A DESCRIPTIVE

ILLUSTRATED CATALOGUE

OF THE

MOLLUSCA

OF INDIANA.

BY RICHARD ELLSWORTH CALL,
PH. D., M. A., M. D.

LETTER OF TRANSMITTAL.

Prof. W. S. Blatchley, State Geologist:

SIR—I hand you herewith my report on the Mollusca of Indiana, prepared in accordance with instructions received from you.

In this paper I have endeavored to fully present the present condition of knowledge relating to these forms in Indiana. It is only fair to say that careful and general collecting over the State would probably increase somewhat the number of species and would largely increase the number of localities at which certain forms would occur, but such extensive collecting appears to be a remote contingency.

The information contained herein is based upon my own personal collecting in the State and on information derived from the shells submitted to me, from time to time, by the persons named below. It has been my plan throughout to make the paper of use to Indiana students who may wish to take up this inviting field of natural history and whose opportunities in the way of authentic collections and the extensive literature are limited. Most of the species are illustrated; the Unios are rather fully depicted in the large series of plates which I submit herewith, and which for the first time, will put this difficult group in a properly illustrated form into the hands of Indiana educators. The drawings have been carefully made and are from Indiana shells, for the greater part. Only a very few forms are not illustrated, and they are such as could be readily identified without illustration.

I am indebted to your courtesy for opportunity to re-describe many critical forms from the collections of the State Museum, an especially desirable thing, for many of the earlier named forms have never been properly described. To the following gentlemen I am also indebted for occasional specimens: Mr. A. W. Butler, Indianapolis; Professor Voorhees, Brookville; Professor J. T. Scoville, Terre Haute; Professor Barton W. Evermann, Washington; Professor Joseph Moore, Richmond; and to the Biological Experiment Station of the Indiana University, at Turkey Lake, for opportunity to examine such shells as that organization collected.

I trust that this report will prove of service in the high schools and colleges of the State, and lead to some general interest in a much neglected branch of the zoology of Indiana.

Very truly,

R. ELLSWORTH CALL.

Brooklyn, N. Y., July 1, 1898.

A DESCRIPTIVE ILLUSTRATED CATALOGUE OF THE MOLLUSCA OF INDIANA.

BY RICHARD ELLSWORTH CALL, PH.D., M.A., M.D.

This catalogue is intended to be complete and to fully exhibit the present state of knowledge concerning the group of which it treats, as presented in the fauna of Indiana. To render its completeness more perfect, all the literature of the subject has been carefully passed in review and all authenticated facts of distribution have been added to those which long personal collection and study of Indiana mollusks have brought to light. Yet, great as the care exercised has been, I can not hope to have included all the known facts of distribution in the State, but believe that all facts of undoubted occurrence of species are included.

Indiana mollusks have long been known. Among the very earliest published papers on American shells are those of Thomas Say, formerly of New Harmony, who may justly be called the father of American conchology. Contemporaneous with him was C. S. Rafinesque, mainly known for his botanical and ichthyological work, who first described many forms from the Ohio River and especially from that portion which flows along the southern boundary of Indiana. But the land shells were first and most completely studied, and most of the earlier work was accomplished among the land forms. Say described from the region around New Harmony, and sent abroad to his correspondents, many Indiana shells. One form which Say described as in a semi-fossilized condition, from the loess region of the lower Wabash, was *Helicina occulta*, a form which has later been found living in several localities, though none of them are within the bounds of this State. In Iowa, near Iowa City, in western Pennsylvania, and near South Pittsburg, Tennessee, this form is now found living. But strange to say none have yet occurred in Indiana. Other forms which Say, and after him other writers, notably Conrad and Lea, described from Indiana have since been found to be synonyms and are properly to be placed under other forms well-known from elsewhere. For historical purposes a summary list of all forms from Indiana, originally

described from the State, is given below, from which it will be seen that three species of land shells, 29 species of fresh-water shells, univalves, and 21 species of fresh-water bivalves were originally made known from within its borders.

THE GENERAL CHARACTER OF THE SHELL FAUNA.

Nearly all the groups recognized in the eastern province of the interior region, both among land and fresh-water shells, are found represented in this fauna. All, however, are not equally well represented. Certain groups of fresh-water univalves are found to be especially well represented over the northern half of the State, in the region of the glacial lakes, while other groups are but sparsely distributed. Among the *Limnœidæ*, so abundant in the northern half of the State, the individuals are frequently very numerous, the grassy shores and reedy margins of the small lakes within the terminal moraine affording the very best conditions for luxuriant development of this family. But the *Strepomatidæ* are represented by comparatively very few forms. The reverse conditions are exhibited in the southern half of the State. In the Ohio River and its tributaries this group of shells becomes a very conspicuous element of the shell fauna. In the Wabash, as far up as Huntington, two or three species abound, but in respect both to individuals and species the southern portions of the State furnish the greatest variety. Beginning with the Ohio River, which is on the northern margin of the great center of distribution of this family, as far as middle Alabama, the *Strepomatidæ* form a characteristic part of the shell fauna. It would seem that as the Ohio is approached from the north and this great geographic area is entered this group of mollusca appears to become more numerous in both individuals and species until the Coosa River, in Alabama, is reached, where the forms are crowded upon each other and abound beyond one's ability to express numbers. The same facts appear to be true of the *Unionidæ*, which, for probably the same geologic reason, has its metropolis in the great Cumberland plateau. Comparatively few species are found in northern Indiana, and those are all forms of wide distribution. But in the Wabash below Terre Haute, in the South Fork of the White River and in the Ohio both species and individuals abound. The Ohio River forms are widely distributed over the Southern States, especially over Tennessee, Kentucky, Alabama, Georgia and Mississippi, but have been given a great variety of names, most of which must now be relegated to synonymy. They are easily connected by geographic series; the types of most groups there known occur in the Ohio River fauna.

In the case of the land shells there is nothing peculiar to the State except that few species and individuals occur in the northern portions. In the southern parts of the State, however, both species and individuals are more numerous. All species found belong to the Central Province of Binney, except a very few of circumpolar distribution, like *Vallonia pulchella* and *Hyalina arborea*, which are found in all suitable localities all over the State. No land shells from this State are peculiar to it, though several were first made known to science from within its borders.

