in the northern part it is found in the swamps bordering the lakes. It is usually found clinging to submerged sticks, stones and aquatic plants. In Carr's Slough, White County, it has been taken by thousands.

Family ANCYLIDÆ.

37. ANCYLUS RIVULARIS Say.

"Small, depressed conic, fragile, sides nearly parallel, a trifle round but narrowed posteriorly; anterior slope long, convex, with a decided 'hump' toward the apex; posterior slope short, concave; sides convex; apex prominent, elevated, obtuse, directed posteriorly and a little to the right side; the apex divides the shell into about three equal parts, one posterior and two anterior; aperture as large as the shell, narrowed posteriorly; peristome entire, simple, acute; color light horn; interior of aperture whitish. Length, 3 mm., width, 2 mm.; height, 1.25 mm."—*Baker.*

Fig. 17. *Ancylus rivularis* Say.

"This small but distinct species may be known by its almost

straight lateral outline and its apex, which is directed posteriorly and to the right side. It is quite abundant, but is almost always overlooked owing to its peculiar shape and inconspicuous habitat. The animal is very slow in movement and progresses similarly to *Planorbis;* it is able to turn its body half way around without moving its shell. The buccal organs can be plainly seen while the animal is feeding."

In Indiana *rivularis* has been taken in the sloughs near Millers, Lake County, by F. M. Woodruff, and in Bass Lake, Starke County, by L. E. Daniels. It is found on decaying aquatic vegetation.

38. ANCYLUS PARALLELUS Haldeman.

"Shell pale, thin, and delicate; lengthened, sides subrectilinear, diverging slightly forwards; apex rather sharp, conspicuous, with two-fifths of the shell posterior to it. Dimensions—Length, 0.25, width, 0.15, height, 0.08 inch."—*Adams.*

Fig. 18. *Ancylus parallelus* Haldeman

Occurs in numbers in Bass Lake, Starke County, usually on submerged decaying stems of the water-lily.

39. ANCYLUS SHIMEKII Pilsbry.

"Elevated, thin, transparent, horn-colored, with a yellowish brown epidermis; aperture ovate, conspicuously wider anteriorly, in many (especially young) specimens slightly reniform by a barely perceptible incurving of the right margin, the anterior, left and posterior margins regularly rounded, the right slightly incurved, straight, or but slightly convex; apex somewhat acute, elevated, strongly deflected posteriorly and to the right, and curved downward, in most specimens quite overhanging the posterior right margin of the shell; the apical portion of the shell (one-half or more) is strongly laterally, or rather, obliquely, compressed, a character which makes the young appear proportionally much narrower than the adults; the anterior slope of the shell is long and strongly convex, the posterior being short and concave. The surface is marked by fine lines of growth. Length, 3.10 mm.; width, 1.70 mm.; height, 1.10 mm."—*Shimek.*

Fig. 19. *Ancylus shimekii* Pilsbry.

Known by its very oblique shell, the apex in some individuals, fairly overhanging the margin. Found with the preceding in Bass Lake. Has also been taken at Rock Island and near Joliet, Illinois. It and other species of *Ancylus* were determined by Dr. Sterki.

40. ANCYLUS FUSCUS Adams.

"Shell thin, transparent without the epidermis, not much elevated, elliptical moderately curved at the sides; epidermis brown, visible through the shell, giving it the appearance of having the same color, thick, rough, slightly extending beyond the margin of the shell: apex obtuse, moderately prominent, scarcely behind the middle, inclining to the right so as to have only two-fifths of the width on that side. Length, .31 inch; width, .22 inch; height, .05 inch."—*W. G. Binney.*

Easily distinguished by its epidermis. Allied to *A. rivularis* Say, but the latter is much more narrow, with its sides straight and its apex more acute. Taken only in Grassy Creek, between Barbee and Tippecanoe lakes, Kosciusko County. Known heretofore from Massachusetts and Ohio.

Fig. 20. *Ancylus fuscus* Adams.

41. ANCYLUS DIAPHANUS Haldeman.

"Shell thin in texture, diaphanous, very wide, nearly circular, depressed; apex obtuse, almost central! Slope scarcely convex. Color very pale olivaceous, translucent, aperture white. Distinguished by its circular and flattened form, and central inconspicuous apex. Length, 5.5 mm.; width, 4.5 mm.; height, 2 mm."—*Haldeman.*

Fig. 21. *Ancylus diaphanus* Haldeman.

Specimens in the State Museum marked "Indiana." Recorded heretofore from Ohio and Wisconsin.

Family PHYSIDÆ.

42. PHYSA SAYI Tappan. Plate I, Fig. 17.

"Sinistral, polished, ovate, whorls five to five and one-half; spire elevated, very acute, the whorls moderately convex; color light horn to light chestnut; sculpture consisting of rather coarse growth lines, crossed by numerous fine, impressed spiral lines, giving the surface of the shell a wavy appearance, as figured for *P. gyrina;* sutures slightly impressed, bordered as in *heterostropha;* protoconch consisting of one and one-half smooth, glossy whorls of a dark chestnut color: aperture very large, long oval, three-fourths to four-fifths the length of the whole shell; peristome thin, generally not very much thickened within, whitish, sometimes bordered with reddish; columella slightly twisted and covered with a spreading callus; the lower part of the aperture is somewhat produced. Length, 19 mm.; width, 12 mm.; aperture length, 14 mm.; width, 6 mm."—*Baker.*

Resembles *P. ancillaria* Say, but that form is more inflated, has the outer lip more spreading and the body whorl more swollen; the spire being always much shorter and the whorls more convex than in *sayi*. This mollusk occurs in ponds, slow-flowing streams and lakes, where it may be found adhering to immersed vegetation or crawling over the muddy bottoms. In Indiana it has been taken in Turkey and Tippecanoe lakes, Kosciusko County, being rather common in the latter. It was originally described from Lake Pipin, Portage County, Ohio.

43. PHYSA RHOMBOIDEA Crandall.

"Shell rhomboid-ovate, large, heavy, robust, yellowish horn-color to pale yellowish brown, texture fine, surface undulating and shining when not covered with a dark coating, spire elevated, acute with dark brown tip, whorls five convex, sutures much impressed, aperture ovate, lip simple, not expanded, sometimes a little compressed, thickened on inner margin with reddish-brown callus, columella well covered with heavy deposit continuing and extending from the lip. On many of them the columella is folded so as to form a narrow umbilicus.

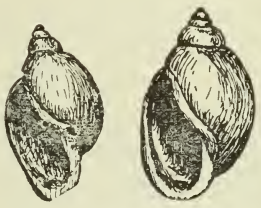


Fig. 22. *Physa rhomboidea* Crandall.

"It is distinguished by its robust appearance, deep sutures, constricted aperture and umbilicus which will be found in a large part of them. It is more like *P. solida* Philippi than any other species. Length, 16 mm.; diameter, 9 mm."—*Crandall.*

A southern form, before recorded from Missouri, Arkansas and New Mexico. Taken in Indiana only in the cypress swamp, Knox County.

44. PHYSA GYRINA ELLIPTICA Lea. Plate I, Fig. 18.

"Differing from typical *gyrina* in being more elliptical, having a shorter, more rounded spire, and hence more convex whorls, the spire, as described by Tryon, 'with the outline not elevated above a continuation of the general curve of the body.' The shell is also more solid and the outer lip thicker, with a very heavy, bluish-white callus. The surface sculpture is the same as in *gyrina*. Length, 12 mm., width, 7.50 mm.; aperture length, 9 mm., width, 3.75 mm."—*Baker.*

This form has been taken in Indiana only in the cypress swamp, Knox County.

45. Physa integra Haldeman. Plate I, Fig. 19.

"Oval, whorls four and one-half to five; spire short, pointed, the whorls convex; sutures well marked, sometimes bordered by a faint white line; color varying from light yellowish-horn to pale brown; sculpture as in *gyrina*, the lines being very deep and the wrinkled ridges very convex; protoconch consisting of one and one-half smooth, rounded, wine-colored whorls; aperture oval, rather wide, produced at the anterior end, about two-thirds the length of the entire shell; peristome thin, thickened within the aperture by a heavy white or yellowish-white callus, which shows through the shell very plainly; it is never bordered by a color stripe; the callus of two or three former peristomes may always be seen on the body whorl and sometimes one or two on the spire; columella broad, flat, white, a callus spreading over the parietal wall. Length, 12 mm., width, 8 mm.; aperture length, 7.50 mm., width, 3 mm."—*Baker.*

Quite common in Lake Michigan, near Michigan City; also in a large spring near Wyandotte, Crawford County. Baker says that in his experience "it is more common than *sayi* but less so than *gyrina*."

Family PLEUROCERIDÆ.

46. Lithasia obovata biconica Pilsbry MS.

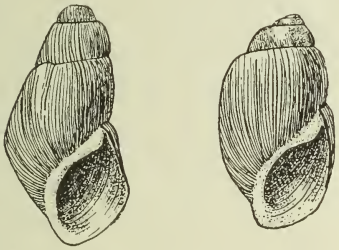
"The adult shell is more lengthened than *obovata*, and more or less biconic, rapidly tapering toward both ends from the middle, which, while not angular, is prominent; the penultimate whorl decidedly higher than in *obovata*, and the aperture is distinctly shorter in shells of the same size. The last whorl slopes steeply below the suture, and is not swollen there. Length, 16; diameter, 10.5; length of aperture, 10 mm. (truncate adult). Length, 17.5; diameter, 12; length of aperture, 11.2 mm. (truncate adult). Length, 19; diameter, 10; length of aperture, 10.2 mm. (truncate adult). Length, 18.5; diameter, 9.5; length of aperture, 10 mm. (truncate adult).

"Wabash River in Gibson County, Indiana, at the Southern Railroad bridge abutment opposite Mt. Carmel, Illinois.

"The adult of *L. obovata* is bluntly oval in outline; the penultimate whorl is short, and the last whorl is puffed out below the suture, as in Fig. 23, representing a shell from the Ohio River at Louisville.

"None of the numerous synonyms of *L. obovata* seem to have been based upon this biconic form, which seems sufficiently distinct to

require a name to signalize its deviation from the type. I may mention that Mr. Bryant Walker has examined the specimens and regards them distinct from *obovata*, though related to that species."—*Pilsbry.*



a *b*

Fig. 23. *Lithasia obovata biconica* Pilsbry MS. *a, Lithasia obovata biconica; b, Lithasia obovata.*

47. PLEUROCERA ALVEARE (Conrad).

"Shell short conical, ventricose; whorls flattened, with a line of wide compressed tubercles at the base of the penultimate whorl; body whorl angulated; angle armed with prominent tubercles; base hardly convex, with about five prominent lines; aperture obliquely elliptical; less than half the length of the shell. The spire is very regularly conical, and the base strongly ribbed."—*Conrad.*

Fig. 24. *Pleurocera alveare* (Conrad).

A number of specimens are in the State Museum, labeled "Indiana." Mr. Daniels has taken it in the Wabash River, in Gibson County, opposite Mt. Carmel, Illinois.

48. GONIOBASIS LOUISVILLENSIS Lea.

"Shell smooth, fusiform, dark horn-color, without bands; spire short; sutures regularly impressed; whorls about five, somewhat convex; aperture, rather large, long elliptical, white within; outer lip acute, slightly sinuous; columella white, thickened above and twisted. Operculum ovate, reddish-brown, rather thin, with the polar point on the left, near the base. Diameter, .25; length, .56 of an inch.

Fig. 25. *Goniobasis louisvillensis* Lea.

"This shell is somewhat like *G. depygis* Say, from the same locality; but is much shorter in the spire and has a differently formed aperture."—*Lea.*

G. louisvillensis is quite common at the Falls of the Ohio, just above New Albany, on the Indiana side, from which locality it was

originally described. Specimens taken by Dr. J. H. Lemon and presented to the State Museum, were identified by Bryant Walker.

49. GONIOBASIS GRACILIOR (Anthony).

"Shell conical, smooth and shining, color dark brown, texture light; whorls about eight, upper ones nearly flat, the last is usually slightly constricted beneath the suture, and beneath this stricture on the periphery of the last whorl revolve one or two broad bands of yellowish-green; sutures impressed, and of a paler color than the rest of the shell; aperture small, pyriform, and inwardly ornamented with alternate bands of a dark ruby color and translucent white, which render this part of the shell peculiarly lively and beautiful; outer lip sinuate; columella dark brown, arcuate, and produced into a distinct sinus. Diameter, 7 mm., length, 19 mm.; length of aperture, 6 mm., width, 5 mm.

Fig. 26. *Goniobasis gracilior* (Anthony).

"This is a very distinct and beautiful species, remarkable for its long, slender form, its polished surface, and for a profound stricture on the body-whorl of many of the specimens, though this last character is not always present; when it is present it furnishes a mark by which this species can be readily distinguished from any other."—*Anthony.*

A common species in Lake Wawasee, Kosciusko County, and Lake Manitou, Fulton County, occurring on the bottom close to shore in water a foot or two in depth. Originally described from lakes in Starke County, Ohio.

50. GONIOBASIS BREVISPIRA Anthony.

"Shell small, elongate, ovate, truncate, rather solid, plain, shining, brownish-green, paler at the sutures; whorls 4-5, convex, somewhat declining at the sutures; aperture ovate; lip dilated before, sinuated behind. Length, 3 mm.; width, 7.5 mm."—*Anthony.*

Fig. 27. *Goniobasis brevispira* Anthony.

Taken in numbers from a large spring near Wyandotte, Crawford County, and in the Tippecanoe River, in Carroll County. Occurs probably in many of the clearer, rapid flowing streams of the State.

51. GONIOBASIS INDIANENSIS Pilsbry, MS.

"Shell similar in form to *G. semicarinata* (Say), and of the light dirty horn-color and somewhat transparent texture prevalent in that

species. Sculpture consisting of one prominent keel above the suture, with two or three acute threads between it and the suture above. This sculpture becomes obsolete on the later whorls, and in adult shells is very faint or not visible on the last whorl, which is well rounded. In immature shells the major keel is peripheral on the last whorl, and there are several minor ones below it. In some individuals the smooth stage supervenes at an earlier age than in others, and the sculpture of keel and threads may then be lost by erosion when the full size of the shell is attained. Adults measure, length, 15 mm.; diameter, 6.3 to 7 mm.

Fig. 28. *Goniobasis indianensis* Pilsbry, Ms.

"Blue River, Wyandotte, Crawford County, Indiana.

"This form is intermediate between *G. semicarinata* (Say) and *G. porrecta* (Lea). It differs from the former in the plurality of spiral keels and their greater prominence and longer persistence, while in *porrecta* the spiral sculpture is much better developed and ordinarily persists to the adult stage." —*Pilsbry.*

Mr. Daniels found this form quite common about the old mill dam near Wyandotte Cave. It was clinging to the stones in the swift running water below the dam.

Family AMNICOLIDÆ.

52. BYTHINIA TENTACULATA L. Plate I, Fig. 20.

"Globose, rather thick, transparent to opaque; color ranging from yellowish to greenish, sometimes brownish; surface shining, smooth, lines of growth very fine; sutures very deeply impressed; whorls five, convex, the last rapidly enlarging and equaling all the others combined; spire elevated, broadly conic; apex small, round, reddish brown; aperture broadly rounded-ovate, narrowed above; peristome thin, rounded, simple, continuous, thickened a little on the inside, bordered all around with yellowish; base of shell rounded, imperforate. Length, 9.50 mm., width, 6 mm.; aperture length, 4.50 mm., width, 3 mm.

Fig. 29. *Bythinia tentaculata* L. Operculum enlarged. (After Baker).

"May be easily distinguished by the size of the last whorl, which more than equals in length that of all the rest.

The species was introduced into this country many years ago and is now found from Vermont and New York to Wisconsin. It is particularly abundant in Lake Michigan. While in motion, the animal of *Bythinia* is rather slow, the tentacles move about nervously and the rostrum is thrust out to its fullest extent. Thus far it has been collected only in Lake Michigan."—*Baker.*

Taken in numbers opposite Michigan City, Millers and Pine. Occurs on the bottom of the lake attached to sticks, stones and other submerged objects.

53. Amnicola lustrica Pilsbry.

"Narrow (for the genus), thin, translucent; color waxy, light brownish or greenish; surface smooth and shining, lines of growth very fine, but distinct when viewed with a lens; sutures very deeply impressed; spire elevated, conical; whorls five, rounded, regularly increasing in size; aperture roundly ovate, slightly angled above, waxy inside; peristome continuous, thin, appressed to the body whorl only for a short distance near the upper terminations; base broadly rounded, with a narrow and deep umbilicus. Operculum similar to that of *A. limosa.* Length, 4 mm., width, 2 mm.; aperture length, 1.50 mm., width, 1.10 mm."—*Baker.*

Fig. 30. *Amnicola lustrica* Pilsbry.

Ranges from New York to Illinois and Massachusetts. Taken at Berry Lake, Lake County, by Baker, and Wawasee and Tippecanoe lakes by Daniels.

54. Amnicola walkeri Pilsbry.

"Thin, narrowly umbilicate, conic, shaped like *Lyogyrus brownii* Carpenter; slightly yellowish corneous; thin, smooth, with faint growth-lines. Whorls four, very convex, separated by deeply constricting sutures, the last whorl rounded below; apex obtuse. Aperture oblique, rather small, mainly basal, a little longer than wide, but nearly circular, the inner margin a trifle straightened above; peristome continuous, in contact with the preceding whorl for an extremely short distance above. Operculum amnicoloid. Height, 3 mm., diameter, 2 mm.; length of aperture, 1¼ mm., width, 1⅛ mm."—*Baker.*

Fig. 31. *Amnicola walkeri* Pilsbry.

Originally described from High Island Harbor, Lake Michigan. Since taken at Grand Rapids, Michigan, and Joliet, Illinois. A number were found in Grassy Creek, Kosciusko County, by Daniels.

55. AMNICOLA EMARGINATA Kuster.

"Small, globose, rather solid; color, different shades of green; surface smooth, polished, lines of growth very faint; sutures well marked; apex very obtuse; comprising one and one-half whorls; when viewed from the front the shell appears to have a truncated spire; spire very broadly truncate-conic; whorls four to four and one-half, very convex; aperture nearly round, appressed to the body whorl; peristome continuous, rather thick, simple; base rounded, with a small umbilicus. Length, 4 mm., width, 2 mm.; aperture length, 1.50 mm., width, 1.10 mm.

Fig. 32. *Amnicola emarginata* Kuster.

"This species at first sight might be taken for *A. lustrica*, but the spire is very *obtuse*, while that of *lustrica* is *acute*, and the last whorl is appressed to the body-whorl, at the aperture in *obtusa*, while in *lustrica* it is entirely free."—*Baker*.

Range from New York west to Iowa and Winnipeg, Canada, south to Kentucky. Taken in Indiana only in beach drift along Lake Michigan opposite Millers, Lake County, by Baker.

56. PALUDESTRINA NICKLINIANA Lea.

"Elongately ovate, turreted; color greenish-horn; surface shining, lines of growth numerous, crowded, raised so as to roughen the surface of the shell; sutures deeply impressed; whorls four to four and one-half, very convex; spire elevated, rather sharply conical; apex small, round, almost concealed in the volution of the second whorl; aperture roundly ovate; peristome sharp, a little thickened on the inside, continuous, the columellar lip being covered with a raised callus which connects the terminations; base of shell rounded; umbilical region rimate and indented. Length, 4.25 mm., width, 2 mm.; aperture length, 1.25 mm., width, 1 mm.

Fig. 33. *Paludestrina nickliniana* Lea.

"*Nickliniana* is a common little species, easily recognized by its narrow, turreted shell and well rounded whorls. The animals are gregarious, congregating together by hundreds. Frequently a piece of water-cress will be found literally black with the shells of this species."—*Baker*.

Berry Lake, Lake County, by Baker.

Family VALVATIDÆ.

57. Valvata sincera Say. Plate I, Fig. 21.

"Depressed, more or less discoidal, rather solid; color brownish, transparent to opaque; surface shining, lines of growth numerous, regular, crowded, sometimes encircled by a few spiral lines; apex large, round, almost concealed in the succeeding whorls; spire very flat, almost discoidal; whorls three and one-half, rounded, rapidly increasing, the last considerably deflected; sutures impressed; aperture round, continuous, whitish or brownish inside; peristome rather thick, simple, continuous, the columellar portion being simply appressed against the body whorl; base rounded, umbilicus round, deep, exhibiting all the volutions. Length, 2.25 mm., width, 6 mm.; aperture length, 2.10 mm., width, 2.10 mm.

"This is a very common species, easily distinguished by its discoidal form and rounded whorls. Like the *Limnæids*, it delights to float on the surface of the water, shell downwards. It is very active, and not at all timid in captivity."—*Baker.*

Occurs in numbers in the beach drift along the south shore of Lake Michigan, opposite Michigan City, Millers and Pine.

58. Valvata bicarinata Lea.

"Depressed, solid, orbicular; horn-colored above and whitish beneath; surface shining, lines of growth distinct; apex large, horn-colored; spire much depressed, flattened; whorls three and one-half to four, rapidly increasing; the carinæ are normally two in number, but a third is frequently developed; one carina encircles the shoulders of the whorls and one the middle of the base, the periphery being sharply rounded; sutures pronounced; aperture rounded, angled more or less by the carinæ, continuous as in *tricarinata;* base keeled; umbilicus widely opened. Length, 3.50 mm., width, 5 mm.; aperture length, 2 mm., width, 2 mm.

Bicarinata should be considered a distinct species from *tricarinata*, since the shells of the two forms are always distinguishable, *tricarinata* being elevated, the width equaling the height, while *bicarinata* is depressed and the height is four-fifths of the width. The former is normally *tricarinate* while the latter is *bicarinate*, although both bi- and tricarinate forms occur in both species. In *tricarinata* the upper surface slopes *upwards* from the carina to the suture, while in *bicarinata* it slopes *downwards*, giving the upper surface a concave appearance."—*Baker.*

Occurs in Lake Michigan, along the borders of Lake, Porter and Laporte counties. The form *normalis* Baker has been taken opposite Millers, Lake County. It "differs from *bicarinata* in being tricarinate, the middle carina very strong and placed on the periphery."

Family VIVIPARIDÆ.

59. Campeloma obesa Lewis.

"Obesely-ovate, very ventricose; whorls five, convex, spire short-conic, sutures well impressed, aperture ovate. Dark olivaceous, bluish-white within the aperture. Length, 32 mm.; diameter, 20 mm.

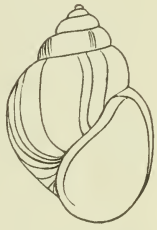


Fig. 34. *Campeloma obesa* Lewis.

"This species much resembles a half-grown *ponderosa*, but is more regularly oval in its outline and of lighter texture. It is regularly distinguished by its very ventricose, rounded form and dark olive green color."—*Lewis.*

This species occurs abundantly in the canal and White River, near Indianapolis. Specimens identified by Bryant Walker.

Family SPHÆRIIDÆ.

60. Sphærium vermontanum Prime.

"Shell very oblique, tumid, inequilateral, full; anterior margin abrupt, posterior drawn out to an angle, basal slightly curved; beaks large, full, prominent, placed very much toward the anterior, in which direction they are slightly inclined; sulcations coarse, moderately regular; epidermis light green; ligament conspicuous; valves solid, interior light blue; hinge-margin much curved, broad; cardinal teeth strong, representing the letter V reversed; lateral teeth elongated, strong. Length .56; width, .37; diameter, .25 inches."—*Prime.*

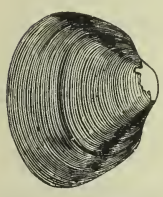


Fig. 35. *Sphærium vermontanum* Prime.

Collected by Baker in Lake Michigan, opposite Millers, Lake County.

61. Sphærium simile Say. Plate II, Fig. 1.

"Large, inflated, rather solid, almost equilateral, transversely oval; umbones depressed, inflated, placed a trifle anterior to the center of the shell, marked by heavy ridges, but not so coarse as in *stamineum;*

dorsal margin very nearly straight, ventral border broadly curved; anterior and posterior margins almost equal, the posterior a little longer than the anterior, the two margins rounded; umbonal slopes rounded; surface shining, growth lines coarse; color dark brown, sometimes with a reddish tinge; ligament weak, very dark horn or black; cardinal teeth small, a single, long, stout, elevated, arched tooth in the right valve, and two stout, elevated teeth in the left valve, the upper tooth being short and curved and the lower tooth long and almost straight; lateral teeth double in the right and single in the left valve, short, elevated, lamellar, nearly straight; muscle scars and pallial line faintly impressed; nacre bluish; cavity of the beaks shallow. Length, 16.50 mm.; height, 11.75 mm.; breadth, 9 mm.

"The hinge teeth are arranged very peculiarly in this species, the laterals being in a direct line with the cardinals, and not at right angles to them, as in the previous species. It is one of the largest of the genus and distinguished from the related species by its transversely oval outline, its peculiarly placed teeth, and its umbonal marking, which is intermediate between *solidulum* and *stamineum*. The umbones are also placed very near the center of the shell."—*Baker.*

Common in Lake Wawasee, Kosciusko County. Occurs also in Lake Maxinkuckee, and in the Wabash River near New Harmony, Posey County.

62. Sphærium fabale Prime. Plate II, Fig. 2.

"Of good size, transversely oval, somewhat compressed, almost equilateral, thin and fragile to quite solid; anterior and posterior margins rounded; ventral margin curved; dorsal margin slightly curved; umbones depressed, almost flush with the hinge line, placed near the center of the shell and quite heavily marked and regular; umbonal slopes gently rounded; surface smooth and shining in young or half grown specimens but dull in old examples; lines of growth typically very coarse and distinct, but finer in some specimens; color light green, yellowish or blackish, the latter a marked character in old specimens; ligament weak, color varying with the shell; cardinal teeth small, those in the left valve unequal, one placed near the dorsal margin and extending from the latter to a point midway between the dorsal and ventral margins of the hinge plate, and one placed near the ventral margin of the hinge plate; the dorsal tooth is nearly straight while the ventral tooth is very arcuate; in the

right valve there is a single, large, arched tooth which extends from the center to the ventral border of the hinge plate, it is large at either end and small in the middle; lateral teeth double in the right and single in the left valve, rather small, elevated, pyramidal, slightly curved; hinge line rather solid; muscle scars indistinct; cavity of the beaks shallow; anterior bluish. Length, 11 mm., height, 9 mm.; breadth, 5.50 mm."—*Baker.*

Taken by Baker at Millers, Lake County, of which locality he writes: "This interesting region, at the extreme southern end of Lake Michigan, is said by Professor Garriott to be the most windswept locality in the Chicago area. This fact accounts for the enormous quantity of sea wrack which lines the shore at this point and which is not to be found in such profusion anywhere else along the shore. This sea wrack has proven prolific collecting ground for molluscan life."

Also taken by Daniels opposite Michigan City and in the Wabash River at New Harmony, Posey County.

63. Sphærium occidentale Prime. Plate II, Fig. 3.

"Small, inflated, fragile, equilateral; umbones prominent but not much elevated, inflated, placed centrally, marked by very fine lines; dorsal and ventral margins rounded; anterior and posterior margins rounded; umbonal slopes rounded; surface shining, marked by very fine lines of growth; color light horn, sometimes darker; ligament as usual; cardinal teeth small, a single, elevated, lamellar, curved tooth in the right valve, the posterior curve of which is longer than the anterior and is club shaped, and two teeth in the left valve, that near the ventral border of the hinge plate being elevated and pyramidal, that on the dorsal border being long, lamellar, depressed, and curved, as in the preceding species; lateral teeth short, elevated, curved, single in the left and double in the right valve; muscle scars scarcely discernible; cavity of the beaks shallow; nacre light purplish or bluish. Length, 7.50 mm.; height, 7 mm.; breadth, 4.50 mm.

"This species is distinguished by its oval outline, which is more regular than that of any other Sphærium found in Indiana. It is very common, and when found at all is usually represented by hundreds of individuals."—*Baker.*

Taken by Mr. Daniels in the Kankakee River, at Shelby and Riverside; in Tippecanoe Lake, Kosciusko County, and in the cypress swamps of Knox County.

64. Sphærium flavum Prime.

"Shell transversely rounded, compressed, equilateral, delicate, margins generally rounded, the posterior a little distended; beaks central, not full, more or less depressed; valves very slight, interior whitish; sulcations pretty deep, regular; epidermis light, of a greenish-yellow color; cardinal teeth small, in the shape of the letter V reversed; lateral teeth elongated. Length, 0.43; height, 0.31; diameter, 0.18 inches.

Fig. 36. *Sphærium flavum* Prime.

"This is a very slight and delicate species, quite distinct from any others."—*Prime.*

Known heretofore from Lake Superior, near Sault Ste. Marie. Taken by Daniels in Lake Wawasee, Kosciusko County, and from the beach of Lake Michigan, near Pine and Millers, Lake County. Identified by Sterki.

65. Calyculina truncata Linsley. Plate II, Fig. 4.

"Very fragile, small, inflated, almost equilateral, rhombic-ovate, translucent; umbones prominent, elevated, full, calyculate, approximating, placed centrally, smooth and shining; dorsal margin straight; ventral margin broadly rounded; anterior margin rounded; posterior margin sharply truncated, rounded on the ventral part; umbonal slopes rounded; surface smooth and shining, lines of growth very fine; color light yellowish green or greenish horn with a zone of yellow bordering the ventral margin of the valve; ligament weak, light horn-color; cardinal teeth small, a single, elevated, lamellar, arched tooth in the right valve, and two teeth in the left valve, the ventral tooth pyramidal, elevated, the dorsal tooth long, lamellar, curved and elevated; lateral teeth long, lamellar, elevated, straight, one in the left valve and two in the right valve; muscle scars scarcely visible; cavity of the beaks shallow; nacre light bluish with a yellow zone on the ventral border. Length, 9.25 mm., height, 7.50 mm., width, 5 mm.

"This species is very like *S. transversa*, but is shorter in comparison with its height, is rhombic in form and the beaks are placed centrally. The two species belong to a natural group of which *transversa* is the leading form."—*Baker.*

Ranges from New England west to Illinois and Wisconsin and south to Kentucky.

Occurs in lakes Wawasee and Tippecanoe, Kosciusko County, and in the cypress swamps of Knox County.

