

AN ILLUSTRATED CATALOGUE

OF THE

MOLLUSCA OF MICHIGAN

BY

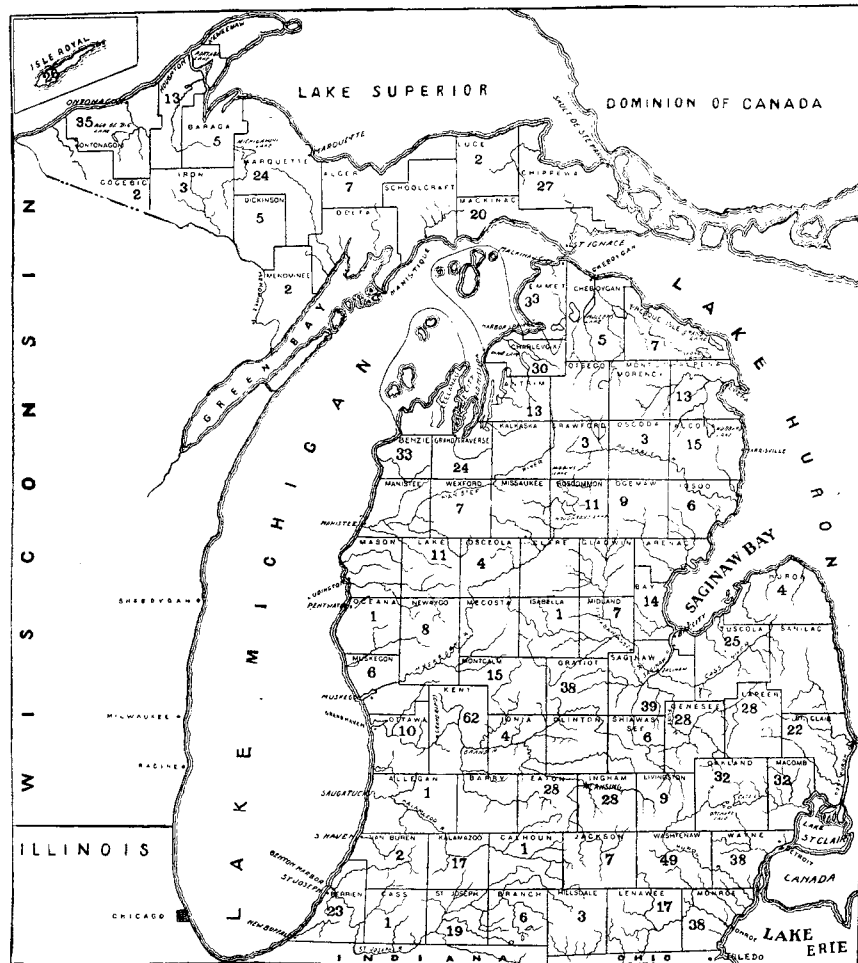
BRYANT WALKER

PART I.

TERRESTRIAL PULMONATA

(LAND SNAILS)

Published by the State Board of Geological Survey, as a part of the Report for 1905, and
as a contribution to the Biological Survey of the State, authorized by
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LETTER OF TRANSMITTAL

OFFICE OF THE STATE GEOLOGIST.

LANSING, MICHIGAN, Jan. 22, 1906.

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

Hon. Fred M. Warner, President.

Hon. W. J. McKone.

Hon. Patrick H. Kelley, Secretary.

Gentlemen:—I herewith transmit for publication as part of your report a contribution to the Biological Survey of the State, authorized by Act 250 of the Session of 1905, a paper by Bryant Walker, Esq., of Detroit, on the Terrestrial Mollusca,—the land snails and garden slugs,—of the State.

Through the generosity of Mr. Walker in illustrations, we are able to show not only the counties in which the different species have so far been found, but figures by which they may be identified.

Mr. Walker has also given references to the names by which they have been known, and the different authors, who have treated them.

Very respectfully,

ALFRED C. LANE,
State Geologist.

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PREFACE.

In an endeavor to compile a complete census of the mollusca of Michigan, the Conchological Section of the Michigan Academy of Science has found the lack of convenient and accessible literature a most serious obstacle to enlisting the interest of the many teachers and students of biology throughout the state.

The present catalogue has been prepared in an attempt to supply this want and to furnish a convenient manual, which would not only embody the recent advances in systematic conchology and exhibit the extent of our present knowledge of the fauna of the state and its distribution, but also enable the student to identify his specimens with some reasonable degree of certainty.

The systematic portion of the work has been adopted *verbatim* from Pilsbry, Crosse and Fischer, and other recognized authorities. The specific descriptions have been prepared with a view to emphasize the distinctive features of the different forms, and in all cases keys have been supplied as an additional assistance.

Through the courtesy of the Secretary of the Smithsonian Institution, electrotypes of the excellent figures contained in the various manuals published by the Institution have been obtained. Other figures as far as possible have been copied from authoritative sources and, where both of these failed, original figures have been prepared.

In the matter of synonymy, the scope of the work is such as to preclude the full presentation that would be expected in a complete monograph. In addition to the citation of the original authority, however, reference has been made to Binney's Manual of American Land Shells, where full details in this particular will be found as to all except the most recently described species. It has also been deemed desirable to include references to the several general catalogues that have been published of the mollusca of the state.

The writer is under many obligations to the members of the Michigan Academy of Science, for valuable material showing the distribution of the different species, and especially to Dr. A. C. Lane and Mr. W. F. Cooper of the State Geological Survey, Mr. R. H. Pettit of the State Agricultural College, Prof. C. A. Davis of the State University, Dr. R. J. Kirkland and Mr. L. H. Streng of Grand Rapids, Sister M. Catherine of St. Mary's Academy, Monroe and Dr. P. E. Marsh of Otter Lake. We also are indebted for much kindly assistance and suggestion, to Dr. H. A. Pilsbry of Philadelphia, and Mr. George H. Clapp of Pittsburg, Pa., and Dr. V. Sterki of New Philadelphia, Ohio.

Several important changes in nomenclature having been made since the paper was submitted for publication, advantage has been taken of the delay in printing to incorporate them and other additional data recently received, thus bringing the subject down to date.

Detroit, September 1, 1906.

BRYANT WALKER.

AN ILLUSTRATED CATALOGUE

OF THE

MOLLUSCA OF MICHIGAN.

INTRODUCTION.

I.

REVIEW OF MICHIGAN CONCHOLOGY.

Barring a few scattering descriptions by European naturalists of such species as were brought home by the early travellers in this country, the history of North American conchology may be said to have begun when Thomas Say, in 1817, wrote the article on "Conchology" for the first American edition of Nicholson's Encyclopedia of Arts and Sciences. Philadelphia then, as now, was the centre of activity in this branch of science in the United States, and in the proceedings of the then newly organized Academy of Natural Science and a few other scientific and literary publications of that city, nearly all the conchological writings for the next twenty years are to be found.

The first record of Michigan conchology was made in 1822, when Thomas Rackett, an English naturalist, in the Transactions of the Linnean Society of London, published a list of seven species of shells collected near Thunder Bay, Alpena county. One of these, *Polygyra monodon*, still bears the name which he gave to it.

Michigan, as such, had no distinctive name in those days, and was known only as a wilderness filled with swamps and savages and located somewhere in that still greater and more indefinite region called the northwest.

But as population increased and young blood from the New England states made itself felt in the new territory, there began a dawn of better things. And one of the first acts of the first legislature of the new state of Michigan in 1837 was the establishment of a State Geological Survey with Douglass Houghton at its head as Geologist and Dr. Abram Sager as Zoölogist. Dr. Sager, who in after years became so well known in the Medical Department of the State University, and, who had already in 1836 supplied Conrad with material for his monograph of the *Unionida*, entered with activity upon the duties of his position and in 1839 published the first paper upon Michigan conchology. It is simply a list of species, 76 in number, one of which was not identified. It is dated January 12, 1839, and is to be found in the Documents of the House of Representatives for 1839 at page 410.

In 1859, the Legislature passed an Act entitled "An Act to finish the Geological Survey of the State." The late Prof. Alexander Winchell was appointed State Geologist and Prof. Manly Miles State Zoologist.

The first report bears date December 31, 1860. It contains in addition to other faunal lists, a catalogue of 161 species of shells, two of which *Planorbis truncatus* and *Unio leprosus* are described as new.

In the years, which had intervened between the publication of these catalogues, in addition to such scientific activity as centered around the labors of Dr. Sager and Prof. Winchell at the university, a little band of active collectors residing at Grand Rapids had done much to develop the fauna of the western part of the state. Alfred O. Currier, John A. McNeil, W. H. DeCamp and L. H. Streng were the leaders.

Mr. Currier came to Grand Rapids in 1850 from Troy, N. Y., where he had become fascinated with the study of conchology from being associated with that eminent conchologist, the late Dr. Wesley Newcomb. He died in 1880 and his extensive collection became the property of the Kent Scientific Institute of Grand Rapids. He published in 1859 (?) a "List of Shells Collected in the Grand River (Mich.) Valley," and in 1865 a "Catalogue of the Mollusca of Grand Rapids, Michigan." In 1867 he published descriptions of four supposed new species from this state in the American Journal of Conchology, III, p. 112. In 1868 he published as No. 1 of the Miscellaneous Publications of the Kent Scientific Institute, an elaborate "Catalogue of the Shell-bearing Mollusca of Michigan." This list was by far the most complete yet published and enumerated 171 species and 6 varieties.

Dr. DeCamp came to Grand Rapids in 1855. In the congenial company of Mr. Currier he turned aside from botanical and geological work, which had previously enlisted his attention, and from that time devoted his leisure hours almost wholly to the study of our local mollusca. He accumulated a large and valuable collection, and his time and specimens were always at the service of his fellow collectors. In 1881, Dr. DeCamp, under the auspices of the Kent Scientific Institute, published a "Catalogue of the Shell-bearing Mollusca of Michigan," in which, in addition to the list of 221 species and 9 varieties, he figured and described three species named by Mr. Currier, but never formally described. He died in 1898.

In 1856, Mr. John A. McNeil settled in Grand Rapids, and became interested in the subject through Mr. Currier and Dr. DeCamp. He remained there as an active and indefatigable collector until 1870, when he left and made collections in Central and South America a specialty. He died about 1891 at Binghamton, N. Y. I am not aware that Mr. McNeil ever published anything upon his Michigan collection. But Prof. Miles acknowledges the assistance afforded by him in the preparation of his catalogue, and Mr. Anthony was also indebted to him for some of the material from which he described a number of Michigan species, and, indeed, named one of them after him.

Mr. Streng, who has been a resident of Grand Rapids since 1870, began to collect as far back as 1850, when a resident of Saugatuck and is still engaged in the pursuit of his favorite study. The writer has elsewhere had occasion to express his obligations to Mr. Streng for much generous assistance in compiling his previous catalogues of the shells of the state.

In 1879, the writer published a "Catalogue of the Shell-bearing Mollusca of Michigan" in the Journal of Conchology, in 1892 a second list in the Nautilus, and a third in 1894.

In addition to the two papers by Mr. Currier, already referred to, the following local lists have been published:

In 1872-3, Mr. Sidney I. Smith published "A Sketch of the Invertebrate Fauna of Lake Superior."

In 1876, Mr. C. E. Beecher and myself compiled for the Ann Arbor Scientific Association a list of the species found in that vicinity.

And in 1893, I published "A List of the Shells of the Saginaw Valley," based upon the collection of the late Dr. George A. Lathrop, and in 1896 a "Report upon the Mollusca Collected in the Vicinity of Charlevoix."

In 1904, Mr. A. G. Ruthven published a list of the Mollusca of Ontonagon county. And in 1905 in connection with the writer a further list of the Mollusca of Ontonagon County and those of Isle Royale.

The following papers have also been published by the writer on special subjects of investigation.

"The Distribution of the Unionidæ in Michigan" (1898), "The Terrestrial Mollusca of Michigan" (1899) and "The Distribution of Polygyra in Michigan" (1905); in 1905 a synopsis of the fauna as known at the present time.

In addition to these papers which are devoted entirely to the shells of the state, many scattering references to our fauna are to be found in the writings of nearly all the prominent conchologists of this county. A full list of these will be found in the bibliography appended to the concluding portion of this paper.

In 1894, the Michigan Academy of Science was organized and the very considerable advances made in knowledge of the molluscan fauna of the state within the last decade have been due, to no small extent, to the influence of this organization in stimulating hearty co-operation among its members. The Section of Conchology was organized in the spring of 1896 with thirteen members. Steps were taken at once to prepare a complete census of the Michigan Fauna. This involved:

First. The compilation of all the records of every species known or cited from the state up to that time, and:

Second. Such additions from year to year as the field work of the members might supply.

The first requirement was accomplished in due time and the second has been very faithfully carried out by most of the members. The work of the Section has naturally developed in two lines:

First, The authentication or disproof of the actual occurrence within the state of all species previously accredited to our fauna and the addition of such new species as were found.

Second, The extension of our knowledge as to the distribution of the different species through the state.

The result of this systematic endeavor has, in the aggregate, been very large, and the completeness of the present catalogue is to no small extent due to the members of the Section.

The growth of our knowledge of the molluscan fauna of the state during the sixty-six years which have elapsed since the first catalogue was published is shown by the following synopsis of the number of species listed in catalogues of Sager (1839), Miles (1860), Currier (1868), DeCamp (1881), Walker (1894), and Walker (1905). In arranging it all those species, whose occurrence in the state is considered doubtful for reasons hereinafter given, and all synonyms and varieties have been eliminated.

SUMMARY.

		F. W.		Bivalves.	Total.	
		Land.	Operculates.			
Sager.....	1839	23	10	4	28	65
Miles.....	1860	42	23	12	56	133
Currier.....	1868	45	36	12	47	140
DeCamp.....	1881	49	30	25	63	167
Walker.....	1894	68	46	29	82	225
Walker.....	1905	78*	51	31	112	272

II.

THE TERRESTRIAL MOLLUSCAN FAUNA OF MICHIGAN.

According to W. G. Binney, all that part of the continent east of the Rocky Mountains and north of Mexico, forms a single Zoölogical province known as the Eastern Province. This again is divided into three regions: Northern, Interior, and Southern. The Northern Region comprises British America and that part of the United States lying east of the Appalachian chain of mountains, while the Interior Region extends from the north region south to the alluvial lands lying along the Gulf of Mexico. Roughly speaking, the dividing line between the Northern and Interior Regions west of the Appalachian chain is the political boundary between Canada and the United States. But practically there is no hard and fast dividing line, and one region gradually merges into the other.

According to Merriam, the upper peninsula and the northern part of the lower peninsula lying east of the Grand Traverse region, and north of Iosco county, belong to the Boreal Zone.

The Lake Michigan shore as far north as the mouth of Grand Traverse Bay and the entire southern part of the state, lying south of (approximately) the north line of Jackson, Washtenaw and Wayne counties are included in the Upper Austral Zone, while the remainder of the state, lying between these, including the Grand Traverse region, form part of the Transition Zone.

Of the twelve species given by W. G. Binney as being universally distributed over North America, all are found in Michigan, and nearly all of them are among our most common and abundant forms. They are:

<i>Pyramidula cronkhitei anthonyi</i> (Pils).	<i>Vitrea hammonis</i> (Ström).
<i>Punctum pygmaeum</i> (Drap).	<i>Vitrea indentata</i> (Say).
<i>Helicodiscus parallelus</i> (Say).	<i>Zonitoides nitida</i> (Mull).
<i>Vallonia pulchella</i> (Mull).	<i>Zonitoides arborea</i> (Say).
<i>Pupilla muscorum</i> (L.)	<i>Zonitoides minuscula</i> (Binn.)
<i>Euconulus fulvus</i> (Mull).†	<i>Zonitoides milium</i> (Mse).

Of the species considered by the same author as characteristic of the Northern Region, twelve are represented in our fauna, viz.:

* An additional species, *Omphalina inornata*, has been authenticated since this synopsis was published making the present number 79. In this table the species of *Carychium* are included in the F. W. pulmonates.

† Since the recent revision of this genus by Pilsbry this species would scarcely fall within this category.

<i>Vitrea limpida</i> Gld.	<i>Pyramidula asteriscus</i> (Mse).
<i>Vitrea binneyana</i> (Mse).	<i>Vertigo gouldii</i> Binn.
<i>Vitrea ferrea</i> (Mse).	<i>Vertigo bollesiana</i> (Mse).
<i>Vitrea multidentata</i> (Say).	<i>Vertigo ventricosa</i> (Mse).
<i>Zonitoides exigua</i> (Stimp).	<i>Cochlicopa lubrica</i> (Mull).
<i>Acanthinula harpa</i> (Say).	<i>Sphyradium edentulum</i> (Drap).

Five of these have apparently a general distribution over the state, viz.:
Vitrea multidentata (Say). *Cochlicopa lubrica* (Mull).
Vertigo gouldii Binn. *Sphyradium edentulum* (Drap).
Vertigo ventricosa (Mse).

Vitrea binneyana (Mse). and *Zonitoides exigua* (Stimp.) have both been reported from Kent county. This, however, is the only locality reported for either of these species south of the line of Wexford and Iosco counties. *Vitrea ferrea* has been found in Gratiot county. With these exceptions, the remaining five boreal species have thus far been found only in the northern counties of the lower peninsula and in the upper peninsula. That is a distribution agreeing substantially with the delineation of the boreal region by Merriam.

Two species, *Vitrea cellaria* and *Agriolimax agrestis* are European species which have been locally introduced in recent years.

The remaining fifty-five species comprised in our fauna, belong to the Interior Region of Binney, which corresponds substantially with the Transition and Upper Austral Life Zones as established by Merriam. Of these, twenty-six species have a general distribution, at least as far north as the eastern extremity of the upper peninsula. One, *Polygyra sayana* (Pils.), is apparently restricted to the northern part of the lower peninsula, but on the east coast comes down as far south as Tuscola and Huron counties. Another, *Pallifera dorsalis*, has only been found as yet, in Marquette county and Isle Royale; while the remaining twenty-seven species have not, as yet, been reported from north of the Saginaw-Grand valley, except *Polygyra monodon* and *Gastrodonta intertexta*, which range northeasterly into the "Thumb" (Huron, Tuscola and Sanilac counties); and *Omphalina inornata*, which has been reported from Oceana county.

Of the thirty-two species given by Binney as of the Northern Region, eight are peculiar to Greenland and Alaska. Of the remaining twenty-four, twenty have been found in Michigan. While of the sixty-nine species belonging to the Interior Region fifty-three are known to inhabit this state. That is of seventy-two Michigan species, twenty, or a little more than one-third belong to the northern fauna and fifty-three to the interior fauna. The addition of the few species not included in Binney's list would not perceptibly change the proportion. This is what would be naturally expected from the position of the state upon the northern border of the Interior Region and its very considerable longitudinal extent.

The eighty-one species included in the present catalogues are divided among twelve families and twenty-five genera as follows:

Family.	Genus.	Subgenus.	Section.	No. of species.
<i>Helicidae</i>	<i>Polygyra</i>		<i>Triodopsis</i>	14
			<i>Stenotrema</i>	3
<i>Circinariidae</i>	<i>Circinaria</i>			1
<i>Zonitidae</i>	<i>Omphalina</i>			2
			<i>Vitrina</i>	1
			<i>Vitrea</i>	4
			<i>Vitrea s. s.</i>	4
			<i>Striatura</i>	1
			<i>Glyphyalina</i>	2
			<i>Paravitrea</i>	1
			<i>Euconulus</i>	2
	<i>Zonitoides</i>		<i>Zonitoides s. s.</i>	2
			<i>Pseudohyalina</i>	4
	<i>Gastrodonta</i>			4
<i>L. macidae</i>	<i>Agriolimax</i>			2
<i>Philomycidae</i>	<i>Philomycus</i>			1
			<i>Pallijera</i>	2
<i>Endodontidae</i>	<i>Pyramidula</i>		<i>Patula</i>	2
			<i>Gonyodiscus</i>	2
			<i>Planogyra</i>	1
			<i>Helicodiscus</i>	1
	<i>Punctum</i>			1
	<i>Sphyradium</i>			1
<i>Succineidae</i>	<i>Succinea</i>			3
<i>Pupillidae</i>	<i>Strobilops</i>			3
			<i>Acanthinula</i>	<i>Zoogenites</i>
	<i>Pupoides</i>			1
	<i>Pupilla</i>			1
	<i>Bifidaria</i>		<i>Privatula</i>	1
			<i>Albinula</i>	2
			<i>Vertigopsis</i>	2
	<i>Vertigo</i>			6
	<i>Vertilla</i>			1
<i>Valloniidae</i>	<i>Vallonia</i>			3
<i>Cochlicopidae</i>	<i>Cochlicopa</i>			1
<i>Auriculidae</i>	<i>Carychium</i>			2

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While it is possible that some of the species quoted by the earlier writers as occurring in Michigan but which have not been recognized by later collectors and have therefore been dropped from the present catalogue may hereafter be found within our borders, and that new or additional ones may be reported, yet it is not probable that the present list will be largely increased.

But, while in this particular our fauna can be said to have been well developed, our knowledge as to the distribution of the different species is lamentably deficient. I have indicated on the accompanying chart (Plate I) the number of species which have been reported from each of the counties of the state. From this it will be seen how small a part of the state has been collected over with any sort of thoroughness. Of the fifteen counties in the upper peninsula, eight are not represented by even a single reported species, while of the sixty-eight counties of the lower peninsula, the

fauna of nineteen, or nearly one-third, is entirely unknown; twenty-one are represented by less than ten species; eleven by from ten to twenty species, and only seventeen by more than twenty, nine by more than thirty, two by more than forty, and one by more than fifty. Kent is the banner county with sixty species to its credit. When it is considered that all of the southern counties have, in all probability, as large a fauna as is now reported from Kent, and that the species reported from Charlevoix and Chippewa counties range through the entire northern part of the lower peninsula, the poverty of our knowledge and its entire inadequacy for anything like positive statements in regard to the distribution of the different species is only too obvious.

The great extent of unknown territory in the center of the state north of the Saginaw-Grand valley is especially noticeable and is particularly unfortunate. The Saginaw-Grand valley and the counties lying south of it, and the Grand Traverse region, have been sufficiently explored to give a substantially accurate knowledge of their fauna as a whole. But with this great stretch of unexplored territory lying between them, the northern extension of the species peculiar to the one, and the southern range of those characteristic of the other are wholly unknown, and any attempt to discuss the reason underlying their distribution is necessarily futile when the facts of distribution themselves are wholly conjectural.

All that can be done now is to state such facts as to the general distribution of the fauna of the state as are shown by the returns of the census (Plate II), noting any apparent peculiarities of the range of the different species and leave any systematic discussion of the subject to such future time as our increased knowledge will justify the attempt.

Of the ultimate origin of our fauna, but little is known. The geologists tell us that the terrestrial mollusca range back in time certainly as far as the Carboniferous age and possibly into the Devonian. Indeed, the fact "that their diversity of form gives sufficient indication that the *Helicidae* had become widely differentiated during those early epochs in which they lived, probably quite as widely as their living representatives are, and under closely similar forms"* would indicate that their separation from their fluviatile or marine ancestors must have occurred at a much earlier date.

A very large part of our fauna is peculiar to North America, and has undoubtedly descended from those ancient forms, which peopled the shores of the great Mesozoic sea and hid under the bark of the fallen giants of the Carboniferous forests. Whether these early mollusca had spread into the Michigan of that day is not known. It seems entirely probable, but there is as yet no evidence either to prove or disprove the existence of such a fauna in this region prior to the Glacial epoch.