HABITS OF THE LAND MOLLUSCA.

The student of Indiana mollusca must first learn something of their habits before he can hope to obtain a representative collection. And such knowledge will not be the easiest to obtain. Of course the larger forms will be the first to attract attention and will probably be the first to be secured. The smaller species will only be obtained after a long experience in field work.

As a rule it will not be found profitable to search for land shells far within dense forests nor on dry hillsides with southern exposure. The margins of open woods, where are to be found numerous fallen trees, or in low-lying lands about river bottoms above the annual limit of floods, rich and rocky hillsides with eastern or northern exposure and covered with open forest are good localities. In such situations these retiring animals may be sought with fair chance of success. It will then be learned that on days during light showers, or after heavy rains, while the ground is still moist, from late in March until June and in the fall from September to early frosts, shells can usually be found. Every possible nook and cranny must be carefully searched. On open hillsides, under grass clumps, in situations where the wild ginger, the wild poppy and trillium grow, the larger shells, like *Mesodon elevata*, will be found. On the under side of chips, pieces of bark, in old stumps, under fallen logs, or between the bark and the decaying wood, the smaller forms will be found. On a day after a warm shower from the upper surfaces of fallen trees with rough bark, such as white oak or poplar trees, in river bottoms, many specimens of *Pupa* or *Vertigo* or *Zonites* may be taken which have been driven out of the cracks and folds in the bark by the rain water. In gardens, in the open fields, about the bases of large flat stones, especially in the spring and fall, many examples of *Vallonia* or *Pupa* may be taken. In swamps which have partially dried up but where an abundant growth of reeds is found, after a rain, hundreds of examples of *Succinea* may be taken, clinging to the under sides of the blades, where they are shel-

tered from the direct rays of the sun. In creek bottoms, after storms, clinging to the under side of plants like the ragweed, may be taken large numbers of *Mesodon clausa* or *Mesodon mitchelliana*. Crawling over the warm surface of the wet sands, in such situations as the last, may be seen hundreds of specimens of *Patula striatella*, and, near Indianapolis and Terre Haute, many examples of the beautiful *Mesodon multilineata*. In short, the collector will soon observe that some species peculiar to nearly all stations will come to light sooner or later. Occasionally a species will be found to be gregarious, especially towards the late fall. Such is the case with *Patula alternata*, which occurs in a great variety of situations all over the State. This shell is probably the most common one in Indiana, and is to be found in every possible situation, sometimes of magnificent development. It is also common to find *Mesodon elevata* and *Mesodon thyroideus* in numbers partially hidden in the soft dirt of damp hillsides which face the north. *Stenotrema monodon* and *Stenotrema hirsutum* are often found in numbers under flat rocks, especially about Madison, on the hillsides along the Ohio River. In these same situations also may be found *Triodopsis tridentata* and *Triodopsis inflecta* and *Triodopsis appressa*, forms which do not appear in the land fauna of the more northern parts of Indiana.

The under surfaces of fallen logs which are partially decayed afford hiding places for numbers of the shelless forms of *Limax* or slugs. The under surfaces of board walks about dwellings, damp places in cellars, or even in the crevices of rocks about well curbs, these forms frequently abound. Usually their presence is made known by a glistening line of shining dry mucus following along which the collector will speedily come to the hiding place of the animal. Traps may be made by laying old boards, not new ones, along the margins of gardens, in yards, or on the margins of forests, and many examples of these animals taken in that way. All forms of this nature should be collected and preserved in alcohol, not only because they are in themselves interesting, but because they have been largely neglected by students of Indiana mollusca. Only a very few forms are now known from this State. Early morning, or late in the afternoon, on damp and dark days, or in damp and secluded ravines, the collector will have best returns for his time and search.

Of the winter habits of these animals very little is known. In this State certain forms, like *Mesodon elevata* and *Mesodon exoleta*, burrow deeply into the earth, boring down into the ground in damp places on hillsides, until eight or ten inches of soil are above them. Here they snugly pass the winter. Others, like *Patula alternata*, collect in num-

bers at the base of old stumps under a thick covering of leaves, and hibernate in that manner. The slugs bury themselves in the decaying materials of logs, under the bark, or crawl far within the clefts of rocks, beyond the reach of frost. Many, indeed, it may safely be said most, perish in the cold of the rigorous Indiana climate, but always enough survive to keep favorable locations well populated with interesting forms. The minute *Pupas* and *Vertigos* and *Vallonias* bury themselves under flat stones or in the earth at the base of grass clumps, where they securely pass the long winter. Of the winter habits of the so-called amphibious *Succineas* nothing is known. It is believed that Indiana students of nature will find this subject of winter habits of the mollusca a most interesting and fruitful one. It promises much that is new or unique.

THE HABITS OF FRESH-WATER UNIVALVES.

Most of the rivers and lakes of Indiana entirely freeze over during a considerable portion of the winter, and this fact precludes careful study of the winter habits of the univalve shells which inhabit them. Such facts as are known are meager and leave the matter in a very unsatisfactory condition. Late in the fall the shells seem to disappear from their accustomed stations, and after a week or two only those of great vitality, such as *Physa* and *Limnophysa*, are to be seen. But with the coming of frost most of these have disappeared. Whether they retire to the deeper parts of the streams and lakes, or whether they burrow deeply into the mud is not known. The large, green univalve, *Campeloma*, is now known to burrow deeply into the soft mud of the river bottoms, to reappear again in the late spring, after the waters have become fairly well warmed. The *Strepomatids* entirely disappear and nothing is known about their winter habits, but it seems probable that they bury themselves in like manner in the soft mud. With them disappear all the minute small shells like *Amnicola* and *Bythinella*. The warm, shallow banks of the larger rivers, which usually present numbers of this form, are barren of life in the winter even when dredged. What becomes of them?