66. Calyculina securis Prime. Plate II, Fig. 5.

"Small, fragile, but stouter than the two previous species, inflated, inequilateral, rhombic-orbicular; umbones elevated, full, much inflated, calyculate, approximate, placed a trifle anteriorly; marked by very fine lines of growth; dorsal margin arched; ventral margin rounded; anterior margin rounded, posterior truncated; umbonal slopes rounded, sub-angulate posteriorly; surface shining, lines of growth very faint; color varying from bright yellow to greenish horn, sometimes very dark horn; ligament as usual; cardinal teeth very small, a single, long, elevated, lamellar, arched tooth in the right valve, which has a large pyramidal projection near the anterior end giving the hinge the appearance of a double tooth, and two teeth in the left valve, one near the ventral margin of the hinge plate, elevated, pyramidal, and one near the dorsal border, lamellar, depressed, curved, extending diagonally toward the ventral border; lateral teeth long, lamellar, elevated, slightly curved, one in the left valve and two in the right; muscle scars faint; cavity of the beaks deep; nacre bluish white, darker near the postero-ventral portion, lighter in yellowish specimens. Length, 6 mm.; height, 5 mm.; width, 3 mm.

"A species at once distinguished by its rhombic-orbicular outline and inflated beaks and shell. It is the smallest *Sphærium* found in Indiana, and is wider in proportion to its length than any other species."—*Baker.*

Range same as preceding. Common in Grassy Creek and in Lake Wawasee, Kosciusko County.

67. Calyculina rosacea Prime.

"Shell small, rounded-oval, fragile, translucent, subequilateral, somewhat compressed, margins generally rounded; beaks nearly central, slightly inclined toward the interior, calyculate, approximate at apex; valves very slight, a little convex in the region of the umbones; striæ regular, hardly visible; epidermis shiny, reddish-brown; hinge-margin nearly straight, delicate, narrow; cardinal teeth nearly obsolete, lateral teeth slight, elongated. Length, .25; width, .18; diameter, .15 inches."—*Prime.*

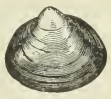


Fig. 37. *Calyculina rosacea* Prime.

Common in Grassy Creek. A few specimens were also secured in Lake Wawasee.

68. Pisidium compressum Prime.

"Shell solid, very oblique, trigonal, triangular, subequilateral, very much drawn up in the region of the beaks, inflated in adult; anterior side a little longer, narrower, produced at the end, posterior broader, sub-truncate; beaks placed a little posteriorly, small, raised, with a wing-shaped appendage on the summits, distant; striæ distinct, regular; epidermis very variable, yellow, gray or chestnut color; valves solid, varying in inflation, interior light blue; hinge thick; cardinal teeth small, robust, compressed, disposed in the shape of the letter V reversed; lateral teeth distinct, short, strong, placed at an obtuse angle with the hinge proper. Length, .16; width, .14; diameter, .09 inches."—*Prime.*

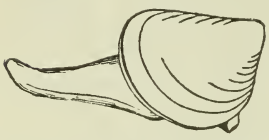


Fig. 38. *Pisidium compressum* Prime.

Ranges across the continent. Occurs in Lake Wawasee and Grassy Creek, Kosciusko County; Bass Lake, Starke County, and Lake Maxinkuckee, Marshall County, from all of which localities it has been collected by Daniels.

69. Pisidium obtusale (Lam.?) C. Pfr.

"Mussel roundish-oval, very much inflated, under the lens extremely finely striate, near the inferior margin with a few deeper striæ and generally with strong lines of "year-growth," with a strong shell, shining, yellowish to grayish horn-colored; superior and inferior margins rather strongly curved, but each one perceptibly less curved toward the anterior; posterior margin strongly curved, anterior part not much longer, little attenuated, broadly rounded, outlines without any angles; beaks broad, prominent, near the middle of the mussel; the valves join at a right or somewhat obtuse angle at the inferior margin; hinge plate narrow, left valve with the exterior cardinal tooth very short, fine, covering half of the inner one, lateral teeth approximate to the cardinals; right valve with the cardinal tooth little curved, thickened posteriorly; animal with syphon depressed-conical, wide at the base, anteriorly* narrow, truncate. Longitude, 3.5; altitude, 2.5; diameter, 2.3 mm. Europe, north of the Alps. (*P. obtusale* is rather variable in size).—*Westerland.* (Translated.)

The present Indiana specimens measure: Longitude, 3.5 to 3.7; altitude, 3.2; diameter, 2.5 to 2.7 mm."—*Sterki.*

Taken in numbers in a spring near Lake James, Steuben County.

* Evidently means "posteriorly."

70. Pisidium nov-eboracense Prime.

"Shell rounded-oval, very inequilateral, inflated, margins rounded; anterior side considerably produced, narrower; beaks situated posteriorly, large, full, prominent; valves comparatively slight, interior light blue; striæ irregular; epidermis variable, generally greenish-yellow or brown; hinge-margin a little curved; hinge slight, narrow; cardinal teeth double, very small; lateral teeth elongated. Length, .35; width, .18; diameter, .13 inches. —*Prime.*

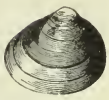


Fig. 39. *Pisidium nov-eboracense* Prime.

Collected in Lake Wawasee, Grassy Creek and Bass Lake, by Mr. Daniels. This and other species of Pisidium and Sphærium identified by Sterki.

71. Pisidium variabile Prime. Plate II, Fig. 6 (enlarged).

"Small, solid, inflated, inequilateral, oblique; umbones very much elevated; full, very prominent, placed posteriorly, smooth and polished to the naked eye but marked by fine lines when viewed with a lens; all margins rounded, the anterior being somewhat pointed or triangular and quite long, while the posterior is short and very broadly rounded; umbonal slopes rounded, the anterior subexcavated; surface shining, marked by rather heavy, regular growth lines; color varying from light yellow or straw to greenish or brownish, with a zone of light or dark color near the ventral margin; in some specimens two zones are present, while in others the zone is hardly visible; ligament small and weak; cardinal teeth small, a single long, arched tooth in the right valve, and two more or less pyramidal teeth in the left valve; the right valve tooth is constricted in the center of the arch and gradually enlarges toward the distal end of the arch, the right arm of arch being the longer and reaching nearly to the base of the hinge plate; the upper left valve tooth is somewhat gourd-shaped, beginning small at the upper margin of the hinge plate and gradually enlarging to about the center of the plate; the lower left valve tooth is large, solid and pyramidal; lateral teeth elevated above the valve edge, triangular; the entire hinge plate about the lateral teeth is enlarged, thick and heavy; cavity of the beaks deep and full; nacre bluish-white, shining. Length, 4.50 mm.; height, 4.50 mm.; breadth, 3.10 mm."—*Baker.*

With the last two species in the lakes and streams mentioned.

72. Pisidium politum Sterki.

"Mussel of medium size, well inflated, rather high, beaks slightly posterior, rather high and prominent, not full but well rounded; scutum and scutellum slightly marked. Superior margin rather

short, rather strongly curved; inferior well curved, more so in front than behind; posterior margin distinctly truncated, with a well marked angle where joining the superior, and a less marked, rounded angle where joining the inferior margin; anterior end forming a slight but distinct angle situated rather high up. Surface very finely, irregularly striated, polished; whitish or straw colored, often leaden-grayish on the beaks, or even all over. Shell moderately thick, nacre whitish; muscular insertions not very distinct; hinge of essentially the same type as that in *Pis. abditum*. Length, 4.7 mm., height, 4 mm., diameter, 2.9 mm."—*Sterki*.

Fig. 40. *Pisidium politum* Sterki.

Recorded from Ohio, Pennsylvania, Michigan, Minnesota and Illinois. Taken in numbers in Grassy Creek, Kosciusko County, by Daniels.

73. PISIDIUM VESICULARE Sterki.

"Mussel small, ovoid, very inequipartite, somewhat oblique, strongly inflated; beaks very posterior, moderately prominent; margins all well rounded, or the scutum forming a very slight angular projection; color yellowish to brownish horn; surface slightly striated, polished, often with a few coarser lines of growth; shell thin, translucent; nacre rather glassy, colorless; hinge rather small, markedly short; cardinal teeth lamellar, the right moderately curved with its anterior end thicker; anterior left distinctly directed upward, curved, often angular; posterior, oblique, moderately curved; groove between them narrow and deep; lateral teeth situated very close to the cardinals, short, especially those in the left valve abrupt, high; ligament short. Length, 2.3 mm.; height, 1.9 mm.; diameter, 1.7 mm." —*Sterki*.

One specimen taken from the stomach of a catfish (*Ameiurus nebulosus* Raf.) from Bass Lake, Starke County.

74. PISIDIUM PAUPERCULUM Sterki.

"Mussel of moderate size, rather oblique, moderately to rather strongly inflated; beaks slightly posterior, moderately large and prominent, rounded; scutum and scutellum slightly marked; edges acute or acutish, not pinched; superior and inferior margins moderately curved, posterior well rounded or slightly truncated, joining the inferior without any marked angle; antero-superior margin sloping, oblique, slightly curved, meeting the inferior at an angle situated rather inferior, more distant in the adult than in younger examples; surface very finely striated, polished; color pale or yellowish to greenish-horn, sometimes whitish or straw in old specimens; shell

thin, translucent; hinge moderately strong; cardinal teeth of the right valve moderately curved, its posterior end thickened, those of the right valve lamellar, almost equal, the superior rather short, slightly oblique and little curved; lateral teeth rather strong; ligament short, thin. Length, 3.2 mm.; height, 2.7 mm.; diameter, 1.9 mm."—*Sterki.*

A common species east of the Mississippi River. Occurs in numbers in Lakes Wawasee and Maxinkuckee.

75. PISIDIUM SCUTELLATUM Sterki.

"Mussel of medium size, rather high, oblique, markedly protracted downward in its anterior part, well rounded, rather strongly inflated; beaks much posterior, rather large, prominent, rounded; superior margin short, little curved, or almost straight, scutum and scutellum well marked, forming projecting angles; the other margins well curved, or the posterior very slightly truncated, anterior end well rounded, or with a slight indication of an angle; surface polished, with irregular striæ and some coarse lines of growth; shell thin, transparent, of a yellowish-horn to amber color, often grayish or brownish-horn in old specimens, and whitish on the beaks; nacre glassy, inner surface microscopically rugulose; hinge fine, short, cardinal teeth lamellar, the one in the right valve moderately curved, its posterior end thicker; the inferior in the left valve curved, the superior little so or almost straight; lateral teeth very short, very abrupt, pointed, thin, little projecting into the cavity of the mussel; ligament small. Length, 4 mm.; height, 3.6 mm., diameter, 2.8 mm."—*Sterki.*

Fig. 41. *Pisidium scutellatum* Sterki.

Recorded heretofore from Michigan, Minnesota and Montana. Taken by Daniels in Lost Lake, Marshall County.

76. PISIDIUM SPLENDIDULUM Sterki.

"Mussel small, well inflated, rather ovoid in outline, scutum and scutellum rather well marked, the former often prominent; beaks slightly posterior, somewhat prominent, moderately large, rounded; color pale to deep horn, surface polished, with very fine, somewhat irregular striæ; shell thin, transparent; hinge rather fine but well formed, plate narrow; cardinal teeth longitudinal, lamellar, the right one rather long, slightly curved, most so at both ends, more or less thickened at the posterior end, and often with a groove; the two in the valve nearly

Fig. 42. *Pisidium splendidulum* Sterki.

equal, parallel, little curved, the superior is anterior for about one-third of its length; lateral teeth comparatively strong, all projecting into the interior of the mussel, pointed; ligament rather long. Length, 2.8 mm.; height, 2.4 mm., diameter, 1.7 mm."—*Sterki.*

Common in Grassy Creek and Lake Wawasee, Kosciusko County; also taken from the stomach of a catfish captured in Bass Lake, Starke County.

77. Pisidium roperi Sterki.

"Mussel rather large, strongly inflated when mature, very little so when young; oblong to ovoid in outline, margins regularly curved, with no projecting angles (in the adult); scutum and scutellum scarcely marked; beaks moderately posterior, very broad, surface somewhat glossy, with irregular, not sharp, striæ and some strongly marked lines of growth; color of the dry shell straw to yellowish-horn, often with one to several fine, concentric lines of purple; shell rather thin, nacre whitish, muscle insertions scarcely marked, hinge comparatively fine and short; cardinal teeth quite small, the right one moderately curved, slightly thickened at the posterior end; the left ones very short; the inferior slightly angular, truncated or pointed on top, the superior sometimes almost obsolete; lateral teeth short, small, scarcely projecting into the interior; ligament rather fine. Length, 5.5 mm., height, 4.4 mm., diameter, 3.8 mm."—*Sterki.*

Ranges from Maine to California. Taken in Grassy Creek and Tippecanoe Lake, Kosciusko County; also recorded from Danville, Indiana, by Sterki.

78. Pisidium medianum Sterki.

"Mussel of rather small size, elliptical in outline, much inflated, often of somewhat irregular growth; superior and inferior margins moderately curved, posterior well rounded, or with a slight angle above, anterior rounded or slightly truncated obliquely; beaks rather in the middle, slightly directed toward the posterior, rather high, prominent over the hinge margin; scutum and scutellum very slightly marked; surface with very fine, crowded striæ, somewhat shining, light horn to yellowish or straw colored; shell thin, nacre colorless, muscle insertions barely perceptible; hinge fine, plate narrow; cardinal teeth lamellar, slightly curved, the right one in its posterior part somewhat thicker, simple or with a fine, longitudinal groove; lateral teeth pointed, the outer ones of the right valve comparatively large; ligament fine. Length, 3.5 mm.; height, 2.8 mm., diameter, 2.3 mm."—*Sterki.*

Common in Michigan and Wisconsin. A number were taken from the stomachs of catfish caught in Bass Lake, Starke County.

79. Pisidium tenuissimum Sterki.

"Rather small, little to strongly oblique, moderately to rather well inflated, with the edges usually acutish, elongated or rather short, rhomboid to oblong-ovoid in outline; hinge margin little inferior, moderately curved, posterior end rounded or sub-truncate obliquely in a postero-anterior direction with a rounded angle above; anterior more or less curved, truncate obliquely with the rounded-angular end inferiorly, or the whole anterior part rather regularly parabolic, with the end in the longitudinal median line; beaks slightly posterior, somewhat broad, moderately elevated over the hinge line, somewhat mammillar; surface very finely, almost regularly striated, highly polished; color horn to smoky, or to greenish, or to light grayish; shell very thin, translucent; hinge very fine, plate very narrow, cardinal teeth very small, short, thin, scarcely or slightly curved; those of the left valve very close together, longitudinal-parallel, the upper little posterior; lateral teeth rather long, markedly straight, slender, thin, with short cusps; also the outer ones in the right valve quite distinct; ligament fine. Length, 3.4 mm.; height, 2.8 mm.; diameter, 2.1 mm."—*Sterki.*

Recorded heretofore from a number of lakes in Michigan. Taken by Daniels at Bass Lake and Lake Maxinkuckee.

80. Pisidium affine Sterki.

"Rather large, well-inflated, slightly oblique, beaks somewhat posterior, large and prominent in full-grown, broad and quite low in young specimens, rounded or slightly flattened on top; superior and inferior margins moderately curved; posterior sub-truncate, with slightly marked angles above and below; supero-anterior forming one regular curve from the beaks to the anterior end, which is low situated and well-rounded; surface distinctly and somewhat irregularly striated, with some coarser lines of growth, dull or somewhat shining; color lighter or darker grayish horn to plumbeous or brownish with a few irregular darker zones corresponding with the lines of growth, and often with fine darker mottlings, usually with a broad lighter zone along the margins; the young are pale horn or straw colored; shell moderately thick, nacre whitish, muscle insertions little; hinge rather stout, plate rather broad; cardinal teeth long, not very strong, the right one curved, its free edge often indented in the middle, its posterior end somewhat thicker, with a fine groove, the left anterior tooth curved, the posterior slightly so, oblique, rather behind the anterior, each covering the other for half their lengths; lateral teeth stout, rather long, their cusps short and somewhat

pointed, the outer ones on the right valve of good size; ligament rather long and stout. Length, 6 mm.; height, 5 mm., diameter, 4 mm."—*Sterki.*

New York to Michigan and Minnesota. Common in Lake Wawasee, Kosciusko County.

81. Pisidium sargenti Sterki.

"Mussel of medium size, somewhat oblique, well inflated; beaks not much posterior, rounded or slightly flattened on top, well prominent over the hinge margin; the latter slightly curved in the adult, almost straight in the young and half-grown, with projecting, not or hardly rounded angles at the scutum and scutellum, which are slightly to well marked, narrow; posterior margin sub-truncate above, passing into the well rounded inferior with an uninterrupted curve, or with a slightly marked, rounded angle, more so in the young; supero-anterior margin little to moderately curved, sloping from the projecting angle at the scutellum to the rounded anterior end; surface regularly and rather coarsely striated, dull, rarely somewhat shining in older specimens; epiconch thin and often worn off, pale horn-colored in the young, lighter to darker grayish to brownish in older specimens, usually with a lighter zone along the margins; shell moderately thick, nacre glassy, colorless to white or bluish, muscle insertions distinct; hinge stout, plate rather broad, cardinal teeth well formed, short, the right one rather strongly curved, its posterior end thickened and grooved; the left anterior angular, stout, the posterior small, oblique; lateral teeth rather short, stout, their cusps short, pointed, the outer ones in the right valve well formed; ligament short, strong. Length, 5 mm.; height, 4.4 mm.; diameter, 3.4 mm.

"New York to Ohio, Michigan, Illinois and Minnesota, rather common in creeks, rivers and small lakes."—*Sterki.*

Taken from the stomachs of catfish captured in Bass Lake.

82. Pisidium strengi Sterki.

"Mussel of moderate size, regularly inflated, rather short; beaks slightly posterior, small, narrow, approximate, somewhat projecting over the hinge margin; superior and inferior margins well curved, the supero-anterior slightly so and forming a steep slope to the somewhat angled anterior end; the posterior end sub-truncate; scutum and scutellum indistinct; angles in front of and behind the beaks slight, rounded; shell rather thin, translucent; surface very finely striate, appearing smooth, with a few fine, irregular lines of growth, and with a slight, dull gloss; color of epiconch pale horn shading

into grayish, whitish or yellowish; nacre almost glassy, muscle scars very slight; hinge fine, plate narrow; cardinal teeth small, thin; the right one curved, its posterior end deeply cleft, the left anterior curved or almost straight, the posterior short, oblique; lateral teeth small, somewhat pointed, the outer ones of the right valve quite small but distinct; ligament small. Length, 4 mm.; height, 3.7 mm.; diameter, 2.6 mm."—*Sterki.*

Ranges from Michigan to New York, Ohio and Indiana, a number of the type specimens having been taken by Daniels from the stomachs of catfish caught in Bass Lake, Starke County.

Family UNIONIDÆ.

83. TRUNCILLA SAMPSONII (Lea).

"Shell smooth, oblique, inflated, very much swollen at the umbones, emarginate behind, round before, very inequilateral; valves thick, slightly thicker before; beaks prominent, swollen, incurved, slightly undulate at the tips; epidermis yellowish, covered with green rays; cardinal teeth rather large, erect and corrugate; lateral teeth thick, short, corrugate and nearly straight; nacre silver white and slightly iridescent."—*Lea.*

Call regarded this species as a variety of *perplexus;* but Simpson, in his "Synopsis of the Naiades," lists it as distinct. Specimens are in the State Museum labeled "Wabash River," and Daniels has taken it in that river at Grand Chain, Posey County.

84. LAMPSILUS OVATUS Say.

"Shell subovate, convex, not remarkably thick, horn-color, not radiated; flattened and fuscous on the anterior margin; beaks decorticated, placed nearer central; umbo prominent; within parlaceous; cavity of the beaks capacious; primary teeth very oblique, almost parallel to the posterior margin and much compressed. Length, three inches; breadth, four inches."—*Say.*

Specimens in the State Museum marked "Ohio River" were probably taken by Dr. Stein in that stream, near Mt. Vernon, Posey County. Say mentioned it as "inhabiting the Ohio River and its tributary streams."

85. LAMPSILIS FALLACIOSUS Smith. Plate II, Fig. 7.

"Shell elongate elliptical, subsolid, inflated, rounded in front, and ending in a rather sharp point behind, at two-thirds of the height of the shell, with a moderate, rounded posterior ridge; beaks not

prominent, their sculpture consisting of a few delicate parallel ridges, somewhat doubly looped, the hinder loops generally open behind; epidermis very smooth and shining, ashy straw color, often brownish on the back of the shell, generally feebly rayed with green; female shell decidedly swollen in the postbasal region, so that the base line is often incurved in front of the swelling; teeth rather delicate, there being one compressed pseudo-cardinal and one lateral in the right valve, and two pseudo-cardinals and two laterals in the left; beak cavities not deep; nacre brilliant, silvery. Length, 90 mm.; height, 40 mm.; diameter, 32 mm.

"This species has generally been confounded with its near ally, *Lampsilis anodontoides* Lea. It is smaller, more inflated, and in every way a more delicate form than the latter; it is not so high, the epidermis is brighter and more glossy, and generally rayed. The postbasal inflation of the female is usually more pronounced, and the posterior point is higher than in *anodontoides*. The latter is usually more yellow or tawny than *fallaciosus*, and is, on the whole, a heavier shell."—*Simpson*.

Occurs in the upper Mississippi drainage; south to the Cumberland and Arkansas rivers. In Indiana it has been taken by Daniels only in the Tippecanoe River, Carroll County. Specimens in the State Museum are marked "Wabash River, Indiana."

86. Lampsilis lienosus Conrad.

"Shell elliptical, inflated, slightly furrowed or contracted from beak to base; substance of the shell thickened toward the base; posterior dorsal and posterior basal margin rounded, extremity sub-angulated; beaks pointed, approximate, slightly prominent, with interrupted undulations; concentric lines prominent; epidermis dark olive, obscurely rayed, wrinkled on the margins; cardinal teeth double in both valves, slightly compressed, oblique, striated; nacre varying from bluish white to deep salmon or purple; cavity most capacious under the umbonal slope. The color of the interior is remarkably inconstant, but a purple approaching to salmon is the most prevailing tint, and the margin is bluish-white."—*Conrad*.

Measurements of Indiana specimens: Length of male, 55 mm., female, 46 mm.; height, male, 31 mm., female, 26 mm.; diameter, male, 19 mm., female, 18 mm.

Common in the canal and White River at Indianapolis. Dr. Stein probably had this species in mind when he listed *U. nasutus* Say from the same locality, as the latter species occurs only in the St. Lawrence Drainage. *Lienosus* is a southern species, Marion County being the most northern point from which it has been recorded.

87. LAMPSILIS NIGERRIMUS Lea.

"Shell smooth, elliptical, rather convex, inequilateral, rounded behind; substance of the shell rather thin; beaks small, slightly prominent, undulated at the tip; ligament rather long and thin; epidermis shining, black, striate, in the young radiate all over the disk; marks of growth rather distant; posterior slope compressed into a small carina; umbonal slope slightly raised and rounded; cardinal teeth rather large, somewhat compressed, oblique, acuminate, crenulate and double in both valves; lateral teeth long, lamellar, somewhat curved and separated from the cardinal tooth; anterior cicatrices distinct; posterior cicatrices confluent; dorsal cicatrices placed near the edge of the plate and on the cardinal tooth; cavity of the shell rather shallow; cavity of the beaks shallow and subrotund; nacre white and very iridescent. Length, 1.3; height, 2.2; diameter, .7 inches.

"All the adults, male and female, of which I have many specimens, are very black and apparently without rays, but when held up to a strong light, delicate obscure rays may be observed, particularly about the umbonal slope. In the individuals of one-third growth and less, the epidermis is dark-green and covered with rays. The female differs much in outline from the male, and is much inflated on that portion of the disk which tends to the posterior basal margin. This enlargement makes that margin obliquely truncate."—*Lea.*

A southern form, whose range is recorded as "Alexandria, Louisiana to Eastern Texas." Listed by Stein from the White River. Taken by Daniels in that stream, near Rockford, Jackson County, where it is common. Identified by Simpson.

88. LAMPSILIS BLATCHLEYI Daniels*. Plate III.

"Shell long, elliptical or obovate, compressed, thin, inequilateral, slightly gaping behind; beaks low, but little inflated, pointed, with minute nodulous sculpture; dorsal and basal outlines lightly curved; anterior end somewhat narrowed, rounded; posterior end rounded and lightly and obliquely subtruncate above; surface with singular growth lines; epidermis somewhat concentrically wrinkled, projecting beyond the border of the shell, yellow green with faint green rays; pseudo-cardinals rudimentary, smooth, subcompressed; laterals straight, single in the right valve, partly double in the left; nacre brilliant, iridescent, having a somewhat coppery lustre in the cavities, becoming very thin and greenish at the edges. Length, 45 mm., height, 21 mm., diameter, 10 mm. Length, 40 mm., height, 17 mm., diameter, 8.5 mm."—*Daniels.*

* Nautilus, XVI, 1902, p. 13.

Wabash River, Section 32, Linn Township, Posey County, Indiana. Found only on gravel bars in swiftly running water. Fourteen specimens were collected in August, 1901. (For exact locality, see map. page 583.)

Five or six additional specimens were taken at the same place in August, 1902, the largest of which had the following dimensions: Length, 56 mm., height, 25 mm., diameter, 14 mm.

89. Anodonta corpulenta Cooper.

"Shell large, inflated, thin to rather solid, slightly inequilateral, subrhomboid, rounded in front and on the base; hinge line slightly curved; dorsal wing somewhat prominent in young shells, ending in an angle behind at the obliquely truncate dorsal slope; posterior ridge rather low; umbonal region very full; beaks with coarse folds which are somewhat doubly looped; surface sub-shining, with strong, irregular growth lines, olive or greenish olive, sometimes having lighter or darker bands; dorsal slope usually having two or three faint dark rays; nacre bluish or reddish. Length, 170 mm.; height, 115 mm.; diameter, 70 mm. Length, 158 mm., height, 116 mm.; diameter, 66 mm.

"Generally less elongated and having the umbonal region more inflated than the varieties of *A. grandis*, and as a rule it is more rhomboid in outline. It is very close to *A. stewartiana*, but the latter is usually more elongated, is darker colored, and is normally covered with a somewhat dusky epidermis."—*Simpson MS.*

Range.—Missouri River; Upper Mississippi River Drainage, east to Indiana. Common in Clear Lake, Laporte County. Identified by Simpson.

90. Anodonta kennicotti Lea.

"Shell smooth, elliptical, somewhat inflated, inequilateral, obtusely angular behind and round before; substance of the shell rather thin; beaks prominent, pointed and granular at the tips; ligament long, thin and dark brown; epidermis varying from pale yellow to dark brown, without rays, with eight or ten rather close lines of growth; umbonal slope raised and rounded; posterior slope rather narrow, elliptical, slightly carinate, with two indistinct lines in each valve from the tips to the margin; anterior cicatrices confluent and very slightly impressed; posterior cicatrices confluent, large and scarcely perceptible, dorsal cicatrices placed over the center of the cavity of the beaks; cavity of the shell rather deep and wide; cavity of the beaks shallow and very obtusely angular, nacre bluish white

and iridescent. Length, 1.2; height, 1.9; diameter, .7 inches. —*Lea.*

A northern species whose range, according to Simpson, is the "Upper and Middle St. Lawrence System; northwest into the McKenzie Drainage." Taken by Daniels in Lake Wawasee, Kosciusko County, where it occurs in marly deposits in shallow water.

91. QUADRULA PYRAMIDATA Lea.

"Shell sub-pyramidal, longitudinal, inequilateral, anterior part swollen recurvely from the beaks to the basal margin, compressed at posterior margin, slightly depressed anterior to umbonal slope; substance of the shell very thick in the region of the teeth and beaks, thin at posterior margin; beaks very much elevated, recurved and incurved; epidermis very dark brown and finely wrinkled; cardinal teeth large, crenate and deeply impressed in the left valve, single and emerging from a pit in the right; lateral teeth long, slightly curved, distinct from the cardinal teeth and pointing toward the basal margin; anterior cicatrices distinct, the great one forming a deep pit; posterior cicatrices distinct, the smaller one being placed at the end of the lateral tooth; dorsal cicatrices situated on the under part of the cardinal tooth; cavity of the beaks deep and angulated; nacre beautifully flesh-colored, very rarely white. Length, 2.3; height, 2.1; diameter, 1.7 inches."—*Lea.*

Ohio, Cumberland and Tennessee River Systems. Taken by Daniels in the Wabash at Terre Haute and Lafayette, and in the Tippecanoe River, in Carroll County.

92. QUADRULA SUBROTUNDA Lea.

"Shell suborbicular, nearly equilateral, subventricose; substance of the shell thick, somewhat thinner behind; beaks thick and elevated; ligament rather short and thick; epidermis yellow and smooth in the region of the beaks; brown and finely wrinkled towards the margin; interrupted rays pass from the beaks and are very visible over the umbones, but are lost in the wrinkles before they reach the margin; cardinal teeth thick and crenate; lateral teeth short, thick and very slightly curved; posterior and anterior cicatrices both distinct; dorsal cicatrices situated on the under side of the cardinal teeth; cavity of the beaks deep and angulated; nacre pearly white and iridescent. Length, 1.6; height, 1.6; diameter, 1.1 inches.

"This is perfectly distinct from any described species and seems peculiar in its yellow beaks and brown margin; as well as in the

beautiful interrupted rays which pass over the umbones, leaving the anterior and posterior slopes usually of a yellow color. In form it approaches *U. ebenus.*"—*Lea.*

Ohio, Cumberland and Tennessee River Systems; west to Arkansas and north to Wisconsin. Occurs plentifully at many different stations in the Wabash River and also in the Tippecanoe.

EXPLANATION OF PLATES.

PLATE I.

Fig. 1. *Polygyra monodon fraterna* Say.
2. *Polygyra monodon* Rackett.
3. *Bifidaria procera* Gould.
4. *Vitrea hammonis* (Strom.)
5. *Vitrea indentata* Say.
6. *Zonitoides nitidus* (Muller).
7. *Zonitoides minusculus* Binney.
8. *Punctum pygmæum* Drap.
9. *Carychium exile* H. C. Lea (enlarged).
10. *Limnæa stagnalis appressa* Say.
11. *Limnæa reflexa kirtlandiana* Lea.
12. *Limnæa palustris michiganensis* Walker.
13. *Limnæa caperata umbilicata* Adams.
14. *Limnæa catascopium* Say.
15. *Limnæa columella* Say.
16. *Limnæa woodruffi* Baker.
17. *Physa sayi* Tappan.
18. *Physa gyrina elliptica* Lea.
19. *Physa integra* Haldeman.
20. *Bythinia tentaculata* L.
21. *Valvata sincera* Say.