But, however that may be, the immediate source of our present fauna must be sought in the states lying to the south and beyond the reach of the ice sheet, which in the Glacial period buried Michigan under hundreds of feet of ice and utterly exterminated every form of molluscan life that may have previously existed here. The extensive Post-pliocene deposits in the Mississippi valley prove conclusively that the fauna then existing was substantially the same as is now found in that region. With the retreat of the ice, the mollusca returned to the north and repopled the new land. It seems probable that even the so-called circumpolar species, which probably originated in the old world, had made their advent into America prior to the Glacial period, during some earlier age, when a milder climate in the ex-

* White, Review Non-Marine Fossil Mollusca of N. A., p 445.

treme north was more favorable to their introduction and dispersion. The fact that three of the seven specimens common to both continents occur fossil in the loess of Iowa, and another, *Vitrea hammonis* (Ström), has been found associated with the remains of a mastodon in Berrien county in this state, would seem to substantiate this theory.

The following species have been found in the Post-glacial deposits in this state:

<i>Polygyra albolabris maritima</i> (Pils).	<i>Helicodiscus parallelus</i> (Say).
<i>Polygyra thyroides</i> (Say).	<i>Strobilops labyrinthicus</i> (Say).
<i>Polygyra monodon</i> (Rack).	<i>Succinea retusa</i> Lea.
<i>Pyramidula alternata</i> (Say).	<i>Bifidaria tappaniana</i> (C. B. Ads).
<i>Vitrea hammonis</i> (Ström).	<i>Vertigo ventricosa elatior</i> Sterki.
<i>Vitrea indentata</i> (Say).	<i>Vertigo morsei</i> Sterki.
<i>Euconulus fulvus</i> (Dr.).	<i>Vertigo gouldii</i> Binn.
<i>Zonitoides minuscula</i> (Binn).	<i>Carychium exiguum</i> (Say).
<i>Zonitoides arborea</i> (Say).	

III.

HINTS ON COLLECTING MOLLUSCA.

The collector should always bear in mind:

First That a dead shell is better than none at all.

Second. That dead shells should not be taken, if live ones can be had and that careful search will usually discover them wherever their "bones" are found.

Third. That all the species are extremely variable in their abundance from year to year, so it is a safe rule "when you're getting, to get a plenty."

COLLECTING APPARATUS.

For land shells, a "Ferriss" hoe is indispensable. This is made by getting a small, light-handed garden hoe and having the blade cut down at a machine shop. It should be about three inches wide on top and taper to a sharp point. Then cut off the handle so that it will be as long as a cane. This makes a most convenient tool for turning over logs and breaking up rotten wood, digging around stumps and among the dead leaves, and in a snake country is very effective for killing rattlesnakes. A pair of fine curved-pointed collecting forceps is also necessary for picking up the small species. Small glass or wooden bottles should be carried, as the small species are apt to get lost in the dirt and slime, if put into the same receptacle as the larger ones. It is better not to put the small species in alcohol as they are collected, as they are then killed at once with the animal more or less extended. If put in a dry bottle and left a few hours they will withdraw into their shells, leaving the aperture clear and fit for examination. This is especially necessary with the *Pupillidae*, where the arrangement of the apertural teeth is a specific characteristic.

For the larger species tin cases of a convenient size to slip readily into the coat pockets are most convenient. Where the larger *Helices* are so abundant as to make it annoying to have to take the cover off continually, it will be found convenient to have a square hole cut in the cover large enough to pass a snail through. Then stretch a piece of thin rubber, such as a piece of bicycle-tire lining, across the top of the can, and put the cover in place so

as to keep it stretched tight. A slit in the rubber corresponding to the hole in the can will enable one to slip the snails into the can, and the elasticity of the rubber will keep them from getting out again. A few leaves should be put into the cans before starting out to prevent the shells from being injured by rolling around inside. As the cans become full, the leaves can be removed. Several boxes and a number of vials should always be carried, so that specimens from different localities may be kept separate.

For the fluviatile species it is necessary to have a dipper and, if possible, a small dredge. The dipper is made from an ordinary tin one, by removing the bottom and substituting one of fine wire cloth. By removing the end of the handle the dipper can be slipped on to the end of a cane or pole when in use. This is useful not only for reaching the larger specimens from the shore or boat, but especially for sifting the mud and sand from the bottom, where a multitude of small species live, which otherwise would not be found. It will be found more convenient to empty the contents of the dipper, when thoroughly washed out, into a pail and carry the whole mass home before undertaking to pick out the shells. If attempted in the field, many of the smaller and more desirable things are apt to be overlooked. By spreading the mass out in the sun for a short time it will become dry and friable so that the shells can be easily separated and picked out. An ordinary reading glass is very useful for the detection of the more minute forms in sorting over such material.

Many desirable species live in water too deep for the convenient use of the dipper, and for these it is necessary to have a small dredge. One with an aperture of 9 x 6 inches is as large as can satisfactorily be used by a single person in a row boat.

Care must be taken to keep the more fragile species separate from the heavier ones, otherwise they are apt to be damaged in carrying the can about.

KIRKLAND'S COLLECTING APPARATUS.*

Scoop.—A common, tin, cylindrical oblique-topped flour sieve with handle. Remove the wire stirring-device and solder up the holes for its axis. Strengthen attachment of handle to body by soldering additional braces between the two. Get more rigidity by winding brass wire around body, soldering the strands from $\frac{1}{2}$ " to 1" apart.

Collecting Bag.—*First:* At a corset factory procure a square yard of the material used for making summer corsets, with a square or triangular mesh, fine enough to retain the smallest specimens and coarse enough to permit escape of sand and mud. With strong linen thread make a double seamed bag with rounded bottom. This bag will be approximately 12" in diameter.

Second: Get a piece of $\frac{1}{2}$ " mesh, galvanized-iron wire netting 11" square, and tack it with staple tacks to a wooden frame 11" square, made of pine 2" wide and 1" thick. To prevent ends of wire catching in or tearing the outer bag, thin strips of wood 1" wide are nailed around the frame so as to cover wire ends.

Make another bag of denim 18" to 20" deep, just large enough to fit the wooden frame. Tack one end of this bag around the frame with large headed tacks.

Insert this second bag within the first and fasten the tops together with four or five strong safety-pins.

* Prepared by Dr. R. J. Kirkland of Grand Rapids, Mich.

This double bag apparatus can be carried in one hand, scoop in the other, and employed around springs, creeks, etc., whenever a patch of alluvium is seen, where *Pisidia* and other mud-loving species are likely to be found. The inner bag will prevent vegetation, dead leaves and sodden twigs from passing through into the outer one. When the bag is sufficiently heavy, carry to water that is deep enough to permit it being soured up and down.

Wash out everything that will pass through the inner bag and remove it. Then continue sousing until all sand and mud is washed away. The comparatively small volume of material remaining may be partly or wholly emptied into the scoop and, by careful immersion, agitation, raising and lowering, the greater portion may be floated off, leaving the residue consisting of pebbles and shells at the bottom. Empty these into a small sack, and repeat procedure until satisfied with catch.

When ready for home, empty contents of small sack into scoop and float off still more debris. At home take a piece of $\frac{1}{4}$ " mesh wire netting 4" or 5" square, concaved with fingers, and remove large pebbles. Put remainder into a dish and cover with alcohol. Let this stand for some hours, then spread out thinly on a newspaper, allowing the material to become thoroughly dry. The alcohol not only kills the animal, but hardens the tissues and contracts the muscles, so that comparatively few have gaping valves later. With a jeweler's loupe and a pair of forceps the final separation may be made when convenient.

Frequently one will have large numbers of other shells: *Amnicola*, *Valvata*, *Paludestrina*, and an occasional *Bifidaria* or *Vertigo*. The inner bag may be dispensed with when dead leaves and twigs are not abundant, and then one will find some of the booty consisting of *Planorbis*, *Physa*, and *Lymnaea*.

WHERE TO COLLECT.

Everywhere. The land species love dampness and darkness. They are to be looked for under logs, bark and leaves in suitable localities. Many species bury themselves in rotten logs, and these should be broken up with the hoe. The accumulation of dead leaves around fallen trees is a favorite habitat and should also be carefully and slowly gone over with fingers and hoe. The thick grass and dense thickets along the margin of ditches and streams will usually reward a careful examination. Southern and western exposures being dryer, are not so fruitful as eastern and northern hillsides and shady ravines. Coniferous forests are usually quite barren of molluscan life. An open hardwood forest in a limestone region is the ideal hunting ground. Nearly every permanent body of water has its mollusks, varying according to its character. Some species are found only in rapid flowing water, and others only in ponds and still water. Ditches and other stagnant waters are usually good collecting ground for *Pisidia* and other small species. The low places in the woods, which dry up in the summer time, have a number of species that are not found elsewhere, and which bury themselves in the mud when the water disappears. Sand banks in rivers and lakes are the favorite resort of many of the smaller species. The under side of the lily pads should be scrutinized, while the *Ancylis* should be looked for on stones and dead clam shells.

CLEANING AND PREPARATION OF SPECIMENS.

The larger *Helices* should not be put into alcohol unless desired for anatomical purposes, as it is almost impossible to remove the animal after it has become hardened. They should be boiled as soon as possible. Dead snails have a fragrance peculiar to themselves, and seldom make good specimens. The water should be boiling, not simply hot. Species of about the same size should be boiled together in order that the operation may be successful. A small wire strainer with a long handle is very convenient for holding the snails while boiling. If dropped directly into the water, there is apt to be trouble in fishing them out and they are likely to be boiled too much. The time varies according to the size and the species, some requiring more time than others. If not boiled enough, the muscular attachment to the shell will not be loosened, and the animal will not "pull" at all. If boiled too long, it is apt to break in two and give a good deal of trouble before extraction. The time required varies from ten seconds for a species of the size of *Polygyra monodon* to sixty seconds for *P. albolabris*. It is well to experiment a little at first with a specimen or two of each kind until the proper time is found. Only a few should be boiled at a time, as they "pull" easier while warm. When boiled, the animal should be slowly and carefully pulled out. Too much haste is apt to cause the animal to break apart, leaving the apical whorls still in the shell. The curved points of the collecting forceps are convenient for extracting the animals and hooks of various sizes can be made from safety pins. By tying these on to small wooden handles very effective instruments can be made. Small hooks of various sizes fitting into an adjustable handle are most convenient and can be obtained from any dealer in dental instruments. A small, fine-pointed, dental syringe is indispensable for this work. If the animal cannot be started with the hook, or if it breaks in two, a jet of water from the syringe will usually solve the difficulty. When the apical whorls are left in the shell, they can sometimes be started by holding the shell carefully in hand so as not to crush it, and then striking the fist sharply on the thigh of the operator. In case very desirable specimens get into this predicament, putting them in alcohol for twenty-four hours will contract the remnant of the animal sufficiently to enable the successful use of the syringe. Many of the species have the aperture so obstructed with teeth, that it is difficult to extract the animal with the hook. In such case a vigorous use of the syringe will force enough of the body out of the shell to enable the hook to be used. Frequently the whole animal can be forced from the shell in this way, especially in the smaller forms. Patience and perseverance will clean nearly every specimen. When the animal is completely extracted the interior should be thoroughly washed out with the syringe. A small piece of sponge on the end of a fine copper wire, which can be bent in any direction, is very useful for removing the mucus, which is apt to adhere to the interior of the shell. This should always be carefully attended to, as it will greatly disfigure the specimen when dried. The exterior should then be thoroughly scrubbed with a soft tooth or nail-brush. When perfectly clean, inside and out, the water should be carefully emptied out and the shell put aside in the air, but not in the sun, to dry. No oil or acid should be used on any of the land shells. It is not desirable to attempt to clean the small species by removing the animals. By keeping them for a short time in a dry place, the animal will retire far within the shell. Then they should be put into 25 per cent. alcohol for a day or two. If to be left longer in the alcohol, the strength

should be increased. Twenty-four hours, however, in the alcohol is all that is necessary. Then they can be dried in the air without leaving any offensive odor. Either before or after drying they can be cleaned by putting them in a bottle with some fine, clean sand and shaking them together until all the dirt has been removed by the sand.

Specimens of land snails desired for anatomical purposes should be drowned before being put into the alcohol or formaldehyde, otherwise they retire as far as possible within the shell and are more difficult to dissect in this contracted condition. By drowning, they die fully extended and can then be put into the preservative. It takes about a day to kill a snail in this way. The alcohol at first should be greatly diluted, not stronger than 25 per cent., after a day or two the specimens should be removed to 50 per cent. alcohol, and later to the undiluted. Formaldehyde, 2 per cent. dilution, is an admirable preservative for material of this kind. It should not, however, be used when it is desired to keep the shells as specimens as it destroys them if left in it any length of time.

With the exception of the larger species of *Planorbis*, which are more easily cleaned by boiling, it is practically immaterial whether the fluviatile univalves are boiled or put directly into diluted alcohol. In either case there is no difficulty in extracting the animals. The minute species are treated the same as the small land shells. In the operculate species, it is desirable to retain the opercula of, at least, part of the specimens. While it adds to the labor, it increases the value of the specimen, if it is always done. These are easily removed from the animal and, after being cleaned, should be put inside the shell and the aperture plugged with cotton. All the foreign matter both inside and outside of the shell should be removed by thorough washing. All the water species are apt to be more or less incrustated with deposits of lime or oxide of iron. These can be removed by immersing them in oxalic acid. Care should be taken not to prolong the operation, or the texture of the shell may be injured. Elbow grease is the most effective agent for making good specimens. When that fails, use the acid. The *Ancylis* are always more or less coated in this way, and can easily be cleaned by floating them for a few seconds on the acid, upside down, and then gently brushing them off with a soft brush while held on the tip of the finger.

The larger bivalves should be well washed and, if necessary, scraped off with the knife as soon as taken, care being taken not to injure the epidermis.

They can be boiled, if desired, when the shells will open and the animals easily removed. But as a rule it is more convenient to cut the muscles, which hold the valves together, with a thin bladed knife and scrape the animal out. Care should be taken not to break the edge of the fragile species when inserting the knife. All traces of animal matter should be removed, and after a thorough washing the valves tied together with a string until thoroughly dried. Never use colored twine for this purpose, as it is apt to stain the shells. Any surface incrustation can be removed either with oxalic or muriatic acid. The latter is more convenient for the larger species, and can be applied with a small brush. It does not bite the fingers, so that it can be used freely. Care, however, must be exercised in using it and the specimens frequently washed, lest damage be done to the shell. The smaller bivalves, the *Sphæria* and *Pisidia*, are best treated by putting into diluted alcohol for a day or two and then drying them. If left too long the shells are apt to open, which interferes with the looks of the specimens.

The larger species of *Sphærium* are better with the animal removed. This

can be done after boiling, or a few days in alcohol. As these are usually too small to be easily tied together to keep the valves from gaping, each specimen, while the hinge is flexible, should be closely wrapped up in a small piece of tissue paper until completely dry.

While it is not usually desirable to keep "dead" shells for the cabinet, occasionally it is necessary. In such cases, the color can be in some measure restored by washing in a solution of paraffine and gasoline (a square inch of the former in half a pint of the latter).

A good collection is characterized by two essentials:

First. The careful selection and preparation of the specimens themselves.

Second. Absolute accuracy in the matter of the localities from which they come.

There is little excuse for having poor and ill-cleaned specimens. There is none at all for failure to keep accurate records of the collector's field work. A drawer of a common species, such as *Polygyra albolabris*, without any indication from where they came, even if well cleaned, would be absolutely without value. Such a drawer of any of our species from fifty or one hundred different localities, definitely indicated, would be a valuable contribution to the conchology of any state.

Specific names can be supplied or corrected any time, but a mistaken or erroneous locality cannot ever be corrected. The collector therefore should be careful never to trust to memory for facts of this kind.

Both in collecting and cleaning, the specimens from each locality should be kept carefully separated and labeled. Too much importance cannot be given to this point. The study of the geographical distribution of the mollusca is one of the most important branches of conchological work, and this, to be of any value, must be based on absolutely accurate work on the part of the collector.

ARRANGEMENT OF THE COLLECTION.

The manner of casing and arranging the collection is largely one of individual preference. A catalogue, however, is essential, and it is better to begin systematically in this particular and thus avoid the necessity of doing it all over again, when the collection begins to assume considerable size. There should be a serial catalogue and a card catalogue. Each addition to the collection should be numbered as soon as received and entered in the serial catalogue, which should be a book ruled in as many columns as the collector desires. A convenient form is as follows:

Serial No.	No. of Spec.	NAME.	From whom Received.	Locality	Remarks.
1	5	<i>Polygyra albolabris</i> (Say).	John Jones	Ann Arbor, Mich.	

The card catalogue is convenient in a small collection. It becomes absolutely necessary in a large one.

The cards should be of uniform size for convenience in handling. If it is

which serves the same purpose. In this way the drawers fit close to each other and no space is lost.

The doors of the case may be of glass or paneled with wood. A thin strip of rubber set just inside the jamb, so that the door will press tightly against it when closed, serves as an efficient dust protector. It is a great nuisance, as well as a constant source of expense, to attempt to have a glass cover for each individual drawer. Cases made as above are practically dust proof.

Each tray should have a neat label giving the serial number, the name and the locality of the specimens it contains. A box, bottom-side up, can be used for separating the genera and species in each drawer. Small labels of convenient size for designating them can be had, already gummed, at any bookseller's.

PACKING SPECIMENS.

Small specimens should not be mixed with large ones, as they are apt to get lost; nor should fragile shells be put in with stronger ones, as they are likely to be broken. The minute specimens can be put into gelatine capsules, small vials, quills or paper tubes made by rolling writing paper around a lead pencil, gumming down the edge and stopping the ends with cotton. Don't mix shells from different localities. Write the locality on a label and wrap it up with each vial or package. Use plenty of cotton in packing fragile shells. Pill boxes and match boxes are convenient for packing purposes. Wrap up *each* vial or box separately, then if a smash does occur there is a fair chance of saving some of the specimens and no danger of mixing the contents of different packages. Don't send paper boxes by mail. It is simply tempting Providence. Pack in a wooden box.

IV.

METHODS OF KILLING AND DISSECTION.

"Specimens of *Polygyra* and *Limax* may be easily kept in captivity by placing them in a box in which there are about four (4) inches of earth covered with dead leaves. The earth must be kept moist. The box must be kept covered with mosquito netting or tarlatan. The mosquito netting will be sufficient for adult individuals, but the young *Limax* would escape easily through its meshes."

"Two pairs of fine scissors will be necessary, one pair with straight points, the other with curved points; one or more fine scalpels, and two pairs of fine forceps, one straight and the other curved. A pair of stronger forceps and a pair of fine pliers will be needed to remove the shell of *Polygyra*. Dissecting needles are also necessary. These can be made by forcing the heads of fine needles, by means of a pair of pliers, into the end of a round stick of smaller diameter. The point of one of these needles should be bent so as to form a hook, first heating the end of the needle to a white heat."

"I have tried all of the various methods recommended for killing *Polygyra* and *Limax*, and find only one that is uniformly successful, and that is drowning. In using hot water and various chemicals, in nearly every case the animal is more or less contracted, and thus rendered useless for the purpose of a successful dissection. In drowning the animal I have used a fruit-preserving jar, as being more convenient than a wide-mouthed bottle. This jar should be completely filled with water, so that, when the cover is fastened on, there will be no air space left. The animals being placed in the

water and the cover screwed on, the jar should be left undisturbed for 48 hours; it requiring about that length of time to drown the animals. Remaining undisturbed, they will die fully extended; but, if the jar is disturbed in the mean time, more or less contraction will take place. The animal when dead should be thoroughly washed to free it from all adhering mucus, and placed in alcohol diluted with about two-thirds the amount of water, additional alcohol being added from day to day till the mixture consists of about 75% of alcohol. The animals should then be removed and placed in undiluted alcohol, the action of the fluid on the integument prevents the proper preservation of the internal organs."

"To remove the shell, preparatory to dissecting the animal, break the peristome with a pair of pliers. The remainder of the shell can be removed with a pair of forceps, carefully breaking off a small piece of shell at a time till it is removed to the apex. The columella can be removed by holding the lower part between the thumb and forefinger of the left hand, and turning the animal with the right. As the columella is like a screw, the animal readily becomes detached by this movement."

"In dissecting the animal, a circular china dish about four inches in diameter and two in depth will be necessary; also a piece of sheet cork as large as will lie at the bottom of the dish, fastened to a thin sheet of lead with either string or rubber bands. It is best to have the lead of the same size as the cork. This leaded cork is to be placed in the bottom of the dish, and the dish filled with alcohol. If the animal has once been placed in alcohol, all dissections should be made in alcohol, but freshly killed specimens may be dissected in water, and many of the organs at this time present a much more natural appearance than when acted on by alcohol. Place the animal on the cork and fasten it down with small pins, or better yet, with very fine, short needles, inserted through the margin of the foot. Then with the fine pair of scissors, commencing at the head, cut through the integument along the center of the back, taking care not to injure any of the organs below. The integument is now to be removed from the dorsal part, turned back and fastened to the cork, removing the needles from the margin of the foot and putting them through the edges of the integument. All the organs of the anterior part of the snail are thus brought into view, and farther dissection of the organs can be intelligently made."

"In the case of the *Limax* nearly all the organs will be brought into view by turning back the integument; but great care must be taken in this genus in cutting through the integument not to injure the pulmonary chamber, as it is situated very near the surface. Also every precaution should be taken that the points of the scissors shall not go below the integument, or the intestine and upper surface of the stomach will be mutilated, and a successful dissection rendered impossible." *

V.

PREPARATION OF THE JAW AND RADULA.

"On opening the head (of the snail) from above, one readily notices at the extreme anterior part, close against the outer integument, a prominent, oval body. This is called the buccal mass. It is easily cut away from the animal, and will be found to contain both jaw and lingual mem-

* Simpson, Bull. N. Y. State Museum, VIII., pp. 241-3 (1901).

brane. These can be removed by fine scissors or knives from the buccal mass in the larger species, but in the smaller species, the method usually employed, is putting the whole buccal mass in a watch crystal, full of a strong solution of caustic potash. Allowing it to remain for several hours, the potash will destroy all of the buccal mass, and leave the jaw and lingual membrane perfectly clean and ready for examination. They must be well rinsed in clean water, in another watch crystal, before examination. Another more expeditious process, is to place the whole buccal mass in a test-tube with the solution of potash, and boil it for a few seconds over a spirit lamp. Pouring the contents of the tube into a watch crystal, the lingual membrane attached to the jaw will be readily seen by a pocket lens. If the species be small, as *Pyramidula striatella*, for instance, its whole body may be thrown into the solution. Still more minute species, as *Zonitoides milium*, for instance, may be treated in this way; crush the whole shell between two glass slides; wash the particles of broken shell in a few drops of water, still keeping the body of the animal on the slide; when clean, drop on it the caustic potash and boil it by holding the slide itself over the spirit lamp."

"For the purpose of examination, the jaw and lingual membrane may be simply mounted in water and covered with thin glass. One must be sure to spread out the lingual membrane, not have its upper side down, and it is well to cut it transversely in several places, as the teeth are beautifully shown and often stand detached on the edges of the cut.

"For preservation for future study, the glycerine preparations sold by the opticians will be found useful, though they have the great disadvantages of deliquescing in warm weather." *

The radula may also be mounted in Canada balsam. In this case they should be stained with carmine or chromic acid, as otherwise the specimen will in time become transparent.

VI.

CLASSIFICATION.