Fresh-water shells, univalves, may be sought with fair hopes of success in all possible stations, but certain ones are especially rich in individuals. Crawling along half buried in the mud of sluggishly flowing streams like the Ohio, the Wabash and the White rivers, at low water, on the margins of deep water, many hundreds of *Campeloma* and *Pleurocera* may be taken. Other forms are found clinging to the surfaces of confervoid covered rocks where the waters flow swiftly, while still others, like *Physa* and *Lymnophysa*, *Planorbis* and *Menetus*, may

be taken abundantly in ponds and lakes, among the reeds or clinging to them, or even floating on the surface, or rather crawling head downwards, in the still waters of river cut-offs and ponds. The minuter forms may be taken in great abundance clinging to the under surfaces of lily-pads in ponds or among the masses of *Potamogeton.* Certain small forms like *Menetus exacutus* are to be taken on the submerged stems of reeds and bullrushes, or even in *Carex* swamps. Occasionally two forms are to be taken on the muddy banks of rivers, above water mark, where springs keep the surface continually wet, such forms as *Limnophysa humilis* and *Limnophysa desidiosa* being thus commonly taken. A very peculiar group of small limnæid mollusks, the *Ancyli,* will be best collected on the inner surface of dead Unios, or fresh-water mussels, in all the rivers where these mollusks abound. Frequent specimens have been taken by me adhering to the larger forms of *Pleurocera* in both the Ohio and the Wabash rivers. The stomachs of the shore forms of river fish, like *Lepomis,* or the small species found in ponds along the Wabash River, furnish many fine examples of *Amnicola* and *Bythinella,* on which they feed largely. These minute forms may be taken with a suitable small meshed dredge by scraping over the soft mud on river banks or by dredging the deeper portions of lakes and ponds. Along the Ohio and the Wabash, in the muddy pools left by the falling waters of early summer, most of the fresh-water univalves, outside the family of Limnæidæ, may commonly be found in numbers.

FRESH-WATER BIVALVES.

The large mussels are well known to all frequenters of the rivers and creeks of Indiana. They are especially abundant in the rivers and streams of the southern half of the State, though the ponds, lakes and rivers of the northern half of Indiana contain many varieties. Their presence in any portion of a river may generally be detected by broken and dead valves which lie on the river bars or are scattered along the banks; they are also found collected in heaps about muskrat burrows or on flat rocks and logs at the river's edge, having been taken there for food purposes by muskrats and raccoons. Usually deep places in rivers which have muddy bottoms furnish the larger forms, like *Unio multiplicatus, Unio pustulatus* and *Unio ebenus,* while *Anodontæ* of several species usually so abound. The habits of these animals differ very greatly. Some kinds will be found crawling around on the shallow bars or near the banks of streams, while others may be obtained only by wading and collecting in very deep water. Muddy bottoms furnish different forms from those which

delight on gravelly bars. Among the mud-loving forms are *Unio tuberculatus, Unio anodontoides* (=*Unio teres* Rafinesque), *Unio parvus* and its related congener, *Unio glans*. On bars which are gravelly and where the water is fairly swift, may be found in large numbers *Unio metanevrus, Unio pustulatus, Unio irroratus* and *Unio cylindricus*. In the lakes of the northern parts of the State are found but few species of Uniones, among them the lake variety of the widely distributed *Unio luteolus* and *Unio rubiginosus*, with *Margaritana rugosa*. *Unio occidens*, usually a mud-loving species, also occurs in suitable locations in some of these northern lakes, but, like *Unio luteolus*, it is essentially a fluviatile species.

In muddy bottoms, or in stations with fine gravelly bottoms, in creeks, rivers and ponds, are to be found numbers of extremely small bivalves belonging to *Sphærium* and *Pisidium*. Ditches and small brooks will often present these forms when no others are to be taken in them. The dredge always succeeds in finding them where other methods fail. They are often mistaken for the young of the larger mussels, but needlessly so. They have no characters in common with their larger associates. One form is common in muddy stations in the Ohio which is quite white and translucent, the *Sphærium transversum* of Say.

THE ENEMIES OF MOLLUSCA.

Birds feed largely on some species of land shells, crushing the shells by a blow with the bill and extracting the soft animal readily. The bluejays strike them against rocks or other hard objects and break the shell in that manner. But field and wood mice are the great enemies of these animals. The habits of many mollusks which lead them to seek shelter under fallen logs along the margins of the forests and in woods often place them in the way of burrowing mice, who delight in them. It is no unusual thing to find hundreds of land shells with the entire top nibbled off, the animals of which have made the dinners of wood mice. Then, too, some species of land shells, notably *Macrocylis concava*, are carnivorous and have developed cannibalistic tendencies. They push their long, slender bodies far within the unprotected apertures of the larger *Mesodons*, destroying them and eating them at their leisure. They seem to be especially fond of the epidermis of many forms, and when collected in the same box with other shells will destroy their epidermis before attacking the inmate, a habit which has rendered useless many a fine cabinet specimen, as

all collectors know. But mice and birds are the chief natural enemies of land mollusca.

Fish destroy many thousands of fresh-water mollusks of all kinds annually. The univalves are taken whole and digested as a mass by their captors. Other fish with heavy pharyngeal plates, like *Moxostoma*, or like *Aplodinotus*, crush the heavy Unionès before ingestion. In shallow creeks, where these large bivalves abound, and where hogs can reach them, they are greedily devoured by these omnivorous feeders. I have seen hogs rooting the largest of these mollusks from their beds in the rivers of the south and crushing them as they would apples, rejecting the shells and using only the soft portions. As noted above, raccoons and muskrats destroy thousands yearly, so many indeed that one wonders how they manage to perpetuate their species.