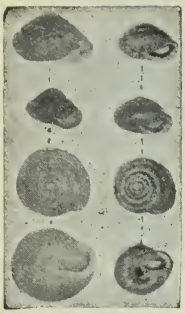
PLATE II.

Fig. 1. *Sphærium simile* Say.
2. *Sphærium fabale* Prime.
3. *Sphærium occidentale* Prime.
4. *Calyculina truncata* Linsley.
5. *Calyculina securis* Prime.
6. *Pisidium variabile* Prime (enlarged).
7. *Lampsilis fallaciosus* (Smith).

PLATE III.

Lampsilis blatchleyi Daniels.

PLATE I.



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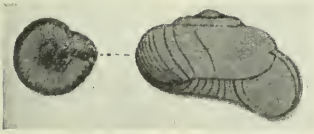

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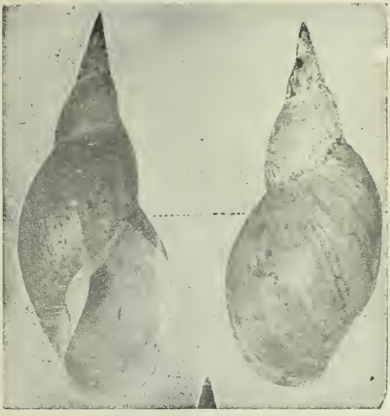

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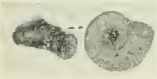

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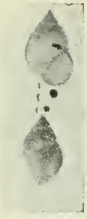

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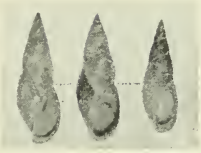

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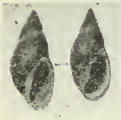

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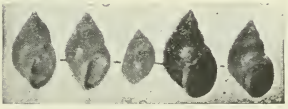

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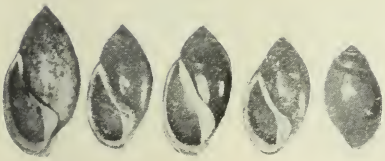

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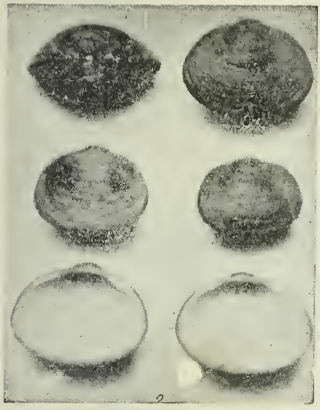

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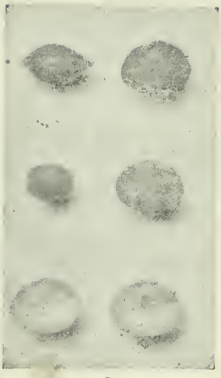

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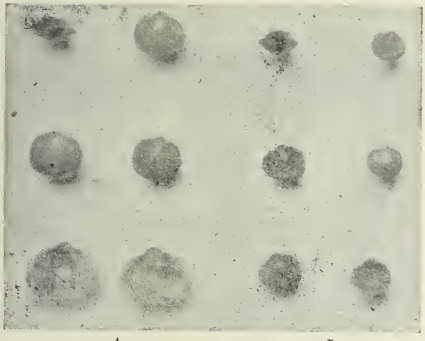

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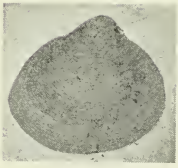

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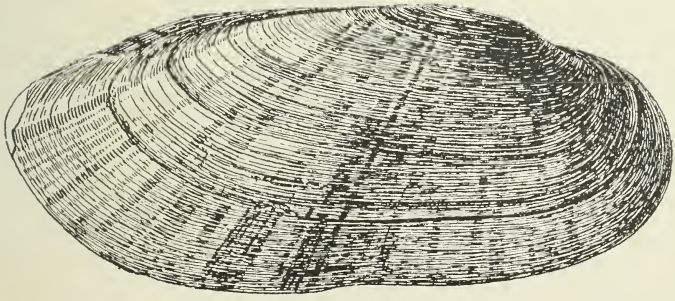

Fig. 7. *Lampsilis fallaciosus* (Smith).

Lampsilis blatchleyi Daniels.

INDEX TO MOLLUSCA OF INDIANA.

(1902 Report.)

(FAMILY NAMES ARE IN SMALL CAPITALS; GENERIC AND SPECIFIC NAMES IN ROMAN.)

23

A STUDY OF THE UNIONIDÆ OF ARKANSAS, WITH INCIDENTAL REFERENCE TO THEIR DISTRIBUTION IN THE MISSISSIPPI VALLEY.

By R. Ellsworth Call, M. Sc., M. A., M. D.

There exists very little published information concerning the abundance, varieties, and geographic distribution of the great molluscan family of *Unionidæ*, within the limits of the State of Arkansas. A few forms were originally accredited to it; some of these have not since been found in the State, nor have some others ever occurred outside its boundary. Of the mollusks of no other one State in the Union is less known.

During the progress of the investigation the results of which are herein recorded, opportunity to consult a number of original types has been afforded with some very interesting results connected with the nomenclature of this great group of mollusks. To those who have not had access to original publications and to original specimens, much of the synonymy herein developed will, perhaps, prove a matter of surprise. The task which one thus assumes is not without its share of responsibility. To do strict justice to those most excellent early investigators, who so completely have rendered all successive students their debtors, is no easy task. That each one did the best he could, or knew, we scarcely can doubt; measured by the faulty notions of species that prevailed during their time they could, perhaps, for the most part, have done little better. A half century spent upon this great family by the veteran Dr. Isaac Lea must, in itself, entitle his opinions to confidence and to weight. But authority may never stand in place of Nature and in place of fact. If so be a more modern notion of what constitutes specific value, coupled with proper regard for environmental factors,

has necessitated the reduction to synonymic rank of very many forms it is only because the facts justify the reduction, and the interests of sound scientific reasoning require it. Of so much synonymy as grew out of personal differences between former students it were better not to speak. It will always stand as a reproach that the best interests of science have thus suffered.

Most of the opinions herein expressed, regarding the specific value of very many forms, are based upon an extensive private collection of *Unionidæ*, which is geographically and numerically all but complete. Added thereto are very many facts gleaned during an engagement of some months in the Smithsonian Institution, at Washington, the time of which was largely devoted to the *Unionidæ*, which had previously been studied by my old friend and preceptor, the competent and painstaking Dr. James Lewis. Many facts, chiefly, however, connected with geographical distribution, were thus collated.

A considerable number of American *Unionidæ*, most of which are represented in the fauna of Arkansas, were originally described by the great French naturalist, Lamarck. Concerning these species there has been much difference of opinion, and even yet, in certain cases, opinions are divergent. To facilitate a correct understanding of Lamarck's species his original descriptions are herein reproduced, and fuller and more complete descriptions added, of forms which are believed to be authentic. These descriptions are accompanied by drawings in the several plates; some of these were executed by the careful hand of Mr. Harry A. Pilsbry and are duly accredited to him on the plates; the remainder were drawn by the writer. Added to the data thus assembled will be found, for Lamarck's species, most of the synonyms which have been erected as species upon his older described forms. The determination of these synonyms was in no sense a patriotic matter, but proceeded on the hard lines recognized in science as just and right. The great naturalist made serious errors, but these could not well be avoided with scanty material and not too full locality references. It is hoped that this rather full synonymy,— which is

not complete, we too well know, — will eliminate from the trade-lists of amateurs species names which should no longer burden our faunal lists. In the matter of other bibliographic references the rule adopted has been to give the volume, page, plate, figure and date reference where the form was first described; added to these are occasional references to well-known and easily accessible works. There has been made no attempt, in the case of the greater number of forms listed, to exhibit but a moiety of the bibliographic matter. Beginning with *Unio elegans* Lea, references have been made to Reeve's great work, the Conchologia Iconica; this has been done in the hope that those to whom access is given to that work will find the critical notes, which are sometimes appended, of service. Many American shells are therein wrongly named but the fault lies in the sending abroad of misnamed specimens of American *Unionidæ*. Some of these errors are corrected by Reeve in the addenda to the Genus *Unio;* the rest remain to puzzle the naturalist. The opportunity to examine and use this great and costly work was afforded by the generous courtesy of Mr. Truman H. Aldrich, of Cincinnati, who kindly loaned me these volumes for a long period of time.

Not the least interesting fact connected with the study of the *Unionidæ* is the one that numerous species have been duplicated by describing the forms assumed by the sexes as of specific value. This has occurred in a number of instances, and is responsible for a considerable number of synonymic names. Among the forms so described, the following may stand as examples: —

Unio donaciformis Lea is the female of *Unio zigzag*, Lea.

Unio ater Lea is a synonym of *Unio purpuratus* Lamarck, and is based on the female form.

Unio patulus Lea is based on the female of *Unio clavus* Lamarck.

Unio lens Lea and *Unio leibii* are both synonyms of *Unio circulus* Lea and are based on the female form. *Unio leibii* is a dwarfed form of *U. circulus.*

Unio brevidens Lea is a male form of a species the female of which was afterwards described as *Unio arcæformis* Lea.

Unio subovatus Lea was based on the male of Say's *Unio ovatus*.

This list, illustrating what appears to have been the misinterpretation of sexual differences, might be extended indefinitely; when extended to its limits the student of the *Unionidæ* will be astonished at the results which he will reach.

Aside from personal collections, made in the intervals of field work in geology, and which were made in the St. Francis, Ouachita and Saline rivers, help has been derived from specimens collected by Professor R. T. Hill, in the Ouachita, by Mr. L. S. Griswold, in the Ouachita well up toward its source, and by Mr. F. A. Sampson, in the White river and in other portions of northern Arkansas. Dr. John C. Branner, State Geologist, has furnished an occasional specimen. Other shells have been sent, for identification, from the Little Red river. It is a matter of regret that more full and exhaustive collections could not be made preliminary to a final paper; it would better represent the wealth of the State in this group of natural objects. It will be noticed that three streams and as many localities furnish the major portion of the species here listed. Reasoning from this fact it is fair to assume that very many forms yet remain to be added to the list on complete examination of the State.

REGISTER OF SPECIES.

UNIO ABERTI Conrad.

Proc. Phila. Acad. Nat. Sci., p. 10, (1850); Jour. Phila. Acad. Nat. Sci., 2d series, Vol. II, Plate XXVI, Fig. 1, (1851).

Unio lamarckianus Lea. Trans. Am. Philos. Soc., 2d series, Vol. 10, Pl. 17, Fig. 20, (1852).

Unio popenoi Call. Bull. Washburn Coll. Lab'y of Nat. Hist., No. II, pp. 48–49, Pl. II, (1885).

This form was described by Lea from the Caddo river, under the name of *Unio lamarckianus*, the specimens of which were submitted to him by Dr. Byrd Powell. Additional examples were submitted by Dr. Hale who collected them in the Ouachita river, near the Hot Springs. The specimen figured by Doctor

Lea is a young one and is by no means a fair illustration of the shell. In the description of the species he mentions the numerous small nodules found over its surface but the figure shows the shell as smooth. The very young shells are nearly as triangular as the well known *Unio elegans* Lea.

In 1885 the writer, without then having access to the complete bibliography of the species, and misled by the great size of the specimens submitted to him, described the form as new, giving it the name of its Kansas discoverer. Later the error was discovered by him and the facts fully stated.* In this last named paper the remarkable character of the ctenidium was made known and illustrated from specimens collected in the Verdigris river, Kansas, by Mr. J. R. Mead.

This species has thus far been only found in the Arkansas and Red river drainage basins. It has not occurred to us in our collecting in the State.

UNIO ALATUS Say.

Nicholson's Encyc., Am. ed., Vol. IV, Pl. IV, Fig. 2, 1816. Also figured in the Am. Jour. of Science and Arts, 1st series, Vol. XIV, Fig. 17*a* and 17*b*. Another good figure may be found in Conrad's Monograph of Unio, Plate XXXI. A figure has recently appeared, in Bull. U. S. Fish Commission, Vol. XIII, Pl. 36, 1893, that is characteristic in all respects, except its alate features. Both alæ are broken in the specimen figured.

This species has not been found abundantly in Arkansas. Its sole occurrence to us was in the St. Francis river, near Wittsburg, in Cross county. It has been seen by the writer from the Ouachita river, Indian Territory, and without doubt will be found in the Arkansas portion of that stream. It is not readily confounded with any other known *Unio* being, when perfect, easily separated from other symphynote species by its dark purple coloration within and its flattened disk. I have received it under the name of *Unio purpuratus* from which species, however, it is entirely distinct.

From the Cedar river, Iowa, were secured very large and

* See American Naturalist, September, Vol. xxi, 1887, p. 860.

fine specimens of this form. One of these measures in length 175 mm., in height 105 mm., in breadth 51 mm.

Unio anodontoides Lea.

Trans. Am. Philos. Soc., Vol. IV, Pl. VIII, Fig. 11, 1830.

Unio teres Rafinesque, *vide* Conrad's Monograph, Pl. XXVIII.

St. Francis river, at Wittsburg and Madison; Saline river, at Benton.

This species is very widely distributed over the United States from western New York to Alabama and Texas, ranging north to Indiana, Minnesota, and Kansas. It is well marked and is distinct from *Unio luteolus* Lamarck, with which it is often confounded. The St. Francis specimens are very large and fine.

Conrad's figure of *Unio teres* is said by him to be based upon a specimen in Mr. Poulson's cabinet, which was said to have been labeled by Rafinesque himself, who collected it "in the west."

Unio arkansasensis Lea.

Jour. Phila. Acad. Nat. Sci., 2d series, Vol. V, Pl. XXX, Fig. 275.

The only Arkansas specimens seen came from the Saline river, near Benton. One is quite imperfect while the other, of the two, is a good representative of the female of the species. The original specimens came from "Hot Springs" and presumably from the Ouachita river.

Unio breviculus Call.

Plate XVII.

Proc. U. S. Nat. Mus., Vol. 10, p. 499, Plate XXVIII, 1887.

White river, Carroll county; Little Red river, Clinton, Van Buren county, Arkansas. Jack's Fork of Current river, Missouri; Big Creek, tributary to Jack's Fork, Texas county, Missouri.

Shell smooth, ovate elliptical, inequilateral, subinflated, biangular posteriorly, circularly rounded before, somewhat

incrassate; umbones slightly elevated, so much eroded that minute characters are indeterminate; ligament large, thick, black, or dark brown; epidermis yellowish horn-color, smooth, polished, rayed with dark green over the whole disk, the rays often interrupted by the lines of growth, which are numerous, but somewhat indistinct; umbonal slope rounded, depressed in the male, slightly elevated in the female; posterior outline emarginate in the female ventrad of the siphonal area, dorsal outline rounded; cardinal teeth double in the left and single in the right valve, short, erect, triangular, solid, smooth, or scarcely crenulate; plate connecting laterals with cardinal teeth thick, somewhat arched; lateral teeth rather short, thick, slightly curved, smooth; anterior cicatrices distinct, large, deeply impressed; posterior cicatrices confluent, well impressed, that of the *retractor pedis* muscle at tip of base of lateral tooth but not on it; dorsal cicatrices numerous and deeply impressed in the cavity of the umbones; nacre salmon colored, occasionally white. Length 71.00 mm.; breadth 27.20 mm.; height 45.50 mm.

Animal dirty, yellowish white; labial palps short, ovately triangular, adherent at base, laterally united so as to form an oval groove, midway from the extremities of which is placed the mouth. In the specimens examined only the anterior one-third of the external branchiæ contained ova. This portion was characterized by the heavy deposit of pigmentary matter at the apex of the chambers, while the remaining margins of the branchiæ were uniform in coloration with the mass of the animal. The posterior borders of the mantle were, as usual, differentiated into a series of tentacular folds; those surrounding the incurrent and excurrent orifices were yellow and brown, the remainder were black.

While the females sustain a general resemblance to *Unio clarkianus* Lea and *Unio gerhardtii* Lea the emarginate character of the female form is utterly unlike anything exhibited by the females of Lea's types.

The above description is repeated from the original, that this form, which has recently been found abundantly near Clinton, Arkansas, may not remain unknown to those persons in that State who take any interest in its natural objects.

UNIO CALIGINOSUS Lea.

Trans. Am. Philos. Soc., 2d series, Vol. 10, Plate VII, Fig. 21, 1845.

St. Francis river, Wittsburg; White river, Carroll county; Ouachita river, Malvern; Saline river, Benton.

These localities all furnished numbers of this form and of great perfection. Among the Uniones with which it groups are *Unio intercedens* Lea, *Unio fallax* Lea, and *Unio subrostratus* Say. The group is widely distributed in the southern States and is characterized by the emargination of the female, on the ventral border.

UNIO CAPAX Green.

Described by Dr. Green in "Cabinet of Natural History and American Rural Sports," Vol. II, p. 290, Phila., 1832.

Figured as *Symphynota globosa* Lea, in Trans. Am. Philos. Soc., Vol. V, Pl. IV, Fig. 12, 1832.

Dr. Green's description has priority by some weeks, though these authors published their diagnoses in the same year. Green's specimens came from the Falls of St. Anthony, and Bayou Teche, La., the localities being widely separated. Dr. Lea's specimens came from the Ohio river, about 150 miles below Louisville.

The species has occurred in our collections from Arkansas only in the St. Francis river at Wittsburg and is represented by two fine examples. It has the habit of *Unio occidens*, with which it groups, preferring muddy bottoms and still waters. It is fairly common throughout the Mississippi valley, in the larger streams that flow into the main river.

A closely related form, from the Altamaha river, Georgia, was described by Dr. Lea under the name of *Unio dolabræformis*, *vide* Trans. Am. Philos. Soc., 2d series, Vol. VI, p. 103, Pl. XXIV, Fig. 113, 1838. It is probably synonymous.

UNIO CASTANEUS Lea.

Trans. Am. Philos. Soc., Vol. IV, p. 91, Pl. XI, Fig. 21, 1830,. Described from the Alabama river, Alabama.

Numerous examples of this shell have been taken in the

Little Red river, in Van Buren county, one fine example of which we have seen, together with a poorer one. It came to us under the name of *Unio arkansasensis* Lea. From Claiborne Parish, Louisiana, we have seen about fifty good examples. The large and old shells resemble much some forms of *Unio ellipsis* Lea.

UNIO CERINUS Conrad.

Monograph of Unio, p. 95, Plate LII, 1838. Reeve, Conchologia Iconica, Vol. XVI, *Unio*, Plate LXXXVII, Fig. 468.

The only Arkansas example which we have seen was taken in the Little Red river, and was loaned to us for examination by Mr. W. A. Marsh. It is a fine female and a very characteristic form. Mr. Lea makes this shell a synonym of his *Unio rubiginosus*, but does so wrongly. Before us are forty or more specimens from Louisiana, the original home of the species, some of which are sufficiently perfect to disclose undulations on the beaks such as no *rubiginosus* ever possessed. They rather ally Conrad's shell to those peculiarly marked Mexican and Central American forms that have similar beaks. No shell with which I am acquainted so well presents similar characters as the common Texan form to which Gould gave the name of *Unio petrinus*, the original examples of which came from Mexico. This species will certainly not fall under *rubiginosus* whatever else may become of it.

UNIO CLAVUS Lamarck.

Plate I.

This shell is one of those prolific sources of synonymy with which the descriptive matter of American fresh-water conchology has become so burdened. In the hope that it will subserve a useful purpose the original description of Lamarck follows, and the synonymy as now understood, excepting only those names which have not been accompanied by figures.

The following description is taken from Volume VI, "Historie Naturelle des Animaux sans Vertebres," page 537, 1838.

"*U. testa sublongitudinali, oviformi, inferne tumida, obtusa; postico latere brevissimo; dente laterali prælongo.*

Var. testa versus extremitatem lateris antici sensim depressa, magis attenuata.

Unio modioliformis Say, Amer. Conch.

*Habite dans le lac Erie. Michaud fils. * * * Test tres blanc. Longueur apparente 72 millimetres. La variete b vit dans la riviere de la Nouvelle-Ecosse. * * * Longueur apparente 53 millimetres.*"

Lamarck's brief description is no doubt responsible for very much of the confusion which attends the separation of this form. To aid in its correct determination the following description has been drawn, from specimens collected in the Duck river, Tennessee. The specimen figured is one of those employed in this diagnosis.

Shell smooth, somewhat elliptical, most of its mass posterior to a line drawn vertically from the umbones, laterally subcompressed, somewhat pointed posteriorly, circularly rounded before; umbones prominent and pointed anteriorly, apiculate; ligament large, thick, light brown; epidermis honey-yellow, smooth, often polished, rayed from the tips of the umbones with green lines over the first formed half of the disk, the rays broadening downward, occasionally interrupted by the lines of growth which are numerous and strongly impressed giving to the lower third of old specimens a striate appearance; umbonal slope rounded anteriorly but compressed posteriorly; in the female, the posterior slope is rather less flattened than in the male, while the outline of the disk is less pointed; cardinal teeth single in the right, double in the left valve, rather short and incrassate, crenulate; plate connecting laterals with the cardinal teeth disposed to folding in the left and pitted in the right to correspond, thick, slightly arched; lateral teeth long-lamellar, curved ventrad, striate; anterior cicatrices confluent, deeply impressed, that of the *retractor pedis* impression very deep and circular and at the end and lower margin of the lateral teeth and partly on them; dorsal cicatrices numerous, small and impressed in an irregular line on the under side of the plate between the cardinal and lateral teeth; nacre pure white, with a very marked iridescence posteriorly between the pallial cicatrix and the margin.

Animal not observed.

Length, 53.00 mm.; breadth, 18.50 mm.; height, 30.00 mm.

The synonymy of this species has been but partially worked out, but it is certain that it will include the following forms:

Unio patulus Lea. 1829. Trans. Am. Philos. Soc., Vol. III, p. 409, Pl. XII, Fig. 20.

Unio decisus Lea. 1830. Trans. Am. Philos. Soc., Vol. IV, p. 92, Pl. XII, Fig. 23.

Unio chattanoogaensis Lea. 1858. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. IV, 1859, p. 209, Pl. XXV, Fig. 90.

Unio consanguineus Lea. 1861. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. V, p. 67, Pl. VII, Fig. 217.

Unio pallidofulvus Lea. 1861. Jour. Acad. Nat. Sci. Phila., 2d, series, Vol. V, pp. 83–85, Pl. XI, Fig. 232.

Unio interventus Lea. 1861. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. V, p. 84, Pl. XI, Fig. 233.

Unio concolor Lea. 1861. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. V, p. 89, Pl. XII, Fig. 237.

Unio anaticulus Lea. 1861. Jour. Acad. Nat. Sci. Phila., 2d series, 1862, Vol. V, p. 92, Pl. XIII, Fig. 240.

Unio crebrivittatus Lea. 1861. Jour. Acad. Nat. Sci. Phila., Vol. VI, 1866, p. 43, Pl. XV, Fig. 41.

Unio curtus Lea. 1859. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. V, 1861, pp. 92–103, Pl. XVII, Fig. 253.

Both this last named form and *Unio anaticulus* were based on deformed specimens of *Uniones* and are, in a certain sense, pathologic forms. To this synonymy must be added those other names under which Say described this species a leading term of which will be *Unio modioliformis*, as had been noted by the editors of Lamarck, in 1838. Other great groups of *Uniones* there are which exhibit a far larger synonymy than does that group which this species of Lamarck heads.

So far as known this form does not occur west of the Mississippi, nor has any member of the group been found which may be located west of that stream. It has its greatest development in the mountain regions of Georgia, Alabama, Kentucky, and Tennessee, though it ranges, as specimens at hand prove, from western New York to Ottawa river, Canada, thence west to Illinois and south to middle Alabama, where some of its forms are exceedingly abundant in the

streams of north-central Alabama, notably in the Coosa, Alabama, and Cahaba rivers.

A good illustration of this form may be found in Conrad's Monograph, Pl. III, fig. 1. Also in Tenney's Zoölogy, Manual, edition of 1872, p. 492, Fig. 460. Reeve, Conchologia Iconica, Plate LXIX, Fig. 354, also well exhibits its chief features, but the beaks are represented to be more decurved than in any specimen we have ever seen.

Unio cornutus Barnes.

Am. Jour. of Sci. and Arts, 1st series, Vol. VI, p. 122, Fig. 5*a*, 5*b*, 1823;

Unio reflexus Rafinesque, in Conrad's Monograph, Pl. IV, Fig. 1, 1838.

This species has been seen by us from only one Arkansas locality. That one was the St. Francis river, at Wittsburg, in Cross county. It has a wide range in its geographical distribution since it occurs from western New York to Kansas and south to Alabama and Texas.

Unio crassidens Lamarck.

Plate II.

Unio niger Rafinesque, in Conrad's Monograph of Unio, Pl. XXVI, 1836.

Unio incrassatus Lea. Trans. Am. Philos. Soc., 2d series, Vol. VIII, Pl. XVI, Fig. 34, p. 217, 1840.

Unio cuneatus Barnes, Am. Jour. of Sci. and Arts, 1st series, Vol. VI, p. 263, 1823.

Lamarck's description included several varieties, some of which were improperly included in the species as limited. Such, for instance, is his variety *a* which is said by Dr. Lea, who saw the type in Paris, to be his *Unio trapezoides* and which is entirely distinct from *crassidens*. The original description here follows from the *Animaux sans Vertebres, 2d Edition*, Vol. VI, p. 532, 1838.

"*U testa ovali, tumida, crassa, postice rotundata, antice, angulis binis ternisve subsinuosa, dente cardinali crassissimo lobato, angulato, striato.*

Habite l'Amerique septentrionale, dans le Mississippi, l'Ohio, et plusieurs lacs. * * * ''

The remainder of the description is concerned with the diagnoses of the varieties which Lamarck considered as belonging to this form. Variety *a* is from the Mississippi; variety *b* from Lake Erie, variety *c* from the Ohio. But each variety appears to be a distinct species.

The following description is based upon specimens obtained from the Cumberland river, at Nashville, Tennessee, where the species is very abundant; also facts are included from characters exhibited by abundant material from the Etowah and Oostanaula rivers, in Georgia. The species is likewise abundant in the Cahaba, Alabama, and Coosa rivers, in Alabama.

Shell smooth, elliptical, compressed, incrassate anteriorly, biangular and much thinner posteriorly; epidermis rather thick, black in old specimens and deep reddish brown in young ones, striate, often with curved, dark green rays extending ventrad from the umbones, in the young shell; the dorso-posterior margin much and quite regularly-curved; posterior umbonal slope eradiate, somewhat flattened, separated from the lateral slope by a marked angle, with a prominent raised line, sometimes two, extending from the umbones and joining the posterior margin at the angles, the whole posterior slope is, commonly, strongly and coarsely striate; umbones small, scarcely prominent, slightly incurved; ligament long, thick, curved with dorsal margin, black; cardinal teeth short, heavy, triangular, striate, single in the right, double in the left valve, the posterior portion of the double left tooth nearly equal in size and shape to the single right tooth; lateral teeth long, thick, straight or nearly so, crenulate, in old specimens this is strongly marked; dorsal plate connecting the lateral with the cardinal teeth scarcely marked, smooth, rounded; anterior cicatrices distinct, deeply impressed, that of the adductor muscle much roughened and pitted with numerous small pits arranged in a row near the edge of the plate forming its upper margin; pallial cicatrix well impressed anteriorly and markedly crenulate throughout; posterior cicatrices distinct, that of the adductor deeply impressed and extending to the posterior end of lateral teeth,

striate, that of the *retractor pedis* muscle deep, pit-like, sometimes confluent with that of the adductor; cavity of the beaks shallow, with a row of minute pit-like dorsal cicatrices some distance within the margin of the plate; nacre rich purple, light, iridescent, the latter feature especially marked posteriorly.

Animal not observed.

Length, 111.25 mm.; breadth, 40.00 mm; height, 69.00 mm.

In very good specimens, not too old, small and well marked foldings, disposed at an angle with the umbonal angle and increasing in number towards the umbones, may be noticed. These are characteristic, and serve to indicate the possible affinities of this species and *Unio incrassatus* Lea, from the Chattahoochee, Oostanaula, and other Georgia streams.

The figure given herewith is drawn from a fine specimen obtained in the Cumberland river, Tennessee, at Nashville, where the form is very abundant. Larger but less perfect specimens are common. In nearly all the great rivers of the south, west of the Appalachian system, this form occurs and usually in great abundance. It has not yet been obtained west of the Mississippi, so far as present information extends.

Unio cuneus Conrad.

Monograph of Unio, Pl. LVIII, Fig. 1, 1836.

Four specimens were found in the Saline river, at Benton. The species was described from the Little Red river, Arkansas, by T. A. Conrad. It has long been properly regarded as identical with *Unio coccineus* Hildreth and should no longer be distributed under its Conradian name. Doctor Ward, of Ohio, many years ago distributed the white-nacred variety of this form under the manuscript name of *Unio gouldianus* Ward, but never described it. The name was adopted by Dr. John Jay, of New York, and published by him in his "Catalogue of Shells in the Jay collection."

The typical forms have a warm pink nacre but are not so common as the white-nacred variety. The range of the species is from western New York to North Alabama and west to central Kansas. In the rivers of Iowa it is both abundant and fine.

In further history of the form it may be stated that the real author of the species was Dr. Hildreth, of Marietta, Ohio, who sent it to Mr. Lea with the manuscript name of *Unio coccineus*. Hildreth did not describe it under that name, even in manuscript, and Mr. Lea, adopting the proposed name, described the species as new in the Trans. Am. Philos. Soc., Vol. VI, Pl. V, Fig. 12, 1834. A good figure may also be found in Conrad's Monograph, Pl. XIII, Fig. 1. The white-nacred variety is figured by Conrad, on the same plate, under the name of *Unio catillus*, from the Scioto river, Ohio.

Unio cylindricus Say.

Plate XI.

Unio cylindricus Say, in Nicholson's Encyc. Am. Ed. Article Conchology, Pl. 4, Fig. 3, 1816.

Unio naviformis Lamarck. Deshayes Encyc. Meth. Vers ,Tome II, p. 580, No. 5, 1830.

Unio naviformis Lamarck. Animaux sans Vertebres, Tome VI, p. 537, No. 20, edition of 1838. From the Ohio.