ORDER PULMONATA.

Animal naked or covered with shell, inoperculate, terrestrial, fluviatile or marine, breathing the air by means of a lung with vascular walls and a contractile orifice. Both sexes are united in each individual, but the genital orifices are either contiguous and opening into a common duct, or separated. Jaw single or composed of three pieces; never of two symmetrical pieces. Radula with very numerous teeth in each row.

Shell of variable shape, *holostomus*.

The *Pulmonata* are divided into two sub-orders according to the position of the eyes and the character of the tentacles, viz.:

I. Eyes placed at the extremity of retractile tentacles...*Stylommatophora*.

II. Eyes placed on the base of contractile tentacles...*Basommatophora*.

The *Stylommatophora* are as a rule terrestrial in their habits, while the *Basommatophora* are amphibious or aquatic.

The *Stylommatophora* are again divided according to the position of the genital orifices.

* W. G. Binney, Man. Am. Land Shells, p. 44.
For full instructions in regard to the preparation of the radulae of the minute species, see Beecher, Journal N. Y. Microscopical Society, 1888, p. 7.

- I. Genital orifices contiguous or united.....*Monotremata*.
- II. Genital orifices separated.....*Ditremata*.

The *Ditremata* are not represented in the fauna of Michigan. The *Monotremata* are divided into two groups, based mainly on the structure of the lung. Only one of them, the *Vasopulmonata*, is represented in the fauna of the state.

The *Vasopulmonata* are again subdivided according to modifications of the pallial region, and particularly with reference to the position of the ureter, viz.:

- I. Kidney lying parallel to heart and gut; the ureter passing direct from the kidney to the anterior margin of the lung.....*Orthurethra*.
- II. Kidney forming the posterior wall of the lung, lying transverse to heart and gut, its apex against the latter; ureter following the last fold of the gut forward to the mantle edge.....*Heterurethra*.
- III. Kidney parallel to the gut, its apex anterior; ureter abruptly deflected from the apex, passing to the posterior end of the lung cavity; thence an open groove or closed tube continues across to the last fold of the gut, which it follows forward to the mantle edge.....*Sigmurethra*.

The *Sigmurethra* are divided into super-families, based upon characters of the foot, lung, central nervous system, radula, etc., as follows:

- I. Margin of the foot defined by grooves, etc.....*Aulacopoda*.
- II. No pedal grooves.
 - A. None of the teeth of the aculeate or thorn-like type; jaw present, distinct.....*Holopoda*.
 - B. All of the teeth aculeate, thorn-shaped; jaw often obsolete.
 - a. Cerebral ganglia concentrated, in close contact.....*Agnathomorpha*.
 - b. Cerebral ganglia separated, a rather long commissure connecting them.....*Agnatha*.

The *Agnatha* are not represented in Michigan.

The *Heterurethra* is composed of the single superfamily, *Elasmognatha*, characterized by the jaw being furnished with an accessory, quadrate piece, which is lacking in both the *Sigmurethra* and *Orthurethra*.

The subdivisions of the *Orthurethra*, if any, have not, as yet, been determined.

The *Holopoda*, *Agnathomorpha*, *Aulacopoda*, *Elasmognatha* and *Orthurethra* represented in the fauna of Michigan, are divided into the families shown on the following table:

CLASSIFICATION OF THE VASOPULMONATA OF MICHIGAN.*

Vasopulmonata.....	{	<i>Sigmurethra</i>	{	<i>Holopoda</i>	<i>Helicidæ</i> .
				<i>Agnathomorpha</i> .	<i>Circinariidæ</i> .
		{	<i>Aulacopoda</i>	{	<i>Zonitidæ</i> .
				{	<i>Limacidæ</i> .
				{	<i>Endodontidæ</i> .
			{	<i>Philomyxidæ</i> .	
	{	<i>Heterurethra</i>	<i>Elasmognatha</i> ...	{	<i>Succinividæ</i> .
				{	<i>Pupillidæ</i> .
				{	<i>Vallonidæ</i> .
				{	<i>Cochlicopidæ</i> .

The *Basommatophora*, according to Fischer (Man. de Con. 446) are divided into three suborders: *Gehydrophila*, *Hygrophila* and *Thalassophila*.

* Adapted from Pilsbry, Proc. A. N. S. P., 1900, 564.

Of these, only the first are terrestrial in their habits and are represented in Michigan by a single family, the *Auriculidae*, and that only by one genus, *Carychium*.

VII.

MEASUREMENT AND DESCRIPTIVE TERMS.

The length or height of a shell is the distance from the apex to the basal edge of the lip, measured along a line drawn through the axis.

The greater diameter is the greatest width, including the lip, measured on a line drawn at right angles to the axis.

The lesser diameter is measured on the same plane, but on a line at right angles to the greater diameter.

Shells are dextral or sinistral, accordingly as the aperture is on the right or left of the axis, when held, apex uppermost, with the aperture facing the observer.

The remainder of the terms in common use are sufficiently indicated on the following diagram:

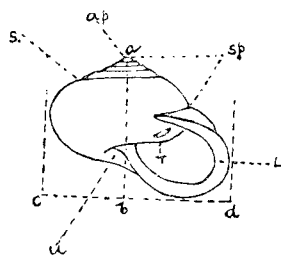


Fig. 1.

a to b.	height.	c to d.	greater diameter.
ap.	apex.	u.	umbilicus.
s.	suture.	l.	lip.
sp.	spire.	t.	parietal tooth.

In using the keys, it is to be borne in mind that they are framed on typical, mature specimens. Varietal and abnormal, or aberrant forms and immature specimens must be determined by careful study of the descriptions and comparisons with normal, adult examples. The name in parentheses after the name under a figure indicates the author from whom the figure is copied, not the authority for the specific name. Figures not so designated are original. All figures of entire shells are life-size unless otherwise indicated.

CATALOGUE.

Order PULMONATA.

Sub-order STYLOMMATOPHORA.

MONOTREMATA.

VASOPULMONATA.

I. SIGMURETHRA.

Superfamily HOLOPODA.

Family HELICIDÆ.

Foot edges without pedal grooves; sole undivided; marginal teeth with wide, short, squarish basal-plates and one or several cusps, the outer cusp never elevated on middle cusp. Shell usually with an expanded or reflexed lip.

Sub-family POLYGYRINÆ Pilsbry.

Genitalia simple; *vas deferens* inserted directly on the well developed long penis, which has no epiphallus or flagellum; no dart sack or mucus glands; no diverticulum on spermatheca duct; eggs small and numerous. Jaw solid, ribbed or smooth; marginal teeth with more than one cusp. Shell with lip thickened within, expanded or reflexed; the embryonic whorls not distinctly differentiated.

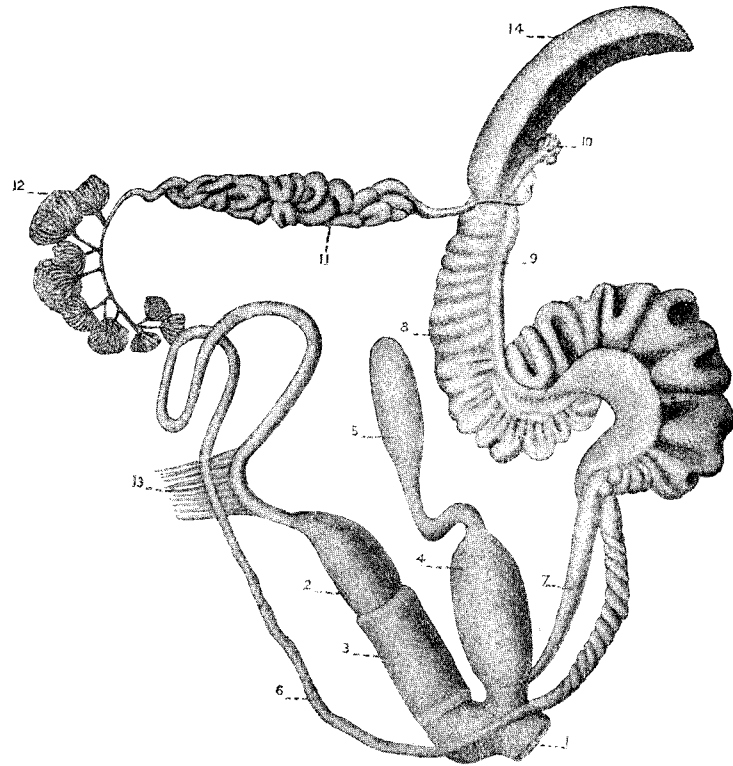


Fig. 2. Genitalia of *P. albolabris* (Simpson).

- | | | |
|-----------------|--------------------|---------------------------|
| 1. Atrium. | 6. Vas deferens. | 11. Hermaphroditic duct. |
| 2. Penis. | 7. Free oviduct. | 12. Hermaphroditic gland. |
| 3. Prepuce. | 8. Uterus. | 13. Penis retractor. |
| 4. Vagina. | 9. Spermatic duct. | 14. Albumen gland. |
| 5. Spermatheca. | 10. Talon. | |

Genus **POLYGYRA** Say.

Shell helicoid, varying from globose or depressed-globose to lens-shaped or planorboid; the periphery carinated or rounded; umbilicus either open or closed. Surface striated or hirsute; corneous, yellow or brown, generally unicolorous, but sometimes with many bands, the most constant being supra-peripheral, the others when present being wholly indefinite in number and position. Lip well reflexed; aperture typically obstructed by three teeth; one parietal, two upon the lip; but any or all teeth often wanting.

Animal heliciform, the mantle sub-central, foot rather long and narrow. No pedal grooves. Surface rather coarsely and irregularly granulated, the granulations finer posteriorly; back with a pair of indistinct grooves extending from mantle to facial area; sides of foot, and sides of top of tail without any distinct, oblique or longitudinal lines, irregularly granulated; tail rounded above, obtuse behind.

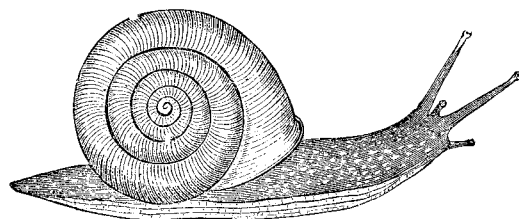


Fig. 3. Animal of *P. albolabris*. (Binney.)

irregularly granulated; tail rounded above, obtuse behind.

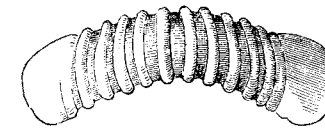


Fig. 4. Jaw of *P. albolabris*. (Binney.)

Jaw arcuate, solid and strong, sculptured with seven to twenty convex ribs; cutting edge without median projection, but denticulated by the ribs.

Radula generally with tricuspid centrals and bicuspid laterals and marginals, the side cusps well developed; in some species, however, there are no side cusps or cutting points whatever on any of the teeth.

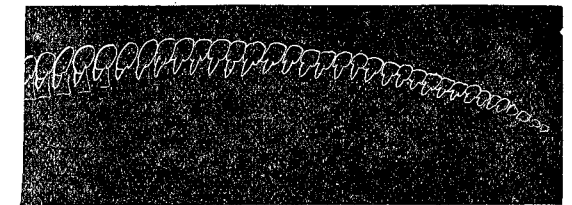
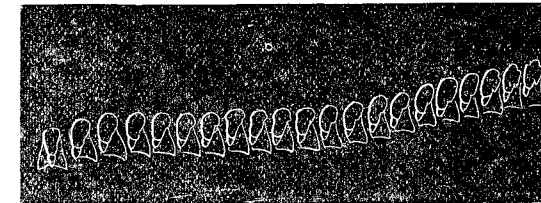


Fig. 5. Dentition of *P. albolabris*. (Binney.)

KEY TO SECTIONS OF *POLYGYRA*.

- I. Aperture lunate, oblique, outer lip broadly expanded *Triodopsis*.
- II. Aperture narrow, basal, outer lip reflexed, not expanded beyond contour of body whorl *Stenotrema*.

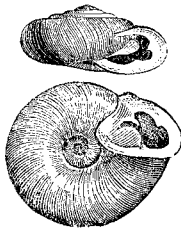
Section **TRIODOPSIS** Rafinesque.

Shell varying from depressed to globose conoidal, umbilicate or imperforate; surface generally striated; whorls 5-6, the last wider, more or less deflexed in front; aperture lunate, typically obstructed by three teeth, two on the lip, on the parietal wall, but any or all of the teeth often absent.

KEY TO THE SPECIES OF *TRIODOPSIS*.

- I. Aperture tridentate.
 - a. Striate and umbilicate.
 - b. Peristome flattened, not inflected above, labial teeth small, of uniform size *tridentata*.
 - bb. Peristome strongly inflected above, aperture dish-shaped, upper labial tooth larger *fraudulenta*.
 - aa. Hirsute and imperforate.
 - b. Diameter exceeding 20 mill., lip broadly expanded, basal tooth long, lamellar *palliata*.
 - bb. Diameter less than 15 mill., lip not expanded beyond contour of body whorl, basal tooth small and acute *inflecta*.

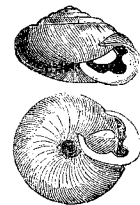
- II. Aperture bidentate.
 - a. Umbilicate.....*sayana*.
 - aa. Imperforate.....*elevata*.
- III. Aperture unidentate.
 - a. Umbilicate.
 - b. Single tooth on basal lip.....*profunda*.
 - bb. Single tooth on parietal wall.....*thyroides*.
 - aa. Imperforate.
 - b. Body whorl wide, diameter twice the height.....*albolabris dentata*.
 - bb. Body whorl ventricose, diameter less than twice the height, *exoleta*.
- IV. Aperture edentate.
 - a. Umbilicate.
 - b. Coarsely striate, lip broadly reflected.....*thyroides*.
 - bb. Finely striate, shining, lip narrower; smaller.....*clausa*.
 - aa. Imperforate.
 - b. Diameter exceeding 20 mm., distinctly striate.
 - c. Lip heavy, broadly reflected; uncolored.....*albolabris*.
 - cc. Lip thin, narrowly reflected; usually banded.....*multilineata*.
 - bb. Diameter not exceeding 17 mm.
 - c. Globosely depressed, polished.....*mitchelliana*.
 - cc. Convexly elevated, striate.....*pennsylvanica*.



POLYGYRA TRIDENTATA (Say).

Shell umbilicated, depressed; light horn or chestnut colored spire very low; whorls 5½, rather convex, the last scarcely deflected in front; aperture trilobate; peristome white, flatly reflected, thickened within, with two acute teeth on its inner margin, a strong oblique tooth on the parietal wall. Alt. 8, greater diam. 16, lesser 14 mm.

- Fig. 6. *P. tridentata*. (Binney.)
- Helix tridentata*, Say, Nich. Encycl., pt. II, fig. 1 (1817).
- Triodopsis* ———, W. G. Binney, Man. Am. Land Shells, 291, fig. 312, (1885).
- Helix* ———, Sager, Doc. H. Rep. Mich., 1839, 420, separate, 14.
- , Miles, Rep. Geol. Surv. Mich., 236, (1861).
- Triodopsis* ———, Currier, Shell-bearing Moll. Mich., 6, (1868).
- , DeCamp, Shell-bearing Moll. Mich., 7, (1881).
- Polygyra* ———, Walker, Rev. Moll. Fauna, Mich., 17, (1894).



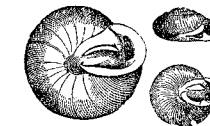
POLYGYRA FRAUDULENTA (Pilsbry).

Shell umbilicated, depressed, globose, ribbed striate; reddish horn colored; spire convex; whorls 6, rather convex, the last deflected anteriorly, constricted behind the lip; aperture trilobate, with a large oblique tooth on the parietal wall; peristome reflected, thickened within, concave above, white, with two teeth, the upper one decidedly inflected, the other sub-basal, acute. Alt. 7½, greater diam. 13, lesser 11 mm.

Fig. 7. *Polygyra fraudulenta*. (Binney)

- Polygyra tridentata fraudulenta* Pilsbry, Proc. A. N. S. P. 1894, 20, pl. I., fig. 6.
 - Triodopsis fallax*, W. G. Binney, Man. Am. Land Shells, 292, fig. 314, (1885).
 - Helix* ———, Sager, Doc. H. Rep. Mich., 1839, 420, separate 14.
 - , Miles, Rep. Geol. Surv. Mich., 235, (1861).
 - Triodopsis* ———, Currier, Shell-bearing Moll. Mich., 6, (1868).
 - , DeCamp, Shell-bearing Moll. Mich., 7, (1881).
 - Polygyra fraudulenta*, Walker, Rev. Moll. Fauna, Mich., 17, (1894).
- More abundant than the preceding species. Distribution the same. This species is frequently confounded with *P. tridentata*, but is very distinct and can be easily separated by its basin-shaped aperture and the larger size of the superior labial tooth.

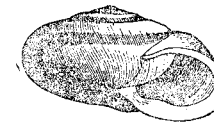
POLYGYRA INFLECTA (Say).



Shell imperforate, depressed, epidermis brownish horn-color; very finely hirsute; whorls with very minute transverse striæ; suture not much impressed; aperture trilobed, very much contracted behind the lip; peristome white, narrow, reflected, not projecting beyond the contour of the body whorl; on the inner margin of the peristome are two acute teeth, with the points directed inwards, one near the base, the other midway between that and the junction of the peristome and the body whorl, with a circular sinus between them; parietal wall with a long arcuated, white tooth. Alt. 6¾, greater diam. 12, lesser 11 mm.

- Helix inflecta*, Say, Jour. A. N. S. P. II., 153, (1821).
 - Triodopsis* ———, W. G. Binney, Man. Am. Land Shells, 289, fig. 310, (1885).
 - Helix* ———, Sager, Doc. H. Rep. Mich. 1839, 420, separate, 14.
 - , Miles, Rep. Geol. Surv. Mich., 235, (1861).
 - Isognomostoma* ———, Currier, Shell-bearing Moll. Mich., 6, (1868).
 - , DeCamp, Shell-bearing Moll. Mich., 7, (1881).
 - Polygyra* ———, Walker, Rev. Moll. Fauna Mich., 17, (1894).
- Quite rare. Kent, Washtenaw, Wayne and Monroe counties. Distinguished from the other tridentate species by its small size and imperforate base.

POLYGYRA PROFUNDA (Say).



Shell broadly umbilicated, orbicularly depressed; yellowish horn-colored, with reddish brown revolving lines and bands; whorls 5, convex, obliquely striated; suture distinct; aperture almost circular, its extremities converging, flattened towards the plane of the base; peristome white, thickened, reflected, with an obtuse tooth on the basal edge; umbilicus rather large and profound; base convex. Alt. 14, greater diam. 29, lesser 27 mm.

- Fig. 9. *Polygyra profunda*. (Binney.)
- Helix profunda*, Say, Jour. A. N. S. P. II, 160, (1821).
- Mesodon profundus*, W. G. Binney, Man. Am. Land Shells, 318, fig. 342, (1885).

- Helix profunda*, Sager, Doc. H. Rep. Mich., 1839, 420; separate, 14.
 —————, Miles, Rep. Geol. Surv. Mich., 236, (1861).
Ulostoma —————, Currier, Shell-bearing Moll. Mich., 5, (1868).
 —————, DeCamp, Shell-bearing Moll. Mich., 6, (1881).
Polygyra —————, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Var. **ALBA** (Walker).

White or pale yellowish horn-color, without bands.

Polygyra profunda alba, Walker, Terr. Moll. Mich., 12, (1899).

Southern part of the state. Not yet reported north of Muskegon county on the west and Macomb county on the east in the lower peninsula.* The variety occurs occasionally, associated with the typical form, in Washtenaw and Monroe counties. The other extreme in coloration, in which the bands coalesce and cover the entire surface (var. *unicolor*) has not yet been noticed in this state.

POLYGYRA SAYANA Pilsbry.

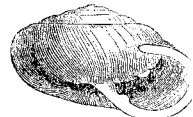


Fig. 10. *P. sayana*.
(Binney.)

Shell umbilicated, orbicularly depressed, thin; light russet, shining; whorls 5-6, finely and obliquely striate; suture impressed; aperture sub-circular; peristome white, narrow, reflected, with a slightly projecting tooth on the inner edge of the basal portion near the umbilicus; parietal wall with a sub-prominent, white tooth; umbilicus moderate, deep base; rounded.

Alt. 14, greater diam. 23, lesser 19 mm.

Polygyra sayana Pilsbry, Proc. A. N. S. P. 1906, 127.

Mesodon sayii, W. G. Binney, Man. Am. Land Shells, 319, fig. 343, (1885).

Helix ———, Miles, Rep. Geol. Surv. Mich., 236, (1861).

Ulostoma ———, Currier, Shell-bearing Moll. Mich., 5, (1868).

—————, DeCamp, Shell-bearing Moll. Mich., 6, (1881).

Polygyra ———, Walker, Rev. Moll. Fauna Mich., 17, (1894).

Rare and restricted to the northern part of the state. Reported from Charlevoix, Emmet, Presque Isle, Huron and Tuscola counties. Not reported from the upper peninsula.

POLYGYRA ALBOLABRIS (Say).

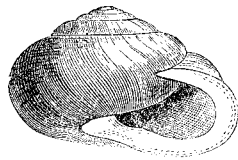


Fig. 11. *P. albolabris*. (Binney.)

Shell imperforate, convex; unicolored, yellowish-brown, russet, or light chestnut color; whorls 5-6, finely and obliquely striate and decussated with very minute, but distinct, wavy, impressed, revolving lines, which are most apparent on the back of the reflected peristome, suture well impressed; peristome white, flattened, abruptly and very widely reflected. Alt. 15¼-24¼, diam. 24¾-34¼ mm.

Helix albolabris, Say, Nich. Encycl., pl. I., fig. 1, (1817).

Mesodon —————, W. G. Binney, Man. Am. Land Shells, 298, fig. 319, (1885).

Helix —————, Sager, Doc. H., Rep. Mich., 1839, 420; separate, 14.

—————, Miles, Rep. Geol. Surv. Mich., 235, (1861).

* In the upper peninsula it has been found in Iron and Dickinson counties.

- Mesodon albolabris*, Currier, Shell-bearing Moll. Mich., 5, (1868).
 —————, DeCamp, Shell-bearing Moll. Mich., 6, (1881).
Polygyra —————, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Var. **DENTATA** Tryon.

Parietal wall with a slight denticle.

Mesodon albolabris dentata, Tryon, Am. Jour. Con. III., 39, pl. vii., fig. 6, (1867).

—————, Currier, Shell-bearing Moll. Mich., 5, (1868).

—————, DeCamp, Shell-bearing Moll. Mich., 6, (1881).

Polygyra —————, Walker, Rev. Moll. Fauna Mich., 16, (1894).

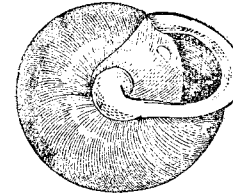


Fig. 12. Var. *dentata*. (Binney.)

Var. **MARITIMA** (Pilsbry.)



Fig. 13. Var. *maritima*.
(Pilsbry.)

Shell smaller, surface very distinctly and beautifully decussated by spiral and oblique lines. Base notably swollen near the umbilicus, back of the lip.

Alt. 12-17, diam. 18¾-24¼ mm.

Helix albolabris maritima, Pilsbry, Proc. A. N. S. P., 1890, 283, fig.

Polygyra —————, Walker, Rev. Moll. Fauna Mich., 16, (1894).

————— *traversensis*, "Leach," Pilsbry, Man. Con. IX, 76, (1894).