But the greatest enemy of molluscan life is man. His refuse from sewerage, factory and mill have quite depleted some rivers of this form of life for long distances or entirely. Rejectamenta from gas factories, dyeing establishments, paper mills and sawmills have annihilated these forms of life for miles. The cultivation of hillsides, otherwise favorable for land shells, the extension of farmed areas, the drainage of swamps and semi-swamps, all have had great influence in depleting the abundance of land shells. It is believed that many of the fine collecting grounds known to Say and the earlier naturalists have in this way been completely destroyed. For the land shells this is, from an economical standpoint, a matter of small moment, for none of them are directly useful to man. But with the river forms this is quite different. Many feeding grounds for fishes have been thus destroyed, and every one knows the important bearing this must have on the development of inland fisheries. Many localities once favorable to fish are now quite devoid of this form of life as a direct result of the destruction of the molluscan life. In the very largest rivers, like the Ohio, this cause is comparatively inoperative, but in rivers like the upper Wabash, the White, the Patoka and the Blue the effect is most disastrous. The embryonic forms of Unios are distributed, in one stage of their development, by fish to which they adhere; the building of dams, preventing the running of fish, has resulted in almost the complete extinction of some forms of *Unio* above them.

SPECIES DESCRIBED FROM INDIANA.

In collating the list of mollusks known from this State, it has been a matter of great interest to determine the place that furnished original habitats. The Utopian community which was founded at New Harmony had among its members some of the foremost naturalists of

America at that time. Besides Say, to whom reference has already been made, there were Owen, Troost and Maclure, all of whom contributed to the scientific status of Indiana in the earlier days. Say especially improved the opportunities afforded by the new country and described many forms from the State. After him Anthony, Conrad and Lea furnish each his quota of forms supposed to be new. The following list gives all the species thus described, and the original locality, notwithstanding that many of them are now properly recognized to be synonyms. These writers seem to have exhausted the possibilities of the State in respect to new species and varieties. The list is quite a respectable one, and if there should have been included those forms which were described by Lea from the vicinity of Cincinnati, and all which occur along the southern shores of Indiana as a part of the Ohio fauna, the list would be much larger.

LAND SHELLS.

HELICINA OCCULTA Say. Near New Harmony.
Succinea vermeta Say. New Harmony.
POLYGYRA FASTIGIATA Say. New Harmony. Doubtful if from Indiana.

FRESH-WATER UNIVALVES.

ANCYLUS TARDUS Say. Wabash River.
VIVIPARA SUBPURPUREA Say. Wabash River.
CAMPELOMA PONDEROSUM Say. Ohio River.
PLEUROCERA CANALICULATUM Say. Falls of the Ohio.
Pleurocera moniliferum Lea. New Harmony.
Pleurocera anthonyi Lea. Fox River, "Indiana."
PLEUROCERA TROOSTII Lea. Near New Harmony. Locality is questionable.
LITHASIA OBOVATA Say. Wabash and Falls of the Ohio.
ANGITREMA VERRUCOSA Say. Wabash River.
ANGITREMA ARMIGERA Say. Wabash River.
Melania nupera Say. Wabash River.
=ANGITREMA VERRUCOSA. Wabash River.
ANCULOSA PRÆROSA Say. Falls of the Ohio.
ANCULOSA TRILINEATA Say. Falls of the Ohio.
GONIOBASIS DEPYGIS Say. Falls of the Ohio.
GONIOBASIS INTERSITA Haldeman. Swan Creek.
This species was based on specimens furnished by Mrs. Say after the death of her husband.
Goniobasis consanguinea Anthony. "Indiana."
Goniobasis bicolorata Anthony. Camp Creek, near Madison.
Goniobasis cubicoides Anthony. Wabash River.
Goniobasis infantula Lea. Falls of the Ohio.
Goniobasis louisvillensis Lea. Falls of the Ohio.
Goniobasis interlineata Anthony. Christy Creek.
Goniobasis spartanburgensis Lea. Wabash River.

Goniobasis informis Lea. Falls of the Ohio.
Goniobasis kirtlandiana Lea. "Indiana."
=*Goniobasis semicarinata* Say. Richmond.
=*Goniobasis bicolorata* Anthony. Camp Creek.
Meseschiza grosvenorii Lea. Wabash River.

This genus is now recognized to have been based upon pathologic specimens of a *Goniobasis*, probably *Goniobasis cubicoides* Anthony. The specimens were not only pathologic, but immature. The writer has several times, in streams in the South, noted many specimens of traumatic shells which might easily be referred to this "genus."

FRESH-WATER BIVALVES.

Unio abruptus Say. Wabash River.
UNIO ORBICULATUS Hildreth.
Unio arquatus Conrad. Wabash River.
=UNIO RECTUS Lamarck. Pathologic.
Unio capillus Conrad. Wabash River.
=UNIO FABALIS Lea. Ohio River.
Unio cicatricosus Say. Wabash River.
=UNIO VARICOSUS Lea.
UNIO CYLINDRICUS Say. Wabash River.
UNIO ELEGANS Lea. Wabash and Ohio rivers.
Unio heros Say. Wabash River.
=UNIO MULTIPLICATUS Lea.
UNIO MYTILOIDES Rafinesque. Wabash River.
UNIO PERSONATUS Say. Wabash River.
Unio phillipsii Conrad. Wabash River.
Unio sampsonii Lea. Wabash River.
=UNIO PERPLEXUS Lea.
UNIO SECURIS Lea. Ohio and Wabash rivers.
UNIO SULCATUS Lea. Wabash and Ohio rivers.
UNIO UNDULATUS Barnes. Wabash River.
MARGARITANA CONFRAGOSA Say. Wabash River.
MARGARITANA DEHISCENS Say. Wabash River.
=*Unio dehiscens* Say.
MARGARITANA MONODONTA Say. Wabash and Ohio rivers.
=*Unio monodonta* Say. From Falls of the Ohio.
ANODONTA EDENTULA Say. "Indiana." Locality not given.
Anodonta ferruginea Lea. Simon's Creek.
ANODONTA IMBECILLIS Say. Wabash River.
ANODONTA SUBORBICULATA Say. Ponds near Wabash River.

Of this list those species which are now believed to be synonyms are printed in *italics*. Of them it will be found that one writer has described the greater number, which fact is not surprising when one knows that Mr. Lea described as new everything which came from different streams or from beyond the borders of different states. Political State boundaries appear to have been, in Mr. Lea's mind,

insuperable obstacles to the distribution of species. Even eliminating these from our lists, there will yet remain a respectable number first made known to science from Indiana.

GEOGRAPHIC DISTRIBUTION OF FRESH-WATER FORMS.