Unio cylindricus Say, Barnes, in Am. Jour. of Sci. and Arts, 1st series, Vol. XIV, Pl. I, Figs. 13a, 13b.

This species is abundant in the St. Francis, Saline, and Ouachita rivers, Arkansas, from which localities many specimens have been seen. In the Cumberland and Harpeth rivers of Tennessee, the largest and finest specimens noticed have been taken. In geographical range the species extends from western New York to Indiana, Kansas, and Texas, and south to Central Alabama, in the Alabama river, at Selma. The specimen figured is from the White river, Indiana, and was contributed by Professor Barton W. Evermann.

Unio donaciformis Lea.

Trans. Am. Philos. Soc., Vol. III, p. 266, Pl. IV, Fig. 3, 1827. Described from Ohio.

Unio zigzag Lea. Trans. Am. Philos. Soc., Vol. III, p. 409, Pl. XII, Fig. 19, 1829. Described from Ohio.

This species is abundant in the St. Francis river, at Witts-

burg. It is reported also from the Ouachita river, near the boundary of the Indian Territory, but we have seen no specimens from that stream. The probable identity of these forms, as given in the above synonymy, was suspected by Mr. Lea himself; it seems, therefore, now more than useless longer to attempt their specific distinction.

UNIO EBENUS Lea.

Trans. Am. Philos. Soc., Vol. IV, p. 84, Pl. IX, Fig. 14, 1830.

Unio subrotundus Lea. Trans. Am. Philos. Soc., Vol. IV, p. 117, Pl. XVIII, Fig. 45, 1831.

Unio lesueurianus Lea. Trans. Am. Philos. Soc., Vol. VIII, p. 195, Pl. VIII, Fig. 6, 1840.

Unio globatus Lea. Jour. Phila. Acad. Nat. Sci., 2d Series, Vol. VIII, p. 5, Pl. I, Fig. 1, 1874.

Unio subglobatus Lea. Jour. Phila. Acad. Nat. Sci., 2d series, Vol. VIII, p. 7, Pl. I, Fig. 3, 1874.

Specimens have been studied from the following Arkansas localities: St. Francis river, Wittsburg; Ouachita river, Malvern. The geographical range of the species is from western New York to Texas, north to Kansas and Minnesota. The species is very abundant in the Mississippi river, at Moline, Illinois; in the Cumberland, at Nashville, Tennessee, in the Alabama, at Selma, and is a common form in the larger rivers west of the Mississippi. This shell is peculiar, though it shares this feature with several other forms, in occurring only in large streams. It is a mud-loving form and commonly abounds in muddy localities, where it occurs at all. The synonymy indicated above is illustrated by specimens in the cabinet of the writer and identified by Dr. Lea. Some of them are from the original localities of the various types.

UNIO ELEGANS Lea.

Trans. Am. Philos. Soc., Vol. IV, p. 83, Pl. IX, Fig. 13, 1830–1. Described from the Ohio river.

Conchologia Iconica, Reeve, *Unio*, Plate LXXIV, Fig. 380, 1868.

Unio truncatus Rafinesque, Say in American Conchology, Pl. 67.

The only Arkansas locality where this form has been found is the St. Francis river, at Wittsburg. It is there a very common shell, preferring rather muddy bottoms. The illustration given by Reeve is a fairly good one, but presents certain artistic effects that are not to be seen in the shell itself. It is a member of a group of which *Unio donaciformis* Lea may be considered a leading term.

Unio gibbosus Barnes.

Am. Jour. Sci. and Arts, 1st series, Vol. VI, Pl. XI, Fig. 12, 1823.

Unio arctior Lea. Trans. Am. Philos. Soc., Vol. VI, p. 10, Pl. IV, Fig. 10, 1834; Conchologia Iconica, Reeve, *Unio* Plate LXXXV, Fig. 454, 1868.

Unio dilatatus Rafinesque, so Conrad in Monograph, Plate XXI, 1838.

Unio stonensis Lea. Trans. Am. Philos. Soc., Vol. VIII, p. 195, Pl. VIII, Fig. 5, 1840; Conchologia Iconica, Reeve, *Unio* Plate LXXXV, Fig. 453, 1868.

Unio gibbosus Barnes, so Reeve in Conchologia Iconica, Pl. LXXIII, Fig. 377.

The figures of all these forms, as given by Reeve, are poor and do not well represent the shells. *U. stonensis* Lea is from Stone river, Tennessee, from which original locality the writer has specimens, and these are part of the original lot, identified by Mr. Lea, and still with the name in his handwriting. They formerly belonged to Dr. Troost, of Nashville, and were donated by Dr. J. Berrien Lindsley, into whose hands many of the shells of the Troost collection passed. There is no question that the form from the Ohio, which Mr. Lea called *Unio arctior*, is a white-nacred variety of *gibbosus*, a form which is commonly marked by a purple nacre. The white-nacred form, or *arctior*, is common in the Saline river, at Benton; it is abundant also in the Piney river, Missouri. Typical *gibbosus* was obtained in the St. Francis, at Wittsburg.

The geographical range of this form is from western New York to Minnesota and Kansas, south to Texas, and east to Georgia. In the Mississippi and Cumberland rivers it is both abundant and variable. There are few shells among the *Unionidæ* that present so great a range of variation as this one.

UNIO GLANS Lea.

Trans. Am. Philos. Soc., Vol. IV, 1830, p. 82, Pl. VIII, Fig. 12. From the Ohio river; Conrad's Monograph, Pl. IX, Fig. 2, 1836.

Unio pullus Conrad. Monograph of Unio, 1838, p. 100, Pl. LIV, Fig 2. From the Wateree river, South Carolina.

Unio granulatus Lea. 1861. Jour. Acad. Nat. Sci. Phila., Vol. VI, 2d series, 1866, p. 48, Pl. XVI, Fig. 46. Big Prairie creek, Alabama.

Unio germanus Lea. 1861. Jour. Acad. Nat. Sci. Phila., Vol. VI, 1866, p. 49, Pl. XIX, Fig. 54. From Coosa river, Alabama.

Unio cromwellii Lea. 1865. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. VI, 1868, p. 258, Pl. XXXI, Fig. 73. From Kiokee creek, Albany, Georgia.

Unio cylindrellus Lea. Jour. Acad. Nat. Sci. Phila. 1868, 2d series, Vol. VI, p. 308, Pl. XLVIII, Fig. 121. From Tennessee, north Georgia, and north Alabama.

Unio corvunculus Lea. Jour. Acad. Nat. Sci. Phila., 2d series, 1868, Vol. VI, p. 314, Pl. L, Fig. 127. From Swamp creek, Whitfield county, Georgia.

The localities at which this species has occurred, in collecting in Arkansas, are all in Carroll county, and presumably from the same portions of the White river. The three specimens submitted were kindly furnished by Mr. F. A. Sampson, of Sedalia, Missouri, by whom they were collected. The synonymy indicated above is based upon very large series of specimens which comprise materials from every one of Lea's localities. The species was also figured by Reeve, in 1868, *Unio* Plate XXXVI, Fig. 190. The specimen figured by him shows the emarginate character of the female, which sex he had before him. The shell is usually abundant in warm, shallow water,

near the margin, and on gravelly bars ; it also occurs commonly in muddy stations having the habit of *Unio parvus* Barnes which heads the group of which *Unio glans* is a member. *Unio ellipsiformis*, Conrad (Monograph of *Unio* Plate 34, Fig. 1, p. 60), 1838, described from Michigan, is also a synonym.

Unio gracilis Barnes.

Described in the Am. Jour. Sci. and Arts, 1st series, Vol. VI, 1823.

Unio fragilis Rafinesque, so Conrad, in Monograph of Unio, Plate XXX, 1836.

Unio dolosus Lea. 1860. Jour. Acad. Nat. Sci. Phila., Vol. V, 1861, p. 75, Pl. IX, Fig. 224. Also Conchologia Iconica, Reeve, *Unio* Plate XLI, Fig. 228. This is a poor figure of an immature specimen.

Unio gracilis Barnes. Reeve, Conchologia Iconica, 1868, *Unio* Plate XXXIX, Fig. 215. This is a figure of an old specimen but does not show the characteristic alation of the dorsal margin.

This species has occurred to us in the Saline river, at Benton, and in the St. Francis river, at Wittsburg. It does not differ in any material respect from the forms found so abundantly in the sloughs along the Mississippi river farther to the north, and in all the larger streams which are tributary to it, except, perhaps, the Missouri river alone. Lea's *dolosus* is very abundant in the Coosa river at Wetumpka, and in the Alabama at Selma. It was also found in numbers in the Cahaba, at Lily Shoals, in Bibb county. There can be no doubt of its identity with the older form described by Barnes.

The typical form of the group that it heads, this species ranges from the Ottawa river, Canada, to Minnesota, Iowa, and Kansas, and south to Central Alabama and to Texas.

Unio grandidens Lea.

Jour. Acad. Nat. Sci. Phila., 2d series, 1862, Vol. V, p. 205, Pl. XXX, Fig. 274. Also Reeve, in Conchologia Iconica, 1868, *Unio* Plate LXXXIII, Fig. 439.

This species has not been found by us in Arkansas nor do we know of the existence of any specimens other than

the types. It was collected by Dr. Byrd Powell, near Hot Springs, Arkansas, and was described from two unmatched valves belonging to old individuals. Reeve gives a very good figure, probably copied from Lea, but is hopelessly confused on the relations of the form. He does not recognize the name of Lea, save as a synonym, but places it under *Unio nodulosus* Wood. He suggests that it has an aspect very much like that exhibited by certain Chinese shells, and thinks that both "may prove to be the *Chama plumbea* of Chemnitz." It is hardly necessary to say that there is no relation to *Chama*, and no question but that the shell is properly credited to Arkansas. It is a member of the pustulate group and is not far removed from *Unio cooperianus*, which it closely resembles.

Unio irroratus Lea.

Trans. Am. Philos. Soc., Vol. III, 1827, p. 269, Pl. V, Fig 5. Described from Ohio.

Unio irroratus Lea, Reeve, in Conchologia Iconica, *Unio* Pl. XII, Fig. 44, female. 1868.

Unio stegarius Rafinesque, so Conrad, in Monograph of Unio, p. 83, Pl. XLVI, Fig. 1, 1838. Also Reeve, in Conchologia Iconica, *Unio* Plate XII, Fig. 45, male. 1868.

This species occurred in the St. Francis river, at Wittsburg, and in the Saline, at Benton. In the first mentioned locality it is very abundant and specimens of all ages were found. The very young have the outline of *Unio elegans*, but they are somewhat longer than the young of that species at a corresponding age. The resemblance of very many of the young to the form described by Conrad as *Unio aberti* is also marked. The triangular outline is lost with age, and the circular form becomes more and more marked. Closely allied to it is the common *Unio dromas* Lea, of the Cumberland river.

Unio hydianus Lea.

Trans. Am. Philos. Soc., 2nd series, Vol. VI, 1834, p. 14, Pl. VI, Fig. 14.

This species was described from the Bayou Teche, Louis-

iana; it occurs abundantly in the St. Francis river, at Wittsburg, and in the Saline river at Benton. It is a synonym of *Unio luteolus* Lamarck, to which the reader is referred.

Unio lachrymosus Lea.

Transactions Am. Philos. Soc., 2nd series, 1827, p. 272, Pl. VI, Fig. 8. Described from Ohio. Also Reeve, in Conchologia Iconica, 1864, *Unio* Pl. IX, Fig. 33.

Unio asperrimus Lea. Trans. Am. Philos. Soc., 2d series, Vol. IV, p. 71, Pl. V, Fig. 3. 1830–1.

Unio quadrulus Rafinesque, so Say, in Am. Conch., Pl. 53, 1834.

Unio quadratus, Rafinesque, so Reeve, in Conchologia Iconica, *Unio* Plate VI, Fig. 24, 1864.

Unio lunulatus, Pratt. Proc. Davenport Acad. Sci., Vol. I, Pl. XXXI, Fig. 1, (1870?).

Obtained by us in the St. Francis river, at Wittsburg, and in the Saline river, at Benton. *Unio lachrymosus* was described from a small and immature specimen; *Unio asperrimus* from an old and well-worn shell. Yet the resemblances are so close that one might easily have recognized their identity. From the Little Arkansas river, Kansas, come the largest and finest specimens of this species that we have ever seen. In geographic range the form extends from western New York to Kansas and Minnesota, and south to Texas and Alabama.

Unio lævissimus Lea.

Trans. Am. Philos. Soc., Vol. III, Pl. XIII, pp. 444–445.

Specimens of this form were taken by Dr. J. C. Branner, in the Little Red river, at Fulton. The shell is somewhat more globose than the same form reported from other localities; the specimens have a slight tendency to vary toward *Unio hermannii* Lea, described originally from Texas. The types of Lea's *Unio lævissimus* came from the Ohio, in which stream it is by no means uncommon. The range of this form is from Western or middle Ohio to Kansas and Nebraska; southward it ranges to Trinity river, Texas. It is a member of the bi-alate group, the leading term of which is *Unio alatus* Say.

UNIO LIGAMENTINUS Lamarck.

Plate XXI.

Animaux sans Vertebres, Ed. 1838, Vol. VI, p. 533.

Described as follows:—

U. testa ovali tumida, sub epiderme candida; ligamento subduplici: unico externo detecto; altero intra natem et cardinem obtecto.

"*Habite la riviere de l' Ohio. A. Michaud. La coquille a sur chaque valve un angle obtus au cote anterieur. Son test est tres blanc. Son corselet est un peu eleve en carene. Dent cardinale fort epaisse. Largeur, 77 millimetres.*"

It is quite possible that the very extensive synonymy that is exhibited by this species is due largely to the incomplete description which Lamarck gave to this form. It is widely distributed over the United States from western New York to Michigan, Minnesota, Dakota, and Kansas; south to Texas, Louisiana, Alabama, and Tennessee. In this vast range, throughout which it is common or abundant, it has a wonderfully diversified environment. Its home may be in sluggish and muddy bayous, where it delights to dwell in mud and sand; in rapidly flowing mountain streams, like the upper Cumberland and the Holston rivers, where it may be found on gravel bars or wedged in between the larger rocks in the middle of the channels; in the muddy or gravelly rivers of the western prairie States, as in Iowa and Illinois, where it dwells indifferently in mud or gravel. It follows therefore, that these great differences in environment will be influential in determining its coloration and its form. So it is among the most variable, in minor details, of any of the common river-mussels of the western States, sharing in this regard the changes in form incident to *Unio luteolus* Lamarck and *Unio complanatus* Solander, the last named being a form which has never yet been found in any stream west of the Appalachians, outside the drainage of the Great Lakes. These very variable shells have been described many times by those who look for differences rather than resemblances, and so the great burden of synonymy has arisen. A partial list of the most

evident synonyms is given below, a list which does not exhaust, by any means, this fruitful mine.

Unio crassus Say. Nich. Encyc. Am. Ed., Article Conchology, Plate I, Fig. 8, 1816; American Conchology, Pl. VIII, 1831; Reeve, in Conchologia Iconica, *Unio* Plate XCV, Fig. 520, 1868. This is a fine figure of a well-rayed female.

Unio carinatus Barnes. Am. Jour. of Sci. and Arts, 1st series, Vol. VI, 1823, pp. 126 and 259, Fig. 10, Plate 11. From Fox river, Illinois.

Unio ellipticus Barnes. Am. Jour. Sci. and Arts, 1st series, Vol. VI, 1823, Pl. 13, Fig. 19, in outline only. From Fox river, Illinois.

Unio crassus Say, so Conrad, in Monograph of Unio, 1836, Pl. XVI; Reeve, in Conchologia Iconica, *Unio* Plate XL, Fig. 220, 1866. This is a fine figure of a large male specimen.

Unio fasciatus Rafinesque, so Conrad, in Monograph of Unio, 1836, Plate I, p. 3.

Unio powellii Lea. Trans. Am. Philos. Soc., 2d series, Vol. X, Pl. XIX, Fig. 25, p. 270, 1852. From the Saline river, Arkansas, where the writer obtained it in large numbers, in 1891.

Unio pinguis Lea. Jour. Acad. Nat. Sci., 2d series, Vol. IV, 1858, p. 78, Pl. XV, Fig. 58. This is a deformed specimen of *Unio ligamentinus* from the St. Peter's, Minnesota, river. The species was based on a single specimen found in the cabinet of Dr. Budd; no other specimens are known.

Unio upsoni Marsh. Ms. Described in a paper read before the Mercer county, Illinois, Historical Society. The types came from Kishwaukee river, Winnebago county, Illinois. The author of the species thinks he has also recognized it from the White river, Indiana. Having seen the original types, no hesitation is felt regarding this disposition of the form.

Additional to these references little will be needed to understand this species. It may be better understood, however, if a full description of the form be given, and such description

follows, drawn from a large series of specimens from the Des Moines river, Iowa, and supplemented by very large numbers from nearly every considerable stream within the geographic range of this form.

Shell large, elliptical, compressed, rounded before, subbiangulate behind, smooth or striate, thickened anteriorly, thin and iridescent posteriorly; epidermis yellowish-straw color, rayed with numerous, broad, green rays, extending from the umbones ventrad; the rays are indistinct or wanting anteriorly; lines of growth numerous and often, especially in old specimens, raised into ridges which are concentric with the ventral margin; ligament long, thick, black, nearly straight; umbones scarcely prominent, approximating, with many very fine, concentric folds, apparent only in young specimens with perfect epidermis; from the posterior edge of the umbones an obtuse angle extends over the disk posteriorly to the margin where it is apparent at one of the angles which renders the outline biangulate; cardinal teeth double in the left, and disposed to be double in the right valve, triangular, crenulate, roughened; lateral teeth long, lamellar, slightly curved ventrad, crenulate; plate between cardinal and lateral teeth incrassate, arched, smooth; anterior cicatrices large, deeply impressed, distinct; posterior cicatrices large, slightly impressed, confluent, that of the *retractor pedis* muscle impressed at the extreme end of the lateral teeth; dorsal cicatrices in the cavity of the umbones as deep pits disposed in a straight line, which ends near the margin of the plate; pallial cicatrix crenulate, deeply impressed anteriorly; nacre pure white, iridescent, in many specimens with a blush of pink or with decided pink coloration.

Length, 125 mm.; height, 75 mm.; breadth, 52 mm.

The measurements given are those of a large specimen from the Des Moines river, at Des Moines. The species often exceeds these dimensions but is commonly found smaller. In the female the posterior margin is much more rounded than in the male, and the biangulate character quite disappears. The general outline is more flowingly rounded, and the transverse measurements somewhat greater, in the female than in the male shell.

Say's description of *Unio crassus* does not agree with his figure, as has already been pointed out by Dr. Lea. He says his species has waves, while the figure, which shows the interior of the shell only, does not give any hint of that character. It is doubtful that the description and figure were made from the same species. Moreover, it will be noticed, from the dates assigned to these several forms in the synonymy, that Say's species was described long before Lamarck framed his description. But there had already been described from Europe, by Retzius, 1788, a species with the name Say employed. Say's name, therefore, falls into synonymy. This shell is often received from correspondents under the name of *Unio luteolus* Lamarck, which form it very closely, in some respects, resembles.

The Arkansas localities, whence the species has been obtained, are the St. Francis river, at Wittsburg; Ouachita river, at Malvern; and Saline river, at Benton. The last named stream is the original one for the shells which Lea described under the name of *Unio powellii*, the female of which is well figured by Reeve in the volume cited. His specimen was a fair exhibition of the Arkansas form.

UNIO LUTEOLUS Lamarck.

Plate III.

Animaux sans Vertebres, 1818, Vol. VI, p. 79; also, same, edition of 1838, Vol. VI, p. 544.

Unio luteolus Lamarck, Reeve, in Conchologia Iconica, *Unio* Plate LVIII, Fig. 239, female; 239b, female, 1867; also, in same, Plate LXI, Fig. 306, as *Unio multiradiatus* Lea, corrected in *errata*. This is a good figure of the female.

Unio siliquoideus Barnes. Am. Jour. Sci. and Arts, 1st series, Vol. VI, p. 269, Fig. 15, 1823. This is female *luteolus*.

Unio inflatus Barnes. Am. Jour. of Sci. and Arts, 1st series, Vol. VI, 1823, p. 266.

Unio hydianus Lea. Trans. Am. Philos. Soc., Vol. VI. p. 14, Pl. VI, Fig., 14, 1834; Reeve, in Conchologia Iconica, *Unio* Plate XXXVII, Fig. 203, female, 1866.

Unio haleianus Lea. Trans. Am. Philos. Soc., Vol. VIII, p. 247, Pl. XXVII, Fig. 63, 1842. Also a form said to be this is figured by Reeve, *Unio* Plate XXIV, Fig. 116, 1865, in Conchologia Iconica. There is no resemblance to Lea's form.

Unio approximus Lea. Trans. Am. Philos. Soc., Vol. X, Pl. V, Fig. 13, p. 74. Described in 1845 from the Red river, Louisiana; published as above in 1848.

Unio distans Anthony. Am. Jour. of Conchology, Vol. I, p. 156, 1865.

Unio affinis Lea. Trans. Am. Philos. Soc., Vol. X, p. 271, Pl. XIX, Fig. 26; Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate LXI, Fig. 307, 1868. Described from Alexandria, Louisiana.

Obtained by us in the St. Francis river, at Wittsburg; and in the Saline river, at Benton. The Benton form is *Unio hydianus* Lea and is a very abundant one in the Saline.

The original description of Lamarck was as follows:—

"*U testa oblongo-ovata, tenui subpellucida, luteo-virente, radiata; latere antico majore, latiore, rotundato.*

"*Habite la riviere Susquehana et celle Mohancks, dans les Etats Unis. * * * La ligament passe entre le crochet et la charniere. Largeur 69 millimetres.*"

This short and imperfect description was not known to the earlier students of American mollusca, and there is little wonder that considerable synonymy has been established on this shell. It has a very wide range, extending from Winnipeg and Slave Lakes and the Saskatchewan river, British America, to central New York, south to Georgia, Alabama, Texas; west to Kansas, Montana and Dakota. In all this range it is abundant in favorable localities and often attains a great size. Lamarck's original specimens did not approach the maximum dimensions which this shell sometimes reaches.

A very beautiful and somewhat depauperate form occurs in the lakes of northern Indiana. It was a specimen of this sort that constituted the basis of Anthony's description of *Unio distans*. Though sometimes confounded with *Unio ligamentinus* Lamarck there is really no excuse for the confusion of the two forms, since they are more dissimilar than alike. The

beaks of the young, and this statement is true as well of old and perfect specimens, are beautifully marked with ridges that are concentric, or better, perhaps, angulated, with the very obtuse angle pointing toward the tip of the umbones. In *Unio ligamentinus* this character is not so marked and differs in the degree of fineness of these ridges.

The following description is based upon a series of shells taken from the Des Moines river, in central Iowa :—

Shell large, elongate, somewhat inflated, rather thin, circularly rounded before, elliptically rounded behind, the male often somewhat pointed posteriorly, female more tumid posteriorly, emarginate ventrally; epidermis light horn color, polished and shining, usually abundantly rayed with narrow, bright, green, crenulate, somewhat curved rays which depart from the beaks and cover more or less closely the posterior three-fourths of the disk, these are often wanting, especially in old specimens; lunule long, narrow; ligament long, thin, light horn color; hinge margin nearly straight or very slightly arcuate; umbones prominent, approximate, concentrically wrinkled, the wrinkles being angulate and the apices of each pointing toward apex of the umbone, light, nearly white, in color when the epidermis is perfect; cardinal teeth double in both valves, equal only in the left valve, rather small, thin, acutely serrate, all directed anteriorly; lateral teeth long, thin, lamellar, striate, nearly or quite straight; dorsal plate smooth, short, rounded, thin ; anterior cicatrices distinct, that of the adductor rather deep, large, striate, irregularly impressed, that of the *protractor pedis* well impressed but not deep; posterior cicatrices confluent, very slightly impressed, smooth, iridescent; pallial cicatrix well impressed before, broad and shallow, or scarcely impressed, behind; dorsal cicatrices numerous, impressed as deep pits in an irregular row in the center of the cavity of the beaks; cavity of the beaks rather shallow; nacre pure white, sometimes somewhat iridescent posteriorly.

The swollen outline of the full grown female apparently led to the description of this form under the name of *Unio siliquoideus* by Dr. Barnes. This variety in the Mississippi and its larger tributaries, especially those which enter it from the

west, is not only abundant, but is frequently the only form found. It is usually, also, of a darker color, and inhabits muddy portions of the river beds. The female shells are usually found in greater abundance than the male forms, but occasionally the latter are most numerous. The female appears to have formed the basis of nearly every described species that has been erected, and which appears in the synonymy given herewith.

UNIO METANEVRUS Rafinesque.

Plate X.

Obliquaria metanevra Rafinesque, Annales Generales des Sciences Physique, Bruxelles, September, 1820, p. 305, Pl. LXXXI, Figs. 15 et 16. Described from Kentucky.

Unio metanevra Rafinesque, so Reeve, in Conchologia Iconica, *Unio* Plate VII, Fig. 25, 1864. A good figure of outside character.

Unio nodosus Barnes, Am. Jour. Sci. and Arts, 1st series, Vol. VI, 1823, Pl. VI, Figs. 7a and 7b, p. 124. Described from Wisconsin; Hildreth in Am. Jour. Sci. and Arts, 1st series, Vol. XIV, p. 281, Fig. 10, 1828.

Unio rugosus Barnes, Am. Jour. Sci. and Arts, 1st series, Vol. VI, 1823, p. 126, Fig. 9. Described from Ohio; Hildreth in Am. Jour. Sci. and Arts, Vol. XIV, 1st series, p. 282, Fig. 12, 1828.

Our Arkansas specimens came from the St. Francis, at Wittsburg; the Ouachita, at Malvern; the Saline, at Benton.

A small number of related forms, constituting a natural group, are headed by this earliest described member; among them are *Unio tuberosus* Lea; *Unio wardii* Lea, and *Unio cylindricus* Say. The type of the group has a wide distribution from Ohio, south to the Coosa and Alabama rivers, Alabama; Louisiana and Texas; west to the Neosho and Elk rivers, Kansas; and north to Dresbach, Minnesota.

This species is exceedingly variable. In the Alabama, Tennessee, Cumberland, and Mississippi rivers it is usually

short, thick, and nodulous, and often exhibits a pinkish tinge within. In the Meramec, White, St. Francis, Saline, and Colorado rivers it is larger, flatter, thinner, less nodulous, or the nodules are less numerous, but the individual ones are much larger and smoother. It is such a shell as this, with absolutely perfect beaks and epidermis, that forms the basis of the figure in the plate. It was collected by Prof. B. W. Everman, in the White river, Indiana, and is among the most perfect full-grown specimens known. The arrow-shaped, green markings are well exhibited in the specimen.

Conrad, in his Monograph, Plate V, Fig. 2, gives a fine figure of this species.

Unio multiplicatus Lea.

Trans. Am. Philos. Soc., 2d series, Vol. IV, 1830–31, p. 106, Pl. IV, Fig. 2. Reeve, in Conchologia Iconica, *Unio* Plate II, Fig. 8, as *Unio heros* Say; Lea figures the animal of his species in Jour. Acad. Nat. Sci. Phila., 2d series, Vol. IV, Pl. 30, Fig. 105.

Unio heros Say. New Harmony Disseminator, Vol. II, p. 291, 1829; Conrad in Monograph of Unio, Pl. LIX.

Unio undulatus Say. American Conchology, 1831, Pl. XVI, figured from the Fox river, Illinois. This is not the *Unio undulatus* Barnes, but Say abandoned his *heros* for the name of Barnes thinking the totally dissimilar forms to be identical.

Unio boykinianus Lea. Trans. Am. Philos. Soc., 2d series, Vol. VIII, 1840, p. 208, Pl. XIII, Fig. 22; Reeve, in Conchologia Iconica, *Unio* Plate I, Fig. 1, 1868. Described from the Chattahoochee river, Georgia.

Unio elliottii Lea. Jour. Acad. Nat. Sci. Phila., Vol. IV, 2d series, 1858, p. 54, Pl. VII, Fig. 37. Described in 1856 from Othcalooga creek, Gordon county, Georgia.

Unio eightsii Lea. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. IV, 1860, Plate LXIV, Fig. 192, p. 367, described from Texas and Mexico.

This is the most ponderous *Unio* found in American waters. It sometimes attains, as in the Ohio river, at Evansville and Louisville, the Cumberland, at Nashville, the Alabama, at

Selma, and the Red river, at Shrevesport, very great development. From all these localities we have seen large examples, some of which are believed to be unrivaled elsewhere.

Though Say's name of *heros* has strict priority, it cannot be used for the following reasons: it was poorly described in the beginning; it was abandoned by its author for the name of *undulatus* which had been given to another and distinct species by Barnes, from which procedure it is clear that Say had no clearly defined view concerning this form. Lea's name and description being the first that was accompanied with figures, and being the first clearly to indicate the limits of the species, must be adopted, and his name is now in common use. Say himself said, in his description of Plate XVI, American Conchology: "I formerly considered this species, with much doubt, as distinct from the *undulatus* of Barnes, and gave to it the name of *heros*, but notwithstanding some differences, I have concluded, after a more mature examination and comparison, that it may be with propriety referred to that species. Barnes drew his description and figure from a specimen then unique, * * * which was so eroded as not to exhibit the ornamental tubercles of the umbo and beak." To all who have seen the perfect forms of *undulatus* Barnes and *multiplicatus* Lea the marked differences in the characters of the beaks will be clear. Say abandoned his name for this form, and another student renamed it.

This shell has occurred to us only in the St. Francis river, so far as collections have been made in Arkansas.

I have not seen a specimen of *Unio gigas* Swainson, but a specimen in the Museum Taylor, England, is figured by Reeve as coming from the Ohio river. *Vide Unio* Plate LVI, Fig. 287, Conchologia Iconica, Vol. XVI, 1867. There can be no question that this is also *Unio multiplicatus* Lea, and that it should be placed under the above synonymy.

Reeve describes and figures a shell under the name of *Unio perplicatus* Conrad, in Conchologia Iconica, Vol. XVI, *Unio* Plate IX, Fig. 35, which had been labeled by J. G. Anthony, but which is most certainly a specimen of *Unio multiplicatus* Lea. The specimen was then in the Museum Cuming.

UNIO OBLIQUUS Lamarck.

Plate IV.

Historie Naturelle des Animaux sans Vertebres, 1818, Vol. VI, p. 72; also same, edition of 1838, Vol. VI, p. 534.