————— *minor*, Sterki, L. & F. W. Moll. N. Phila, 4, (1894).

—————, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Abundant over the entire state, and exhibits great variation in size, color and thickness of the shell. Deeply colored examples when fresh, frequently have the lip tinged with light purple, which, however, fades out gradually, especially when exposed to the light. The dentate form occurs not infrequently associated with the type. It is, perhaps, questionable whether the true var. *maritima* occurs in this state. The shells from Traverse City, called var. *traversensis* by Leach, but never formally described, are very similar, but not quite typical, lacking the swollen base characteristic of the New Jersey form. They seem to be intermediate between the true *maritima* and the form described by Sterki as var. *minor*. The same form has been found at Grand Rapids, and occurs in many localities in the sandy districts in the western and northern parts of the state. It is an interesting coincidence, if nothing more, that this form first discovered in the sandy regions of New Jersey, should reappear under similar environmental conditions in Michigan, and be accompanied by a fluviatile form (*Lymnaea galbana* Say), which, until found here, was considered extinct and peculiar to the recent deposits in New Jersey.

Taking all the material now accessible into consideration, it does not seem feasible to separate the several forms known as *maritima*, *traversensis* and *minor* into distinct varieties. As a whole they seem to be a well marked depauperate race, the result of unfavorable conditions of environment and characteristic of the sandy regions of the northern and western counties. But they vary in size and contour quite as much as the typical form and grade insensibly into each other and into it. At present therefore, it would

seem best to consider them simply as phases of one variety and to unite them under the name having priority.

P. albolabris ruja DeKay, cited by DeCamp, is simply a more deeply colored form and is not entitled to varietal distinction.

POLYGYRA ZALETA (Binney).

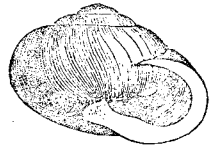


Fig. 14. *P. zaleta*. (Binney.)

Shell imperforate, convex, somewhat ventricose; uniform yellowish horn or russet color; whorls 5-6, finely and obliquely striate; body whorl large and ventricose; suture well marked; aperture rounded; peristome thickened, white, reflected; parietal wall with a prominent, white, oblique tooth.

Alt. 17, greater diam. 28, lesser 23 mm.

- Helix zaleta*, Binney, Bost. Jour. Nat. Hist. I., 492, pl. xx, (1837).
Mesodon exoletus, W. G. Binney, Man. Am. Land Shells, 39, fig. 331, (1885).
Helix zaleta, Sager Doc. H. Rep. Mich., 1839, 420, separate, 14.
 ——— *exoleta*, Miles, Rep. Geol. Surv. Mich., 235, (1861).
 ———, Currier, Shell-bearing Moll. Mich., 5, (1868).
 ———, DeCamp, Shell-bearing Moll. Mich., 6, (1881).
Polygyra ———, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Probably extends over the entire southern part of the state, although not yet reported west of Saginaw, Ingham and Branch counties. The only records north of the Saginaw-Grand valley are Osceola and Mackinac counties. This species is frequently mistaken for the dentate form of *P. albolabris* or *vice-versa*, and, indeed, in some cases it is not easy to tell from the shell alone, where a given specimen belongs. In such cases a dissection of the animal is necessary, as there are very distinct differences in the details of the genitalia. Usually, however, the two forms can be separated without difficulty, *zaleta* being much more ventricose and having a rounder aperture than *albolabris*, which is more depressed, wider in proportion to its height, and with the aperture wider and more flattened in the direction of the plane of the base. Usually known as *P. exoleta* Binney, but *zaleta* has priority

POLYGYRA MULTILINEATA (Say).

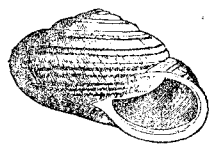


Fig. 15. *P. multilineata*. (Binney.)

Shell imperforate, depressed, sub-globose; spire convex; rather thin; yellowish brown, or russet color, with numerous reddish, revolving bands; whorls 5-6, convex, closely and obliquely striate, the last ventricose; suture distinctly marked; aperture lunate; peristome white, reflected, rather thin.

Alt. 14, greater diam. 23, lesser 20 mm.

- Helix multilineata*, Say, Jour. A. N. S. P., II., 150, (1821).
Mesodon multilineatus, W. G. Binney, Man. Am. Land Shells, 302, fig. 323, (1885).
Helix multilineata, Sager, Doc. H. Rep. Mich., 1839, 420, separate, 14.
 ———, Miles, Rep. Geol. Surv. Mich., 236, (1861).
Mesodon ———, Currier, Shell-bearing Moll. Mich., 5, (1868).
 ———, DeCamp, Shell-bearing Moll. Mich., 6, (1881).
Polygyra ———, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Var. ALBA Witter.

- Helix multilineata alba*, Witter, Quar Jour. Con., I., 384, (1878).
Mesodon ———, Currier, Shell-bearing Moll. Mich., 5, (1868).
 ———, DeCamp, Shell-bearing Moll. Mich., 6, (1881).
Polygyra ———, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Unicolored, pale horn-color without bands.

Var. RUBRA Witter.

- Helix multilineata rubra*, Witter, Quar Jour. Con., I., 384, (1878).
Mesodon ——— *unicolor*, Currier, Shell-bearing Moll. Mich., 5, (1868).
 ———, DeCamp, Shell-bearing Moll. Mich., 6, (1881).
Polygyra ———, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Unicolored, deep reddish brown or chestnut.

Abundant south of the Saginaw-Grand valley. North of that it has been reported only from Benzie and Osceola counties. It also occurs in Menominee county in the upper peninsula. The varieties occur occasionally associated with the typical form, although var. *rubra* has not yet been reported from the eastern part of the state.

A peculiar color-form, deep brown or chestnut color with a yellowish band of variable width and position between the periphery and umbilical depression has been found in Kent county.

POLYGYRA PALLIATA (Say).



Fig. 16. *P. palliata*. (Binney.)

Shell imperforate, thin, depressed; light to dark brown or chestnut color, and rough with minute, acute, projections and stiff hairs; whorls 5, flattened above and rounded below, with numerous fine oblique striæ; aperture trilobate, much contracted by the peristome and teeth; peristome white, widely reflected, with two projecting teeth on the inner margin, the upper one acute and prominent, the basal tooth long, lamellar; parietal wall with a very prominent, white, curved tooth.

Alt. 10, greater diam. 21, lesser 18 mm.

- Helix palliata*, Say, Jour. A. N. S. P., II., 152, (1821).
Triodopsis ———, W. G. Binney, Man. Am. Land Shells, 284, fig. 303, (1885).
Helix ———, Sager, Doc. H. Rep. Mich. 1839, 420, separate, 14.
 ———, Miles, Rep. Geol. Surv. Mich., 236, (1861).
Xolotrema ———, Currier, Shell-bearing Moll. Mich., 5, (1868).
 ———, DeCamp, Shell-bearing Moll. Mich., 6, (1881).
Polygyra ———, Walker, Rev. Moll. Fauna Mich., 17, (1894).

Saginaw-Grand valley and southeastern part of the state. It will probably be found to have a general distribution through the entire southern portion, although it has not been reported from any of the southwestern counties.

Currier lists* a var. *alba*, but gives no description. It is not represented in his collection now in the Kent Scientific Museum at Grand Rapids. DeCamp also quotes it as being in his collection, but it was not there when the collection came into my possession. It has not been found by any Michigan collectors.

POLYGYRA ELEVATA (Say).Fig. 17. *P. elevata*. (Binney.)

Shell imperforate, very convex, elevated, almost conical; yellowish horn-color; whorls 7, rounded, finely; obliquely striate, the last ventricose; suture distinct, aperture contracted by the peristome, somewhat triangular; peristome white, thickened, reflected, its basal portion with an obsolete lamellar denticle; parietal wall with a large, white, obliquely curved tooth.

Alt. 17, greater diam. 25, lesser 20 mm.

Helix elevata, Say, Jour. A. N. S. P., II., 154, (1821).

Mesodon elevatus, W. G. Binney, Man. Am. Land Shells, 306, fig. 328, (1885).

Helix elevata, Sager, Doc. H. Rep. Mich., 1839, 420, separate, 14.

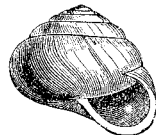
———, Miles, Rep. Geol. Surv. Mich., 235, (1861).

Xolotrema ———, Currier, Shell-bearing Moll. Mich., 5, (1868).

———, DeCamp, Shell-bearing Moll. Mich., 6, (1881).

Polygyra ———, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Very rare. Niles and Grand Rapids are the only authentic localities. It has been reported from Osceola County, and as fossil in recent deposits near Ann Arbor.

POLYGYRA PENNSYLVANICA (Green).Fig. 18. *P. pennsylvanica*. (Binney.)

Shell imperforate, globosely elevated, yellowish horn-colored; whorls 6, closely and obliquely striate; suture impressed; aperture subtriangular; lip narrow, white, roundly reflected with a slight thickening at the base; umbilical region indented.

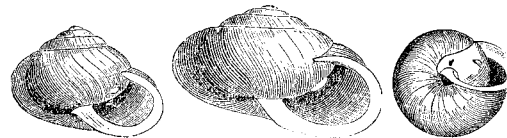
Alt. 11, diam. 18 mm.

Helix pennsylvanica, Green, Cont. Macl. Lyc. I. 8, (1827).

Mesodon pennsylvanicus, W. G. Binney, Man. Am. Land Shells, 304, fig. 324, (1885).

Monroe county and Bois Blanc Island, Detroit river.

The occurrence of this species in Michigan was until the present year (1906) considered extremely doubtful. It has, however, been recently collected by Sister M. Catherine near Monroe. It is easily distinguished from allied species by its striate surface, imperforate base and edentulous aperture.

POLYGYRA THYROIDES (Say).Fig. 19. *P. thyroides*. (Binney.)

Shell narrowly umbilicate, depressed, globose; uniform light horn or russet color; whorls 5, finely and obliquely striate; spire more or less elevated; suture well impressed; aperture oblique, lunate; parietal wall with a prominent white tooth, which is occasionally obsolete; peristome white, thickened; widely reflected; its exterior yellowish; umbilicus partially covered by the reflected peristome.

Alt. 13, greater diam. 22, lesser 19½ mm.

Helix thyroides, Say, Jour. A. N. S. P. I., 123, (1817).

Mesodon thyroides, W. G. Binney, Man. Am. Land Shells, 313, fig. 235, (1885).

Helix thyroides, Sager, Doc. H. Rep. Mich., 1839, 420, separate, 14.

——— *thyroides*, Miles, Rep. Geol. Surv. Mich., 236, (1861).

Mesodon ———, Currier, Shell-bearing Moll. Mich., 5, (1868).

———, DeCamp, Shell-bearing Moll. Mich., 6, (1881).

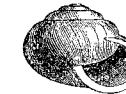
Polygyra ———, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Var. **PULCHELLA** Cockerell.

Helix thyroides pulchella, Cockerell, Jour. Con., VII., 39, (1892).

Pale horn-color, tinged with vinous, especially near the aperture.

Generally distributed through the southern part of the state and on the western side ranges as far north as Chippewa county. The variety occurs not unfrequently in Kent county.

POLYGYRA CLAUSA (Say).Fig. 20. *P. clausa*. (Binney.)

Shell sub-imperforate, conoidly semi-globose, rather solid with crowded rib-like striæ; yellowish horn-color, shining; whorls 5½, rather convex, gradually increasing, the last rounded, constricted behind the lip; umbilicus narrow, almost covered by the reflected peristome; aperture rounded; peristome narrow, white, reflected; base very convex.

Alt. 11½, greater diam. 18½, lesser 16 mm.

Helix clausa, Say, Jour. A. N. S. P., II., 154, (1821).

Mesodon clausus, W. G. Binney, Man. Am. Land Shells, 315, fig. 338, (1885).

Helix clausa, Sager, Doc. H., Rep. Mich., 1839, 420, separate, 14.

———, Miles, Rep. Geol. Surv. Mich., 235, (1861).

Polygyra ———, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Very rare in Michigan. Until recently Grand Rapids was the only authentic locality recorded. But it has been lately collected in considerable abundance near Monroe.

POLYGYRA MITCHELLIANA (Lea).Fig. 21. *P. mitchelliana*. (Binney.)

Shell imperforate, depressed conoid-globose, thin; finely striate; yellowish horn-color, polished; spire briefly conoid; whorls 5, moderately convex, gradually increasing, the last ventricose, sub-constricted behind the lip; aperture rounded, peristome narrow, white, thickened, reflected; base very convex.

Alt. 10, greater diam. 16½, lesser 14½ mm.

Helix mitchelliana, Lea, Trans. A. P. S., VI., 87, pl. XXIII, fig. 71, (1839).

Mesodon mitchellianus, W. G. Binney, Man. Am. Land Shells, 305, fig. 326, (1885).

Polygyra mitchelliana, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Very rare. Armada, Macomb county, is the only reported locality. This species in general appearance is very similar to *P. clausa*, but is distinguished by being imperforate.

Section **STENOTREMA** Rafinesque.

Shell small, compact, imperforate or umbilicate; sub-globose, globosely depressed or lens-shaped, the periphery varying from rounded to acutely keeled, surface dull, smooth, generally hirsute. Whorls, 5-6 closely revolving, the last suddenly deflexed in front. Aperture basal, narrow, obstructed by an oblique blade-like parietal tooth, parallel to the reflexed basal lip, the latter often notched in the middle. Last whorl generally having in its last fourth, a short, transverse, internal partition on the axis.

KEY TO THE SPECIES OF *STENOTREMA*.

- I. Lip notched *hirsuta*.
 II. Lip without notch.
 a. Base narrowly excavated, imperforate or narrowly umbilicate, hirsute, diameter 11 mm. *fraterna*.
 aa. Basal excavation and umbilicus wider, smooth, depressed, diameter 9 mm. *monodon*.

POLYGYRA HIRSUTA (Say).

Fig. 22.
P. hirsuta
(Binney.)

Shell imperforate, sub-globose; brownish or chestnut, thickly hirsute; spire convex, elevated; whorls 5, rounded; suture distinct; aperture contracted, very narrow, almost closed by an elongated, lamelliform tooth on the parietal wall, extending from the center of the base into the edge of the aperture; peristome narrow, very much depressed and reflected against the outer whorl, with a deep notch near the centre; base convex.

Alt. $4\frac{3}{8}$, greater diam. $7\frac{1}{2}$, lesser 7 mm.

- Helix hirsuta*, Say, Jour. A. N. S. P., I., 17, (1817).
Stenotrema hirsutum, W. G. Binney, Man. Am. Land Shells, 278, fig. 295, (1885).
Helix hirsuta, Sager, Doc. H. Rep. Mich., 1839, 420, separate, 14.
 ————, Miles, Rep. Geol. Surv. Mich., 235, (1861).
Stenotrema ————, Currier, Shell-bearing Moll. Mich., 5, (1868).
 ————, DeCamp, Shell-bearing Moll. Mich., 7, (1881).
Polygyra ————, Walker, Rev. Moll. Fauna Mich., 17, (1894).

Common where found, but apparently local in its distribution. Macomb, Wayne, Washtenaw, and Monroe, in the southeastern part of the state, and Branch, Berrien, Kent, and Muskegon, in the western, are the only counties thus far to be credited with it. It probably has a general distribution south of the Saginaw-Grand Valley.

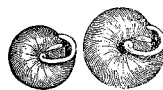
POLYGYRA FRATERNA (Say).

Fig. 23. *P. fraterna*.
(Binney.)

Shell narrowly umbilicated or imperforate, globose, depressed, reddish horn-colored, minutely hirsute; whorls $5\frac{1}{2}$, the upper ones flattened, the two last convex, the last constricted behind the peristome; aperture widely lunar, with a lamelliform tooth on the parietal wall; peristome narrow, reflected, base convex, narrowly excavated.

Alt. 6, greater diam. 11, lesser 10 mm.

- Helix fraterna*, Say, Long's Exped. II, 257, pl. XV., fig. 3, (1824).

- Stenotrema monodon*, W. G. Binney, Man. Am. Land Shells, 280, fig. 298-9, (1885).
Helix fraterna, Sager, Doc. H. Rep. Mich., 1839, 420, separate, 14.
 ————, Miles, Rep. Geol. Surv. Mich., 235, (1861).
 ————, *monodon*, Miles, Rep. Geol. Surv. Mich., 236, (1861).
Stenotrema ————, Currier, Shell-bearing Moll. Mich., 6, (1868).
 ————, DeCamp, Shell-bearing Moll. Mich., 7, (1881).
 ————, *fraterna*, DeCamp, Shell-bearing Moll. Mich., 7, (1881).
Polygyra monodon, Walker, Rev. Moll. Fauna Mich., 17, (1894).
 ————, *fraterna*, Walker, Rev. Moll. Fauna Mich., 17, (1894).

Var. **ALBIDA** Walker.

Pale greenish-white.

Polygyra monodon albida, Walker, Terr. Moll. Mich., 15, (1899).

The umbilicate form has an abundant and general distribution in all parts of the state. The imperforate variety is apparently restricted to the southern part of the state, while the var. *albida* has thus far been reported only from Charlevoix and Grand Rapids. This species has been commonly known as *P. monodon* Rackett, the imperforate form being designated as var. *fraterna* Say. But it seems that Rackett's species is that described by Ward as *P. leaii*. It follows that this form must be given Say's name. The umbilicate and imperforate forms inosculate too closely to justify varietal distinction.

POLYGYRA MONODON (Rackett).

Fig. 24.
P. monodon

- Shell umbilicate, globosely depressed, light horn-color, whorls 6, obsolete striate, narrow, slowly and regularly increasing, convex, the last somewhat flattened below the periphery and constricted behind the peristome; suture distinctly depressed; base convex, rather widely excavated around the umbilicus; a prominent oblique white tooth on the parietal wall; peristome narrowly reflected.
 Alt. 5, greater diam. 9, lesser 8 mm.
 Alt. 4, greater diam. 7, lesser $6\frac{1}{2}$ mm.
Helix monodon, Rackett, Linn. Trans. XIII., 42, pl. V., fig. 2, (1822).

- Stenotrema monodon leaii*, W. G. Binney, Man. Am. Land Shells, 281, fig. 297, (1885).
 ————, *leaii*, Currier, Shell-bearing Moll. Mich., 6, (1868).
 ————, *leaii*, DeCamp, Shell-bearing Moll. Mich., 7, (1881).
Polygyra ————, Walker, Rev. Moll. Fauna Mich., 17, (1894).

Generally distributed south of the Saginaw-Grand valley. Alpena, the type locality, is the only reported locality further north.

This abundant little species is easily distinguished from *P. fraterna* by its smaller size, with one more whorl, larger umbilicus and wider basal excavation and lack of epidermal hairs. Its habits also are quite different as it is usually found in low damp places, such as river margins, where it is associated with the *Succineas*, *Zonitoides nitidus*, *Pomatiopsis lapidaria* and other small moisture-loving species; while *fraterna* is usually found in the dryer localities frequented by the larger helices. It has until quite recently been known as *P. leaii* (Ward). but Dr. Pilsbry has shown that this form was the type of Rackett's species.

Superfamily AGNATHOMORPHA.

Family **CIRCINARIIDÆ.**

Animal naked, with an internal shell or bearing an external, heliciform shell. Foot without pedal grooves or caudal mucus pore. Jaw ribless, with or without a median projection on the cutting margin. Radula with arcuate rows of teeth. Centrals short, rudimentary; marginals aculeate, with narrow basal plates.

Genus **CIRCINARIA** (Beck) Pilsbry.

Shell thin, widely umbilicated, depressed, striate or wrinkled; color uniform; whorls 4½-5, the last broad, depressed, moderately deflexed in front; aperture obliquely ovate; peristome somewhat thickened or expanded, the margins approximating, the basal shortly reflexed.

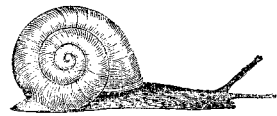


Fig. 25. Animal of *C. concava*. (Binney.)

Animal heliciform; mantle posterior covered with a shell; eye-peduncles long and slender; foot narrow, twice as long as diameter of shell, tail pointed, scarcely reaching behind the shell; respiratory and anal orifices on the right of the mantle under the peristome of the shell; generative orifice behind the right eye peduncle; no distinct locomotive disk or caudal mucus pore.



Fig. 26. Jaw of *C. concava*. (Binney.)

Jaw crescentic, ends sharply pointed, anterior surface striated; cutting margin smooth, with a median projection.

Radula with the rows of teeth arranged *en chevron*. Centrals very small, basal plate triangular, apex pointed forward, more or less truncated and incurved; lower lateral angles somewhat expanded, base incurved, uni or tricuspid; laterals wanting; marginals arcuate with long narrow basal plates.

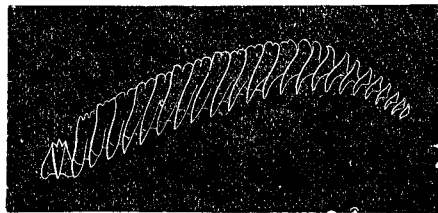


Fig. 27. Dentition of *C. concava*. (Binney.)

CIRCINARIA CONCAVA (Say).

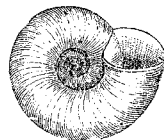


Fig. 28. *C. concava*. (Binney.)

Shell depressed, whitish or greenish-white horn-color; whorls above flattened; rounded below; finely striate, outer whorl expanding slightly towards the aperture; suture rather deeply impressed; umbilicus wide and deep; aperture rounded, somewhat flattened above; its edge frequently tinged with reddish brown; peristome slightly thickened and subreflected below.

Alt. 8, greater diam. 17, lesser 14 mm.

Helix concava, Say, Jour. A. N. S. P., II., 159, (1821).
Macrocyllis ———, W. G. Binney, Man. Am. Land Shells, 199, fig. 209, (1885).

- Helix concava*, Sager, Doc. H. Rep. Mich., 1839, 420, separate, 14.
- , Miles, Rep. Geol. Surv. Mich., 235, (1861).
- Macrocyllis* ———, Currier, Shell-bearing Moll. Mich., 4, (1868).
- , DeCamp, Shell-bearing Moll. Mich., 5, (1881).
- Selenites concavus*, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Generally distributed south of the Saginaw-Grand Valley. North of that it has only been reported from Lime island in the St. Mary's river.

Superfamily AULACOPODA.

KEY TO THE FAMILIES OF AULACOPODA.*

- I. Marginal teeth with narrow, lengthened basal plates, either unicuspid and thornlike or bicuspid by elevation of outer on middle cusps.
 - a. Foot-margin wide; shell more or less spiral, ovotestis imbedded in liver *Zonitidæ*.
 - aa. Foot-margin narrow; shell a thin internal plate, not spiral; ovotestis free from liver *Limacidæ*.
- II. Marginal tooth with short, wide and squarish basal plates with one or several cusps, the outer cusp never elevated on middle cusp.
 - a. Shell spiral, usually wholly external *Endodontidæ*.
 - aa. No shell, mantle covering the whole upper surface *Philomyxidæ*.

Family **ZONITIDÆ.**

Animal entirely covered with an external, more or less shining shell, with or without caudal mucus-pore; foot-margin wide and sole frequently tripartite, defined by a pedal groove; ovotestis imbedded in liver; marginal teeth with narrow, elongated basal plates and either unicuspid and thorn-shaped by suppression of side cusps, or bicuspid by elevation of outer on middle cusps.