The following summary tables of distribution of the fresh-water forms have been prepared, which will exhibit at a glance all the known facts in distribution at the present time. Sufficiently full collections of the land shells have not been made to warrant the preparation of similar tables for that division. The hydrographic map (Plate I) exhibits the drainage areas employed as best showing the distribution of the fresh-water forms.

SUMMARY OF GEOGRAPHIC DISTRIBUTION.

FRESH-WATER FORMS.

SPECIES.	Ohio Basin.	Whitewater Basin.	Patoka Basin.	East White Basin.	West White Basin.	Wabash Basin.	Maumee Basin.	St. Joseph Basin	Kankakee Basin.	Lake Michigan Basin.
UNIVALVES.										
Amnicola cincinnatiensis Anth.	×	.....	.....	.....	.....	.....	.....	.....	.....	.....
Amnicola limosa Say	×	×	×	×	×	×	×	×	×	×
Amnicola porata Say	×	×	×	×	×	×	×	×	×	×
Ancylus tardus Say.....	×	×	×	×	×	×	×	×	×	×
Bulinus hypnorum Linnæus..	.....	.....	.....	.....	×	×	.....	×	.....	×
Helisoma bicarinata Say	.....	×	.....	.....	×	.....	×	×	×	×
Helisoma campanulata Say....	.....	.....	.....	.....	.....	×	×	×	.....	×
Helisoma trivolvis Say.....	×	×	×	×	×	×	×	×	×	×
Limnophysa caperata Mull....	.....	.....	.....	.....	×	×	.....	.....	×	×
Limnophysa desidiosa Say.....	×	×	×	×	×	×	×	×	×	×
Limnophysa humilis Say	×	×	×	×	×	×	×	×	×	×
Limnophysa palustris Mull....	×	×	×	×	×	×	×	×	×	×
Limnophysa reflexa Say	×	×	×	×	×	×	×	×	×	×
Menetus exacutus Say	....	.....	.....	×	×	×	.....	.....	×	.....
Physa ancillaria Say	.....	.....	.....	.....	.....	×	.....	.....	×	×
Physa gyrina Say	×	×	×	×	×	×	×	×	×	×
Physa heterostropha Say.....	×	×	×	×	×	×	×	×	×	×
Valvata tricarinata Say.....	.....	.....	.....	.....	.....	.....	.....	×	.....	.....
Somatogyrus subglobosus Say ..	×	×	.....	.....	.....	×	.....	.....	.....	.....
Pomatiopsis lapidaria Say	×	.....	.....	.....	×	×	.....	.....	.....	.....
Campeloma decisum Say.....	.....	.....	.....	.....	.....	×	×	×	.....	×
Campeloma integrum DeKay ..	.....	.....	.....	.....	×	.....	×	×	.....	.....
Campeloma ponderosum Say...	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Campeloma rufum Hald	.....	.....	.....	×	×	×	×	×	.....	.....
Campeloma subsolidum Anth..	.....	.....	.....	.....	×	×	.....	×	×	.....
Lioplax subcarinata Say	×	.....	.....	.....	.....	×	.....	×	×	.....
Vivipara contectoides Binney .	.....	.....	.....	.....	.....	×	.....	×	×	.....
Vivipara intertexta Say	.....	.....	.....	.....	.....	×	.....	×	.....	.....
Vivipara subpurpurea Say	.....	.....	.....	.....	.....	×	.....	.....	.....	.....
Anculosa prærosa Say	×	.....	.....	.....	.....	.....	.....	.....	.....	.....
Anculosa trilineata Say.....	×	.....	.....	.....	.....	.....	.....	.....	.....	.....
Anculosa carinata Brug	×	.....	.....	.....	.....	.....	.....	.....	.....	.....
Angitrema armigera Say	.....	.....	.....	.....	.....	×	.....	.....	.....	.....
Angitrema verrucosa Say	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Goniobasis bicolorata Anth....	×	.....	.....	.....	.....	.....	.....	.....	.....	.....
Goniobasis cubicoides Anth ...	.....	.....	.....	.....	.....	×	.....	.....	.....	.....
Goniobasis depygis Say	×	.....	.....	.....	.....	.....	.....	.....	.....	.....
Goniobasis infantula Lea.....	×	.....	.....	.....	.....	.....	.....	.....	.....	.....
Goniobasis informis Lea.....	×	.....	.....	.....	.....	.....	.....	.....	.....	.....

SUMMARY OF GEOGRAPHIC DISTRIBUTION—Continued.