Unio undatus Barnes, *in partim*. Am. Jour. of Sci. and Arts, 1st series, Vol. VI, 1823, p. 121, Fig. 4. From the Wisconsin and Fox rivers.

Unio cordatus Rafinesque, so Conrad, in Monograph of Unio, p. 48, Pl. XXV, 1836; also Reeve, *Unio* Plate LXXIII, Fig. 376, 1868.

Unio obliquus Lamarck, so Conrad Monograph Pl. XLIII, Fig. 2, 1838. Conrad is in error in making *ebenus* Lea a synonym of this form.

Much confusion exists regarding this species, which is a highly characteristic one. Very much more extensive collecting than has hitherto been done by any person or organization throughout the range of the form will be needed to place it properly. Whether *Unio pyramidatus* Lea and *Unio mytiloides* Rafinesque may not also fall under it as synonyms could not now be gainsaid.

Lamarck's original description was as follows:—

"*U. testa sublongitudinali, ovato-rotundata, obliqua, sub epiderme candida; ligamento subduplici; dente cardinali crasso, sulcato, bipartito.*

"* * * *Habite la riviere de l'Ohio. A. Michaud. Distincte de la precedente par sa forme: elle est renflee vers les crochets, deprimee vers l'autre extremite, bisillonnee sur le cote anterieur. Longueur apparente, 61 millimetres.*"

The following description is based upon specimens taken from the Cumberland river, at Nashville, Tennessee, where the species is very abundant, and attains a very large size:—

Shell heavy, sulcate, thick, large, triangularly cordate, wrinkled parallel with the lines of growth, compressed on the posterior umbonal slope, turgid or swollen at the umbones, very solid and thick anteriorly; epidermis rather thick, striate, especially at the margins, black or reddish corneous, olivaceous in the young, eradiate; lines of growth numerous, well impressed, crowded confusedly; dorso-posterior margin

arcuate, almost circular in old specimens; posterior umbonal slope rounded, much produced in old specimens, with rather marked angle at junction with posterior margin; ventral margin disposed to be sulcate; anterior margin rounded, scarcely produced, not as far forward as the umbonal tips; umbones large, very thick, turgid, somewhat produced beyond the anterior margin, approximating in perfect specimens, minutely undulated at tips; ligament large, thick, long, black, curved parallel to the dorsal margin; lunule large, cordate, black; cardinal teeth large, heavy, short, bifid in the left and disposed to be trifid in the right valve, rough, striate-crenulate, all segments departing at varying angles from a point immediately under the apex of the umbones, the dorsal division in the left valve the largest and heaviest, and parallel to the cardinal teeth; plate joining cardinal teeth with the laterals short, thick, smooth dorsally, but striate ventrally, margin somewhat crenulate; lateral teeth long, thick, slightly curved ventrad, striate-crenulate, rough; anterior cicatrices deep, rough-pitted, distinct, outline of the adductor somewhat triangular, that of the *protractor pedis* elliptical, behind rather than under the adductor; posterior cicatrices distinct, well and deeply impressed, the adductor concentrically striate; the *retractor pedis* circular, pit-like, impressed just below the ends of the lateral teeth; pallial cicatrix broad, crenulate, well impressed throughout, but not deeply impressed anteriorly; dorsal cicatrices not impressed in the cavity of the beaks, but as a broad row on the posterior margin of plate formed by the cardinal teeth, numerous and rough; nacre white, in some specimens with occasional brownish blotches, iridescent posteriorly; dimensions of average mature specimen: length, 95.56 mm.; breadth, 45.00 mm.; height, 77.40 mm.

The only locality in Arkansas which is represented by this form, so far as our collections extend, is the Ouachita river, at Arkadelphia. A single specimen only was secured, but it compares well with typical specimens from the Cumberland river. Not far removed from the forms which we believe will properly group with this as synonyms are other forms such as *Unio plenus* Lea and *Unio solidus* Lea, the relationships of which are yet somewhat problematical.

Unio occidentalis Conrad.

Monograph of Unio, 1836, p. 64, Pl. XXXVI, Fig. 1.

This is an abundant species in central Arkansas, particularly in the Little Red river, Van Buren county; found also in the White river, Carroll county; Saline river, Benton, Saline county.

There is no other form with which this species will be easily confused. It groups with *Unio phaseolus* Hildreth, but is quite distinct from that form; it is commonly much smaller. It was described originally from the Current river, Arkansas, and is not yet known to occur outside of the State.

Unio ozarkensis Call.

Plate XVIII.

Proc. U. S. Nat'l Mus., Vol. X, p. 498, Pl. XXVII, 1887.

The original description of this species follows: —

Shell smooth, elliptical, somewhat compressed laterally, inequilateral, thick, but thickest anteriorly; epidermis thin, striate toward the margins, yellowish-brown, or olivaceous, marked with numerous, obscure, narrow, green rays disposed regularly over the central portion of the disk; lines of growth rather numerous, dark, well marked; dorso-posterior margin curved; posterior umbonal slopes always eradiate, more or less biangulate, which angulations continued posteriorly mark the siphonal area and render the posterior margin biangular; umbones small, triangular, scarcely prominent, approximating, marked — in non-eroded specimens — by two or three rather coarse undulations; ligament short, thick, light brown; cardinal teeth disposed to be double in both valves, short, oblique, thick, unequally bifid, striated, the posterior division generally thickest and heaviest; lateral teeth rather short, slender, slightly curved, crenulate at extremities, in general direction forming nearly a right angle with a line drawn through the tip of the umbo and the anterior division of the cardinal tooth; anterior cicatrices deep, pit-like, striate, confluent, though in occasional specimens the *protractor-pedis* impression is distinct from the adductors and deep; posterior cicatrices distinct, that of the *adductor* muscle being usually well impressed, that

of the *retractor-pedis* muscle circular, pit-like, impressed at extreme end of lateral tooth; pallial cicatrix well impressed throughout, but especially marked anteriorly; dorsal cicatrices irregularly crowded and placed near the inferior edge of the plate, which connects the lateral and cardinal teeth; nacre usually silvery white, occasionally salmon, or warm pink, iridescent posteriorly. Length, 54.50 mm.; breadth, 15.28 mm.; height, 32.76 mm.

The original localities are the White and Current rivers of Arkansas and Missouri; and Jack's Fork of the Current river, Missouri. A single specimen referable to this form has been seen from the Little Red river, at Clinton.

UNIO PARVUS Barnes.

Am. Jour. of Sci. and Arts, 1st series, Vol. VI, 1823, p. 274, Fig. 18; Lea figures the animal in Jour. Phila. Acad. Nat. Sci., 2d series, Vol. IV, Pl. XXIX, Figs. 102, 102a; Conrad, Monography of Unio, 1836, Pl. IX, Fig. I; Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate XXXV, Fig. 186, a very poor figure from a specimen in the Museum Cuming.

Unio paulus Lea. Trans. Am. Philos. Soc., Vol. VIII, 1840, p. 213, Pl. XV, Fig. 29. From the Chattahoochee river, Georgia.

Unio minor Lea. Trans. Am. Philos. Soc., Vol. IX, 1843, p. 276, Pl. XXXIX, Fig. 3. From Lakes Monroe and George, Florida.

Unio marginis Lea. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. VI, p. 255, 1868, Pl. XXXI, Fig. 69. From Dougherty county Georgia.

Unio corvinus Lea. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. VI, 1868, p. 310, Pl. XLVIII, Fig. 123. From Flint river, Georgia, and Neuse river, North Carolina.

Unio vesicularis Lea. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. VIII, 1874, p. 37, Pl. XII, Fig. 34. From Lake Ocheechobee, Florida.

The Arkansas localities for this form are the St. Francis river, at Wittsburg; Ouachita river, at Arkadelphia; Saline

river, at Benton. It no doubt occurs in abundance in many other streams in the State. It is usually a very abundant shell, preferring the muddy banks of bayous and sluggishly flowing portions of streams, where it may be found most commonly buried in the mud. There is but the minute opening leading from the siphons to indicate its presence.

So few animals of the *Unionidæ* have been described that it may not be amiss to insert at this place a description of the animal of *Unio parvus* based upon the examination of specimens taken in the Des Moines river, in central Iowa.

Animal of *Unio parvus.* Color of the mass whitish; tentacular portion of mantle dark brown, ending in a caruncle; labial palps large, white, triangular, united at base and partially so over the posterior margin; external ctenidium smaller than the internal, thicker and larger at the posterior extremity, which is rounded, and on the margin, which is marked by a double row of minute, white papillæ; ctenidia united above throughout their entire length; free below; internal ctenidium white, ovate.

The mass of the animal within the cavity of the beaks is light brown owing to the color of the large liver which shows through the thin tissues separating it from the cavity of the branchiæ.

The chief anatomical peculiarity is the presence of the caruncle in the female; this is somewhat separated from the main tentacular mass and is supported by a slender pedicel.

Unio phaseolus Hildreth.

Am. Jour. Sci. and Arts, 1st series, Vol. XIV, 1828, p. 283, Fig. 14; Say, in American Conchology, 1830, Plate 22; Reeve, in Conchologia Iconica *Unio* Plate LXXIII, Fig. 378, 1868; Lea figures splendidly the soft parts in Jour. Acad. Nat. Sci. Phila., 2d series, Vol. IV, Plate XXIX, Fig. 101.

Unio planulatus Lea. Trans. Am. Philos. Soc., Vol. III, 1829, p. 431, Pl. IX, Fig. 13.

Unio camelus Lea. Trans. Am. Philos. Soc., Vol. V, 1834, p. 102, Pl. XV, Fig. 45. Reeve, in Conchologia

Iconica, *Unio* Plate LV, Fig. 283, 1867. Both Reeve and Dr. Lea had before them, for drawing and description, large and well-worn, very old, specimens.

This form has occurred to us in the Ouachita, at Malvern, and the Saline river, at Benton. From the last named place large and fine examples that would readily pass under the name of *Unio camelus* Lea were obtained. The range of the species is from western New York west to Kansas and south to Texas. It attains a very great size in the Cumberland river, Tennessee, where it is exceedingly abundant. Specimens collected by amateurs have been received under the name of *Unio arctior* Lea.

Unio plenus Lea.

Trans. Am. Philos. Soc., Vol. VIII, 1840, p. 211, Pl. XIV, Fig. 26; Reeve, Conchologia Iconica, *Unio* Plate LXI, Fig. 305, Vol. XVI.

The westernmost range for this form has been determined thus far to be eastern Kansas in the Neosha river. In Arkansas it has occurred to us in collections made in the Ouachita river, at Malvern, and in the St. Francis river, at Wittsburg. It is a very abundant shell in the first named stream. See remarks under *Unio obliquus* Lamarck.

Unio plicatus Lesueur.

Name adopted by Lea from ms name given by Lesueur. *Vide* Trans. Am. Philos. Soc., Vol. III, 1829, p. 409.

Unio rariplicata Lamarck. Historie Naturelle des Animaux sans Vertebres, edition 1818, Tome VI, p. 71. From the Ohio.

Unio hippopœus Lea. Trans. Am. Philos. Soc., 2d series, Vol. X, Pl. I, p. 67, Pl. I, Fig. 1, 1845. From Lake Erie. Reeve, in Conchologia Iconica, Vol. XVI, *Unio* Plate XI, Fig. 40, 1864. This is a depauperate form of *Unio plicatus*.

Unio neislerii Lea. Jour. Acad. Nat. Sci., Phila., Vol. IV, 1859, p. 212, Pl. XXVI, Fig. 93. From the Flint river, Georgia.

Unio brazosensis Lea. Jour. Acad. Nat. Sci. Phila., 2d

series, Vol. VI, 1868, Pl. 48, Fig. 122, p. 309. Based upon a young specimen from the Brazos river, Texas.

Unio lincecumii Lea. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. VI, 1868, p. 312, Pl. 49, Fig. 125. Species based upon three specimens from the Brazos river, Texas.

Unio perplicatus Conrad. Jour. Acad. Nat. Sci., Phila., 2d series, Vol. VIII, p. 178.

Unio pauciplicatus Lea. Jour. Phila. Acad. Nat. Sci., 2d series, Vol. VIII, 1874, p. 29, Pl. 9, Fig. 26. Described from specimens obtained in the Colorado river, Austin, Texas.

Reeve also figures, under the MS name of *Unio perlensis* Conrad, with the habitat "North America", a shell contributed to the Museum Cuming by John G. Anthony, which appears to be an abnormal form of this species. *Vide* Conchologia Iconica, Vol. XVI, *Unio* Plate XI, Fig. 42.

This *Unio* occurs in great numbers in the St. Francis river, at Wittsburg, rivaling all others, save, perhaps, *Unio trapezoides* Lea. The form is the short and somewhat ventricose one, which Mr. Conrad called *perplicatus*. It also occurred in some abundance in the Saline river, at Benton.

The form which Mr. Lea called *Unio hippopœus*, from Lake Erie, is without question a depauperate *plicatus* and is not entitled even to varietal distinction. Throughout the great geographical range of this species almost every possible variety of environment is to be found, and it would be strange indeed if the shells did not in some measure respond to these factors. It is usually abundant, wherever it occurs at all. In central Iowa it is rare, but in the Mississippi river, on the eastern border of that State, it is both common and large. In the Cumberland river it is a very abundant shell; and is, in short, to be reckoned among the most common of our Unios. In Arkansas, aside from the localities named above, the shell is said to be abundant in the Little Red river, though we have not seen specimens that came from that stream. From the Cedar river, Iowa, was obtained a specimen which presented the following dimensions: length, 135 mm.; height, 98 mm.; breadth, 59 mm.

UNIO PURPURATUS Lamarck.

Plate V.

Animaux sans Vertebres, 2d Ed., Vol.VI, p. 533, 1838. Described from the Mississippi; Reeve, in Conchologia Iconica, Vol. XVI, *Unio* Plate XXIV, Fig. 115, 1865.

Unio ater Lea. Trans. Am. Philos. Soc., Vol. III, 1829, Pl. VII, Fig. 9, p. 426. This is the female and was described from specimens taken in the Mississippi river, below Natchez.

Unio lugubris Say. American Conchology, 1832, Plate XLIII. Described from the Bayou Teche, Louisiana. This name was proposed by Say for Lea's species, he doubtless thinking that Nilsson's name had priority.

Unio poulsonii Conrad. New Fresh Water Shells of the United States, 1834, pp. 25–26, Pl. I; Reeve, in Conchologia Iconica, Vol. XVI, 1866, *Unio* Plate LI, Fig. 270. Conrad described his form from the Black Warrior river, Alabama.

Unio coloradoensis Lea. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. III, 1857, p. 314, Pl. XXXI, Fig. 29. Described in 1856, from specimens obtained in the Colorado river of Texas.

This species is among the most ponderous of North American *Uniones*. Chiefly confined to the streams of the southern United States it yet ranges as far north as middle Kansas, and eastwardly to north Alabama and Georgia. In Mississippi, Louisiana, Arkansas, and Texas it is both common and large, but does not rival the giant forms which have come to our cabinet from the Little Arkansas river, near Wichita, Kansas. Two specimens from that locality, and those not the largest, form the basis of the figures which are given herewith.

Lamarck's description, but not his original one, is given herewith, the bibliographic reference to which appears in the above synonymy.

"*U. testa ovato elliptica, tumida, anterius subbiplicata, intus viridi-violaceo purpureoque tincta; dente laterali crenulato.* * * * *Habite le Mississipi* * * * *Je la crois des grandes rivieres de l'Afrique.* * * * *Belle et grande*

coquille a nacre pourpree avec des taches irregulieres d'un vert violatre, sur-tout sous les crochets. Largeur de mon exemplaire, 139 millimetres. La dent cardinale est epaisse mais de taille mediocre. L'autre dent est tres finement crenelee.''

The reference of this form to the rivers of Africa is, of course, entirely incorrect; its general resemblance to *Pleiodon* may have caused the statement.

Lea's *Unio ater* is the female of this species, while his *Unio coloradoensis* is based upon a large male. Conrad's *Unio poulsonii* is also a male. Again Say described, for his form, the female.

The shell may be described as follows from the appearances presented by mature and large specimens taken in the Little Arkansas river, Kansas, by Mr. J. R. Mead.

Shell large, heavy, smooth, striate, posteriorly elliptical, convex, thick, very thick anteriorly, rounded before, obtusely biangulate behind; epidermis thick, black, striate towards the margin, and on the posterio-dorsal slope, umbonal slope shining, eradiate or obscurely rayed, the rays seen only on the thin margins of the old specimens, in the young as many capillary lines over the whole disk of the umbones; lines of growth conspicuous, numerous and crowded, in old specimens forming slightly raised ridges, which are parallel to the margins but which, posteriorly, form imbrications, these are often broken and give the shell an exceedingly rough appearance; dorso-posterior margin slightly curved; posterior, umbonal slope marked by two carinæ, one of which is very prominent, the other but slightly indicated, these, at the posterior margin, indicate the positions of the incurrent and excurrent orifices and render the margin biangulate; umbones large, prominent, rounded, always so eroded in the old shell as not to disclose the character of the undulations, but nearly perfect, young specimens present indications of apiculate folds; ligament long, thick, black, scarious, rough; cardinal teeth single in the right and double in the left valve, of young specimens, but disposed to be trifid in the right valve, in large and old specimens, erect, dentate, rough, triangular, the anterior portion, in the left valve, the larger; lateral teeth long, straight, thick-lamellar, smooth, but often slightly crenulate on the margin, separated

entirely from the cardinals, there being no connecting plate, forming an angle of 130° with a line drawn through the tips of the umbones to the tip of the anterior division of the cardinals; anterior cicatrices distinct, very large, and very deeply impressed, striate, sometimes roughened, deepest close to the base of the cardinal teeth; pallial cicatrix very deep anteriorly, crenulate, and lightly impressed behind; posterior cicatrices large, confluent, not at all impressed, concentrically striate, the *retractor pedis* impression neither on nor very near the end of the lamellar laterals; dorsal cicatrices disposed variously, and always irregularly, in the cavity of the beaks, sometimes quite central; nacre always rich purple, commonly roughened with numerous small pear-like masses studding the body cavity.

Dimensions of large male: length, 165.00 mm.; breadth, 66.00 mm.; height, 116.50 mm. Dimensions of large female: length, 141.50 mm.; breadth, 68.15 mm.; height, 96.76 mm.

Unio pustulatus Lea.

Trans. Am. Philos. Soc., Vol. IV, 1830, p. 79, Pl. VII, Fig. 9. Described from the Ohio.

Unio nodulatus Rafinesque. So Conrad, Monography of Unio, Pl. XLV, Fig. 1, 1838; Reeve, in Conchologia Iconica, Vol. XVI, *Unio* Plate XIII, Fig. 51, 1864.

This form is easily distinguished from the related species which follows, by the fewer pustules which are larger than in *Unio pustulosus* Lea, and are besides differently disposed over the disk. Moreover, its quadrate outline is dissimilar to that presented by any other of the pustulate Uniones.

In the St. Francis river, at Wittsburg, the species occurs in very great numbers, and is well developed and perfect; it was also found, sparingly, at Benton, in Saline river. It is so well marked that very few synonyms have been made from this shell, a fact that few other species will illustrate.

Unio pustulosus Lea.

Plates XIII–XV.

Trans. Am. Philos. Soc., Vol. IV, 1830, p. 64, Pl. VIII, Fig. 7, from the Ohio and Alabama rivers; Reeve, in

Conchologia Iconica, Vol. XVI, *Unio* Plate XII, Fig. 43, as *Unio bullatus*, Rafinesque, 1864; *Unio bullatus* Rafinesque; so Conrad, in Monograph of Unio, Pl. XL, Fig. 2, 1838. This is probably the form intended by Hildreth as his *Unio verrucosa alba*. *Vide* Am. Jour. Sci. and Arts, 1st series, 1828, Vol. XIV, p. 289.

Unio schoolcraftensis Lea. Trans. Am. Philos. Soc., Vol. V, 1832, p. 37, Pl. III, Fig. 9, from Fox river, Wisconsin. This name, for grammatical reasons, was subsequently changed to *schoolcraftii*. Reeve also figures this form, Conchologia Iconica, Vol. XVI, *Unio* Plate I, Fig. 3, 1868. Plates XIII, XIV, Figs. 1–4, herein.

Unio prasinus Conrad. New Fresh Water Shells of the United States, 1834, p. 44, Pl. III, Fig. 1. An immature shell from Fox river, Wisconsin. Reeve, Conchologia Iconica, Vol. XIV, *Unio* Plate VII, Figs. 26a, 26b, 1864; these two figures are excellent, and are taken from specimens presented to the Museum Cuming by John G. Anthony.

Unio turgidus Lea. Trans. Am. Philos. Soc., Vol. VI, 1834, p. 11, Pl. V, Fig. 11; Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate III, Fig. 10, 1864. Described from near New Orleans, Louisiana.

Unio dorfeuillianus Lea. Trans. Am. Philos. Soc., Vol. VI, 1836, p. 73, Pl. XVII, Fig. 54; Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate X, Fig. 38, 1864. A poor figure. Described from the Ohio river, at Cincinnati. Plate XV, Figs. 1–2, herein.

Unio mortoni Conrad. Monograph of Unio, p. 11, Plate VI, Fig. I, 1836. Described from the Bayou Teche, Louisiana. This is Lea's *Unio turgidus*.

Unio pernodosus Lea. Trans. Am. Philos. Soc., Vol. X, 1845, p. 71, Pl. III, Fig. 8; Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate XII, Fig. 46, 1864. Described from North Carolina.

Unio asperatus Lea. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. V, 1861, p. 68, Pl. VII, Fig. 218; Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate LXXXV,

Fig. 450, 1868. Described from the Alabama river, at Claiborne.

Unio vallatus Lea. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. VI, 1868, p. 315, Pl. L, Fig. 128. Described from Alabama.

Unio refulgens Lea. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. VI. 1868, p. 317, Pl. LI, Fig. 130. Described from Lauderdale county, Mississippi. Plate XV, Figs. 3–4, herein.

Unio sphœricus Lea. Jour. Acad. Nat. Sci. Phila., 2d series, 1868, Vol. VI, p. 319, Pl. LI, Fig. 132. Described from the Pearl river, Mississippi.

Unio cahabensis Lea. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. VIII, 1874, p. 17, Pl.V, Fig. 14. Described in 1871 from the Cahaba river, Alabama.

This is an abundant form in the St. Francis, at Wittsburg, and a common one in the Saline, at Benton. It is, no doubt, quite generally distributed over the State, and the various names above listed are represented by many of the varying forms which the species exhibits. It will be noticed, in the above synonymy, that several of the so-called species come from the same stream or drainage area, and their descriptions are separated from one another by the interval of a few years. Specimens of every form listed in this synonomy, Lea's species all having been named by himself, have been seen and studied in the course of the past ten years. With the exception of *Unio turgidus* Lea examples of every species is before the writer at this time. No hesitation is felt in regarding this series of forms as one species, varying only in those trivial matters which should not, at most, constitute varietal value and which are the expression of different geographic factors.

The plates given herein show certain of the forms of this widely distributed shell, in some of its most marked phases. Recently, from Louisiana comes a form of *pustulosus* that is very like *sphœricus*, as it is found in Texas ; from the Ouachita, at Arkadelphia, come excellent specimens of *refulgens* which, in large series, approach the Louisiana forms. The St. Francis river presents the typical specific form, and with it *sphœricus*

and *dorfeuillianus*, all intergrading in so marked a manner that identity must be regarded as established. From the Little Arkansas, at Wichita, Kansas, come numbers of magnificent examples of *schoolcraftii*, some entirely covered with pustules, others absolutely devoid of even a semblance of one; indeed, the writer's collection contains some fifty examples from that stream, exhibiting every phase of nodulation from absolutely smooth specimens to those showing great numbers of small pustules. The characters of the cardinal teeth alone would have sufficed, in the hands of species mongers, to make a dozen "extremely characteristic" species.

The Des Moines river, in central Iowa, presents only the form to which Mr. Lea gave the name of *Unio schoolcraftii*. From this form of the shell a number of the figures given have been made. As in typical *pustulosus* so here there is every degree of nodulation and even of rotundity of form. *Unio vallatus* from Alabama, which was collected by the writer in great numbers in Alabama a few years ago, much resembles the form from Iowa even in the numbers and disposition of the pustules. The female is often somewhat emarginate, but does not approach *Unio pustulatus* Lea in that respect. In *refulgens* the truncated posterior is the most marked differential feature. Plates XII to XIV represent *schoolcraftii* in its various phases.

Unio rectus Lamarck.

Plate VII, (male in outline.)

Historie Naturelle des Animaux sans Vertebres, 1819, Vol. VI, p. 74; described from Lake Erie. Same, 2d edition, Vol. VI, p. 537, 1838; Reeve, in Conchologia Iconica, Vol. XVI, *Unio* Plate XIX, Fig. 86, 1865, the figure is that of a large and old male; Conrad, Monograph of Unio, Pl. XV, 1836.

Unio prælongus Barnes. Am. Jour. of Sci. and Arts, 1st series, Vol. VI, No. 1, p. 261, Fig. 11, 1823.

Unio sageri Conrad. Monograph of Unio, 1836, p. 53, Pl. XXIX, from the Detroit river.

Unio leprosus Miles. Annual Report of the Geological

Survey of Michigan, 1861, p. 240. From the Huron river.

Arkansas specimens have been seen only from the St. Francis, at Wittsburg, and the Saline, at Benton. It doubtless occurs in nearly all the large streams in that State.

Lamarck's description of *Unio rectus* runs as follows:—

"*U. testa transversim elongata, angusta, convexa, anterius, subangulata; latere antico striis longitudinalibus obliquis, remotis obsoletis. * * * Habite le lac Erie, Michaud. Elle a presque la forme du mytilus lithophagus, Son test est blanc, recouvert d' un epiderme brun noiratre. Largeur, 100 millimetres.*"

The figures here given in the plate are of shells collected in the Des Moines river, and upon similar shells the description of the species, given below, is based: —

Shell large, smooth, elongate, compressed laterally, thick, very thick anteriorly, rounded before, pointed posteriorly, epidermis thick black, or reddish corneous, shining, obscurely rayed with dark green, the broad rays not very apparent in old specimens, lines of growth numerous, well marked, imbricated posteriorly, and often so on ventral margin; dorso-posterior margin straight, or nearly so; posterior umbonal slopes gently rounded, becoming more angular near the beaks, much imbricated towards posterior margin; umbones small, scarcely approximating, marked, in non-eroded specimens, by many minute, fine, concentric crenulations or folds; ligament long, thick, black, sometimes dark brown; cardinal teeth double in the left, and disposed to be double in the right valve, the larger portion erect, sometimes sharp, sometimes blunt, and commonly gently posteriorly recurved, the characters of the double portion in left valve various, sometimes sharp, often blunt, or smooth rounded; lateral teeth long, lamellar, straight, finely crenulate on margins; anterior cicatrices very large, deep, striate, distinct, that of the *protractor pedis* impression considerably above the lower margin of the large and deep adductor cicatrix; posterior cicatrices not deeply impressed, confluent, very large, pallial cicatrix very deep anteriorly, irregularly impressed throughout, crenulate; dorsal cicatrices impressed deeply in the center of the cavity of the

beaks, large, often pit-like, in old shells exhibiting two or three large scars, circular in outline, and as deep as the *protractor pedis* impression, though the posterior one is commonly oval; plate connecting the cardinal and lateral teeth not well developed; nacre usually dark purple, often pink, white, or salmon; frequently the coloration is confined to the region of the cardinal and lateral teeth, the remainder of the interior being pure white.

Length, 171 mm.; breadth, 60 mm.; height, 70 mm.

These are the dimensions of very large shells collected in the Cedar river, Iowa.

This species ranges from New York to Minnesota, Nebraska, Kansas, Indian Territory and Texas, to Georgia, and is common throughout all that vast area.

UNIO RETUSUS Lamarck.

Plate VIII.

Historie Naturelle des Animaux sans Vertebres, 1819, Vol. VI, p. 72; also, 2d edition, 1838, Vol. VI, p. 534. Described as from Nova Scotia. Reeve, in Conchologia Iconica, Vol. XVI, *Unio* Plate LXXI, Figs. 363a, 363b, 1868.

Unio torsa Rafinesque. Annales Generales des Sciences Physiques, Bruxelles, 1820, Vol. V, p. 311, Plate LXXXII, Figs. 1, 2 et 3. Described from the Ohio. See also Conrad, in Monograph of Unio, Plate VIII, 1836, p. 19.

Unio obtusa Say. So Deshayes, in Cuvier's Regne Animal, *teste* Lea. I have been able to find no work in which Say uses this name for any *Unio*.

Lamarck described this shell in the following terms:—

"*U. testa rotundata, tumida, intus violacea; natibus retusis, erosis; dente laterali breviusculo.* * * *

Habite les rivieres de la Nouvelle-Ecosse. A. Michaud. Test epais; epiderme d' un vert jaunatre; dent cardinale grossiere, sillonnee, divisee en deux. Longueur apparente, 47 millimetres."

The range of this species is rather more restricted than is

common for Unios of this type. It has been found only in the drainage of the Ohio, and the Mississippi river itself, but is not yet known from streams beyond. South it ranges to the Holston river, in east Tennessee, and to the Cumberland, at Nashville. It is there quite abundant. There is certainly an error in assigning to this species the distant habitat of Nova Scotia, as was done by Lamarck in originally describing it. The great traveler and naturalist, Michaud, had secured this form, with numerous others, during his visit to the New World, and from material furnished by him Lamarck drew his description. The localities were either confused by Lamarck, or what would be more natural under the circumstances, had been confounded by the collector. However this may be, the original shells were most certainly obtained elsewhere than in the region named by Lamarck.