KEY TO GENERA OF ZONITIDÆ.†

- I. ♀ System bearing a long dart-sack surmounted by one or more coronal glands, and usually containing a slender, curved dart.
 - a. Shell with internal teeth, or a layer of callus on the floor of last whorl *Gastrodonta*.
 - aa. No internal teeth or callus.
 - b. Surface polished or with minute spiral lines *Zonitoides*.
 - bb. Surface conspicuously striate or constulate *Pseudohyalina*.
- II. ♂ System lacking dart-sack and its accessories.
 - a. No noticeable shell-lobes developed, caudal mucus-pore present.
 - b. Shell small depressed and glassy; lower part of vas deferens not enlarged *Vitrea*.
 - bb. Shell larger, smoky; lower part of vas deferens greatly enlarged *Omphalina*.
 - aa. Right shell lobe developed; no caudal pore *Vitrina*.

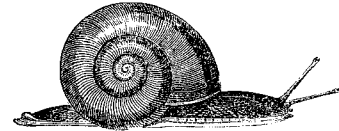
* Adapted from Pilsbry, Naut. IX. 169.
 † Adapted from Pilsbry, Naut. IX. 17.

Subfamily ZONITINÆ Pilsbry.

♀ System lacking dart-sack and its accessories.

Genus **OMPHALINA** Rafinesque.

Shell umbilicated or perforated, globosely depressed, thin, striated or wrinkled above, smooth below, reddish horn-color, lighter below, shining; aperture large, lunar-ovate; peristome simple, straight, acute, extremities approaching, that of the columella subreflected.



Animal (of *O. fuliginosa*) nearly twice as long as diameter of the shell, blackish or bluish-black; darkest on the head, neck and eye-peduncles, eye-peduncles short in proportion to the length of the animal and set widely apart. Respiratory foramen in the angle formed by the junction of the peristome with the body whorl. Base of foot whitish, the locomotive band defined by two very fine lines or furrows. A double marginal furrow runs along the side of the foot from the head nearly to the posterior, where it passes upwards and joins that from the opposite side, leaving posteriorly a flattened, rounded extremity, somewhat prominent and glandular, in the centre of which is a longitudinal sinus, fissure or mucus pore.



Fig. 30. Jaw of *O. fuliginosa* (Binney.)

Jaw arcuate, ends acuminate, often recurved, sometimes blunt; anterior surface without ribs, cutting margin with a beak-like projection.

Dentition: centrals with base of attachment longer than wide, with lateral expansions at the corners of the lower margins; laterals of the same type as the centrals, but rendered asymmetrical by the depression of the inner, lower, lateral expansion of the base of attachment and the inner side-cusp and cutting point; marginals with narrow, lengthened basal plates, either unicuspid and thorn-like or bicuspid by elevation of outer on middle cusp.

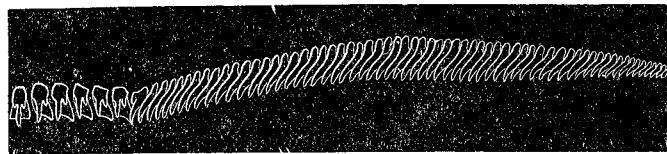


Fig. 31. Dentition of *O. fuliginosa*. (Binney.)

KEY TO THE SPECIES OF *OMPHALINA*.

- I. Shell larger, 26 mm. in diam., umbilicus wide..... *fuliginosa*.
- II. Shell smaller, 15 mm. in diam., umbilicus minute..... *inornata*.

OMPHALINA FULIGINOSA (Griffith).

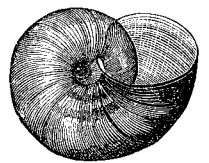
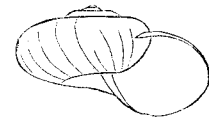


Fig. 32. *O. fuliginosa*. (Binney.)

Shell rather large, thin, depressed, chestnut brown sometimes almost black, shining and wrinkled; whorls $4\frac{1}{2}$, rapidly increasing, the last whorl very voluminous and expanding transversely toward the aperture; suture slightly impressed; aperture very oblique, ample, lunate-ovate; peristome simple, thin, with a light testaceous deposit within, extremities approaching that of the columella somewhat reflected; umbilicus deep and much expanded.

- Alt. 13, greater diam. 26, lesser 22 mm.
- Helix fuliginosa*, Griffith, Bost. Jour. Nat. Hist., III., 417, pl. XXIV, (1840).
- Zonites* ———, W. G. Binney, Man. Am. Land Shells, 207, fig. 217, (1885).
- Helix* ———, Sager, Doc. H. Rep. Mich., 1839, 420, separate, 14.
- , Miles, Rep. Geol. Surv. Mich., 235, (1861).
- Hyalina* ———, Currier, Shell-bearing Moll. Mich., 4, (1868).
- , DeCamp, Shell-bearing Moll. Mich., 5, (1881).
- Zonites fuliginosus*, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Apparently rare and local. Reported from Ottawa, Kent, Genesee, Tuscola, Lapeer, Washtenaw and Monroe counties, which indicates a range across the southern part of the state.

OMPHALINA INORNATA (Say).



Fig. 33. *O. inornata*. (Binney.)

Shell depressed; light yellowish, horn-color, smooth, shining, obscurely striate; whorls $4\frac{1}{2}$; suture slightly impressed; aperture transverse, slightly oblique, broader than high, with a white, callus deposit just within the margin; lip thin, acute, its ends somewhat converging, the basal extremity impinging on the small umbilicus; base somewhat flattened, indented in the centre.

Alt. $8\frac{1}{2}$, diam. 15 mm.

- Helix inornata*, Say, Jour. A. N. S. P., II., 371, (1821).
- Zonites inornatus*, W. G. Binney, Man. Am. Land Shells, 217, fig. 229, (1885).
- Helix inornata*, Sager, Doc. H. Rep. Mich. 1839, 420, separate p. 14.
- , Miles, Rep. Geol. Surv. Mich., 235, (1861).
- Zonites inornatus*, Walker, Rev. Moll. Fauna Mich., 16, (1894).

This species, after escaping observation for forty years, has recently been discovered by Mr. W. Miller, who has submitted specimens found near Grand Rapids. He also reports it from Hart, Oceana county, but the specimens from the latter locality have been lost or mislaid, and consequently have not been authenticated.

It is a well marked species and easily distinguished from *O. fuliginosa* by its smaller size and minute umbilicus.

Genus **VITRINA** Draparnaud.

Shell external, imperforate, pellucid, glossy, depressed: spire short; whorls 2-3, rapidly increasing, the last wide; aperture large; peristome thin.



Fig. 34. Animal of *Vitrina*. (Binney.)

Animal heliciform, obtuse before, pointed behind-mantle, posterior with an anterior prolongation covering the back, and with a process or prolongation which is reflected backward upon the shell. A distinct locomotive disk. No caudal mucus pore. Respiratory orifice subcentral, on the right side of the mantle, under the peristome of the shell. Anal orifice contiguous to the respiratory orifice.



Fig. 35. Jaw of *V. limpidus*. (Binney.)

Jaw highly arched, ends acuminate, blunt; cutting margin with a prominent, bead-like median projection. Dentition; centrals with a quadrangular base of attachment, longer than broad, tricuspid; laterals arranged in straight transverse rows, asymmetrical; marginals with sole-shaped base of attachment and aculeate, bifid cutting-points.



Fig. 36. Dentition of *V. limpida* (Binney.)

VITRINA LIMPIDA Gould.

Shell imperforate, globosely depressed, thin, fragile, transparent, shining; whorls 2½-3; scarcely convex, with very minute lines of increase, the last whorl large and very much expanded; suture not much impressed, aperture large, subovate, peristome thin and acute.

Alt. 3, diam. 6 mm.

Vitrina limpida, Gould, Agassiz's Lake Superior, 243, (1850).
 _____, W. G. Binney, Man. Am. Land Shells, 177, fig. 170, (1885).
 _____, Walker, Rev. Moll. Fauna Mich., 16, (1894).

A northern species, reported from Isle Royale, Ontonagon county, Lime Island in the St. Mary's river, Charlevoix, Traverse City, and Crystal Lake, Benzie county.

Genus **VITREA** Fitzinger.

Shell small, thin, fragile, shining, hyaline, smooth, convexly depressed, last whorl not descending at the aperture, umbilicate or imperforate; aperture lunate; peristome thin and sharp.



Fig. 38. Animal of *V. cellaria* (Binney.)

Animal black or bluish-black on the upper parts, lighter, sometimes wholly white posteriorly. Foot long and narrow.

Jaw arcuate, ends attenuate, pointed or rounded; concave margin with a median rounded projection. Dentition as in *Omphalina*.

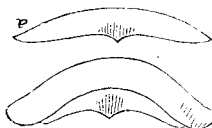


Fig. 39. Jaw of *V. cellaria* (Binney.)



Fig. 49. Dentition of *V. cellaria* (Binney.)

KEY TO THE SECTIONS OF *VITREA*.

- I. No internal teeth.
 - a. Surface smooth, spiral lines, when present, very minute... *Vitrea* s. s.
 - aa. Surface minutely striate, reticulated with impressed, spiral lines..... *Striatura*.
 - aaa. Surface with sharply defined, impressed, radial lines..... *Glyphyalina*.
- II. With internal, radial rows of teeth..... *Paravitrea*.

KEY TO THE SPECIES OF *VITREA*.

- I. Body-whorl with two or three rows of internal teeth..... *Multidentata*.
- II. No internal teeth in body-whorl.
 - a. Surface with impressed, radiating lines.
 - b. Imperforate or nearly so..... *indentata*.
 - bb. Umbilicate..... *rhoadsi*.
 - aa. Surface with microscopic revolving lines.
 - b. Body-whorl rapidly widening toward the aperture, base flattened, spire subplanulate, brownish horn-colored, diameter 5 mm. *wheatleyi*.
 - bb. Body-whorl regularly increasing, spire slightly elevated, base rounded, light steel gray, diameter 2½ mm..... *ferrea*.
 - aaa. Surface smooth, polished.
 - b. Diameter exceeding 10 mm., base bluish-white, thickened within *cellaria*.
 - bb. Diameter 4-5 mm. No basal thickening.
 - c. Umbilicus small, dark horn-colored..... *hammonis*.
 - cc. Umbilicus wider, almost colorless..... *binneyana*.

Section **VITREA** s. s.

Shell smooth and polished; spiral lines, when present, very minute.

VITREA CELLARIA (Muller).



Fig. 41. *V. cellaria* (Binney.)

Shell very much depressed, thin, fragile, pellucid; greenish horn-color above, paler beneath, smooth, highly polished; whorls 5, slightly rounded; aperture oblique, transverse, umbilicus moderate, regularly rounded, deep; base rounded, thickened within by a testaceous, bluish-white deposit; peristome simple, acute.

Alt. 5, greater diam. 13, lesser 11½ mm.

Helix cellaria, Muller, Verm. Hist., II., 28, (1774).
Zonites cellarius, W. G. Binney, Man. Am. Land Shells, 448, fig. 493, (1885).
 _____, Walker, Rev. Moll. Fauna Mich., 16, (1894)

A European species that has been locally introduced with foreign plants and is usually found in quantities where it occurs. Reported from Detroit, Alma, Gratiot county, Bay City and Muskegon. Easily distinguished from allied species by its larger size and the callus deposit within the aperture, which renders the base opaque and bluish-white.



Fig. 42. *V. hammonis* (Binney.)

VITREA HAMMONIS (Ström).

Shell narrowly umbilicate, small, depressed-conic, thin, fragile; pale or brownish horn-color, wrinkled, shining; whorls 4 the last rapidly enlarging toward the aperture; aperture transversely rounded; peristome simple, its edge rather thickened, not acute; base rounded.

Alt. 2, greater diam. 5, lesser 4¾ mm.

Helix hammonis, Strom, Trondb. Selsk, Skrift, III., 425, pl. IV., fig. 16, (1765).

Zonites viridulus, W. G. Binney, Man. Am. Land Shells, 64, fig. 21, (1885).

Helix electrina, Miles, Rep. Geol. Surv. Mich., 235, (1861).

Hyalina ———, Currier, Shell-bearing Moll. Mich., 4, (1868).

—————, DeCamp, Shell-bearing Moll. Mich., 5, (1881).

Zonites radiatulus, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Common and of general distribution, although not as abundant as its associated species, *Z. arborea*. The identity of the American species with that described by Ström has been only recently established, and it has been usually known of *V. electrina* (Gld.), *viridula* (Mke.), or *radiatula* (Ald.).

Careful attention is required to distinguish this species from three others, which are of about the same size and same general appearance, viz.: *V. indentata*, *V. wheatleyi* and *Z. arborea*. But when once recognized, the difference between them will be found to be constant and well marked.

V. hammonis is characterized by its more pointed spire, slightly impressed suture, rapidly enlarging body whorl and narrow umbilicus, perfectly smooth surface with neither radiating nor revolving, impressed lines. *V. indentata* is imperforate and has distant, impressed radiating lines which are quite distinct from the growth-lines. It is also lighter colored.

In *V. wheatleyi*, the umbilicus is wider and rapidly increases in size toward the aperture, which gives it an irregular shape; the base is somewhat flattened; the aperture is more transverse, and the last whorl is slightly descending at the aperture. Surface with microscopic revolving, impressed lines.

Zonitoides arborea differs in the wider umbilicus, more depressed spire, and its regularly increasing, more numerous, and more convex whorls, which are separated by a well marked suture. Surface with very fine, impressed, revolving lines.

VITREA WHEATLEYI (Bland).



FIG. 43.

V. wheatleyi.
(Binney.)

Shell umbilicated, depressed, thin, shining, pellucid; brownish horn-colored, finely striated, striæ decussated by very minute spiral lines; spire subplanulate; suture slightly impressed; whorls convex, the last more convex at the base, rapidly increasing, at the aperture scarcely descending; umbilicus pervious, rapidly widening toward the aperture; aperture depressed, obliquely lunate; peristome simple, acute, the margins approximating joined by a thin callus.

Alt. 2, greater diam. 5, lesser $3\frac{1}{2}$ mm.

Zonites wheatleyi, Bland, Ann. N. Y. Acad. N. S., II., 368, fig. 1, (1883).

—————, W. G. Binney, Man. Am. Land Shells, 222, fig. 237, (1885).

Helix limatula, Miles, Rep. Geol. Surv. Mich., 235, (1861).

This species has only been recently recognized as a member of our fauna. It has been found in Tuscola, Kalamazoo, Kent, Benzie and Grand Traverse counties, which indicate a general distribution in the northern and western portion of the lower peninsula.

It is peculiar in the oval shape of the umbilicus, resulting from the rapid increase in the size of the body whorl during the last half of its growth.

VITREA BINNEYANA (Morse).

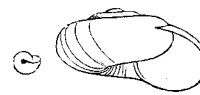


Fig. 44. *V. binneyana*.
(Binney.)

Shell broadly umbilicated, subglobose, transparent, almost colorless, shining, smooth, with microscopic wrinkles of growth and still more delicate, oblique wrinkles; spire not much elevated; whorls about 4, rounded, gradually increasing, the last globose; aperture oblique, subcircular, large; peristome simple, acute.

Alt. 2, diam. 4 mm.

Hyalina binneyana, Morse, Jour. Portl. N. H. Soc., I., 13, fig. 25-6, (1864).

Zonites binneyanus, W. G. Binney, Man. Am. Land Shells, 180, fig. 174, (1885).

—————, Walker, Rev. Moll. Fauna Mich., 16, (1894).

A northern species of general distribution north of Iosco county. It has also been reported from Kent county. Easily distinguished by its open umbilicus, smooth surface and white color.

Section STRIATURA Morse.

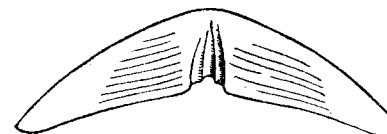


Fig. 45. Jaw of *V. ferrea*. (Binney.)

Shell small, striate, reticulated with impressed, spiral lines, thin, translucent, without teeth in the aperture.

Jaw almost smooth, with a median furrow and notch; central tooth of radula very large.

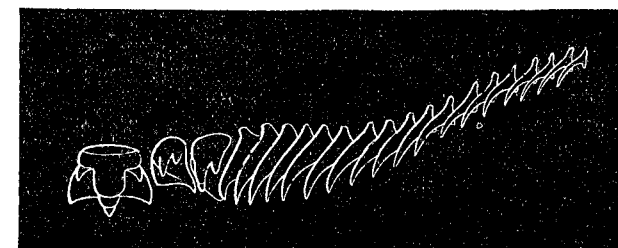


Fig. 46. Dentition of *V. ferrea*. (Binney.)

VITREA FERREA (Morse).



Fig. 47. *V. ferrea*.
(Binney.)

Shell umbilicated, depressed-globose; transparent, of a light steel-gray color, not shining, marked with very delicate incremental wrinkles and microscopic revolving lines; reticulating the surface; spire slightly elevated; whorls 3, the last rapidly enlarging, globose; suture distinct and deeply channeled near the apex; aperture large, transversely subcircular; peristome simple, acute, its extremities not approaching, that of the columella scarcely subreflected.

Alt. $1\frac{1}{4}$, greater diam. $2\frac{1}{2}$ mm.

Striatura ferrea, Morse, Jour. Portl. N. H. Soc., I., 17, figs. 36-40, (1864).

Zonites ferreus, W. G. Binney, Man. Am. Land Shells, 181, fig. 175, (1885).

—————, Walker, Rev. Moll. Fauna Mich., 16, (1894).

A northern species of general distribution. Gratiot county is the most southerly locality reported. The characteristic sculpture of the surface can be seen only with the microscope.

Section **GLYPHYALINA** Von Martens.

Upper surface of the shell marked with sharply defined, radial impressions.

VITREA INDENTATA (Say).

Shell imperforate, flattened, thin, pellucid; epidermis highly polished, corneous; whorls rather more than 4, rapidly enlarging, with regular, subequal distant, radiating, impressed lines, which on the body whorl extend to the centre 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 centre of the base of the shell; umbilicus none, but the umbilical region is indented.

Alt. $2\frac{1}{2}$, greater diam. 5, lesser $4\frac{1}{2}$ mm.

Helix indentata, Say, Jour. A. N. S. P., II., 372, (1822).

Zonites indentatus W. G. Binney, Man. Am. Land Shells, 62, fig. 15, (1885).

Helix indentata, Miles, Rep. Geol. Surv. Mich., 235, (1861).

Hyalina indentata, Currier, Shell-bearing Moll. Mich., 4, (1868).

DeCamp, Shell-bearing Moll. Mich., 5, (1881).

Zonites indentatus, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Generally distributed in both peninsulas but not as common as either *V. hammonis* or *Z. arborea*. Distinguished by the impressed radiating lines and imperforate base.

VITREA RHOADSI Pilsbry.

Shell umbilicate, depressed, thin, pellucid, corneous; surface polished with numerous impressed radiating lines; whorls about 4, rapidly enlarging, suture impressed, aperture rather large, transverse; lip simple, acute.

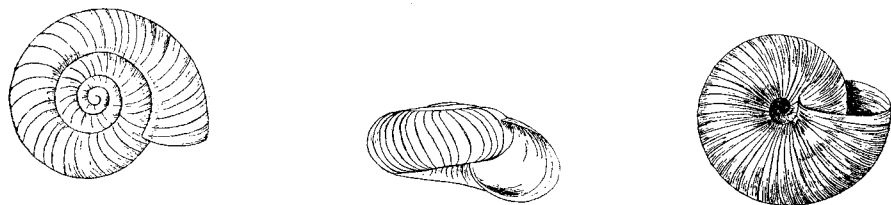


Fig. 49. *V. rhoadsi*. $\times 5\frac{1}{2}$.

Alt. $2\frac{1}{2}$, diam. 4.8 mm.

Vitrea rhoadsi, Pilsbry, Naut. XII., p. 101, (1899).

This recently described species resembles *V. indentata* in the impressed radiating lines, which sculpture the surface, but differs in being distinctly umbilicate. It has thus far been reported only from the Grand Traverse region at Charlevoix, Petoskey and Carp Lake, Emmet county.

Section **PARAVITREA** (Pilsbry).

Shell depressed or discoidal, perforate or narrowly umbilicate, composed of numerous closely coiled whorls, usually grooved radially above; thin and fragile; internally having obliquely radial laminae or rows or pairs of teeth at intervals of a third of a whorl, some or all of them often wanting, especially in old individuals.

VITREA MULTIDENTATA (Binney).

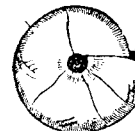


Fig. 50. *G. multidentata* (Binney.) $\times 4.7$.
Alt. $1\frac{1}{2}$, greater diam. $3\frac{1}{4}$ mm.

Helix multidentata, Binney, Bost. Jour. Nat. Hist., III., 425, pl. XXII., fig. 5, (1840).

Zonites multidentatus, W. G. Binney, Man. Am. Land Shells, 183, fig. 180, (1885).

Gastrodonta multidentata, Currier, Shell-bearing Moll. Mich., 4, (1868).

DeCamp, Shell-bearing Moll. Mich., 5, (1881).

Zonites multidentatus, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Rare and local. It has been found in Marquette, Ontonagon, Emmet, Grand Traverse, Benzie, Iosco, Saginaw, and Kalamazoo counties, which indicates a general distribution throughout the state.

Genus **EUCONULUS** Reinhardt.

Shell imperforate or very narrowly perforate, turbinata, arcti-spiral; whorls 5-6, rather convex; aperture depressed-lunar; the penultimate whorl strongly excided, somewhat oblique. Peristome with margins separated.

Animal bluish-black on the head, neck and eye peduncles, lighter on the sides and base; foot very narrow, threadlike, a distinct caudal mucus-pore.



Fig. 51. Jaw of *Euconulus* (Binney.)
Jaw arcuate, ends attenuated; anterior surface smooth, concave, margin smooth, with an obtuse median projection. Dentition as usual in the family, but is peculiar in the bifurcation of all the marginal teeth.



Fig. 52. Dentition of *Euconulus*. (Binney.)

KEY TO THE SPECIES OF *EUCONULUS*.

- I. Whorls 5 or less, wider and spire less elevated than in II., the peripheral angle in middle of whorl.....*fulvus*.
- II. Whorls 6, very narrow, spire more elevated, peripheral angle above the middle of the whorl.....*chersinus polygyratus*.

EUCONULUS FULVUS (Muller).

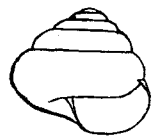


Fig. 53.
E. fulvus. $\times 5\frac{2}{3}$.

Shell subperforate, subconical, thin, pellucid; smooth, shining, minutely striated, amber-colored; whorls 5 rounded above, the last one distinctly angular in front, the angle disappearing on the latter part of the whorl; suture distinct and deep; aperture transverse, narrowly lunate, rounded below, peristome simple, acute; base convex, indented.

Alt. 3, greater diam. 4, lesser $3\frac{1}{2}$ mm.
Helix fulva, Draparnaud, Hist. Nat. Moll. France, 81, pl. VII., fig. 12-3, (1805).

Zonites fulvus, W. G. Binney, Am. Land Shells, 67, fig. 26, (1885).

Helix chersina, Miles, Rep. Geol. Surv. Mich., 235, (1861).

Conulus ———, Currier, Shell-bearing Moll. Mich., 4, (1865).

—————, DeCamp, Shell-bearing Moll. Mich., 5, (1881).

Zonites fulvus, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Common and of general distribution in both peninsulas. This species is distinguished from *E. chersinus polygyratus* by its more conical, less elevated spire, fewer, wider whorls and peripheral angle, the aperture is more transverse and more rounded below.