SPECIES.	Ohio Basin.	Whitewater Basin.	Patoka Basin.	East White Basin.	West White Basin.	Wabash Basin.	Maumee Basin.	St. Joseph Basin.	Kankakee Basin.	Lake Michigan Basin.
UNIVALVES.										
Goniobasis interlineata Anth.	.....	×	.....	.....	.....	.....	.....	.....	.....	.....
Goniobasis intersita Hald	×	.....	.....	.....	.....	.....	.....	.....	.....	.....
Goniobasis livescens Menke	.....	.....	.....	.....	.....	×	×	×	.....	×
Goniobasis louisvillensis Lea	×	.....	.....	.....	.....	.....	.....	.....	.....	.....
Goniobasis semicarinata Say	.....	×	.....	.....	.....	.....	.....	.....	.....	.....
Goniobasis spartanburgensis Lea	.....	.....	.....	.....	.....	×	.....	.....	.....	.....
Goniobasis pulchella Anth	×	×	×	×	×	×	×	×	×	×
Lithasia obovata Say	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Meseschiza grovesnorii Lea	.....	.....	.....	.....	.....	×	.....	.....	.....	.....
Pleurocera canaliculatum Say	×	.....	.....	.....	×	×	.....	.....	.....	.....
Pleurocera elevatum Say	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Pleurocera moniliferum Lea	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Pleurocera simplex Lea	×	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pleurocera subulare Lea	×	.....	.....	.....	.....	×	×	×	×	×
Pleurocera troostii Lea	.....	.....	.....	.....	.....	×	.....	.....	.....	.....
Pleurocera undulatum Say	×	.....	.....	.....	.....	×	.....	.....	.....	.....
BIVALVES.										
Pisidium abditum Hald	×	.....	.....	.....	×	×	×	×	×	.....
Pisidium rotundatum Prime	.....	.....	.....	.....	.....	.....	.....	×	.....	.....
Pisidium virginicum Bourg	×	.....	.....	.....	.....	.....	.....	×	.....	.....
Sphærium fabale Prime	.....	.....	.....	.....	.....	×	.....	.....	×	.....
Sphærium rhomboideum Prime	.....	.....	.....	.....	.....	.....	.....	×	.....	.....
Sphærium solidulum Prime	×	×	×	×	×	×	×	×	×	×
Sphærium sphæricum Anth	.....	.....	.....	.....	.....	×	.....	.....	.....	.....
Sphærium stamineum Conrad	×	.....	.....	.....	.....	.....	.....	.....	.....	.....
Sphærium striatinum Lam	×	×	×	×	×	×	×	×	×	×
Sphærium sulcatum Lam	×	.....	.....	.....	.....	×	.....	×	.....	.....
Sphærium transversum Say	×	×	×	×	×	×	×	×	×	?
Anodonta decora Lea	×	×	.....	.....	.....	.....	.....	×	.....	.....
Anodonta edentula Say	×	×	×	×	×	×	×	×	×	×
Anodonta ferruginea Lea	.....	.....	.....	.....	×	.....	.....	.....	.....	.....
Anodonta ferussaciana Lea	×	×	×	×	×	×	×	×	×	×
Anodonta footiana Lea	.....	.....	.....	.....	.....	×	.....	×	.....	.....
Anodonta grandis Say	×	×	×	×	×	×	×	×	×	?
Anodonta imbecillis Say	×	×	.....	.....	×	×	.....	.....	.....	.....
Anodonta pavonia Lea	.....	.....	.....	×	.....	×	.....	.....	.....	.....
Anodonta plana Lea	×	×	×	×	.....	.....	.....	.....	.....	.....
Anodonta salmonia Lea	×	.....	.....	.....	×	×	.....	×	.....	.....
Anodonta shæfferiana Lea	.....	.....	.....	.....	×	.....	.....	.....	.....	.....
Anodonta subcylindracea Lea	.....	.....	.....	.....	.....	×	×	×	×	.....
Anodonta wardiana Lea	×	.....	.....	×	×	.....	.....	.....	.....	.....
Anodonta suborbiculata Say	.....	.....	.....	.....	.....	×	.....	.....	.....	.....
Anodonta undulata Say	.....	.....	.....	.....	.....	.....	.....	×	.....	.....
Margaritana calceola Lea	×	×	×	×	×	×	×	×	×	?
Margaritana complanata Bar	×	×	.....	.....	×	×	.....	.....	.....	.....
Margaritana confragosa Say	.....	.....	.....	.....	.....	×	.....	.....	.....	.....
Margaritana dehiscens Say	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Margaritana hildrethiana Lea	×	.....	.....	×	×	×	.....	.....	.....	.....
Margaritana marginata Say	×	×	×	×	×	×	×	×	×	?
Margaritana monodonta Say	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Margaritana rugosa Barnes	×	×	×	×	×	×	×	×	×	×
Unio abruptus Say	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Unio cyphia Raf	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Unio alatus Say	×	.....	.....	×	×	×	.....	.....	×	.....
Unio anodontoides Lea	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Unio arctior Lea	×	.....	.....	.....	×	×	.....	.....	.....	.....
Unio asperrimus Lea	×	.....	....	×	×	×	.....	.....	×	.....
Unio camptodon Say	×	×?	.....	.....	.....	×	.....	.....	.....	.....
Unio capax Green	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Unio cicatricosus Say	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Unio cincinnatiensis Lea	×	.....	.....	.....	.....	.....	.....	.....	.....	.....
Unio circulus Lea	×	.....	.....	×	×	×	×	×	×	.....
Unio clavus Lam	×	×	×	×	×	×	×	×	×	?
Unio coccineus Lea	×	.....	.....	×	×	×	.....	.....	×	.....
Unio cooperianus Lea	×	.....	.....	.....	.....	×	.....	.....	.....	.....

SUMMARY OF GEOGRAPHIC DISTRIBUTION—Continued.