From specimens furnished by Professor Barton W. Evermann, and taken in the White river, Indiana, the following description is drawn:—

Shell rotund, large, smooth, convex, heavy, rounded before, circular behind; epidermis rather thin, polished, striate, disposed to imbrication towards the margins, olivaceous, lines of growth numerous, crowded, darker; dorso-posterior margin curved and rounded; postero-dorsal umbonal slope lighter horn-colored, with numerous capillary rays of green, which are especially marked near the beaks, this slope is separated from the lateral umbonal slope by a rather well marked angle, it has also two slightly marked carinæ; umbones large, prominent, approximating closely, curved anteriorly, and projecting slightly beyond the antero-ventral margin, smooth; ligament short, thick, curved with dorsal margin, light horn-color; lunule large, cordate, scarious; cardinal teeth single in the right, double in the left valve, multi-tuberculate, striate, crenulate, the folds all originating at a common point immediately under the tip of the umbone, as a whole the segments are triangular, massive, thick, short; lateral teeth long, curved, commencing well toward the dorsal margin, and nearly on a line with the anterior portion of the cardinals, lamellar, somewhat thick, double in both valves, crenulate on the margins; the plate connecting the cardinal with the laterals

has several folds or plications, rather thin; anterior cicatrices distinct, deep and pit-like, not very large, the adductor roughened, the *protractor pedis* striate; posterior cicatrices deeply impressed, large, confluent, that of the *retractor pedis* at the tip of lamellae of lateral teeth; dorsal cicatrices numerous, pit-like, often confluent, placed on the plate formed by the base of the cardinal teeth; pallial cicatrix well impressed throughout, but deepest and most crenulate anteriorly; nacre rich purple, lighter to white on the margins, beyond the pallial line.

Length of a mature specimen, 70.75 mm.; breadth, 43.50 mm.; height, 74.56 mm.

The species has not yet been found, to our knowledge, in Arkansas; the conditions which obtain in the bayous along the Mississippi are such, however, that it may reasonably be expected to occur since it is common in the Mississippi river farther to the north.

Unio rotundatus Lamarck.

Plate IX.

Animaux sans Vertebres, in Historie Naturelle, 1819, Vol. VI, p. 75; also, same, edition of 1838, Vol. VI, p. 538. From unknown locality.

Unio suborbiculatus Lamarck, Historie Naturelle Animaux sans Vertebres, Vol. VI, p. 81; also 2d edition, 1838, Vol. VI, p. 546. From locality unknown.

Unio glebulus Say. Transylvania Journal of Medicine, Vol. IV, p. 526, 1831; also American Conchology, 1832, Plate 34, female; Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate LXXIV, Fig. 384, young and not characteristic female. Described from the Bayou Teche, Louisiana.

Unio subglobosus Lea. Trans. Am. Philos. Soc., Vol. V, 1837, p. 30, Pl. II, Fig. 3; Reeve, Conchologia Iconica, Vol. XVI, Plate *Unio* LXIV, Fig. 321, 1868. Described from the Bayou Teche, Louisiana. Reeve's figure is that of an old male.

Reeve also figures, as this form, a shell on Plate XXIII, Vol. XVI, figure 106, which is certainly some other species. Correcting the error in the addendum to *Unio* he quotes Conrad, who thinks that the shell may be *Unio kienerianus* Lea. It is certainly much like it.

This is a rare species, and will probably always be so considered. It has not occurred to any collector outside of Louisiana, though it has been found in other than the original locality. There is a fine specimen in my collection which was recently obtained in Crass Lake near Shrevesport, Louisiana, by Mr. Wayland Vaughan, that is very characteristic indeed. Besides, there is before us a suite of three specimens that formerly belonged to Dr. Gerard Troost, of Nashville, Tenn., a warm personal friend of Thomas Say, and a member, for a time, of the singular community which sprang up at New Harmony, Indiana. To him Say gave these examples of his *glebulus*, the original label of which is still treasured with the specimens. They came into my hands through the kind liberality of Dr. J. Berrien Lindsley, of Nashville, who became the owner of Troost's collection, or of most of it. The history is complete, and there is no question that this lot has passed nnder the inspection of the great naturalist who described it as new. The suite is from the Bayou Teche, Louisiana.

Lamarck described this shell in the following terms:—

"*U. testa elliptico-rotundata, inferne ventricosa, sub epiderme splendide margaritacea; cardine arcuato. Habite* * * * . *Coquille rare, d'une forme singuliere pour le genre, et dont la nacre est argentee, legerement teinte de rose, irisee et tres brillante. Largeur, 78 millimetres. Elle a un pli sur le cote anterieur.*"

The "silvery nacre" indicated by Lamarck has been exhibited by but one specimen which has come to our notice. The original description of *Unio suborbiculatus* Lamarck comes nearer to the conditions exhibited by this shell, but the example must have been a very large one. To connect the two better, in the mind of the reader, it is only necessary to add that Lamarck himself gives Say's *glebulus* as a synonym, that is to say, this has been done by Deshayes, who edited the second edition of the Animaux sans Vertebres. Lea, who saw the original example of *Unio rotundatus*, in the collec-

tion of the Baron de Ferussac, surrendered his species to Lamarck.

From the examples in our cabinet, formerly belonging to Troost, the following description is made: —

Shell subcircular in outline, globose, convex, the longitudinal about twice the lateral diameter, the male somewhat compressed, rounded before, and angular behind, the female somewhat emarginate posteriorly; epidermis thin, olivaceous, greener over the umbones, eradiate, striate towards the margin, velvety; lines of growth numerous, and crowded, especially so near the region of the margin, often broad and darker colored; posterior-umbonal slope separated from the lateral slope by a well-marked angulation, with two rather faint carinæ; umbones small, scarcely rounded, depressed, without undulations; ligament short, rather thin, scarious, light brown, curved with the dorsal margin; cardinal teeth short, thick, erect, slightly inclined forwards, double in the left, and disposed to be trifid in the right valve, the central mass of the right tooth far the largest; the plate connecting the cardinals with the laterals is poorly developed, thin, rounded, smooth; lateral teeth short, distant from the cardinals, straight, single in the right and double in the left valve, crenulate, rather thin; anterior cicatrices distinct, deep, and pit-like, roughened, somewhat excavated under the plate formed by the cardinal teeth; pallial cicatrix faintly impressed throughout; posterior cicatrices very large, confluent, that of the *retractor pedis* at extreme tip of lateral teeth; dorsal cicatrices small, arranged in a more or less regularly disposed row within the cavity of the beaks, pit-like and deep; nacre purplish or rose-tinted, — this coloration is most marked on the teeth and extends as a mere blush of pink or rose over the balance of the shell. One specimen, from Shreveport, is pure white except a portion of the lateral teeth and the tips of the cardinals, approaching most nearly Lamarck's description of the silvery nacre. Dimensions of mature male: length, 61.60 mm.; breadth, 31.32 mm.; height, 45.58 mm.; of mature female: length, 54.20 mm.; breadth, 32.70 mm.; height, 41.02 mm.

This species will doubtless yet be found in southeastern Arkansas, in muddy bayous. Its close resemblance to a

Cyrena or to a *Cyprina* in color, and general character of the epidermis, will serve to readily distinguish it from all related forms.

Unio securis Lea.

Trans. Am. Philos. Soc., Vol. III, 1829, p. 437, Pl. XI, Fig. 17; embryo figured in Jour. Acad. Nat. Sci. Phila., 2d series, Vol. IV, p. 47, Pl. V, Fig. 6, 1858; Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate LXI, Fig. 304, 1868. Described from the Ohio.

Unio lineolatus Rafinesque. So Say, in American Conchology, Plate XLVIII. This part, VII, is undated and was published by Mr. T. A. Conrad, after Mr. Say's death.

The only occurrence to us, in Arkansas, of this shell was in the St. Francis river, at Wittsburg, where it is commonly found on the muddy bottoms in great numbers and of large size. Its cuneiform shape separates it readily from all others likely to be found in Arkansas.

Unio speciosus Lea.

Jour. Acad. Nat. Sci. Phila., 2d series, Vol. V, p. 207, Pl. 31, Fig. 276; Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate LXXXIV, Fig. 447, 1868. Described and figured from Texas.

This shell has not been found by us in Arkansas nor have we seen more than one specimen, said to have been taken in the Ouachita river, near the Indian Territory boundary. If this is its real habitat it properly belongs in this list and will, besides, be found at other localities within the State of Arkansas.

Unio subgibbosus Lea.

Jour. Acad. Nat. Sci. Phila., 2d series, Vol. IV, 1858, Pl. VI, Fig. 36, p. 53. Described from the Oostanaula and Etowah rivers, Floyd county, Georgia.

In the remarks accompanying this form's characterization Mr. Lea says that he has specimens received from Dr. Hale, from the Red river, Arkansas. On this statement the shell is

listed in this register. Recently a large set of some twenty specimens was received from Carney Bayou, Claiborne Parish, Louisiana, rendering it very likely that the shell will yet be found abundantly in favorable localities in Arkansas. Some years since the writer collected it, in large numbers, in Piney river, Texas county, Missouri. It groups with Barnes form, along with *Unio sublatus* Lea, though the specific value of all the forms is doubtful, the point cannot be settled now. The specimens from Louisiana and Missouri have been compared with large suites from the Oostanaula river, collected in 1881. They differ in no respect.

Unio subrostratus Say.

New Harmony Disseminator of Useful Knowledge, January 15, 1831; reprint by Say, p. 6. From the Wabash river. The shell which Reeve figures for this species, Conchologia Iconica, Vol. XVI, *Unio* Plate XVII, Fig. 78, is *Unio iris*, and was drawn from a specimen communicated by John G. Anthony, who, evidently, did not know the species.

Unio nashvillianus Lea. Trans. Am. Philos. Soc., Vol. V, 1834, p. 100, Pl. XIV, Fig. 43; Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate XXX, Fig. 158. Described from specimens communicated by Dr. G. Troost from the Cumberland river, at Nashville. See below.

Unio mississippiensis Conrad. Jour. Acad. Nat. Sci. Phila., 2d series, 1850, p. 277, Pl. XXXVIII, Fig. 11; Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate XIX, Fig. 85. Described from the lower Mississippi.

Unio nigerrimus Lea. Trans. Am. Philos. Soc., Vol. X, 1852, p. 268, Pl. XVIII, Fig. 23. From Alexandria, Louisiana.

Unio rutersvillensis Lea. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. IV, 1860, p. 356, Pl. LX, Fig. 181. Described from Rutersville, Fayette county, Texas.

Unio topekaensis Lea. Jour. Acad. Nat. Sci., 2d series, Vol. VI, 1868, p. 313, Pl. XLIX, Fig. 126. Described from near Topeka, Kansas.

Specimens were secured from the White river, Carroll

county; the St. Francis river, at Wittsburg; the Ouachita, at Arkadelphia; the Saline, at Benton.

A specimen of this shell was reported on by Dr. Lea in the Proceedings of the Philadelphia Academy of Natural Sciences for 1860, page 51, to which was assigned the indefinite locality of "Arkansas." It was reported under the name of *Unio nasutus* Say, a species which does not occur west of the Appalachians, outside of the drainage of the Great Lakes. It was peculiar in that the teeth were reversed, being single in the left and double in the right valve.

In some MS notes left by Dr. G. Troost in his copy of Volume I of Observations on the Genus Unio, now in the library of Dr. J. Berrien Lindsley, of Nashville, the statement is made that the shell which Lea called *Unio nashvillianus* was not originally found in the Cumberland river, but in the Harpeth river, some miles further south. The original locality will, therefore, be the latter river. The original specimen, with Lea's name in MS is now in my possession. The writer has, however, found the species in the Cumberland, at Nashville.

UNIO TETRALASMUS Say.

Plates XIX, XX.

American Conchology, Plate XXIII, 1830. Described from the Bayou St. John, Louisiana. This plate is copied in Plate XX herein, figures 4, 5.

Unio declivis Say. Transylvania Journal of Medicine, Vol. IV, 1831, p. 527; American Conchology, Plate XXXV, 1832; Conrad, Monograph of Unio, p. 45, Pl. XXIII, Fig. 1, 1836. Described from the Bayou Teche, Louisiana.

Unio camptodon Say. American Conchology, 1832, Pl. XLII, Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate LXX, Fig. 356. From near New Orleans, Louisiana.

Unio geometricus Lea. Trans. Am. Philos. Soc., Vol. V, 1832, p. 38, Pl. IV, Fig. 10. Described from the Bayou Teche, Louisiana.

Unio excultus Conrad. Monograph of Unio, 1836,

pp. 99–100, Pl. LV, Fig. 1. Described from near New Orleans, Louisiana. A copy of this figure is given herewith, Plate XX, Figs. 1–3.

Unio sayii Ward. So Tappan in Am. Jour. Sci. and Arts, 1st series, Vol. XXXV, 1839, p. 268, Pl. III, Fig. 1; Conrad, Monograph Plate LVI, Fig. 2, as *Unio sayanus* Ward. These figures are produced herewith, on Plate XIX, figures 3–5. Described from Circleville, Ohio.

Unio symmetricus Lea. Trans. Am. Philos. Soc., Vol. X, 1845, p. 73, Pl. IV, Fig. 11. From the Red river, Alexandria, Louisiana.

Unio subcroceus Conrad. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. II, p. 297, 1854, Pl. XXVI, Fig. 1. Described from a stream in Arkansas, tributary to the Canadian fork of Red river.

Unio manubrius Gould. Proc. Bost. Soc. Nat. Hist. Vol. V, 1855, p. 229. From Chihuahua, Mexico.

Unio jamesianus Lea. Jour. Acad. Nat. Sci. Phila., 2d series, 1858, Vol. IV, p. 52, Pl. VI, Fig. 35. Described from a single specimen obtained at Jackson, Mississippi, and then in the cabinet of U. P. James, of Cincinnati. The specimen is a pathologic representative of *Unio tetralasmus* Say.

This widely distributed species occurs from Ohio, south to central Alabama and through Texas into Mexico. Its most northern and western locality thus far is central Kansas, not far from Wichita. It preserves its specific characters so generally that it is a matter of great surprise that so many synonyms should fall under it. The study of the figures, descriptions, and localities above indicated, will furnish convincing evidence of identity. Of the total number listed, seven came from Louisiana and contiguous territory; of these seven, five are from the same State, and of these five, two are from the same bayou. The pathologic *Unio jamesianus* is not the first shell or the only one which has been projected into specific distinction; the small *Unio liebii* Lea and the *Unio hippopæus* Lea, both from Lake Erie, are further illustrations.

This species occurs in Arkansas in the White and the Black rivers, and in the Red river, near the Louisiana boundary.

Unio trapezoides Lea.

Trans. Am. Philos. Soc., Vol. IV, 1830, p. 69, Pl. III, Fig. 1; Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate V, Fig. 17, 1864. Described from Lake St. Joseph, Louisiana.

Unio interruptus Say. Transylvania Journal of Medicine, Vol. IV, p. 525, 1831; also American Conchology, 1832, Pl. XXXIII. From Bayou Teche, Louisiana.

Unio atromarginatus Lea. Trans. Am. Philos. Soc., Vol. VIII, 1840, p. 207, Pl. XIII, Fig. 21. From the Chattahoochee river, Georgia. Evidently a junior.

Unio sloatianus Lea. Trans. Am. Philos. Soc., Vol. VIII, 1840, p. 217, Pl. XVI, Fig. 33. From the Chattahoochee river, Georgia.

This is an abundant shell in the St. Francis river, at Wittsburg, at which point very large and fine specimens were secured. It also occurred in the White river, at Augusta, where a single valve was found on the bank; in the Saline, at Benton; and in the Ouachita, at Malvern.

I am not sure that Lea's *atromarginatus* falls into the synonymy of his *trapezoides* but it appears to do so judging from the only specimens which have come to notice. From Louisiana come very numerous and fine specimens of this species, but they do not attain the great dimensions reached by the shells from the St. Francis. The species is a mud-loving one, and delights in sluggishly flowing water. The general transverse form, and the peculiar folds or plications on the posterior margin and slope, will serve to distinguish this species from all others.

Unio trigonus Lea.

Trans. Am. Philos. Soc.,Vol. IV, 1831, p. 110, Pl. XVI, Fig. 40; so, also, Reeve, Concholgia Iconica, Vol. XVI, *Unio* Plate LXXXVI, Fig, 459. From the Ohio river.

Unio chunii Lea. Jour. Acad. Nat. Sci. Phila., Vol. V, 1862, p. 196, Pl. XXVII, Fig. 265. From Dallas, Texas.

Unio riddellii Lea. Jour. Acad. Nat. Sci. Phila., Vol. V, 1862, pp. 197–8, Pl. XXVII, Fig. 267; Reeve, Con-

chologia Iconica, Vol. XVI, *Unio*, Plate LXXXIII, Fig. 442. From Dallas, Texas.

The geographic range of this heavy and well marked shell is very wide, extending from western New York to Minnesota, and Iowa, and Kansas; to Texas, east to Mississippi and Tennessee. In Arkansas it has been found in the St. Francis river at Wittsburg.

UNIO TUBERCULATUS Barnes.

Am. Jour. Sci. and Arts, last series, 1823, Vol. VI, p. 125, Pl. VII, Figs. 8a, 8b; also, figured as *Unio verrucosus* Rafinesque, in Poulson's translation of "Monograph of the Bivalve Shells of the river Ohio", 1832, frontispiece; same, in Chenu, Bibliotheque Conchyliologique, 1845, p. 17, Pl. II, Figs. 10–12; Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate 1, Fig. 4; the figure is that of a fine old male.

The range of this form is very great; specimens have been found from western New York to Minnesota, Iowa, and Nebraska; to Kansas, and central Texas; to Georgia, and Alabama. It is commonly abundant wherever found. In the Cahaba river, Alabama, where the shell is very abundant, more than half of those taken have purple nacre. The nacre is usually white, though, in large specimens, it is often blotched with irregularly distributed, brownish spots.

In Arkansas specimens have been taken in the Saline river, at Benton; in the St. Francis, at Wittsburg. Its great length, nodulous anterior portion, striate, posterior slopes, bi-angulate and compressed posterior, will serve to easily separate it from its congeners. The species was originally described from Wisconsin.

UNIO TUMESCENS Lea.

Trans. Am. Philos. Soc., 2d series, Vol X, 1845, p. 71, Pl. III, Fig. 7. Described from Alexandria, Louisiana.

This species was erected on one perfect shell, and one valve of a second specimen. The only locality in Arkansas, from which specimens were secured, is the Ouachita river, at Arkadelphia. It appears to be very rare. It is also credited to

the Tennessee drainage of north Alabama and east Tennessee. It is a very tumid shell and bears some points of resemblance to *Unio trigonus* Lea, but is abundantly rayed over the whole disk, and is of a honey yellow color.

Unio undulatus Barnes.

Am. Jour. Sci. and Arts, 1st series, Vol. VI, p. 120, Fig. 2, 1823; Reeve, Conchologia Iconica, Vol. XVI, Pl. IV, Fig. 16, as *Unio costatus* Rafinesque. Described from Ohio.

Unio latecostatus Lea. Trans. Am. Philos Soc., Vol. X, 1845, p. 68, Pl. I, Fig. 2. Described from the Black Warrior river, at Tuscaloosa, Alabama.

Unio atrocostatus Lea. Trans. Am. Philos. Soc., Vol. X, 1845, p. 70, Pl. II, Fig. 5; Reeves figure 404, Conchologia Iconica Vol. XVI, *Unio* Plate LXXVII is of *plicatus* and not of this shell at all.

Unio quintardii Cragin. Bull. Washburn Coll. Lab'y of Nat. Hist. Vol. II, p, 6, 1887. From Salt Creek. Indian Territory, Sac and Fox Reservation.

Unio pilsbryi Marsh. Nautilus, Vol. V. May, 1891, p. 1; illustrated in The Nautilus, Vol. VII, No. 1, May, 1893, Pl. I, Figs. 7 and 8. Described from the Little Red river, Arkansas. Inspection both of the types, and the published figures confirms this disposition of the form.

Specimens were observed on the bars of the Saline river, at Benton. It occurs commonly in the Little Red river, near Clinton, Van Buren county, from which locality came the shells that were characterized by the name of *Unio pilsbryi*. The species is of wide distribution, ranging from New York to Kansas, Nebraska, Dakota, and to west Central Texas; east to Georgia, Alabama, and intermediate States. It is flatter than *Unio plicatus*, and the undulations are differently disposed; they are commonly more numerous than in Lesueuer's species, and often are interrupted or broken; not infrequently specimens are found in which the undulations cover the entire disk, at other times they are few in number, and almost entirely confined to the posterior slope. This is one of the most

common Unios in North America. Conrad figures this shell as *Unio costatus* Rafinesque, on Plate VII of his Monograph.

Unio venustus Lea.

Trans. Am. Philos. Soc., Vol VI, 1834, p. 4, Pl. II, Fig. 4; Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate LXIV, Fig. 326. Described from Potosi, Missouri.

Unio pleasii Marsh. The Nautilus, Vol. V, No. 1, p. 2, May, 1891. Described from the Little Red river, Van Buren county, Arkansas.

Specimens have been seen from the Little Red river — the lot forming the types of Marsh's supposed new form, and from the White river, Carroll county. While the species does present some features, like those of the young of *Unio ligamentinus* Lamarck, it is entirely distinct from that shell; the comparison was not fortunate, for very many characters that are not allied to those of the Lamarckian form are exhibited; among them may be mentioned the capillary character of the rays, their wavy outlines, their crowding, also the character of the teeth, which are unlike those of young *ligamentinus*, the beaks, which are more elevated, the emarginate character of the female, which is not like the outline of the female *ligamentinus*. The shell which most nearly represents this one is *Unio spatulatus* Lea, but it appears to be distinct from it. Having seen and compared the types of *Unio pleasii* with the real *venustus* there is no hesitation in uniting them.

Unio ventricosus Barnes.

Am. Jour. of Sci. and Arts, Vol. VI, 1st series, 1823, p. 267, Figs. 14a, 14b, 14c; Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate XLIII, Fig. 235; American Conchology, Say, Plate XXXII. Described from the Wisconsin and Mississippi rivers.

Unio occidens Lea. Trans. Am. Philos. Soc., Vol. III, 1829; p. 435, Pl. X, Fig. 16. Described from the Ohio river.

Unio cardium Rafinesque. So Conrad, in Monograph of Unio, 1834, p. 7.

Unio satur Lea. Trans. Am. Philos. Soc., 2d series, Vol. X, 1852, p. 265, Pl. XVII, Fig. 19; Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate XCII, Fig. 501. Described from Alexandria, Louisiana.

Unio canadensis Lea. Jour. Acad. Nat. Sci. Phila., Vol. IV, 1859, p. 268, Pl. XLIV, Fig. 148. Described in 1857, from the St. Lawrence river, at Montreal.

Unio subovatus Lea, of Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate LXXXV, Fig. 456. This is not the true *subovatus* Lea.

Specimens were obtained only in the Saline river, at Benton. The form is very widely distributed, and presents variant features in all its different habitats. Commonly abundant wherever it occurs at all, when perfect specimens are obtainable it constitutes one of the most beautiful of Uniones. It is the type of a great natural group, which includes *Unio ovatus* Say, *Unio subovatus* Lea, *Unio capax* Green *Unio lineatus* Lea, and others. Specimens of the last named, from the original locality in Georgia, indicate that it too must pass into the list of synonyms.

MARGARITANA COMPLANATA Barnes.

Plate XVI.

Alasmodonta complanata Barnes, Am. Jour. Science and Arts, 1st series, Vol. VI, p. 278, Pl. XIII, Figs. 17a, 17b, 1823.

Symphynota complanata Lea. Trans. Am. Philos. Soc., 1829, Vol. III, p. 448. Transferred from *Unio*.

Unio complanatus Lea. So Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate L, Fig. 266.

This species is rarely found in the St. Francis, at Wittsburg. While it has a wide range it appears to be most abundant in western Illinois, in the Mississippi river, and throughout Iowa. The last named State may, indeed, be said to be its metropolis. The figure is made from a young individual taken in the Des Moines river, and is designed to show the characters of the beaks, which are peculiar to this form.

MARGARITANA CONFRAGOSA Say.

New Harmony Disseminator of Useful Knowledge, Vol. II, No. 22, 1829, p. 339; American Conchology, Plate XXI, 1830. Described from the Wabash river, Indiana.

Unio confragosus Say. So Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate LX, Fig. 299. A fine figure of the external view of the shell.

This species has occurred only in the St. Francis river, so far as present information extends. It is a form which loves to dwell in the soft mud of sluggishly flowing streams. Just over the Louisiana boundary line, in Claiborne Parish, this shell occurs in numbers. It is not without reason, therefore, that it may be expected to occur in other portions of the State of Arkansas than the one listed.

MARGARITANA RUGOSA Barnes.

Alasmodonta rugosa Barnes. Am. Jour. of Sci. and Arts, 1st series, Vol. VI, 1823, p. 278, Pl. XIII, Figs. 21a, 21b; DeKay Natural History of New York, Vol. V, Mollusca, p. 196, Pl. XIV, Fig. 226. 1843.

Unio rugosus Barnes. So Reeve, Conchologia Iconica, Vol. XVI, *Unio* Plate LX, Fig. 302, 1867. Reeve says this is equivalent to *Unio abducta* Say, a species which we have been unable to find that Say ever characterized.

Specimens were obtained in the White river, Carroll county; and in the Saline, at Benton, where the form appears to be abundant. This shell has a wide range from New England, to west central Kansas, Texas, Louisiana, Alabama, and Georgia; the northernmost range, that is authoritatively known, is the Rideau and Ottawa rivers, Canada.

ANODONTA EDENTULA Say.

Alasmodonta edentula Say. New Harmony Disseminator of Useful Knowledge, Vol. II, No. 22, 1829, p. 340; described from the Wabash river.

Anodonta edentula Say. DeKay Nat. Hist. N. Y., Pt. V, 1843, p. 201, Pl. XVI, Fig. 231; Lea, Trans. Am. Philos. Soc., Vol. IV, 1858, p. 50, Pl. VI, Fig. 37.

Anodonta ferruginea Lea. Trans. Am. Philos. Soc., 2d series, Vol. VIII, 1840, p. 289, Pl. XIX, Fig. 43. Described from Simon's Creek, Indiana.

Anodonta tetragona Lea. Trans. Am. Philos. Soc., 2d series, Vol. X, 1845, Pl. VIII, Fig. 25, p. 82; described from Alexandria, Louisiana.

Anodonta shafferiana Lea. Trans. Am. Philos. Soc., 2d series, 1852, Vol. X, Pl. XXVI, Fig. 50, p. 288; described from Horn Lake creek, Tennessee, and Flat Rock creek, Indiana; Reeve, *Anodon* Plate XXXV, Fig. 143, Conchologia Iconica, Vol. XVII.

Anodonta arkansasensis Lea. Trans. Am. Philos. Soc., 2d series, Vol. X, 1852, p. 293, Pl. XXIX, Fig. 56. Described from Kansas.

Alasmodonta rhombica Anthony. Am. Jour. Conchology, Vol. I, 1865, p. 158.

Anodon annulatus Sowerby. Reeve, Conchologia Iconica, Vol. XVII, *Anodon* Plate XVIII, Fig. 67. This figure and description are based upon a specimen in the Museum Cuming, from an unknown habitat; it shows the characters of the beaks of *edentula*, and is without question that form.

This is the most common and abundant *Anodonta* in the west. The characters of the dorsal margin are such that it is often mistaken for a *Margaritana* as, indeed, was the case when originally described. Subjected to a vast variety of environmental conditions, it is not surprising that very many names have been applied to its differing forms. It is not easily separated, at times, from the form called *Anodonta undulata* Say, which is supposed to be entirely confined to the regions east of the Appalachians, or to waters draining into the Great Lakes.

Reeve's Fig. 60, Vol. XVII, Conchologia Iconica, Plate XVII, is not *Anodonta edentula*, but is something else.

The species has occurred in collections made in the St. Francis river, at Wittsburg, and in the Saline, at Benton; a single imperfect specimen was picked up in a small stream, without a name, in the southeastern part of Craighead county.

ANODONTA GRANDIS Say.

New Harmony Disseminator, Vol. II, 1829, No. 22, p. 341; Reeve, Conchologia Iconica, Vol. XVII, Plate *Anodon* I, Fig. 1, 1870. Described from the Fox river, and the Upper Mississippi river.

Anodonta stewartiana Lea. Trans. Am. Philos. Soc., 2d series, 1834, Vol. V, p. 47, Pl. VII, Fig. 17; Reeve, Conchologia Iconica, Vol. XVII, *Anodon* Plate XXXIII, Fig. 133. Described from the Bayou Teche, Louisiana.

Anodonta plana Lea. Trans. Am. Philos. Soc., 2d series, 1834, Vol. V, p. 48, Pl. VII, Fig. 18, as *palna* in typographic error; Reeve, Conchologia Iconica, Vol. XVII, *Anodon* Plate XXIV, Fig. 94. Described from Bear Grass creek, near Louisville, Kentucky.

Anodonta declivis Conrad. Am. Jour. Sci. and Arts, Vol. XXV, 1st series, p. 341, Pl. I, Fig. 11, 1834. Described from the Flint river, Morgan county, Alabama,

Anodonta corpulenta Cooper. Appendix to "Narrative of an Expedition through the Upper Mississippi to Itasca Lake, etc., under the direction of Henry B. Schoolcraft," p. 153; Reeve, Conchologia Iconica, Vol. XVII, *Anodon* Plate XXXII, Fig. 129. Described from the Lake of the Woods, and the Upper Mississippi.

Anodonta decora Lea. Trans. Am. Philos. Soc., 2d series, Vol. VI, 1836, p. 64, Pl. XX, Fig. 63; Reeve, Conchologia Iconica, Vol. XVII, *Anodon* Plate XXI, Fig. 83, 1869. Described from the Ohio river.

Anodonta gigantea Lea. Trans. Am. Philos. Soc., 2d series, Vol. VI, 1838, p. 1, Pl. I, Fig. 1; Reeve, Conchologia Iconica, Vol. XVII, *Anodon* Plate XXXVII, Fig. 152. Described from Port Gibson, Mississippi.

Anodonta ovata Lea. Trans. Am. Philos. Soc., 2d series, Vol. VI, 1838, p. 2, Pl. II, Fig. 2; Reeve, Conchologia Iconica, Vol. XVII, *Anodon* Plate XXII, Fig. 85, 1869. Described from Marietta, Ohio. Reeve's figure, which is that of a shell without decortication of the beaks, shows well the undulate-apiculate character of the tips.

Anodonta harpethensis Lea. Trans. Am. Philos. Soc., 2d series, Vol. VIII, p. 224, Pl. XIX, Fig. 42; Reeve, Conchologia Iconica, Vol. XVII, *Anodon* Plate XXI, Fig. 82, 1869. Described from the Harpeth river, Tennessee.

Anodonta linnæana Lea. Trans. Am. Philos. Soc., 2d series, Vol. X, 1852, p. 289, Pl. XXVII, Fig. 51; Reeve, Conchologia Iconica, Vol. XVII, *Anodon* Plate XXXV, Fig. 144. Described from Lake Concordia, Louisiana.