E. fulvus mortoni Jeffr., was cited in my Terr. Moll. of Mich. (1894), from East Saginaw. The recent receipt of authentic examples from England has shown that the identification was erroneous.

EUCONULUS CHERSINUS POLYGYRATUS (Pilsbry).



Fig. 54.
E. chersinus polygyratus
 $\times 6\frac{2}{3}$.

Shell minutely perforate, subglobose elevated, conical, thin, pellucid, smooth, shining, deep, brownish amber-colored; whorls 6 or more, rounded, very narrow; the last bluntly but decidedly angular in front, the angle above the middle of the whorl, base peculiarly sloping below the periphery; spire elevated, outline convex; upper surface with lustre of silk; base glossy, with a silky band around the outer margin; suture distinct and deep; aperture transverse, very narrow; peristome simple, acute.

Alt. 2.2, diam. 3 mm.

Conulus chersinus polygyratus, Pilsbry, Naut. XII., 116, (1899).

Not as common as the preceding species, but of general distribution in both peninsulas.

The narrow whorls and peculiar base of this species result in making the aperture narrower and less transverse than in typical *fulvus*. The convex, dome-shaped spire and more numerous whorls are also very characteristic, when once recognized.

Subfamily **ARIOPHANTINÆ** Pilsbry.

♂ System bearing a long dart-sack, surmounted by one or more coronal glands, and usually containing a slender curved dart.

Genus **ZONITOIDES** Lehman.

Shell depressed or subdiscoidal, umbilicate, smooth or ribbed, striate or costulate, shining, pellucid, corneus, aperture obliquely lunate. No internal teeth or callus.



Fig. 55. Jaw of *Z. arborea*.
(Binney.)

Jaw long, narrow, arcuate with ends pointed or rounded, lower margin smooth, with a wide median impression. Dentition as usual in the family.

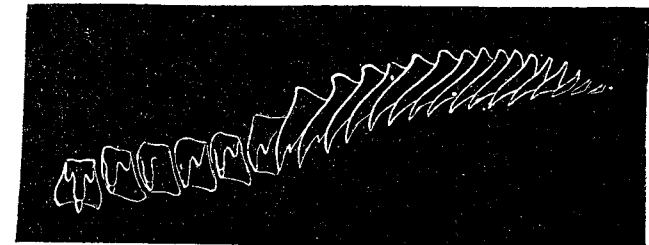


Fig. 56. Dentition of *Z. arborea*.—(Binney.)

Section **ZONITOIDES** s. s.

Surface polished.

KEY TO THE SPECIES OF *ZONITOIDES* s. s.

- I. Umbilicus wide, diameter $7\frac{1}{2}$ mm. *nitida*.
- II. Umbilicus moderate, diameter 5 mm. *arborea*.

ZONITOIDES NITIDA (Muller).

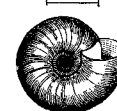
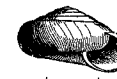


Fig. 57.
Z. nitida (Binney.)

- Helix nitida*, Muller, Hist. Verm., II., 32, (1774).
- Zonites nitidus*, W. G. Binney, Man. Am. Land Shells, 60, fig. 12, (1885).
- Helix hydrophila*, Miles, Rep. Geol. Surv. Mich., 235, (1861).
- Hyalina nitida*, Currier, Shell-bearing Moll. Mich., 4, (1868).
- , DeCamp, Shell-bearing Moll. Mich., 5, (1881).
- Zonites nitidus*, Walker, Rev. Moll. Fauna Mich., 16, (1894).

A common and abundant species of general distribution. It frequents the muddy banks of streams, where it is associated with the *Succineas*, *Pomatiopsis* and other semi-amphibious species. When alive, it is easily identified, not only by its greater size, but by the dark color of the animal which makes the shell appear to be black, when cleaned it is distinguished from *Z. arborea* on the one hand by its greater size and wider umbilicus and from *V. cellaria*, on the other, by its more convex whorls and lack of the basal callus-deposit.

ZONITOIDES ARBOREA (Say).

Fig. 58.
Z. arborea.
(Binney.)

Shell umbilicated, depressed, very slightly convex, thin, pellucid; amber-colored, smooth with microscopic revolving lines, shining; whorls 4-5, with very minute oblique microscopic striæ; suture well impressed; aperture transversely rounded; peristome thin, acute; umbilicus moderate, well developed, round and deep.

Alt. $2\frac{3}{4}$, greater diam. 5, lesser $4\frac{1}{2}$ mm.

- Helix arborea*, Say, Nich. Encycl. pl. IV., fig. 4, (1817).
Zonites arboreus, W. G. Binney, Man. Am. Land Shells, 61, fig. 13, (1885).
Helix ———, Sager, Doc. H. Rep. Mich., 1839, 420, separate, 14.
 ——— *arborea*, Miles, Rep. Geol. Surv. Mich., 235, (1861).
Hyalina ———, Currier, Shell-bearing Moll. Mich., 4, (1868).
 ———, DeCamp, Shell-bearing Moll. Mich., 5, (1881).
Zonites arboreus, Walker, Rev. Moll. Fauna Mich., 16, (1894).

This is the most common species of the family, and is found abundantly everywhere. Usually associated with *Vitrea hammonis*, *V. indentata*, *V. wheatleyi*, and *Zonitoides nitida*. For the differential characters, see the keys and the remarks under the several species cited.

Subgenus **PSEUDOHYALINA** Morse.

Surface closely striatè, ribbed or costulate.

KEY TO THE SPECIES OF *PSEUDOHYALINA*.

- I. Surface striate.
 a. Shell larger, 5.5 mm. in diameter..... *limatula*.
 aa. Shell minute, 2.5 mm. in diameter..... *minuscula*.
 II. Minute, diameter $2\frac{1}{2}$ mm. or less, surface ribbed or costulate.
 a. Surface ribbed, ribs oblique to lines of growth..... *exigua*.
 aa. Surface costulately [folded and reticulated with longitudinal ribs, very minute..... *milium*.

ZONITOIDES LIMATULA Ward.

Fig 59. *Z. limatula*. $\times 4\frac{1}{2}$.

Shell small, widely umbilicated, depressed, thin, greenish-white; whorls rather more than 4, convex, with fine, oblique, parallel striæ, becoming subobsolete in the base; suture well impressed; aperture subcircular; lip thin, acute, its ends approaching; umbilicus round and deep, exhibiting all the volutions.

Alt. 2.5, diam. 5.5 mm.

- Helix limatula*, Ward, Bost. Jour. Nat. Hist., III., 434, pl. XXI., fig. 2, (1840).
Zonites limatulus, W. G. Binney, Man. Am. Land Shells, 220, fig. 233, (1885).
Helix limatula, Miles, Rep. Geol. Surv. Mich., 235, (1861).
Pseudohyalina ———, Currier, List Shell-bearing Moll. Mich., 6, (1868).
 ———, DeCamp, Shell-bearing Moll. Mich., 5, (1881).
Zonites limatulus, Walker, Rev. Moll. Fauna Mich., 16, (1894).

This is apparently one of the rarest of Michigan species. None of the citations have been authenticated, and several of them have been proven to be erroneous. A single specimen in the collection of Mr. L. H. Streng, from Grand Rapids, is the only Michigan example that has thus far passed under observation. It is easily distinguished by its color, wide umbilicus and striate surface.



Fig. 60.
Z. minuscula.
(Binney.)

ZONITOIDES MINUSCULA (Binney).

Shell umbilicated, minute, depressed convex; whitish; whorls 4, convex, slowly increasing in diameter, very finely striate; suture deep; aperture nearly circular; peristome thin, acute; umbilicus large, deep and exhibiting the volutions; base rounded.

Alt. 1, greater diam. $2\frac{1}{2}$, lesser $2\frac{3}{4}$ mm.

- Helix minuscula*, Binney, Bost. Jour. Nat. Hist., III., 435, pl. XXII., fig. 4, (1840).
Zonites minusculus, W. G. Binney, Man. Am. Land Shells, 63, fig. 18, (1885).
Helix minuscula, Miles, Rep. Geol. Surv. Mich., 236, (1861).
Pseudohyalina ———, Currier, Shell-bearing Moll. Mich., 5, (1868).
 ———, DeCamp, Shell-bearing Moll. Mich., 6, (1881).
Zonites minusculus, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Common and of general distribution in the lower peninsula. Has not yet been reported from the upper peninsula. A well marked little species, characterized by its depressed form and large umbilicus.

ZONITOIDES EXIGUA (Stimpson).

Fig. 61.
Z. exigua. $\times 6.4$.
(Binney.)

Shell broadly umbilicated, depressed, pellucid, greenish horn-color, spirally striate and with distant longitudinal oblique ribs; spire very low; apex smooth; whorls $3\frac{1}{2}$, convex, the last rounded; aperture oblique, transversely rounded, remote from the axis; peristome simple, acute.

Alt. $\frac{1}{2}$, greater diam. $2\frac{1}{2}$ mm.

- Helix exigua*, Stimpson, Proc. B. S. N. H., III., 175, (1850).
Zonites exiguus, W. G. Binney, Man. Am. Land Shells, 181, fig. 177, (1885).
Pseudohyalina exigua, Currier, Shell-bearing Moll. Mich., 5, (1868).
 ———, DeCamp, Shell-bearing Moll. Mich., 6, (1881).
Zonites exiguus, Walker, Rev. Moll. Fauna Mich., 16, (1894).

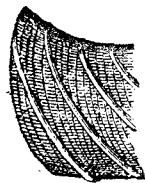


Fig. 62. Sculpture of *Z. exigua*. (Binney.)

Generally distributed in the northern part of the state. The only locality reported south of Lake county is Grand Rapids. Distinguished from *Pyramidula asteriscus*, the only species with which it is likely to be confounded, by its larger size and the position of the ribs, which are oblique to the lines of growth.

ZONITOIDES MILIUM (Morse).



Fig. 63. *Z. milium*. ×10. (Binney.)

Shell widely umbilicated, depressed, transparent, shining, greenish-white, distinctly and regularly striate above, with microscopic revolving lines, more conspicuous below; spire very low; whorls 3, rounded, rapidly increasing; aperture very oblique, semi-circular, remote from the axis; peristome simple, acute.

Alt. 1/2, greater diam. 1 1/2 mm.

Helix milium, Morse, Proc. B. S. N. H., VII., 28, (1859).
Zonites ———, W. G. Binney, Man. Am. Land Shells, 66, fig. 23, (1885).
 ———, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Owing to its minuteness this species is apparently rare, but evidently has a general distribution throughout the state. "The surface of the shell is raised in numerous costal folds, frequently anastomosing; longitudinal ribs reticulate the surface and render the folds so crenulated that in certain lights the shell appears as if ornamented with strings of beads. This peculiar character disappears at the base of the shell and is replaced by revolving lines and regular lines of accretion."—(Morse).

Genus **GASTRODONTA** Albers.

Shell subperforate or umbilicated, orbicularly convex or depressed, light horn-color, finely and obliquely striate, sometimes glassy; whorls 5-7, aperture lunate, base furnished with internal teeth, not reaching the margin, or thickened by an internal deposit of callus; peristome simple acute.

Animal bluish-black or dark slate-color above, paler on the posterior extremity and base; foot narrow and long; eye-peduncles long and slender; a distinct locomotive disk; pedal grooves terminating in a longitudinal mucus pore.



Fig. 64. Animal of *G. ligera*. (Binney.)



Fig. 65. Tail of *G. suppressa*. (Binney.)



Fig. 66. Jaw of *G. ligera*. (Binney.)

Jaw strongly arcuate, ends rounded; anterior surface striated; concave margin with a well developed median projection.

Dentition as usual in the family.

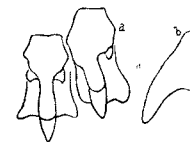


Fig. 67. Dentition of *G. intertexta*. (Binney.)

KEY TO THE SPECIES OF *GASTRODONTA*.

- I. Aperture with internal teeth on base of shell.....*suppressa*.
- II. Aperture edentulous, callus deposit on base of shell.
 - a. Spire somewhat elevated, acute.
 - b. Surface distinctly obliquely striate, not shining.....*intertexta*.
 - bb. Surface shining, very finely striate.....*ligera*.
 - aa. Spire depressed, obtuse, surface shining.....*demissa*.

GASTRODONTA INTERTEXTA (Binney).



Fig. 68. *G. intertexta*. (Binney.)

Shell perforated, subpyramidal; yellowish horn-color; whorls 6-7, slightly angled, closely and finely striate; striae cut by very minute spiral lines; usually with a narrow, light-colored band and an ill-defined brownish band below it, frequently, however, unicolored; aperture rounded, a little transverse; peristome thin, thickened within by a callus deposit, umbilical perforation small; base whiter than the upper surface.

Alt. 10, greater diam. 15, lesser 13 1/2 mm.
Helix intertexta, Binney, Bost. Jour. Nat. Hist., III., 413, pl. XX., fig. 2, (1840).
Zonites intertextus, W. G. Binney, Man. Am. Land Shells, 214, fig. 226, (1885).

Rare in Michigan. Sanilac county is the only known locality. Distinguished from *G. ligera* by its greater size, coarse, unpolished, striate surface and angulated body whorl.

GASTRODONTA DEMISSA (Binney).



Fig. 69. *G. demissa*. (Binney.)

Shell perforated, depressed-convex; yellowish horn-color, shining; whorls 6, minutely striate; spire obtusely convex; suture impressed; aperture transverse, not large, slightly oblique, a white callus deposit on the base; peristome thin, acute; base rather flat, smooth; umbilical region somewhat impressed.

Alt. 6, greater diam. 11 1/2, lesser 10 1/2 mm.
Helix demissa, Binney, Bost. Jour. Nat. Hist., IV., 361, pl. XVI, fig. 16, (1843).
Zonites demissus, W.G. Binney, Man. Am. Land Shells, 212, fig. 223, (1885).

Very rare. Kent county is the only locality reported. Very similar to *G. ligera* in color and texture, but differs in size and shape, being more depressed and the spire being convex with an obtuse apex. *G. ligera* is larger, more strongly striate, the body-whorl is more ventricose and the spire more elevated and acute.

GASTRODONTA LIGERA (Say).



Fig. 70.
G. ligera.
(Binney.)

Shell perforated, orbicularly convex; yellowish horn-color, shining; whorls 7, finely and closely striate; smooth below; spire rather elevated, acute; suture not much impressed; aperture semi-lunate, rounded; peristome thin, acute; aperture thickened within by a white callus deposit on the base and outer wall.

Alt. 10, greater diam. 15, lesser 13 mm.

- Helix ligera*, Say, Jour. A. N. S. P., II., 157, (1821).
Zonites ligerus, W. G. Binney, Man. Am Land Shells, 213, fig. 225, (1885).
Helix ligera, Sager, Doc. H. Rep. Mich., 1839, 420, separate, 14.
 ———, Miles, Rep. Geol. Surv. Mich., 235, (1861).
Mesomphix ———, Currier, Shell-bearing Moll. Mich., 4, (1868).
 ———, DeCamp, Shell-bearing Moll. Mich., 5, (1881).
Zonites ligerus, Walker, Rev. Moll. Fauna Mich., 16, (1894).
 Generally distributed in the southern part of the state.

GASTRODONTA SUPPRESSA (Say).



Fig. 71.
G. suppressa.
(Binney.)

Shell subperforated, subconical; shining, pale yellowish horn-color; spire somewhat pointed or obtuse; whorls 7-8, regularly and slowly increasing in diameter, striate above, smoother below; suture distinctly impressed; aperture transverse not much expanded; peristome simple, acute, thickened by a white callus deposit within, with one or two lamelliform, parallel teeth on the base; base flat, indented in the centre, near the aperture yellowish white and opaque; umbilicus small and rounded in young shells, obsolete or diminishing to a mere perforation when adult.

Alt. 5, greater diam. 8 mm.

- Helix suppressa*, Say, New Haven Diss., II., 229, (1829).
Zonites suppressus, W. G. Binney, Man. Am Land Shells, 225, fig. 241, (1885).
 ———, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Apparently rare and local. Washtenaw, Genesee and Kent counties are the only localities reported.

Family **LIMACIDÆ**.

Animal naked, with a thin, internal, shelly, non-spiral plate; no caudal mucus pore; foot margin narrow. Jaw arched, without ribs, with a median projection to the cutting edge. Lingual membrane with the rows of teeth horizontal or slightly oblique; marginal teeth with narrow basal plates, either unicuspid and thornlike, or bicuspid by elevation of outer on middle cusp.

Genus **AGRIOLIMAX** Morch.



Fig. 72.
Jaw of *A. agrestis*.
(Binney.)

Animal shortly carinate behind. Jaw arcuate with slightly attenuated but blunt ends; anterior surface smooth, cutting margin with a decided beak-like projection. Central tooth of radula tricuspid; laterals bicuspid, in a straight row; marginals in oblique rows. Eggs orbicular.

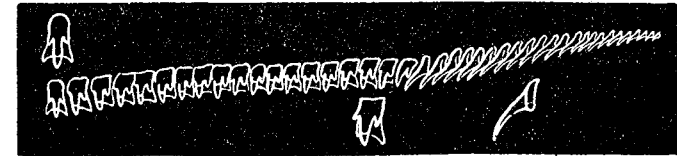


Fig. 73. Dentition of *A. agrestis*. (Binney.)

KEY TO THE SPECIES OF *AGRIOLIMAX*.

- I. Upper surface of body covered with smooth, flat tubercles separated by shallow furrows darker than general body color; respiratory foramen surrounded by a whiteish border; mucus milky white. *agrestis*.
 II. Smaller; tubercles on body more prominent, not flattened, intervening furrows of same color as general surface. No border around respiratory orifice; mucus thin, colorless *campestris*.

AGRIOLIMAX AGRESTIS (Linnæus).



Fig. 74. *A. agrestis*. (Binney.)

Body, when in motion, cylindrical, elongated, terminating acutely, tail shortly carinated; foot very narrow; upper surface rugose, rugæ separated by darker

colored, anastomosing lines; mantle large, ovate-oblong, rounded at both extremities, concentrically rugose; eye-peduncles elongated, cylindrical, with small ocular bulbs; lower tentacles immediately under them, very short; respiratory foramen posterior, large, surrounded with a whitish border; color varying from whitish through every shade of cinereous and gray to black, and through various shades of yellowish or amber-color to brownish, unicolored or irregularly maculated with small black points; sole sallow-white; mucus milky.

Length 25-50 mm.

Limax agrestis, Linnæus, Syst. Nat. (x), I., 652, (1758).

———, W. G. Binney, Man. Am. Land Shells, 453, fig. 498, (1885).

A European species locally introduced. It has been found at Lansing, Olivet and Lime Island in the St. Mary's river, and is reported from Ann Arbor. Larger than our native species, *A. campestris* and differs externally in the white ring around the respiratory orifice and the darker colored lines, which separate the rugæ on the upper surface of the body and the milky-white mucus which it exudes when touched. Anatomically the two forms are easily separated.

AGRIOLIMAX CAMPESTRIS (Say).



Fig. 75. *A. campestris*.
(Binney.)

Color usually various shades of amber or gray, without spots or markings, sometimes blackish; head and eye peduncles smoky; body cylindrical, elongated, terminating in a very short carina at its posterior extremity; mantle

oval, fleshy, but little prominent, with fine concentric lines; back covered with prominent, elongated tubercles, intervening furrows of same color as general surface; foot narrow, whitish; respiratory foramen on the posterior dextral margin of the mantle; mucus thin, watery.

Length 25 mm.

Limax campestris, Binney, Proc. B. S. N. H., 1841, 52.
 _____, W. G. Binney, Man. Am. Land Shells, 237, fig. 257, (1885).
 _____, Walker, Rev. Moll. Fauna Mich., 16, (1894).
 Common and of general distribution.

Family **ENDODONTIDÆ**.

Shell with opaque, brown coloring or flammules, usually rib-striate, the lip thin, unexpanded and sharp. Marginal teeth with wide, short and squarish basal plates, with one or several cusps, the outer cusp never elevated on middle cusp.

KEY TO SUBFAMILIES OF *ENDODONTIDÆ*.

- I. Jaw arcuate, its component laminae compactly soldered together *Endodontinae*.
- II. Jaw arcuate, composed of numerous, separate, rhomboidal, more or less overlapping plates connected by membrane only *Punctinae*.

Subfamily **ENDODONTINÆ** Pilsbry.

Jaw formed of overlapping laminae partially soldered together, or solid and vertically striated.

KEY TO GENERA OF *ENDODONTINÆ*.

- I. Shell broadly umbilicate, spire conoidly depressed or flattened, lacking internal teeth on outer wall of the body whorl..... *Pyramidula*.
- II. Shell discoidal, body whorl with internal teeth on outer wall arranged in pairs..... *Helicodiscus*.

Genus **PYRAMIDULA** Fitzinger.

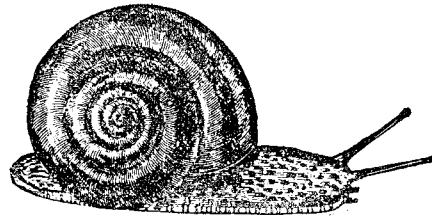


Fig. 76. Animal of *P. solitaria*. (Binney.)
 Animal having the sole undivided; lateral margin of the foot with a distinct border bounded by a groove, the grooves meeting above the tail, no caudal mucus pore; eye-peduncles long and slender.



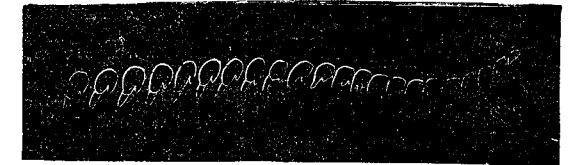
Fig. 77. Jaw of *P. alternata*. (Binney.)
 Jaw arcuate, its component laminae generally compactly soldered and indicated only by fine striae, which diverge slightly from the middle.

Radula having the centrals unicuspid or tricuspid; laterals unicuspid or bicuspid, marginals bicuspid or multicuspid, with low, wide basal plate.

Shell openly umbilicated, varying in contour from flattened to conoidal. Generally opaque, often rib-striate. Unicolored, spirally banded or flammulate. Whorls subcylindrical or keeled, the apex generally smooth. Aperture rounded-lunate; lip simple and thin.



Fig. 78. Dentition of *P. alternata*. (Binney.)



KEY TO THE SPECIES OF *PYRAMIDULA*.

- I. Shell large, banded or flammulate.
 - a. Transversely banded..... *solitaria*.
 - aa. Obliquely flammulate..... *alternata*.
- II. Shell smaller, unicolored, widely umbilicated, ribbed striate.
 - a. Spire slightly elevated, obtuse, tooth on base of aperture, diam. 8 mm. *perspectiva*.
 - aa. Spire more elevated, umbilicus narrower, no tooth in aperture, diam. 6 mm. *cronkhitei anthonyi*.
 - aaa. Spire flat, prominently ribbed, minute..... *asteriscus*.

Subgenus **PATULA** Held.

Shell rather large and solid; with convex spire and open umbilicus; whorls rounded or carinate at the periphery. Surface striate, ribbed-striate or spirally ribbed; obliquely flamed, unicolored or spirally banded; lip thin, simple.

PYRAMIDULA ALTERNATA (Say).

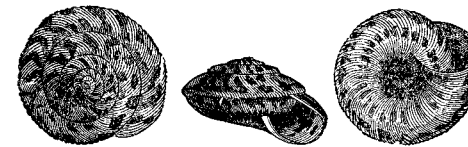


Fig. 79. *P. alternata*. (Binney.)