SPECIES.	Ohio Basin.	Whitewater Basin.	Patoka Basin.	East White Basin.	West White Basin.	Wabash Basin.	Maumee Basin.	St. Joseph Basin.	Kankakee Basin.	Lake Michigan Basin.
BIVALVES.										
Unio cornutus Barnes	×	.....	.....	×	×	×	.....	.....	×	.....
Unio crassidens Lam	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Unio cylindricus Say	×	.....	.....	×	×	×	.....	.....	×	.....
Unio distans Anth	.....	.....	.....	.....	.....	.....	.....	×	.....	.....
Unio donaciformis Lea	×	.....	.....	×	×	×	.....	.....	.....	.....
Unio dorfeuillianus Lea	×	.....	.....	.....	.....	.....	.....	.....	.....	.....
Unio ebenus Lea	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Unio elegans Lea	×	.....	.....	×	×	×	.....	.....	×	.....
Unio ellipsis Lea	×	×	×	×	×	×	×	×	×	×
Unio fabalis Lea	×	.....	.....	.....	.....	×	.....	×	.....	.....
Unio foliatus Hild	×	.....	.....	.....	.....	.....	.....	.....	.....	.....
Unio fragosus Conrad	×	.....	.....	.....	×	×	.....	.....	.....	.....
Unio gibbosus Barnes	×	×	×	×	×	×	×	×	×	×
Unio glans Lea	×	.....	.....	×	×	×	×	.....	.....	.....
Unio gracilis Barnes	×	.....	.....	.....	.....	×	.....	.....	×	.....
Unio graniferus Lea	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Unio iris Lea	×	×	×	×	×	×	×	×	×	×
Unio irroratus Lea	×	.....	.....	×	×	×	.....	.....	.....	.....
Unio lachrymosus Lea	×	×	.....	×	×	×	.....	.....	×	.....
Unio lævissimus Lea	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Unio lens Lea	×	.....	.....	×	×	×	.....	.....	.....	.....
Unio ligamentinus Lea	×	×	×	×	×	×	×	×	×	×
Unio luteolus Lam	×	×	×	×	×	×	×	×	×	×
Unio metanevrus Raf	×	.....	.....	×	×	×	.....	.....	×	.....
Unio multiradiatus Lea	×	×	×	×	×	×	×	×	×	×
Unio multiplicatus Lea	×	×	.....	×	×	×	×	.....	.....	.....
Unio mytiloides Raf	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Unio nasutus Say	.....	.....	.....	.....	.....	.....	.....	×	.....	.....
Unio obliquus Lam	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Unio occidens Lea	×	×	×	×	×	×	×	×	×	×
Unio orbiculatus Hild	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Unio ovatus Say	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Unio parvus Barnes	×	×	×	×	×	×	×	.....	×	.....
Unio perplexus Lea	×	.....	.....	×	×	×	.....	.....	.....	.....
Unio personatus Say	.....	.....	.....	.....	.....	×	.....	.....	.....	.....
Unio phaseolus Barnes	×	.....	.....	×	×	×	×	.....	×	.....
Unio plenus Lea	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Unio plicatus LeSueuer	×	×	×	×	×	×	.....	.....	×	.....
Unio pressus Lea	×	×	×	×	×	×	×	×	×	×
Unio pustulatus Lea	×	.....	.....	.....	×	×	.....	.....	.....	.....
Unio pustulosus Lea	×	.....	.....	.....	×	×	×	.....	.....	.....
Unio pyramidatus Lea	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Unio rangianus Lea	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Unio rectus Lam	×	×	×	×	×	×	×	×	×	×
Unio retusus Lam	×	.....	×	×	×	×	×	.....	.....	.....
Unio rubiginosus Lea	×	×	×	×	×	×	×	×	×	×
Unio sampsonii Lea	.....	.....	.....	.....	.....	×	.....	.....	.....	.....
Unio securis Lea	×	.....	.....	.....	×	×	.....	.....	.....	.....
Unio solidus Lea	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Unio spatulatus Lea	×	.....	.....	×	×	×	.....	.....	×	.....
Unio subovatus Lea	×	.....	.....	.....	×	×	.....	.....	×	.....
Unio subrostratus Say	×	.....	.....	.....	×	×	×	.....	.....	.....
Unio sulcatus Lea	×	.....	.....	.....	×	.....	.....	.....	.....	.....
Unio tenuissimus Lea	×	.....	.....	.....	.....	×	.....	.....	.....	.....
Unio triangularis Barnes	×	.....	.....	×	×	×	.....	.....	.....	.....
Unio trigonus Lea	×	.....	.....	.....	.....	×	.....	.....	×	.....
Unio tuberculatus Barnes	×	×	×	×	×	×	.....	.....	×	.....
Unio undulatus Barnes	×	×	×	×	×	×	.....	.....	×	.....
Unio varicosus Lea	×	.....	.....	.....	.....	.....	.....	.....	.....	.....
Unio ventricosus Barnes	.....	.....	.....	.....	.....	.....	×	×	×	×
Unio verrucosus Barnes	×	.....	.....	.....	×	×	.....	.....	×	.....
Unio zigzag Lea	×	.....	.....	×	×	.....	.....	.....	.....	.....
Totals	127	47	37	61	81	131	49	59	63	35

The ten drainage basins which are represented in these tables cover the entire State, and the tables afford a fairly reliable statement of the distribution of fresh-water forms over Indiana. It is interesting to note that this distribution appears to have some relation to the existence of the moraines of the Glacial Epoch and to have been in some definite sense determined thereby. This evidence has been elsewhere considered,* and I need not now stop to refer to it in detail. Northwards of this ancient ice barrier many southern forms have not yet succeeded in establishing themselves; but south of it many southern species of *Strepomatidæ* and *Unionidæ* are known to occur, though their metropolis is farther to the south within the borders of Tennessee and Alabama. A few forms are distributed over the entire State, a list of which is herewith presented:

REGISTER OF GENERALLY DISTRIBUTED SPECIES.

Unio clavus.
Unio iris.
Unio luteolus.
Unio ligamentinus.
Unio multiradiatus.
Unio rubiginosus.
Margaritana marginata.
Anodonta ferussaciana.
Anodonta grandis.
Sphaerium striatinum.
Amnicola porata.
Limnophysa palustris.
Limnophysa desidiosa.
Physa heterostropha.
Goniobasis pulchella.
Unio ellipsis.
Unio pressus.
Unio gibbosus.
Unio rectus.
Unio occidens.
Margaritana calceola.
Margaritana rugosa.
Anodonta edentula.
Sphaerium solidulum.
Sphaerium transversum.
Amnicola limosa.
Limnophysa reflexa.
Helisoma trivolvis.
Physa gyrina.

These species are among the most common in North America, and most of them have a very wide range indeed. They are mostly hardy species and though subjected to a great variety of stations and environmental conditions do not appear to have suffered much individual variation, none of the species being critical ones, that is, forms which are with difficulty recognized. All present a strongly characteristic facies and all are easily determined, no matter from what portion of the State they may come.