Anodonta virens Lea. Trans. Am. Philos. Soc., 2d series, Vol. X, 1852, p. 290, Pl. XXVIII, Fig. 53; Reeve, Conchologia Iconica, Vol. XVII, *Anodon* Plate XXXIV, Fig. 138. This form was described from the Red river, near Alexandria, Louisiana. Through some curious blunder Reeve says "River Euphrates."

Anodonta gesneri Lea. Jour. Acad. Nat. Sci. Phila., 2d series, 1859, p. 231, Pl. XXXI, Fig. 109; Reeve, Conchologia Iconica, Vol. XVII, *Anodon* Plate VII, Fig. 15. Described from the Uphaupee creek, Macon County, Georgia.

Anodonta inornata Anthony. Am. Jour. of Conchology, Vol. II, 1866, p. 145. *Teste* Lea.

This is, without doubt, the most abused American *Anodonta*. Of wide distribution it is one of the most polymorphous shells found on the continent. A number of years ago attention was called to this variant shell, and some of the synonymy here indicated definitely was there hinted at.* There is scarcely a stream in all the great Mississippi Valley but that in it some form of this abundant shell occurs. In outline every one of the forms given above may be found in every lot which numbers forty or fifty specimens, and if the old and the young are taken and compared, all the forms from *gigantea* to *ovata* and *virens* may be obtained. It has fared rather better than the European *Anodonta cygnea*, of which over one hundred and twenty synonyms are known, but by the time it has had attention equal to that of its European congener, it may fare as badly.

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* American Naturalist, Vol. XIV, 1880, pp. 529–530.

The group has received too little attention, and too much reliance has been placed upon authority to fully and correctly understand this shell. Those who collect *Unionidæ* by proxy, and whose acquaintance with streams and lakes is confined to the views from passing train or from study window, will continue to see many species in this polymorphous form.

Specimens were obtained in the St. Francis river, at Wittsburg, and in the Saline, at Benton. It will doubtless be found, in numbers, in the old river beds of all the larger streams, and in most ponds and lakes throughout the State of Arkansas. It ranges to western New York and to central Texas, and north to British America.

ANODONTA IMBECILLIS Say.

New Harmony Disseminator of Useful Knowledge, 1829, Vol. II, No. 23, p. 355; Reeve, Conchologia Iconica, Vol. XVII, *Anodon* Plate XXVII, Fig. 102, as of Lea. Described from the Wabash river.

Anodonta incerta Lea. Trans. Am. Philos. Soc., Vol. V, 1832, p. 45, Pl. VI, Fig. 16; Reeve, Conchologia Iconica, Vol. XVII, *Anodon* Plate XVII, Fig. 59. Described from the Ohio river.

Anodonta hordea Gould. Proc. Bost. Soc. Nat. Hist., Vol. V, 1855, p. 229; Reeve, Conchologia Iconica, Vol. XVII, *Anodon* Pl. XVIII, Fig. 66, as *Anodon hordeum* Gould. Lea says this is Say's *Anodonta imbecillis;* it must be confessed that Reeve's figure bears no resemblance to it as it is generally understood on this side of the Atlantic.

There is no *Anodonta* in American waters so easily determined as this one, and so little likely to be confounded with any other species. It is commonly of a bright green color, and is of very thin texture, resembling nothing else in our waters. In Arkansas it has been found only in the St. Francis river, at Wittsburg, but doubtless occurs elsewhere. We have it from various localities in Louisiana and Texas, whence it ranges to western New York and Canada.

ANODONTA OPACA Lea.

Trans. Am. Philos. Soc., 2d series, Vol. X, p. 285, Pl. XXV, Fig. 46. Described from near New Orleans, and from near Little Rock, Arkansas.

This is a member of the *grandis* group and it is not sure but that it should have been placed under the synonymy of that species. It has not been seen by us in any collection from Arkansas, and is admitted to this list on the strength of the original description, which credits it to this State.

There have been listed in the foregoing pages fifty-nine species of *Unionidæ*, illustrating the three common North American genera. Had there been recognized the great number of synonymous forms, with which mere collectors seek to enrich their cabinets, the list might have been greatly extended. At present we know, from Arkansas, 52 species of *Unio*, 3 species of *Margaritana*, and 4 species of *Anodonta*.

The *Unionidæ* abound in the streams of Arkansas; varieties or species may be relatively few, but individuals are very abundant. They are to be sought in every conceivable condition of bottom, and other factors of environment. Often certain forms affect stated or well-known sorts of stations in cold and clear, or warm and muddy waters; others will be found on gravelly or sandy bars, ordee ply buried in mud, close to the river's margin. Careful search rarely fails to reveal some form of interest.

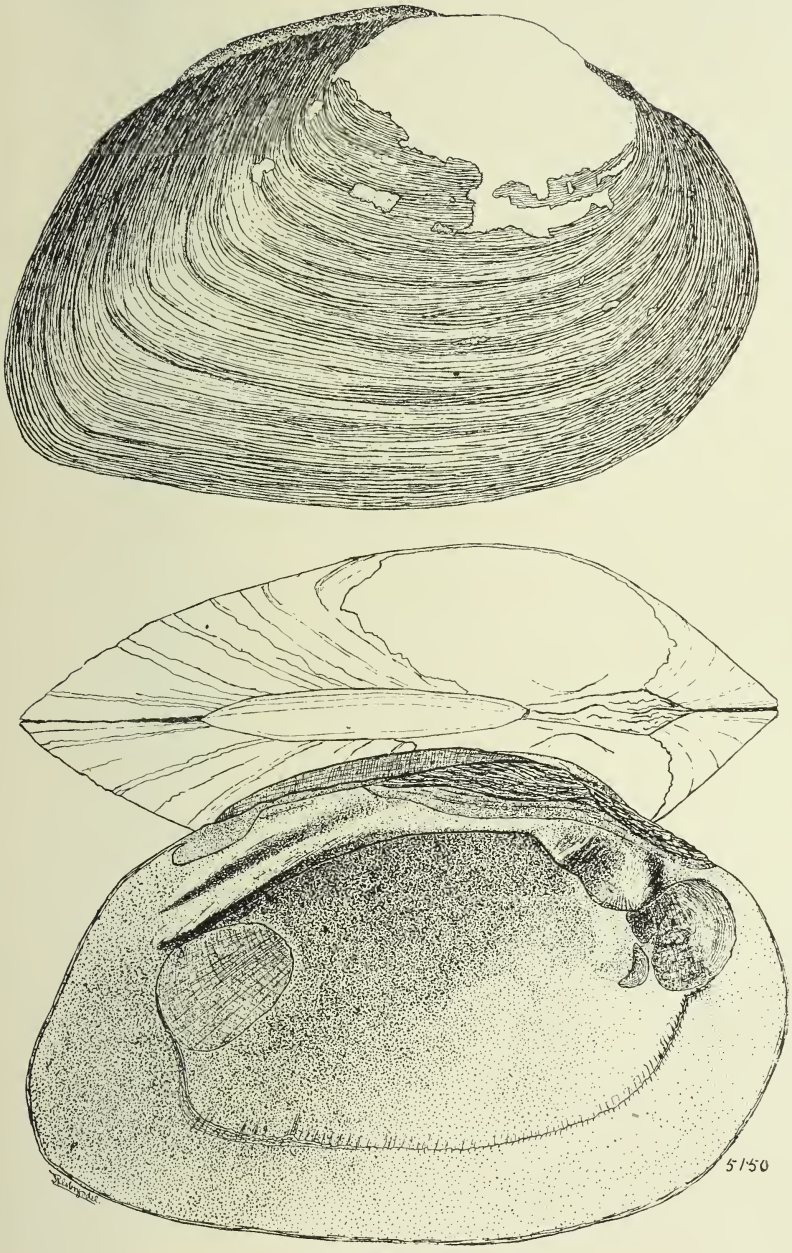
LOUISVILLE, KENTUCKY, Nov. 16, 1893.

Issued January 3d, 1895.

CALL ON UNIO. PLATE I.

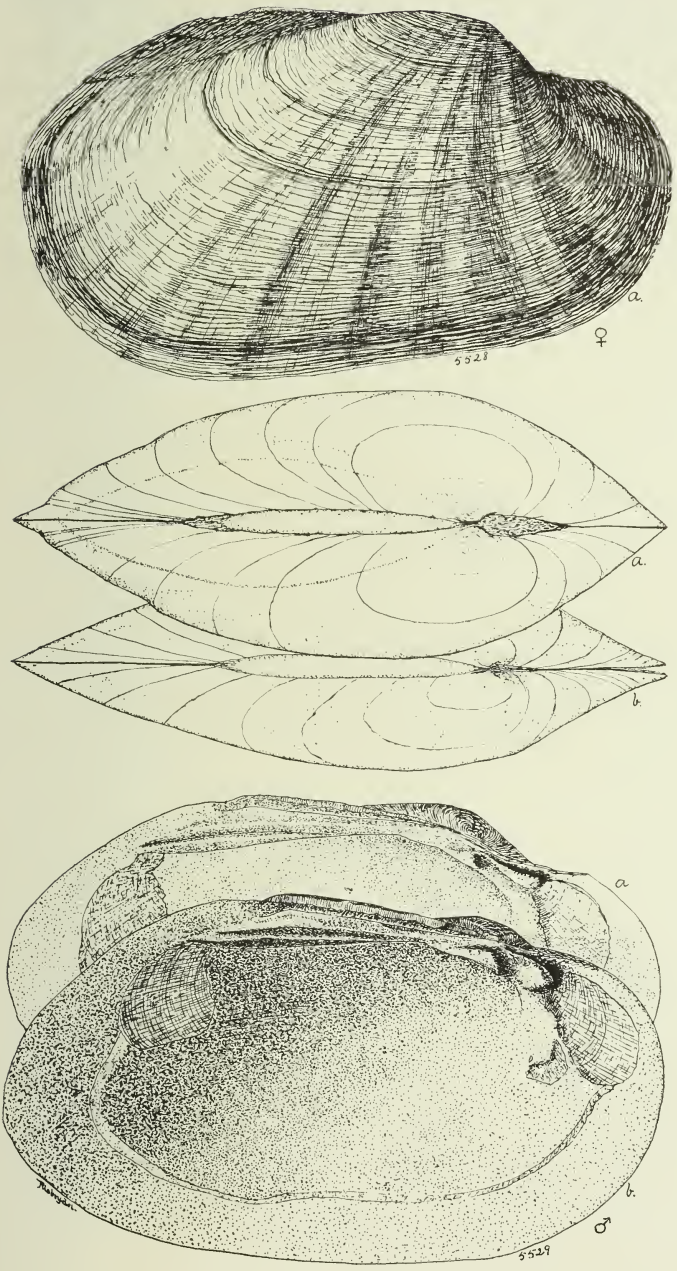
Unio clavus Lamarck.

CALL ON UNIO. PLATE II.

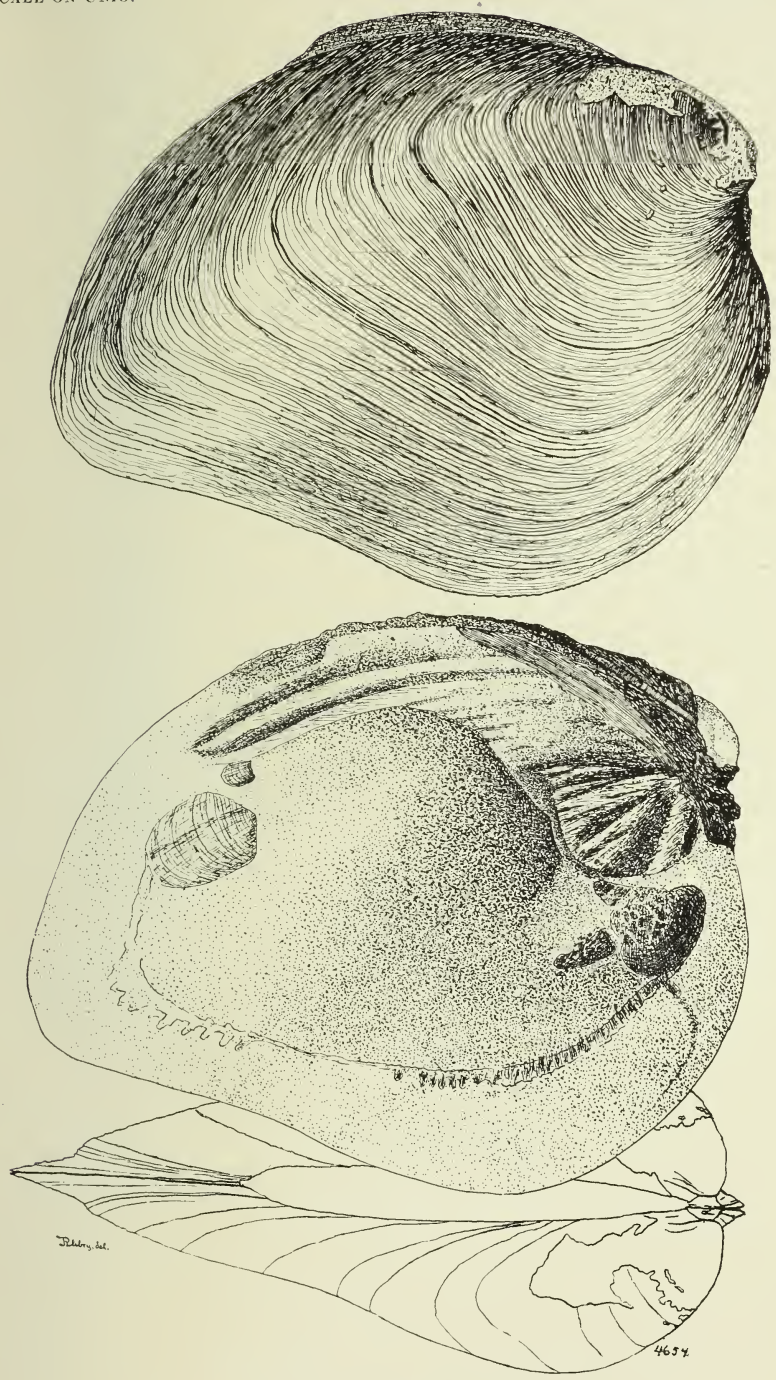


Unio crassidens, Lamarck.

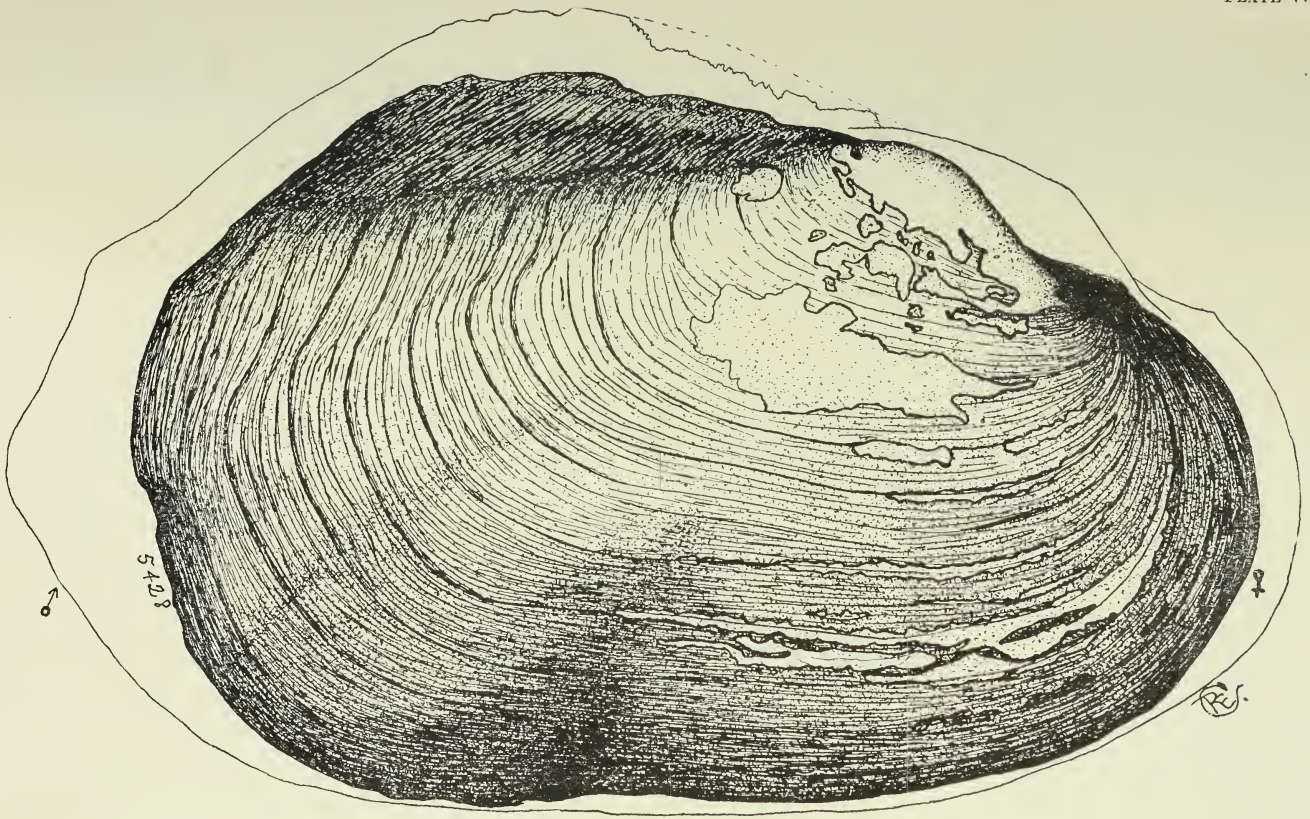
CALL ON UNIO. PLATE III.



Unio luteo'us Lamarck.

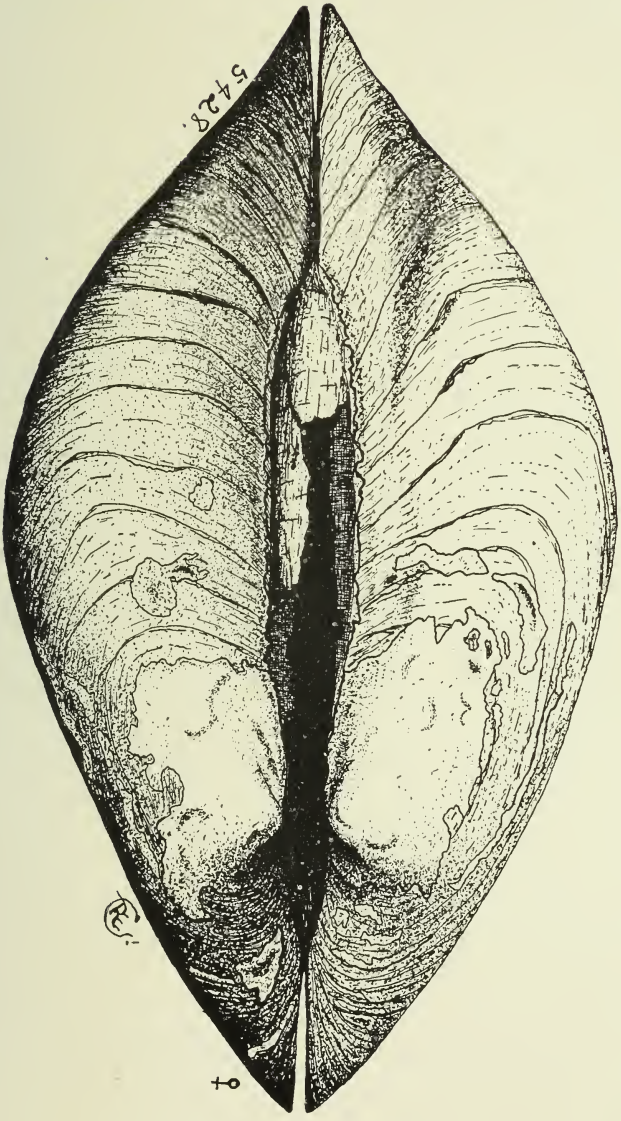


Unio obliquus Lamarck.



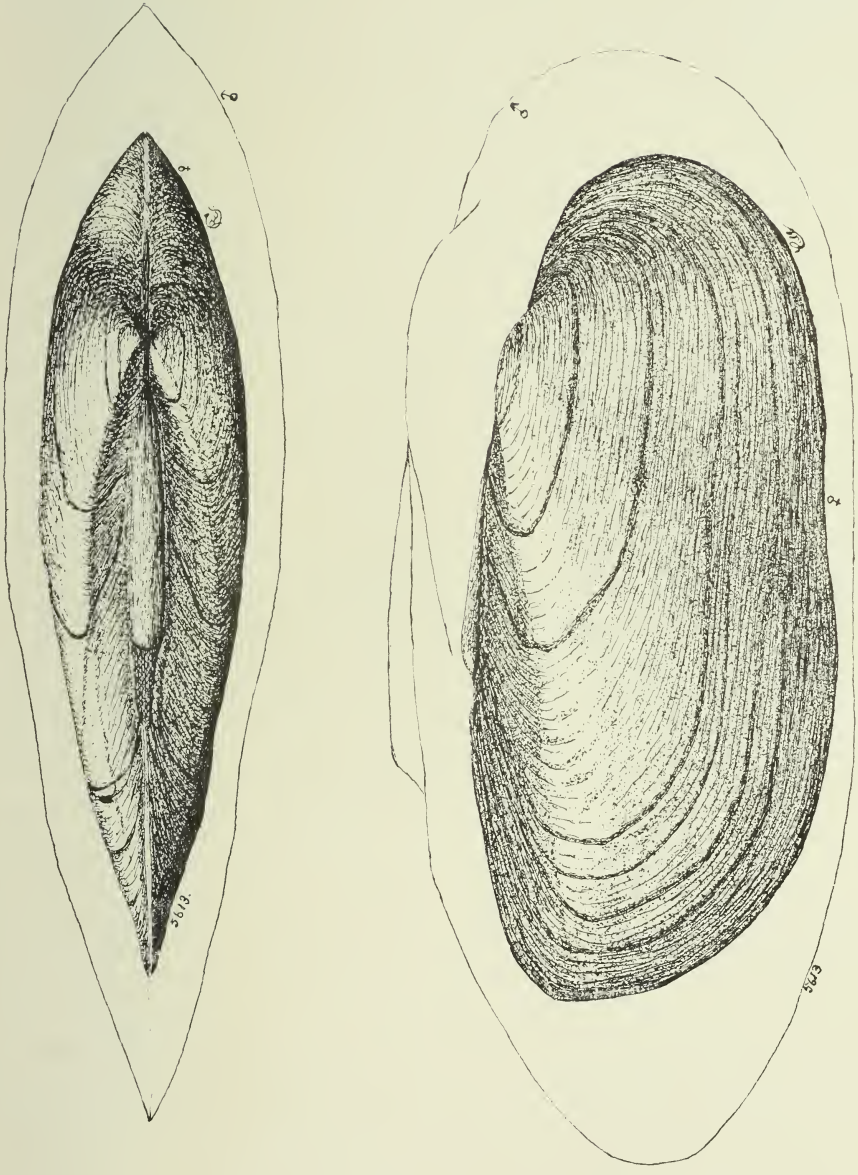
Unio purpuratus Lamarck.

CALL ON UNIO. PLATE VI.

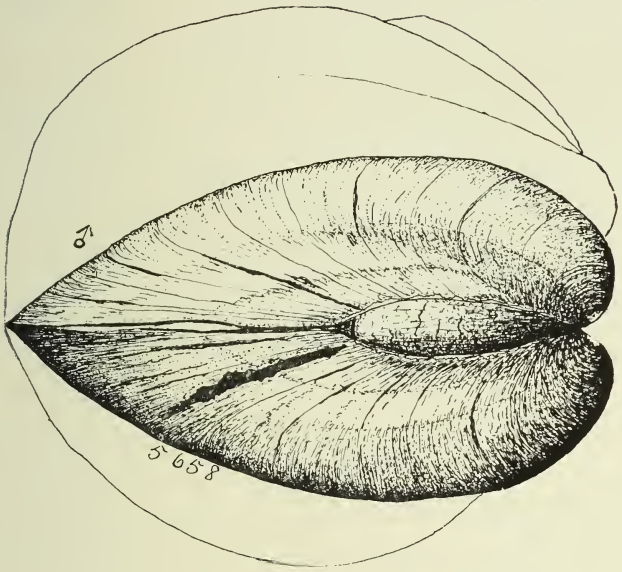


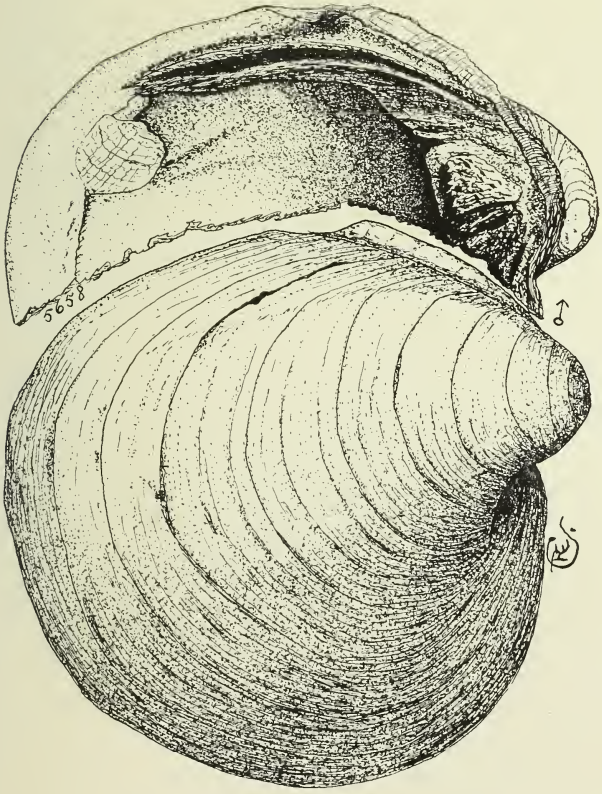
Unio purpuratus Lamarck.

CALL ON UNIO. PLATE VII.

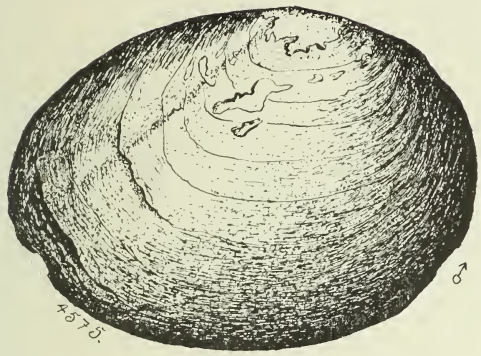


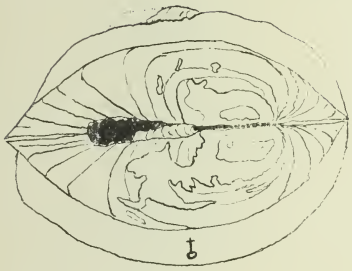
Unio rectus Lamarck.

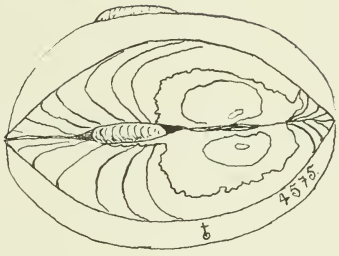


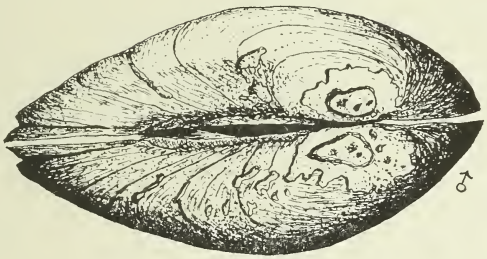


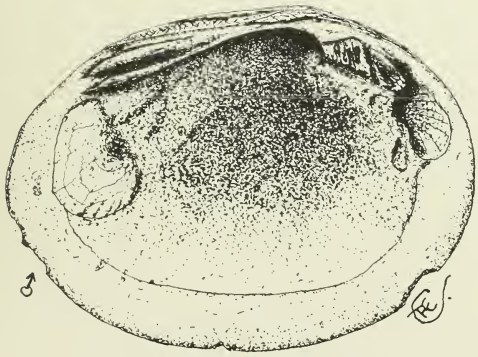
Unio retusus Lamarck.