Shell broadly umbilicated, orbicularly depressed, thin, smoky horn-colored with red, interrupted, obliquely arranged patches and spots; above closely rib-striate, smoother below; whorls 5½, flattened, often angular at the periphery; aperture oblique, lunately rounded, banded within; peristome simple, acute.

- Alt. 10, greater diam. 21, lesser 19 mm.
Helix alternata, Say, Nich. Encycl., pl. I., fig. 2, (1817).
Patula _____, W. G. Binney, Man. Am. Land Shells, 255, fig. 269, (1885).
Helix _____, Sager, Doc. H. Rep. Mich., 1839, 420, separate, 14.
 _____, Miles, Rep. Geol. Surv. Mich., 235, (1861).
Anguspira _____, Currier, Shell-bearing Moll. Mich., 5, (1868).
Anguspira _____, DeCamp, Shell-bearing Moll. Mich., 6, (1881).
Patula _____, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Var. **ALBA** (Tryon).

- Anguispira alternata alba*, Tryon, Am. Jour. Con., II., 261, (1866).
Anguspira ————, Currier, Shell-bearing Moll. Mich., 5, (1868).
Anguispira ————, DeCamp, Shell-bearing Moll. Mich., 6, (1881).
Patula ————, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Unicolored pale greenish-white.

The typical form is common everywhere. The variety is found occasionally associated with it in the western part of the state, from Kent county to the St. Mary's river. It has not as yet been reported from the eastern part of the state.

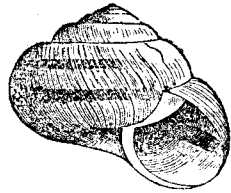
PYRAMIDULA SOLITARIA (Say).

Fig. 80. *P. solitaria*. (Binney.)

- Helix solitaria*, Say, Jour. A. N. S. P., II., 157, (1821).
Patula ————, W. G. Binney, Man. Am. Land Shells, 254, fig. 267, (1885).
 ————, Sager, Doc. H. Rep. Mich., 1839, 420, separate, 14.
 ————, Miles, Rep. Geol. Surv. Mich., 236, (1861).
Anguspira ————, Currier, Shell-bearing Moll. Mich., 5, (1868).
Anguispira ————, DeCamp, Shell-bearing Moll. Mich., 6, (1881).
Patula ————, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Var. **ALBINA** (W. G. Binney).

Lighter colored without bands.

- Patula solitaria albina*, W. G. Binney, Man. Am. Land Shells, 254, fig. 268, (1885).

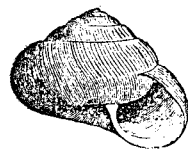


Fig. 81. var. *albina*. (Binney.)

Subgenus **GONYODISCUS** Fitzinger.

Shell rather small, depressed, with low but convex spire and open umbilicus. Apical $1\frac{1}{2}$ whorls smooth, the rest obliquely ribbed-striate, rather tubular, rounded or keeled at the periphery, unicolored. Aperture wide, lunate; lip simple.

PYRAMIDULA PERSPECTIVA (Say).

Fig. 82. *P. perspectiva*. (Binney.)

Shell broadly and perspectively umbilicated, orbicular, scarcely convex, above, excavated below; thin, reddish horn-color, regularly ribbed; whorls $6\frac{1}{2}$, gradually increasing; aperture small, lunately subcircular, with a single subprominent tooth on the base of the shell near the columella; peristome simple, acute, its extremities widely separated.

Alt. 3, greater diam. 8, lesser $7\frac{1}{2}$ mm.

- Helix perspectiva*, Say, Jour. A. N. S. P., I., 18, (1817).
Patula ————, W. G. Binney, Man. Am. Land Shells, 260, fig. 276, (1885).
 ————, Sager, Doc. H. Rep. Mich., 1839, 420, separate, 14.
 ————, Miles, Rep. Geol. Surv. Mich., 236, (1861).
Patula ————, Currier, Shell-bearing Moll. Mich., 5, (1868).
 ————, DeCamp, Shell-bearing Moll. Mich., 6, (1881).
Pyramidula ————, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Generally distributed south of the Saginaw-Grand valley and northerly on the western side of the state to the Grand Traverse region. Distinguished from *P. cronkhitei anthonyi* by its greater size, coarser striae, wider umbilicus and the tooth within the aperture near the base of the columella.

PYRAMIDULA CRONKHITEI ANTHONYI Pilsbry

Fig. 83. *P. cronkhitei anthonyi*. (Binney.)

Shell widely umbilicated, orbicularly convex, thin, brownish horn-color; closely-ribbed striate; whorls 4, flattened above, rounded below, the last rather wide, aperture sub-circular; peristome simple, acute, its terminations approaching.

Alt. 3, greater diam. 6, lesser $5\frac{1}{2}$ mm.

- Pyramidula cronkhitei anthonyi*, Pilsbry Proc. A. N. S. P. 1906, 153.
Patula striatella, W. G. Binney, Man. Am. Land Shells, 69, fig. 28, (1885).
 ————, Miles, Rep. Geol. Surv. Mich., 236, (1861).
 ————, Currier, Shell-bearing Moll. Mich., 5, (1868).
 ————, DeCamp, Shell-bearing Moll. Mich., 6, (1881).
Pyramidula ————, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Var. **ALBINA** "Morse," Ckll.

Greenish white, otherwise similar to the type.

- Patula striatella albina*, "Morse," Cockerell, Naut. III., 102, (1890).
Pyramidula ———— *alba*, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Var. **CATSKILLENSIS** (Pilsbry).

Umbilicus wider and periphery distinctly angulated.

- Pyramidula striatella catskillensis*, Pilsbry, Naut. XII., 86, (1898).

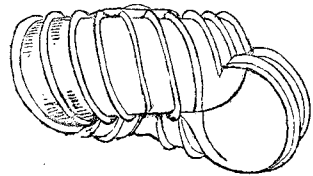
The typical form is very abundant in all parts of the lower peninsula, Isle Royale being the only recorded locality in the upper peninsula. The variety, *albina*, has been found only at Mackinac Island and Isle Royale.

Var. *catskillensis* is a northern form, ranging the Grand Traverse region through the upper peninsula, where it is the prevalent form.

Subgenus **PLANOGYRA** Morse.

Shell minute, orbicularly depressed, openly umbilicated, the spire flat, whorls bearing thin, sharp, spaced laminae, parallel to growth striae. Aperture rounded, lunar; lip simple.

PYRAMIDULA ASTERISCUS (Morse).



Shell widely umbilicated, orbicularly depressed, with from 25 to 30 delicate, thin, transparent laminae parallel with growth lines, with wavy edges and inclined backwards; whorls 4, the upper one flattened, the last globose; suture deeply impressed; aperture sub-circular; peristome simple, acute.

Fig. 84. *P. asteriscus*. $\times 26\frac{3}{4}$. (Morse.) Alt. $\frac{1}{2}$; greater diam. $1\frac{1}{2}$ mm.
Helix asteriscus, Morse, Proc. B. S. N. H., VI., 128, (1857).
Patula ———, W. G. Binney, Man. Am. Land Shells, 186, fig. 185, (1885).

Pyramidula ———, Walker, Rev. Moll. Fauna Mich., 16, (1894).

A northern species, which thus far has only been found at Charlevoix, Isle Royale and the Porcupine Mountains, Ontonagon county. Very minute, but very distinct in the position and character of the epidermal ribs, which follow the lines of growth, differing in this respect from *Zonitoides exigua*.

Genus **HELICODISCUS** Morse.

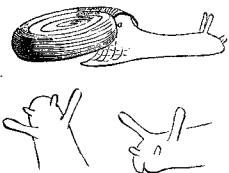


Fig. 85. Animal of *H. parallelus*. (Binney.)
 The shell lies perfectly flat upon the posterior end of the foot; the eye-peduncles standing nearly vertical; posterior end of the long and narrow foot conspicuously furrowed above, very short behind the mantle.



Fig. 86. Jaw of *H. parallelus*. (Binney.)
 Jaw arcuate, striate, the striae diverging somewhat from the median line; median projection inconspicuous.
 Radula with centrals tricuspid, decidedly narrower than the laterals; laterals with large square basal-plates; marginals low and wide, tricuspid.

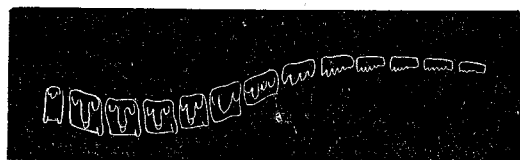


Fig. 87. Dentition of *H. parallelus*. (Binney.)

HELICODISCUS PARALLELUS (Say).



Fig. 88. *H. parallelus*. $\times 57$. (Binney.)

Shell widely umbilicated, discoidal; whorls 4, equally visible above and below, with numerous, equidistant, parallel, raised, revolving lines; suture much impressed; aperture remote from axis, semi-lunate, narrow, not expanding; peristome acute, thin; within the aperture on the extreme circumference, are from one to three pairs of minute, conical, white teeth.

Alt. $1\frac{1}{2}$; greater diam. $3\frac{1}{2}$, lesser 3 mm.

Planorbis parallelus, Say, Proc. A. N. S. P., II., 164, (1821).
Helicodiscus lineatus, W. G. Binney, Man. Am. Land Shells, 75, fig. 37, (1885).
Helix lineata, Miles, Rep. Geol. Surv. Mich., 235, (1861).
Helicodiscus ———, Currier, Shell-bearing Moll. Mich., 5, (1868).
 ———, DeCamp, Shell-bearing Moll. Mich., 6, (1881).
 ——— *lineatus*, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Common and of general distribution. Easily distinguished by its planorboid form and internal teeth.

Sub-family **PUNCTINÆ** Morse.

Jaw in numerous, distinct pieces, sometimes soldered together above, free and imbricated below. Marginal teeth quadrate.

KEY TO GENERA OF **PUNCTINÆ**.

- I. Shell minute, subdiscoidal, openly umbilicated..... *Punctum*.
- II. Shell pupæform, perforate..... *Sphyradium*.

Genus **PUNCTUM** Morse.

Shell minute, thin, subdiscoidal, but with convex spire, openly umbilicated. unicolorous; whorls about 4, convex, the apical $1\frac{1}{2}$ smooth, rather distinctly demarked from the following whorls, which have oblique striae or irregular riblets and excessively fine spiral striae; the last whorl cylindrical, not descending in front. Aperture lunate, rounded; lip simple, thin.

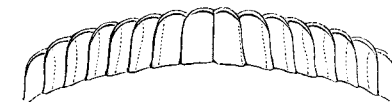


Fig. 89. Jaw of *P. pygmaeum*. (Binney.)

Jaw arcuate or horse-shoe shaped, composed of numerous separate rhomboidal plates bound together by a thin transparent membrane, more or less overlapping, the outer imbricating over the inner plates; the median two or three plates slightly separated, not overlapping.

Radula long and narrow; teeth rather separated, not in the least overlapping; centrals tricuspid, with narrow basal plate; laterals with wider rhombic basal-plates and bicuspid; marginals not differentiated in any way from the laterals, but becoming lower with shorter cusps.

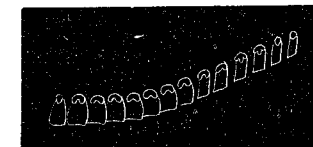


Fig. 90. Dentition of *P. pygmaeum*. (Binney.)

PUNCTUM PYGMÆUM (Draparnaud).

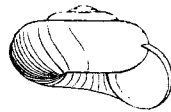


Fig. 91.
P. pygmaeum.
(Binney.)

Shell very minute, broadly umbilicated, subglobose; reddish horn-color, shining, finely striate and with microscopic revolving lines; whorls 4, convex, gradually increasing; aperture subcircular, oblique; peristome simple, acute.

Alt. 1, greater diam. 1½ mm.

Helix pygmaea, Draparnaud, Tabl. Moll. France, 93, (1801).
Microphysa ———, W. G. Binney, Man. Am. Land Shells, 71, fig. 31, (1885).

Punctum pygmaeum minutissimum, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Generally distributed, but rarely found on account of its minute size.

Genus **SPHYRADIUM** Charpentier.

Shell elevated, pupæform. Jaw and radula as in *Punctum*.



Fig. 92. Dentition of *S. edentulum*. (Gwatkin.)

SPHYRADIUM EDENTULUM (Draparnaud).



Fig. 93.
S. edentulum.
×11.6. (Binney.)

Shell minute, cylindrical, apex obtuse, finely and obliquely striate, light horn-color; whorls 5, moderately convex, suture deep; aperture circular; the peristome nearly continuous, simple, everted at its columellar margin, where it partially conceals a small umbilicus; aperture edentulous.

Alt. 1 3-5, diam. 4-5 mm.

Pupa edentula, Draparnaud, Hist. Moll., 52, pl. III., fig. 28-9, (1805).
Vertigo simplex, W. G. Binney, Man. Am. Land Shells, 191, fig. 195, (1885).
———, Miles, Rep. Geol. Surv. Mich., 236, (1861).
———, Currier, Shell-bearing Moll. Mich., 5, (1868).
———, DeCamp, Shell-bearing Moll. Mich., 7, (1881).
Pupa edentula simplex, Walker, Rev. Moll. Fauna Mich., 17, (1894).

Apparently of general distribution, though not abundant. Characterized by its cylindrical form, striate surface and edentulous aperture.

Family **PHILOMYCIDÆ**.

Animal limaciform, mantle covering the whole body; jaw with or without anterior ribs and a median projection to cutting edge; lingual membrane of *Helicidæ*; no shell.

KEY TO GENERA OF **PHILOMYCIDÆ**.

- I. Jaw smooth.....*Philomycus*.
- II. Jaw ribbed.....*Pallijera*.

Genus **PHILOMYCUS** (Rafinesque) Ferussac.

Animal limaciform. Body somewhat flattened, terminating obtusely or in a somewhat truncated form, obtuse anteriorly. Back convex, more flat, when fully extended. Integuments with irregular vermiform glands, anastomosing with each other and having a general longitudinal direction. Mantle covering the whole body. Foot expanded at its margin and visible beyond the edges of the mantle. No locomotive disk. Respiratory orifice near the head, some way to the rear of the right eye-peduncle. Anal orifice contiguous to and a little above and in advance of the pulmonary orifice. Orifice of organs of generation behind and below the right eye-peduncle. No caudal mucus pore. No external or internal shell.



Fig. 94. Jaw of
P. carolinensis.
(Binney.)

Jaw horn-colored, arcuate, with irregular concave margin, bearing a blunt slightly projecting beak; terminations blunt; the anterior surface convex, without a decided median carina, anterior surface smooth.

Lingual membrane arranged as usual in *Helicidæ*, long and narrow; centrals with a long narrow base of attachment, widening toward the lower margin, which is excavated, unicuspid; laterals like the centrals, but asymmetrical; marginals quadrate, longer than wide, obtusely bicuspid.

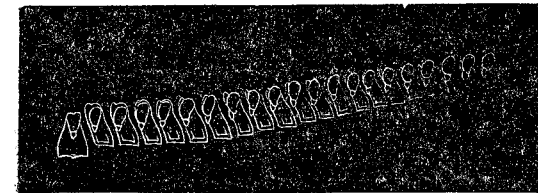


Fig. 95. Dentition of *P. carolinensis*. (Binney.)

PHILOMYCUS CAROLINENSIS (Bosc).

Body elongated, subcylindrical, flattened towards its posterior extremity,



Fig. 96. *P. carolinensis*. (Binney.)

which is obtuse; eye-peduncles short, stout, terminating in a bulb; tentacles immediately below, very short, nearly conical; mantle fleshy, covering the whole body, surface longitudinally rugose; color above whitish or yellowish-white, variegated with clouds and spots of brownish and blackish, so arranged as to form three ill-defined longitudinal bands, inferior margin white or yellowish; foot whitish, extending a little beyond the mantle posteriorly, show-

ing a whitish, flattened border. Respiratory orifice large, on the right side, one-fourth of an inch behind the origin of the eye-peduncle. Length 3-4 inches.

Limax carolinensis, Bosc., Vers de Buffon de Deterville, 80, pl. III, fig. 1.

Tebennophorus ———, W. G. Binney, Man. Am. Land Shells, 241, fig. 260, (1885).

—————, Walker, Rev. Moll. Fauna Mich., 16, (1894).

Generally distributed in the lower peninsula.

Genus **PALLIFERA** Morse.

Jaw stout, arcuate, ends but little attenuated, blunt; anterior surface with stout, separate ribs. Other characteristics as in *Philomycus*.

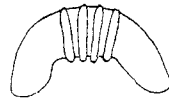


Fig. 97. Jaw of *P. dorsalis*. (Binney.)

Fig. 98. Jaw of *P. hemphilli*. (Binney.)

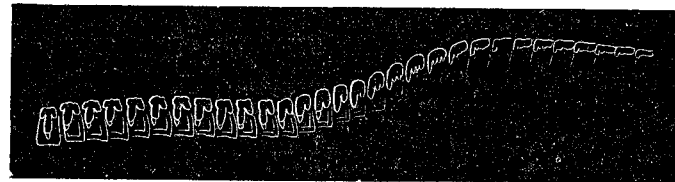
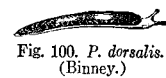


Fig. 99. Dentition of *P. dorsalis*. (Binney.)

KEY TO THE SPECIES OF **PALLIFERA**.

- I. Light colored. Jaw with nine ribs.....*dorsalis*.
- II. Black. Jaw with five ribs, concentrated on the middle third.....*hemphilli*.

PALLIFERA DORSALIS (Binney).



Color of upper surface ashy, with a shade of blue. An interrupted black line extending down the centre of the back; eye peduncles black, about one-eighth of the length of the body; tentacles blackish, very short. Body cylindrical and narrow, terminating posteriorly in an acute point; base of foot white, very narrow, its separation from the body not well defined. Upper surface covered with elongated and slightly prominent glandular projections, the furrows between indistinct. Respiratory orifice very minute, situated on the right side, about one-eighth of an inch behind the insertion of the eye-peduncle. The mantle is closely connected with the body.

Length, 18 mm.

Philomycus dorsalis, Binney, Bost. Jour. Nat. Hist., IV., 174 (1842).

Tebennophorus ———, W. G. Binney, Man. Am. Land Shells, 244, fig. 261, (1885).

A species of the Northern region found only as yet in Ontonagon and Marquette counties, and at Olivet, Eaton county. Distinguished by its slender form, light color and strongly ribbed jaw.

PALLIFERA HEMPHILLI (W. G. Binney).



Fig. 101. *P. hemphilli*. (Binney.)

Length (in alcohol) 25 mm.

Tebennophorus hemphilli, W. G. Binney, Man. Am. Land Shells, 247, (1885).

Animal long, narrow, cylindrical, with a pointed tail. Black. Jaw strongly arched with a median projection and four or five ribs, all concentrated on the middle third, the outer thirds being ribless. Originally described from North Carolina and Georgia, this species has recently been taken in Ontonagon county and at Ann Arbor. Easily distinguished from *P. dorsalis* by its color and the peculiar arrangement of the ribs on the jaw.

II. **HETERURETHRA**.

Superfamily **ELASMOGNATHA**.

Family **SUCCINEIDÆ**.

Tentacles but little developed or wanting. Jaw surmounted by an accessory quadrangular plate. Central tooth of the lingual membrane tricuspid, of the same size as the laterals, which are tricuspid or bicuspid, of the type of the *Helicidae*. Marginal teeth quadrate, with narrow base, multicuspid reflection, serrate by the splitting of the inner cusp into numerous denticles. Shell external or internal, very thin, transparent, spiral.

Genus **SUCCINEA** (Draparnaud).

Shell imperforate, thin, ovate or oblong; aperture large, obliquely oval. columella simple, acute; peristome simple, straight.



Fig. 102. Animal of *Succinea*. (Binney.)

Animal heliciform, thick and blunt before, short and pointed behind; mantle central, simple, protected by a shell which does not conceal the whole retracted animal; respiratory and anal orifices on the right of the mantle edge under the peristome; generative orifice behind the right eye-peduncle; no caudal mucus pore.

Jaw with an upper, quadrangular, accessory plate; strongly arched, the end acuminate or blunt, with a median projection to the cutting margin, ribbed or smooth.



Fig. 103. Jaw of *S. retusa*.

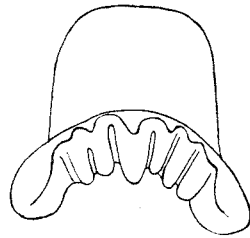


Fig. 104. Jaw of *S. ovalis*.



Fig. 105. Jaw of *S. avara*.

Radula with centrals tricuspid; laterals bicuspid or tricuspid; marginals short, serriform; the centre of the lower edge of the basal plates of the centrals and inner lower lateral angle of the basal plates of the laterals and marginals cut away. The reflection of the teeth is small in proportion to the size of the basal plates.

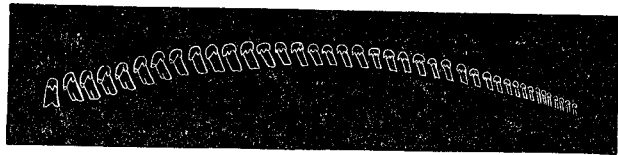


Fig. 106. Dentition of *S. retusa* (Binney.)

KEY TO THE SPECIES OF *SUCCINEA*.

- I. Spire very small, aperture very large, more than one-half of entire length of shell.
 - a. Body whorl large, expanded, aperture broadly oval.....*obliqua*.
 - aa. Body whorl compressed, elongate, aperture elongated.....*retusa*.
- II. Spire prominent, acute, whorls very convex, suture deep, aperture rounded at both extremities, ovate, hirsute when young.....*avara*.

SUCCINEA RETUSA Lea.



Fig. 107. *S. retusa*. (Lea.)



Fig. 108. *S. calumetensis*. X2. (Calkins.)



Fig. 109. *S. retusa*. (Binney.)

Shell ovate, somewhat conic, very thin, pellucid, light yellow or grayish, horn-color; shining, very minutely striate; whorls 3, the last compressed and elongated; spire short but acute; suture impressed; aperture elongated, more or less patulous, expanding anteriorly.

Alt. 15, of aperture, 10 mm.
Succinea retusa, Lea, Trans. Am. Phil. Soc., V., 117, pl. XIX., fig. 86, (1837).
 ——— *ovalis*, W. G. Binney, Man. Am. Land Shells, 338, fig. 368, (1885).

Succinea ovalis, Sager, Doc. H. Rep. Mich., 1839, 420, separate, p. 14.
 ——— ———, Miles, Rep. Geol. Surv Mich., 236, (1861).
 ——— ———, Currier, Shell-bearing Moll. Mich., 4, (1868).
 ——— ———, DeCamp, Shell-bearing Moll. Mich., 5, (1881).
 ——— ———, Walker, Rev. Moll. Fauna Mich., 17, (1894).



Fig. 110. *S. retusa magister*.



Fig. 111. *S. retusa decampii*. X2.
 Var. **MAGISTER** Pilsbry.



Fig. 112. *S. retusa peoriensis*. X2

“Distinguished from *S. retusa* Lea, by its larger size, less developed spire and larger aperture.”

Alt. 18, greater diam. 9½-10, length of aperture 13-14 mm.
Succinea retusa magister, Pilsbry, Naut. XII., 103, (1899).

Var. **DECAMPII** Tryon.

Ovate-conic, translucent, finely striate, polished; spire short, acute; suture moderately impressed; whorls 3, very oblique, narrow, flattened; aperture narrow, ovate; columella slightly incurved; yellowish-ash color, edge of aperture black.

Alt. 10, diam. 5 mm.
Succinea decampii, Tryon, Am. Jour. Con., II., 237, pl. II., fig. 23, (1866).
 ——— *decampii*, Currier, Shell-bearing Moll. Mich., 4, (1868).
 ——— ———, DeCamp, Shell-bearing Moll. Mich., 5, (1881).
 ——— *ovalis decampii*, Walker, Rev. Moll. Fauna Mich., 17, (1894).

Var. **PEORIENSIS** Wolf.

Ovate, spire obtuse, more elevated than in the typical form; body-whorl less elongated and more inflated; aperture nearly oval, somewhat angular above and regularly rounded below, scarcely patulous.

Alt. 10, diam. 6 mm.
Succinea peoriensis (Wolf), Walker, Naut. VII., 127, (1894).
 ——— *peonensis*, DeCamp, Shell-bearing Moll. Mich., 5, (1881).
 ——— *ovalis peoriensis*, Walker, Rev. Moll. Fauna Mich., 17, (1894).

This species usually known as *S. ovalis*, Gould *non* Say, is one of the most abundant and variable species found in the state. The variation is so great and the characteristics afforded by the shells alone are so slight and elusive, that until the anatomical details have been worked out, which, perhaps, may afford more reliable specific features, it is questionable whether any satisfactory arrangement can be made. There are several well marked varieties found in Michigan, which might be satisfactorily described from selected examples, but, in any considerable number of specimens, they seem to intergrade almost without limit. Under these circumstances it does not seem wise to attempt to do more than to define the varietal forms already described, it being understood, of course, that intermediate forms of all grades of relationship are liable to be met with. What may perhaps be

considered the typical form (*ovalis* Gld.), is that represented by Fig. 109, copied from Binney, and is characterized by its very short, rather blunt spire, elongated body whorl, and patulous aperture, expanding anteriorly.

Pilsbry's var. *magister* is distinguished by its large size, less developed spire and larger aperture. It has been cited from Michigan by Pilsbry, but I have never seen any specimens from this state that answer the description. The figure is from the type in the collection of the Philadelphia Academy. Tryon's var. *decampii* is well marked typically by its elongated, compressed form, peculiar color and black-edged lip. But the color and form are not always correlated. Specimens similar to *peoriensis* in form, and to *decampii* in color are not uncommon. In form this variety, typically, is similar to a well marked race of larger size, which is quite characteristic of the northern part of the state, and which has been erroneously quoted as *S. higginsii* Bld. In the western part of the state a much larger form is found, with a somewhat more elongated spire than in the typical form, which seems to be nearer Lea's *retusa* (fig. 107). Calkins' *S. calumetensis*, (fig. 108), is a doubtful form scarcely, if at all, different from the *ovalis* of Gould.

A very large form from East Saginaw, collected by the late Dr. G. A. Lathrop, seems to bear the same relation to the elongated northern form referred to in connection with var. *decampii* that typical *retusa* apparently does to the *ovalis* of Gould. The elucidation of the inter-relationship of these puzzling forms requires careful anatomical comparison and is one of the most important problems in regard to our terrestrial mollusca, which still remains to be solved.

SUCCINEA OVALIS Say.



Fig. 113.
S. ovalis.
(Binney.)

Shell ovate, pale green, yellowish-green, amber-colored or cinereous, thin and fragile, pellucid; shining, minutely wrinkled or striated; whorls 3, the last very large and much expanded, and more or less oblique; spire very small, not prominent nor pointed; suture distinct, impressed; aperture oval, large and expanded. columella thin, sharp, narrowed; peristome thin.

Alt. 18 to 25 mm.

- Succinea ovalis*, Say, Jour. A. N. S. P., I., 15, (1817).
- *obliqua*, W. G. Binney, Man. Am. Land Shells, 341, fig. 371, (1885).
- *campestris*, Sager, Doc. H. Rep. Mich., 1839, 420, separate, p. 14.
- , Miles, Rep. Geol. Surv. Mich., 236, (1861).
- *obliqua*, Miles, Rep. Geol. Surv. Mich., 236, (1861).
- , Currier, Shell-bearing Moll. Mich., 4, (1868).
- , DeCamp, Shell-bearing Moll. Mich., 5, (1881).
- , Walker, Rev. Moll. Fauna Mich., 17, (1894).

Although not as abundant as either *retusa* or *avara*, this species has a general distribution in the lower peninsula. It has not yet been reported from the upper peninsula except on Isle Royale. Occasional specimens are very close to the eastern form known as *S. totteniana* Lea, both in color and form.

The accepted nomenclature of this species (*S. obliqua*, Say), has been erroneous for many years. Say's original description of *S. ovalis* in 1817 has priority over his later use of *obliqua* for another form of the same species. Dr. Amos Binney attempted to apply *ovalis* to the species now known as

S. retusa Lea, and to retain the name of *obliqua* for this form, but such usage cannot be supported by the recognized law of priority in nomenclature.

SUCCINEA AVARA Say.



Fig. 114.
S. avara.
(Binney.)

Shell rather small, very thin and fragile, yellowish horn-color, amber-colored or greenish; shining, minutely hirsute when young; whorls 3, very convex, separated by a deep suture; last whorl large, not much expanded; spire very prominent, acute; aperture ovate, rounded at both extremities, about half as long as the shell.

Alt. 6-10 mm.

- Succinea avara*, Say, Long's Exped., II., 260, pl. XV., fig. 6, (1822).
- , W. G. Binney, Man. Am. Land Shells, 339, fig. 369, (1885).
- , Miles, Rep. Geol. Surv. Mich., (1861).
- , Currier, Shell-bearing Moll. Mich., 4, (1868).
- , DeCamp, Shell-bearing Moll. Mich., 5, (1881).
- , Walker, Rev. Moll. Fauna Mich., 17, (1894).

Var. **ALBA** Cockerell.

Shell white or greenish white.

Succinea avara alba, Cockerell, Naut. VII., 43, (1893).

Var. **MAJOR** W. G. Binney.

Larger, Alt. 10-14 mm.

Succinea avara major, W. G. Binney, Proc. A. N. S. P., 1858, 199.

Var. **VERMETA** Say.

Succinea vermeta, Say, New Harm. Diss., II., 230, (1829).

————, Miles, Rep. Geol. Surv. Mich., 236, (1861).

————, Currier, Shell-bearing Moll. Mich., 4, (1865).

————, DeCamp, Shell-bearing Moll. Mich., 5, (1881).

Suture very deeply impressed, almost scalariform.

Very abundant and of general distribution. The varieties *major* and *vermeta* occur quite frequently associated with the type and intergrade completely with it and with each other. The var. *alba* is more rare. Two or even all of the varietal characteristics may be not uncommonly found exemplified in a single individual.

III. ORTHURETHRA.

KEY TO THE FAMILIES OF ORTHURETHRA.

- I. Shell elongated, subcylindrical.
 - a. Columella truncated.....*Cochlicopidæ*.
 - aa. Columella continuous with the basal lip.....*Pupillidæ*.
- II. Shell conical, heliciform.
 - a. Aperture with parietal lamellæ.....*Pupillidæ*.
 - aa. No apertural lamellæ.....*Valloniidæ*.

Family PUPILLIDÆ.

Jaw smooth or finely striate, lower margin with or without a projection, sometimes reinforced with a superior arched appendage, like forming a double jaw, and to be compared to the accessory plate of the jaw of *Succinea*; lingual membrane similar to that of the *Helicidæ*; central tooth of same form and usually of same size as the laterals, laterals tricuspid; marginal teeth quadrate, wide, low denticulated.

Shell generally multispiral, elongated, conic or cylindrical; aperture small, often narrowed by internal teeth or lamellæ.

"As it is well known, most of the folds or teeth in the apertures of *Pupa* (*Pupilla*) have definite positions, and the principal ones are homologous throughout the group.

We therefore offer below a revised terminology of the apertural armature applicable to all *Pupidæ* (*Pupillidæ*), and requiring no especial reference to a key, as the terms are to a large extent sub-explanatory.

The plan is to call all projections upon the parietal wall and columella "lamellæ," those within the basal and outer walls of the aperture "plicæ" or folds. The nomenclature of particular folds is then as follows:

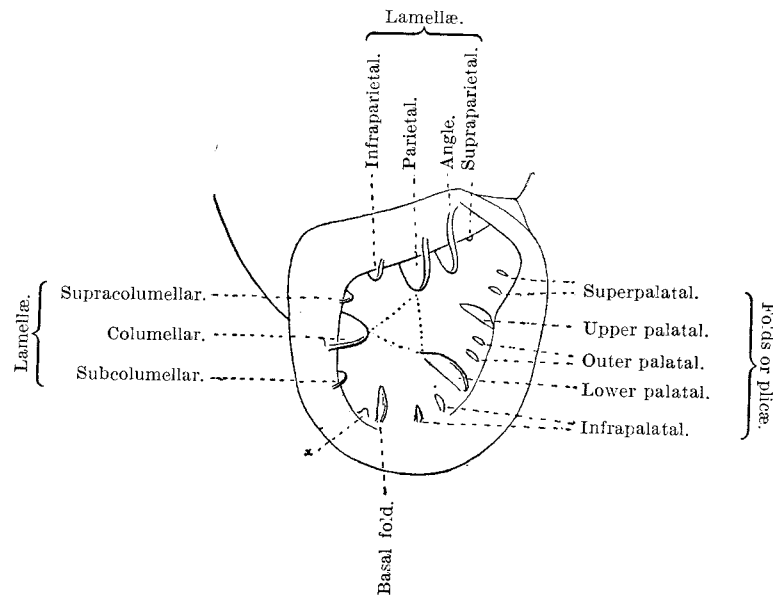


Fig. 115. Apertural lamellæ and folds of *Pupillidæ*. (Pilsbry.)

"But few *Pupidæ* (*Pupillidæ*), have all the folds named, and some of them are rarely present in American species. The infra-parietal, supra and sub-columellar lamellæ and the infra-, inter- and supra-palatal folds are 'secondary' in nearly all groups, and often vary in the species. The others are more constant, and vary but little in position when developed. The parietal and columellar lamellæ and the lower parietal fold, are at the angles of a nearly equilateral triangle, when the said palatal is not deeply immersed."*

* Pilsbry, Proc. A. N. S. P. 1903, 582.

KEY TO THE GENERA OF PUPILLIDÆ.

- I. Shell globose, conic or depressed, heliciform; aperture with entering lamellæ.....*Strotilops*.
- II. Shell elongated, pupiform.
 - a. Lip simple, surface costate.....*Acanthinula*.
 - b. Lip thickened, surface smooth or finely striate.
 - c. Aperture with outer lip regularly rounded, lower tentacles present.
 - d. Aperture edentate.
 - e. Spire acuminate, lip thickened, flatly reflected.....*Pupoides*.
 - ee. Spire cylindrical, obtuse, lip sharp, expanded.....*Pupilla*.
 - dd. Aperture dentate, lip more or less expanded.
 - e. No tooth on the columella.....*Pupilla*.
 - ee. One or more teeth on the columella.....*Bifidaria*.
 - cc. Aperture with outer lip more or less contracted above the middle, usually strongly indented, lower tentacles obsolete....*Vertigo*.

Genus STROBILOPS Pilsbry.

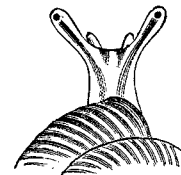


Fig. 116. Animal of *Strotilops*. (Binney.)

Shell umbilicated, globose, conic or depressed, obliquely and coarsely striated, smoother below; whorls 5 or 6, the last globose; aperture lunately rounded; peristome thickened, reflected; the parietal wall and base of the last whorl, each with two or more entering, revolving laminae.

Animal quite small in comparison to the size of the shell; eye-peduncles thick, bulbous; eyes very large.

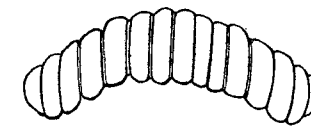


Fig. 117. Jaw of *Strotilops*. (Binney.)

Jaw low, wide, slightly arcuate, ends scarcely attenuated, blunt; cutting margin without median projection; anterior surface with crowded ribs, denticulating either margin and more developed on the centre of the jaw.

Lingual membrane as usual in *Helicidæ*, long and narrow, with 78 rows of 13- 1- 13 teeth with 5 perfect laterals.

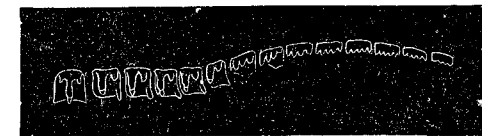


Fig. 118. Dentition of *Strotilops*. (Binney.)

KEY TO THE SPECIES OF STROBILOPS.*

- I. Spire elevated, conoidal, internal lamellæ on floor of body whorl 2 to 4, short.....*labyrinthica*.
- II. Spire globosely elevated, internal lamellæ on floor and adjacent side wall of body whorl, 6 or more.
 - a. Six long lamellæ; umbilicus a perforation merely.....*virgo*.
 - aa. About 8 short lamellæ arranged in a curved radial series, umbilicus wider and deep.....*affinis*.

* Adapted from Pilsbry, Naut. VII, 56.

STROBILOPS LABYRINTHICA (Say).

Shell umbilicated, elevated conoidal, brownish horn-color, with strong ribs above, below almost smooth; spire obtuse; whorls wider than high, regularly increasing in size from apex to periphery; body-whorl obtusely angulated 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 to four short, internal lamellæ on base of body whorl.

Alt. $1\frac{3}{4}$, greater diam. $2\frac{1}{4}$ mm.

Helix labyrinthica, Say, Jour. A. N. S. P., I., 124, (1817).

Strobila ———, W. G. Binney, Man. Am. Land Shells, 264, fig. 281, (1885).

Helix ———, Miles, Rep. Geol. Surv. Mich., 235, (1861).

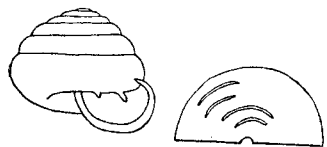
Strobila ———, Currier, Shell-bearing Moll. Mich., 4, (1868).

—————, DeCamp, Shell-bearing Moll. Mich., 6, (1881).

Strobilops ———, Walker, Rev. Moll. Fauna Mich., 17, (1894).

Apparently rare in this state. Bay, Saginaw, Kent, Kalamazoo and Berrien counties are the only localities reported.

This species is easily to be distinguished from both *virgo* and *affinis*, not only by the constant difference in the number and situation of the internal lamellæ, but by the depressed form, more conical spire, stronger ribs and flattened base; viewed from above the whorls are noticeably wider than in either of the other species and the peripheral angle is much stronger. Its general appearance is that of a lower, wider shell than either of the other species.

STROBILOPS VIRGO (Pilsbry).

Shell umbilicated, globosely elevated; white or pale brownish color; finely and closely ribbed above, ribs sub-obsolete on the base; spire high; dome-shaped; whorls $5\frac{1}{2}$, narrow, about 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; 6 long lamellæ on the base and outer wall of the body whorl.

Alt. 2, greater diam. $2\frac{1}{4}$ mm.

Strobila labyrinthica virgo, Pilsbry, Naut. VI., 94, 1892.

Strobilops virgo, Pilsbry, Naut. VII., 56, (1893).

—————, Walker, Rev. Moll. Fauna Mich., 17, (1894).

The only species yet reported from the northern part of the state, where it is quite abundant. South of Iosco county, the only localities reported are in Oakland, Saginaw and Kalamazoo counties.

Aside from the peculiar arrangement of both the internal and parietal lamellæ, *virgo* is easily separated from *labyrinthica* by its rounded dome-shaped spire, finer ribs, rounder aperture, and more convex base and less accentuated peripheral angle.

From *affinis*, it differs in size, narrow umbilicus, more rounded spire and more rounded base; the arrangement of the apertural lamellæ is also quite different. Only four of the lamellæ appear on the base, the others being at and above the periphery.

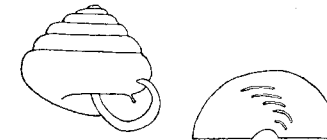
STROBILOPES AFFINIS Pilsbry.

Fig. 121. *S. affinis*. ×8.4.

Shell umbilicated; obtusely elevated; dark brown; finely and closely ribbed above, ribs lighter below; spire obtusely elevated; whorls $5\frac{1}{2}$, rather narrow, higher than wide, body whorl obtusely angled at the periphery, somewhat flattened, but rounded below, impressed around the umbilicus, which is round and deep; aperture lunately rounded; peristome thickened, narrowly reflected; about 8 short lamellæ arranged in a forwardly curved radial series from the axis across the base and up the outer wall of the body whorl.

Alt. $2\frac{1}{2}$, greater diam. $2\frac{7}{8}$ mm.

Strobilops affinis, Pilsbry, Naut. VII., 56, (1893).

Apparently of general distribution in the southern part of the state, but as yet has not been reported north of the Saginaw-Grand valley.

Its essential characteristics as compared with the other species of the genus, have already been pointed out. But it may be added, that while it is uniformly larger than either of the others, in contour it is intermediate between them, although, as a whole, nearer to *virgo* than *labyrinthica*. Compared with *labyrinthica*, the spire is more obtusely elevated, the whorls are narrower, the base more rounded, the aperture is rounded below and the peripheral angle is less pronounced. Compared with *virgo* the spire is not so globosely elevated; but is higher in proportion to the body whorl; whorls are rather wider, the ribs stronger, the base more flattened; the peripheral angle more marked; the aperture about the same in both. The arrangement of the lamellæ is very characteristic five only appear on the base, the others being at and above the periphery.

Genus **ACANTHINULA** Beck.

Shell minute, pyramidal or globosely turbinata, thin, brown, minutely umbilicated. Epidermis raised into lamellæ crossing the whorls. Aperture subvertical or subcircular; the lip acute, expanded toward the columellar insertion, the margins remote.

Section **ZOÖGENITES** Morse.

Shell globosely turbinata, perforate, ornamented with oblique, cuticular lamellæ.



Fig. 122. Animal of *A. harpa*. (Binney.)

Animal with the foot-edges prominently crenulated; labial lobes large; lower tentacles nearly obsolete. Genitalia unknown.

Jaw arched, with numerous wide, subobsolete ribs. Radula with formula 11, 6, 1, 6, 11. Middle teeth tricuspid, the mesocone not reaching edge of square basal plate; laterals bicuspid; marginals wide with many irregular cusps.



Fig. 123. Jaw of *A. harpa*. (Binney.)

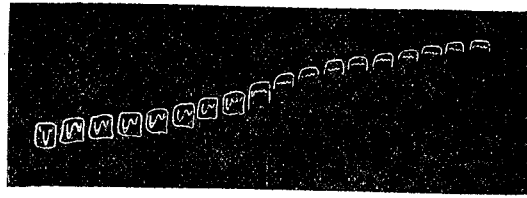


Fig. 124. Dentition of *A. harpa*. (Binney.)

ACANTHINULA HARPA (Say).



Fig. 125. *A. harpa*. (Binney.) ×6.

Shell subperforate, ovately conic, pellucid, very thin, irregular striate, light horn color; spire conical, rather obtuse; whorls four, convex, the upper ones smooth, the last two with prominent distant, thin, colorless ribs, the last whorl rounded, somewhat longer than the spire; aperture lunately oval; peristome simple, acute.

Alt. 3½, greater diam. 2 mm.

Helix harpa, Say, Long's Exped., II., 256, pl. XV., fig. 1, (1824).
Acanthinula harpa, W. G. Binney, Man. Am. Land Shells, 185, fig. 183, (1885).
 ———, Walker, Rev. Moll. Fauna Mich., 16, (1894).

A northern species. The Porcupine mountains, Ontonagon county, and Isle Royale, in the Upper Peninsula, and Charlevoix, Petoskey and Beulah, Benzie county, in the Grand Traverse region are the localities thus far reported. Easily distinguished by its elevated shape and prominent ribs.

Genus **PUPOIDES** Pfeiffer.

Shell rimate, cylindrically ovate, apex rather obtuse, rather smooth, shining, pellucid; whorls 6-7, rather convex, aperture semi-ovate, edentate; peristome thickened, reflected, its external margin decidedly arcuate.

Animal as in *Pupilla*.

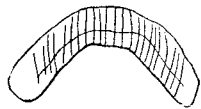


Fig. 126. Jaw of *P. marginatus*.



Fig. 127. Dentition of *P. marginatus*. (Binney.)

PUPOIDES MARGINATUS (Say).



Fig. 128. *P. marginatus*. (Binney.) ×4.

Shell fusiform, regularly diminishing in size from the body-whorl to the apex, smooth; brownish horn-color; whorls 6 very convex, very lightly striate; suture well impressed; aperture lateral, rounded oval; peristome white, rather broadly reflected, strongly curved above; umbilicus perforated.

Alt. 5½, diam. 2-2½ mm.

Cyclostoma marginata, Say, Jour. A. N. S. P., II., 172, (1821).
Pupa { *fallax* W. G. Binney, Man. Am. Land Shells, 324, fig. 351, (1885).

Bulimus marginatus, Miles, Rep. Geol. Surv. Mich., 236, (1861).
Pupa fallax, Walker, Rev. Moll. Fauna Mich., 17, (1894).

Not a common species. Reported from Berrien, Kent, Genesee, Monroe, and Washtenaw counties.

Genus **BIFIDARIA** Sterki.

Shell small, umbilicus perforate, cylindrical, turriculate, conic or ovoid; surface smooth, polished or finely striate or, rarely, finely ribbed; aperture lateral, oval or sub-orbicular; contracted by one or more teeth on the parietal wall and inner margin of the lip and columella; peristome expanded or reflected; parietal lamella large and more or less distinctly complex, formed by the fusing of the parietal and supraparietal lamellæ; the columellar lamella also generally somewhat complex; the typical inferior and superior palatal lamellæ are generally present and as a rule deep seated, never reaching the margin.

Animal, jaw and dentition as in *Pupilla*.



Fig. 129. Animal of *B. tappaniana*. (Binney.)



Fig. 130. Jaw of *B. tappaniana*. (Binney.)

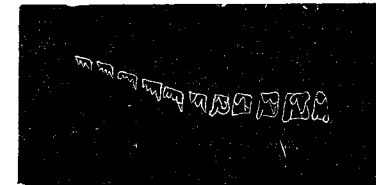


Fig. 131. Dentition of *B. tappaniana*. (Binney.)

KEY TO THE SECTIONS OF *BIFIDARIA*.*

- I. Parietal and angle lamellæ very short, small and tuberculiform; no palatal folds; shell cylindrical. *Privatula*.
- II. Parietal and angle lamellæ elongate, more or less united, either by a callous ridge, or so extensively as to appear like a single sinuous, or emarginate lamella. *Albinula*.
- III. Parietal lamella simple; no angle lamella; parietals normal or increased by accessory denticles, often standing on a callous ridge. . . *Vertigopsis*.

KEY TO THE SPECIES OF *BIFIDARIA*.

- I. Base of shell between umbilicus and margin compressed, forming a keel.
 - a. Shell cylindrical, apex obtuse, length more than 4½ mm. . . . *armifera*.
 - aa. Shell sub-conical, length 3 mm. *contracta*.
- II. Base of shell rounded.
 - a. Aperture multidentate, labial teeth on a ridge of callus, contracting the aperture.
 - b. Shell obtusely conical, last whorl widest, parietal and inferior palatal teeth straight. *tappaniana*.

* Adapted from Pilsbry, Proc. A. N. S. P., 1900, 593.