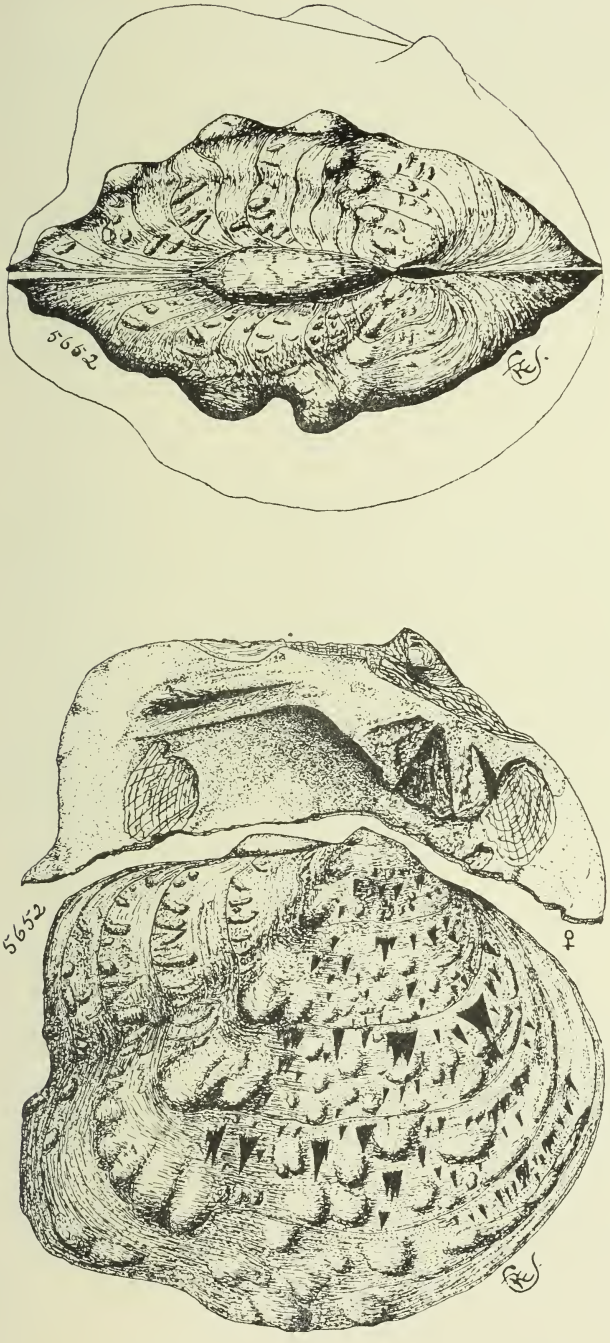




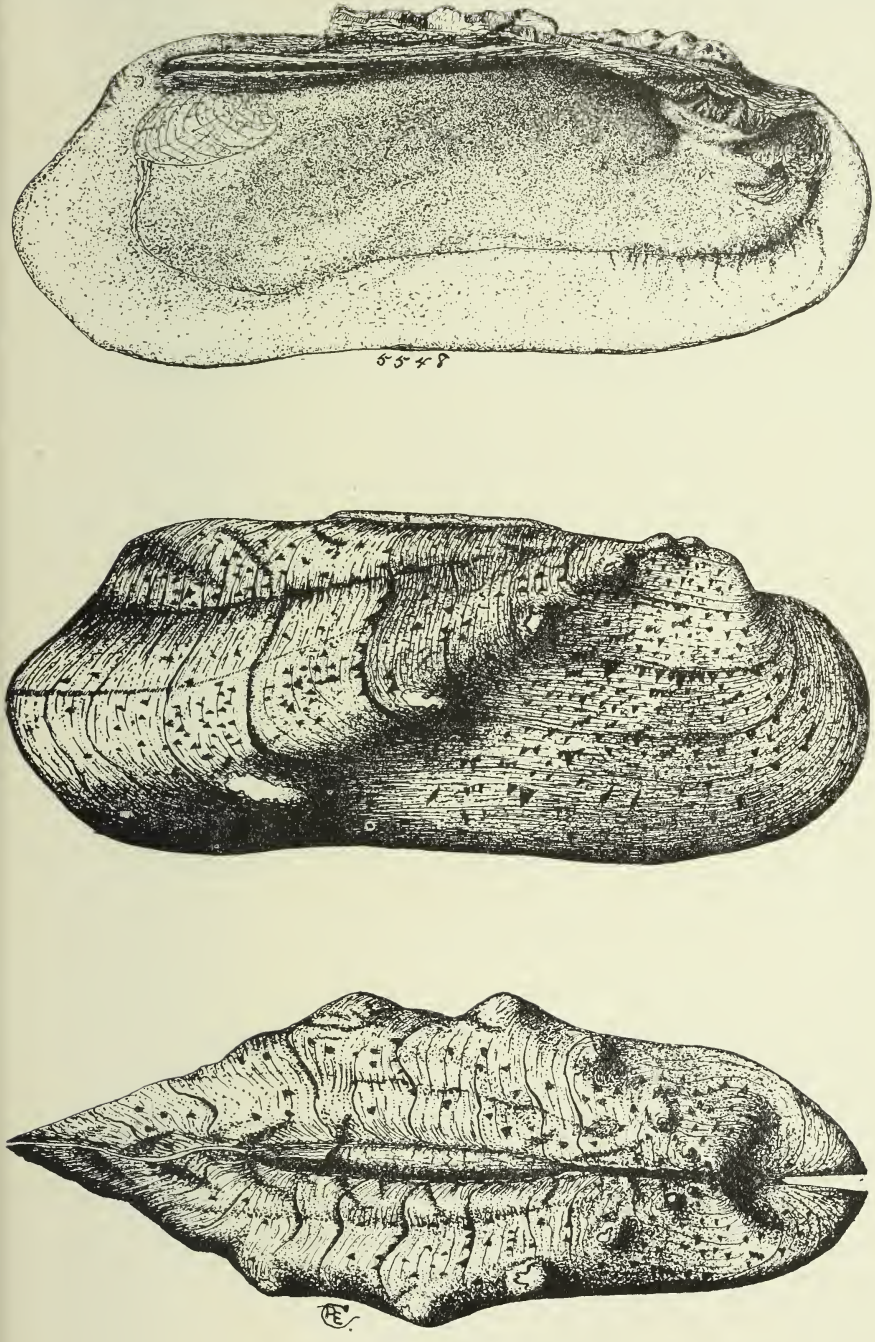


Unio rotundatus Lamarck.

CALL ON UNIO. PLATE X.



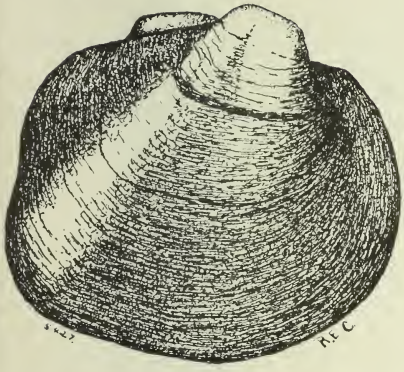
Unio metanevrus Rafinesque.

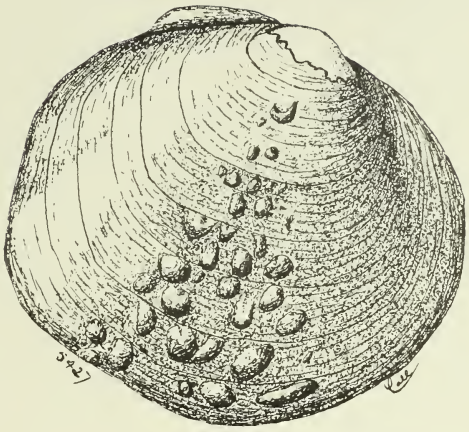


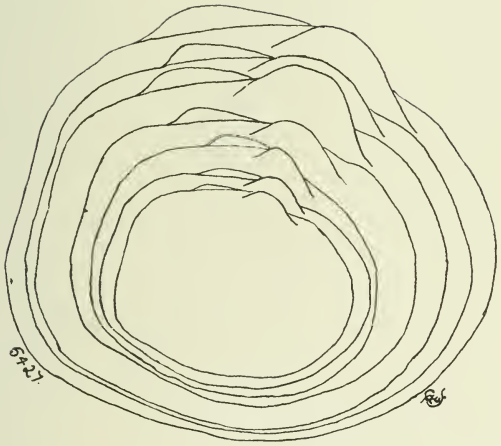
Unio cylindricus Say.

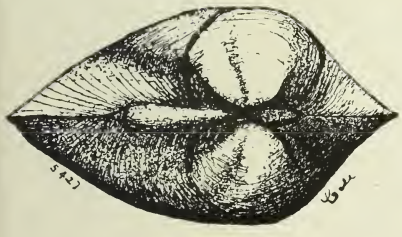
Unio schoolcraftii Lea.

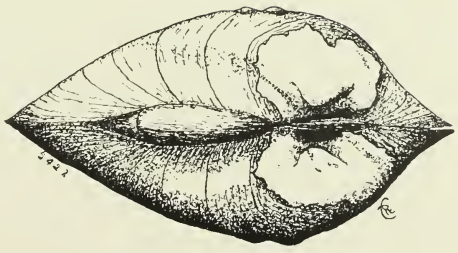
(REDUCED.)





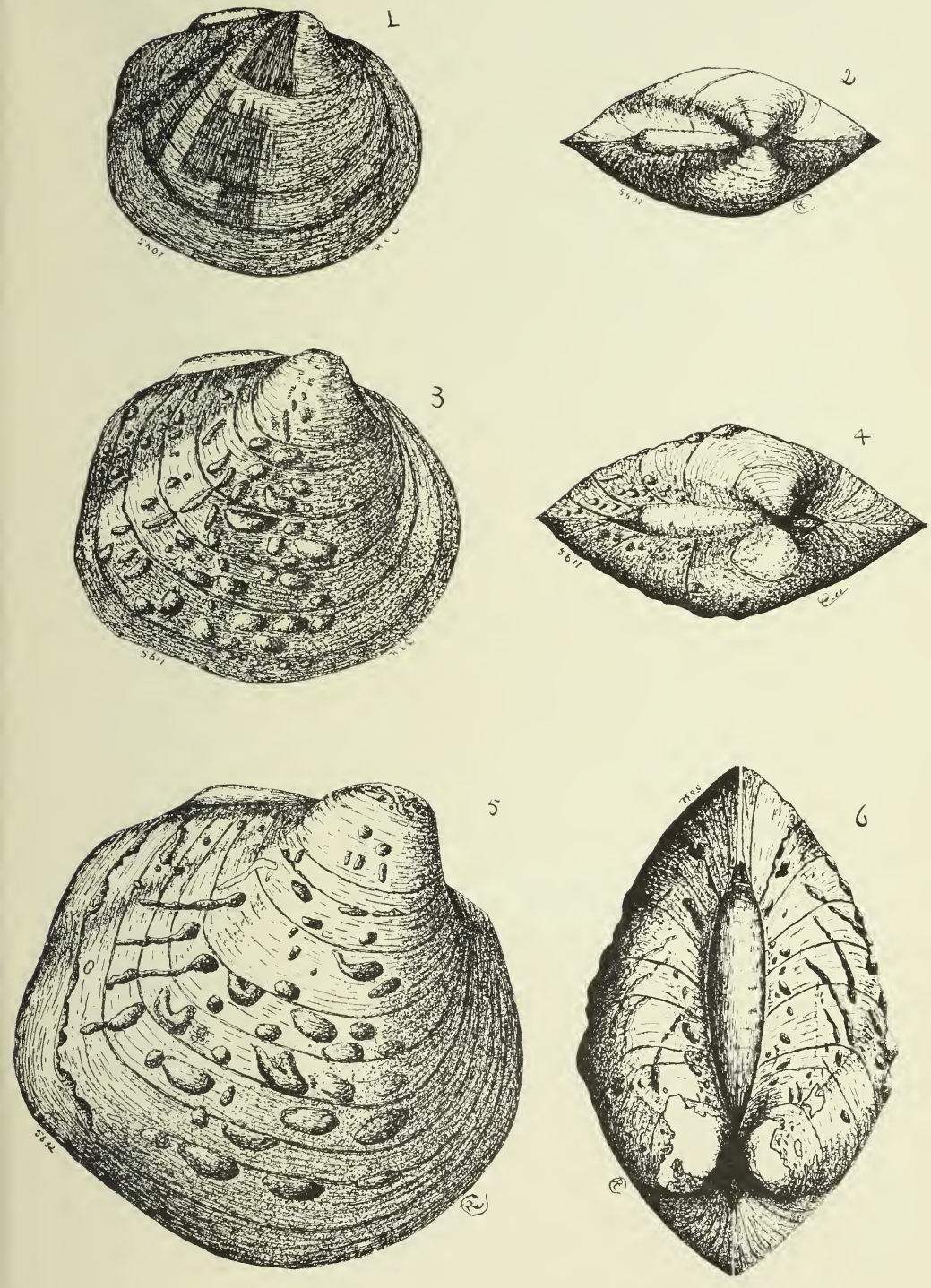




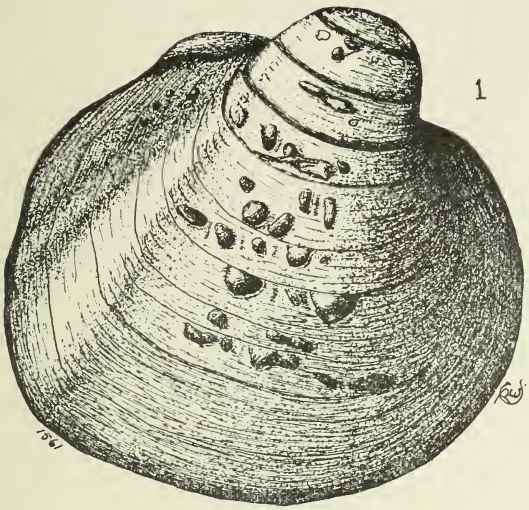


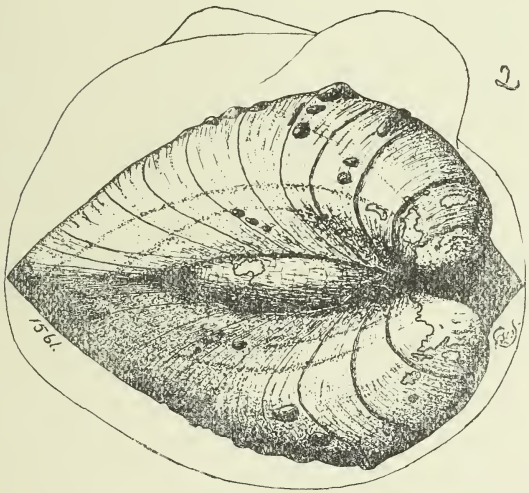
Unio schoolcraftii Lea.

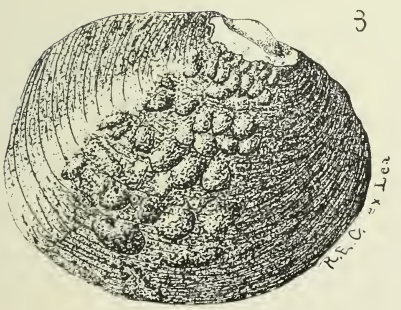
(VARIETIES.)

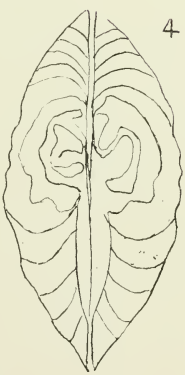


Figs. 1–4. Unio schoolcraftii Lea.
Figs. 5–6. Unio pustulosus, Lea.



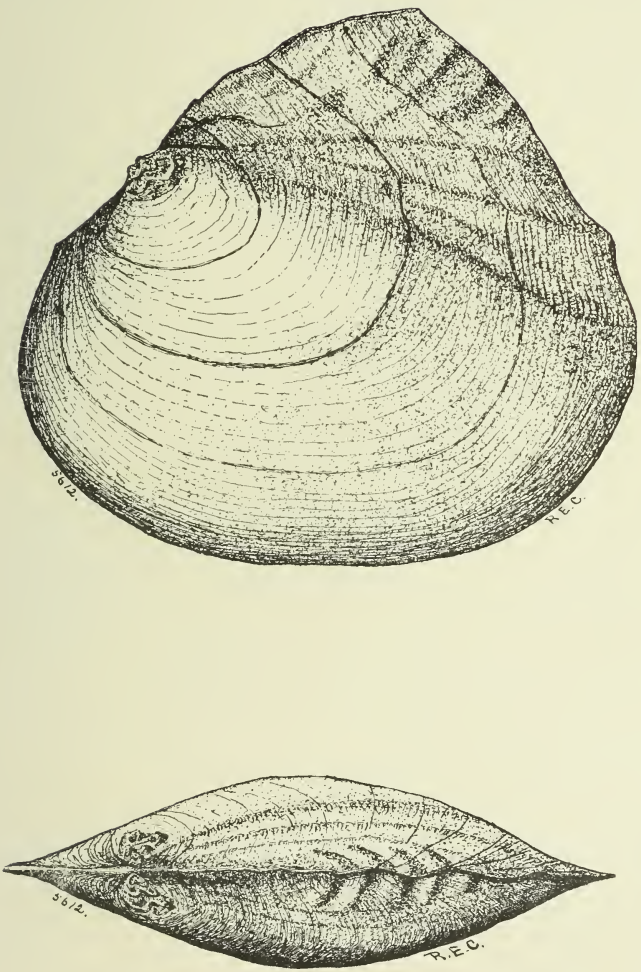






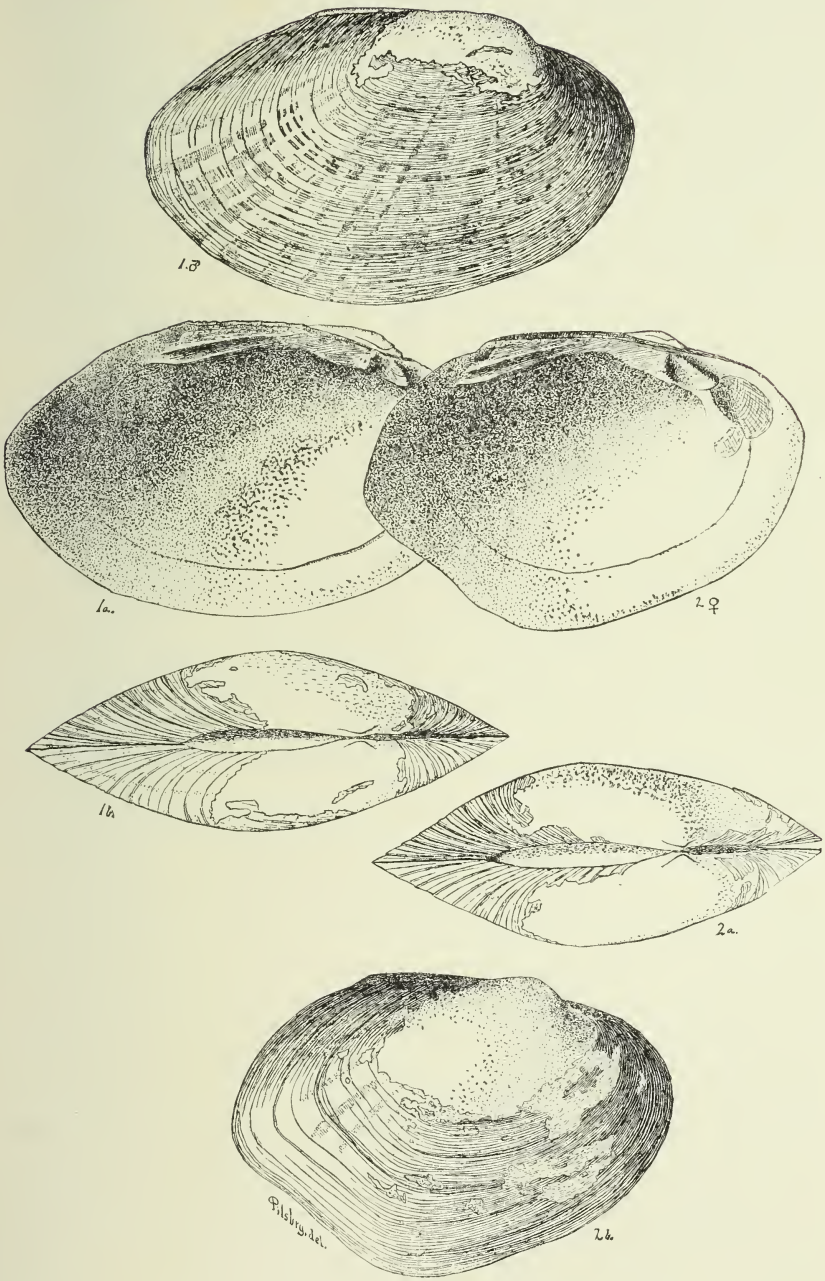
Figs. 1–2. Unio dorfeuillianus Lea.
Figs. 3–4. Unio refulgens Lea.

CALL ON UNIO. PLATE XVI.



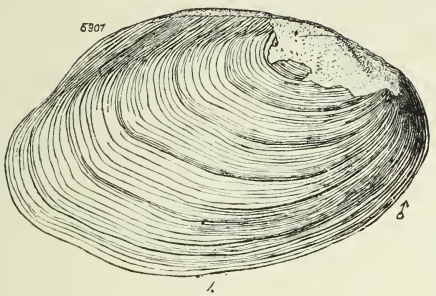
Margaritana complanata, Barnes.

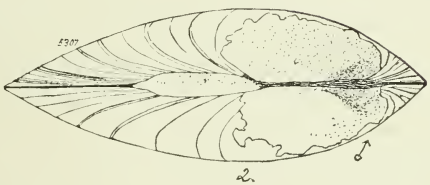
CALL ON UNIO. PLATE XVII.

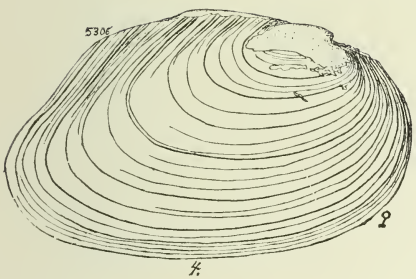


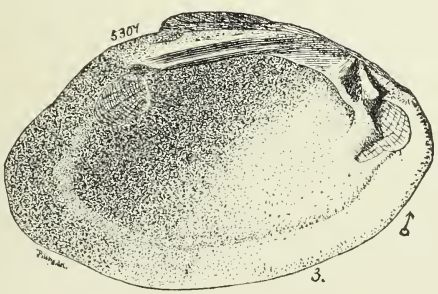
Unio breviculus Call.

CALL ON UNIO. PLATE XVIII.



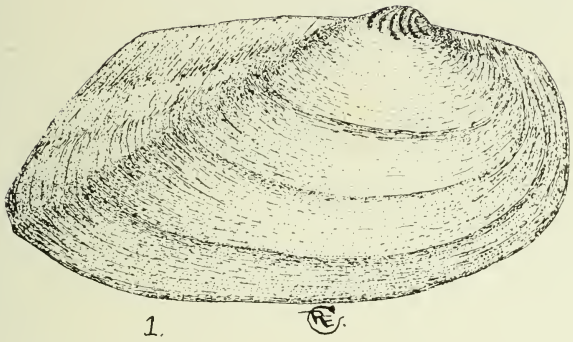


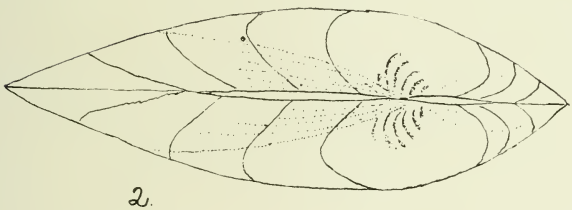


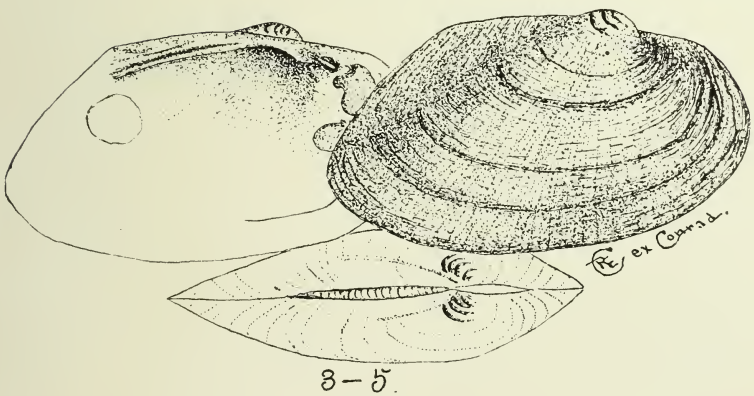


Unio ozarkensis Call.

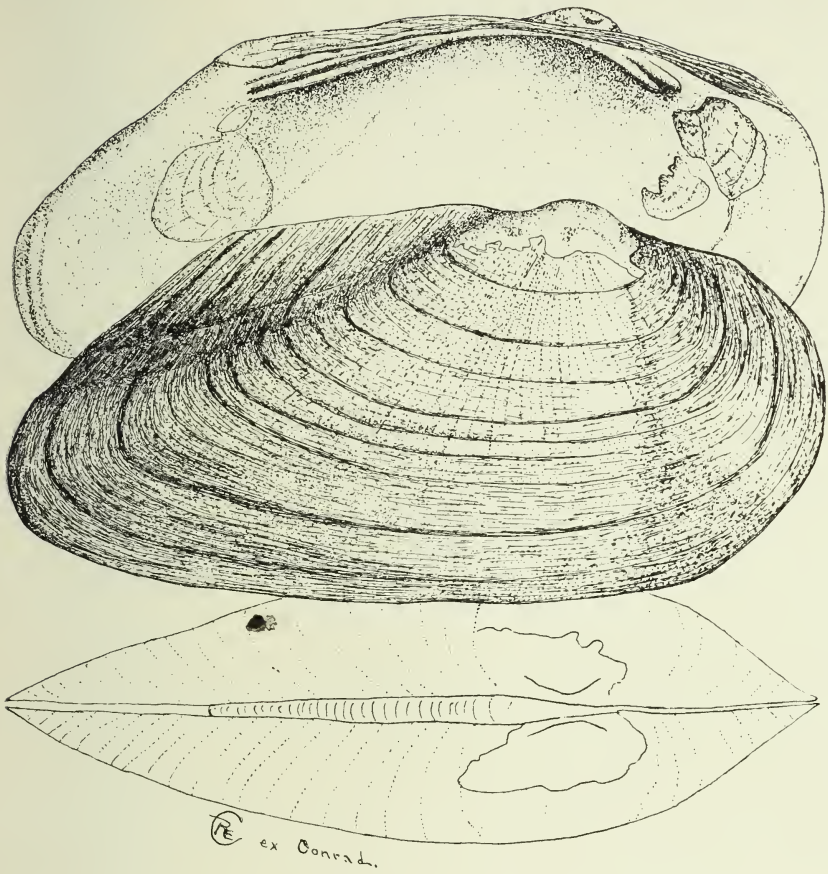
CALL ON UNIO. PLATE XIX.

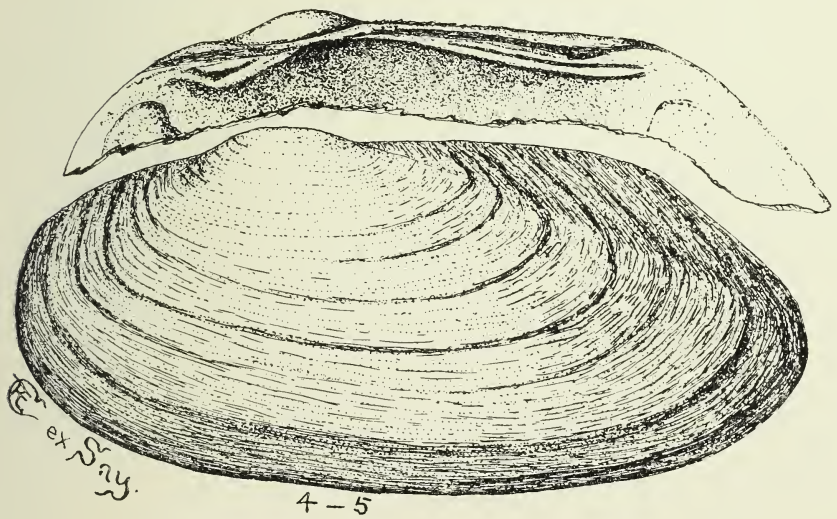




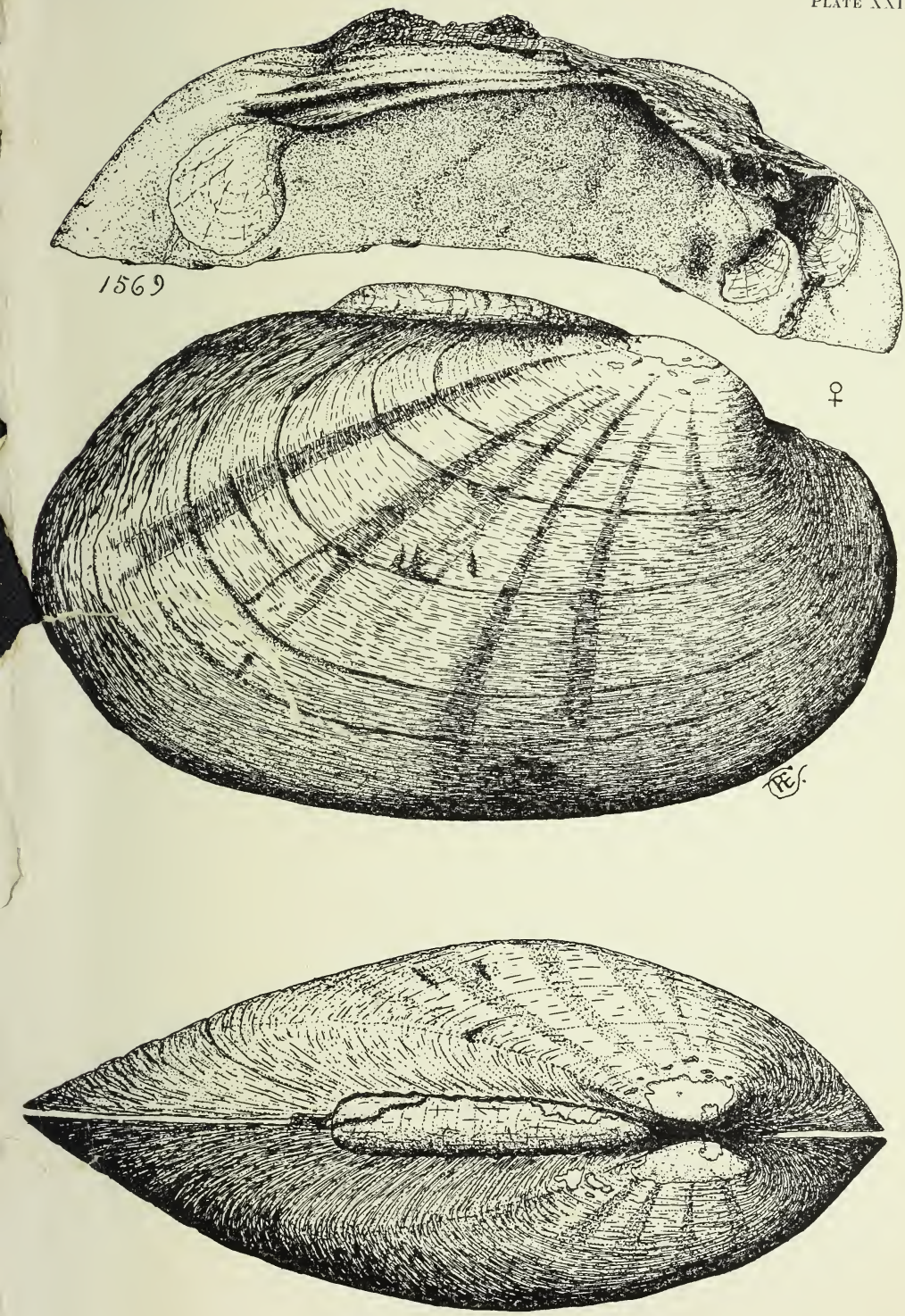


Figs. 1–2. Unio sayii Ward.
Figs. 3–5. Unio sayanus Conrad.





Figs. 1–3. Unio excultus Conrad.
Figs. 4–5. Unio tetralasmus Say.



Unio ligamentinus Lamarck.