A further study of the geographical tables will demonstrate that the richest shell faunas occur in the Wabash and the Ohio drainages, these two areas furnishing nearly the same species in common, though many of each are not generally distributed over the State. Of the shells which are both common and yet limited in distribution *Unio*

*See Proceedings Indiana Academy of Science, for 1896, pp. 248 *et seq.*

ebenus, Unio irroratus and *Unio cyphia,* among the bivalves, and *Campeloma ponderosum* and *Pleurocera canaliculatum,* among the univalves, will serve as types. The differences between the two basins may be noted from the following lists, in which synonyms appear in small capitals:

OHIO BASIN.	WABASH BASIN.
UNIO CAMELUS.	*Unio personatus.*
Unio varicosus.	UNIO SAMPSONII.
UNIO CINCINNATIENSIS.	*Anodonta suborbiculata.*
Unio foliatus.	*Margaritana confragosa.*
Unio dorfeuillianus.	*Sphaerium sphaericum.*
Sphaerium stamineum.	**Sphærium fabale.*
Anculosa prœrosa.	GONIOBASIS SPARTENBURGHENSIS.
Anculosa trilineata.	*Goniobasis livescens.*
Anculosa carinata.	*Goniobasis cubicoides.*
GONIOBASIS BICOLORATA.	*Angitrema armigera.*
Goniobasis depygis.	MESESCHIZA GROVESNORII.
GONIOBASIS INFANTULA.	*Pleurocera troostii.* Doubtful.
GONIOBASIS INFORMIS.	*Vivipara subpurpurea.*
Goniobasis intersita.	*Vivipara contectoides.*
GONIOBASIS LOUISVILLENSIS.	*Vivipara intertexta.*
PLEUROCERA SIMPLEX.	*Menetus exacutus.*
Amnicola cincinnatiensis.	*Campeloma decisum.*
	Campeloma rufum.
	Campeloma subsolidum.
	Limnophysa caperata.
	Planorbella campanulata.

Here is a total of eleven species found in the Ohio basin against fifteen which are found in the Wabash basin. The proportion would be substantially the same if the synonymous forms included, printed in small capitals, were not excluded from the list. None of the members of the genus *Vivipara* appear in the Ohio basin, while but two *Uniones* are found in the Wabash Basin that are not found in that of the Ohio. No limnæids appear to be characteristic of the Ohio basin, while three such are found in the Wabash. Yet it is to be constantly borne in mind that further collections may invalidate this comparison by the discovery of other common forms, or that some of these forms may yet be ascertained to be common to the two faunas.

Turning again to the northern portion of the State, the most interesting fact presented is the existence of a number of Ohio drainage forms in the Maumee River, a stream of the Atlantic drainage. Opportunity was afforded the writer, in 1895, to make a small collec-

*Not seen; admitted to the list on the authority of Temple Prime, vide "Catalogue of the Species of Corbiculadæ," p. 10, 1863.

tion in the Maumee and the St. Mary's rivers, at Fort Wayne, well within the Maumee basin. While the collection was by no means exhaustive, it developed some very interesting facts which possess more than a passing significance.

Among the Ohio River forms found were the following:

Unio rubiginosus.
Unio glans.
Unio luteolus.
Unio retusus.
Margaritana complanata.
Anodonta edentula.
Unio clavus.
Unio gibbosus.
Unio parvus.
Unio pressus.
Margaritana calceola.
Goniobasis pulchella.

These species are accredited to the Western fauna, and most of them are not hitherto recorded as belonging to the Atlantic fauna. Two of these were so recorded by the writer as long ago as 1877, in the Erie Canal, in the Mohawk drainage, at Mohawk, N. Y., and record made of the fact in the "American Naturalist," Vol. XII, pp. 472, 473. Other records have since appeared. *Unio luteolus* is often quoted in faunal lists used for exchange purposes by Eastern collectors, but in every case where specimens have been secured, thus far, they have proven to be the male forms of the totally distinct *Unio cariosus,* a form not yet found in Western waters. *Anodonta edentula* may be, and probably is, a geographic variety of the Eastern *Anodonta undulata,* but the Maumee forms are Western in facies. It is therefore proper to regard it here as a Western shell in the drainage of an Atlantic stream. So far as the specimens go which are in my possession, they do not present very marked differences from the same shells found a few miles to the west in waters tributary to the Wabash. The environmental factors are precisely the same in both areas, and there should be no marked differences. There are none. But mingling with the Western fauna of the Upper Wabash were found large numbers of the Eastern strepomatid shell, *Goniobasis livescens,* a form which is abundant from New York throughout northern Ohio and along the Great Lakes. Near Huntington, on the Wabash, this shell was the most abundant strepomatid found. The same facts were true of the St. Mary's and the Maumee, though the greatest numbers were found in the former stream, clinging to the rocks along the banks, in the heart of the city of Fort Wayne. Associated with them were large numbers of *Pleurocera subulare,* a form abundant in the East, but also of wide Western distribution, and an undetermined pleuroceroid mollusk of Western affinities. It closely resembles *Pleurocera lewisii,* but of this determination I am yet uncertain.

It is important to note, in this connection, that the headwaters of the Aboite River, or its east fork, approach to within three miles of the St. Mary's at Fort Wayne, and that the divide at that locality is barely perceptible. Moreover, the Wabash and Erie Canal has long established water communication between the two basins—probably long enough to establish interchange of faunas, especially in the case of the univalves, which are far more migratory in their habits than the Unionidæ. This is the case in the Erie Canal in New York, by means of which the advent of the Western faunas into Eastern waters may be almost chronologically traced. To offset this possible explanation, is the fact that the species seem to be well established, and occur, many of them, in great numbers in the Maumee Basin. But, whatever the explanation, the species appear in the two basins, and in them both there is a commingling of the two faunas, with but few Western representatives of the Eastern fauna. The Western representatives in the Eastern fauna greatly outnumber, both in species and individuals, the Eastern fauna in the Western Basin.

The suggestion of the relation of this distribution to glaciation and its physiographic results has before occurred to the writer, though in another connection. As long ago as 1886, in discussing certain anomalies in the distribution of Ohio River forms of *Unionidæ* in the State of Kansas, attention was directed to this problem in the following language: "Considerable data have accumulated in the hands of the writer which seem to imply the necessity of correlating this peculiar distribution with certain facts in glacial geology, but those data will not warrant the statement that such correlation exists. Attention is directed to this problem in the hope that other observers may use their opportunities and supply all the information possible."* A recent writer proposes,** the same explanation for the distribution of the two faunas in this region and, from the facts we have herein adduced, the locality offers most excellent opportunities for a careful study of the problem. Yet, the fact of the artificial connection of these two areas must constantly be borne in mind. A second region where the heads of the drainage areas are practically coincident occurs in Kosciusko County, where the several small lakes and general low-lying region are all drained by streams which flow either into the Tippecanoe or the Turkey rivers, the first of which is tributary to the Wabash, the second to the St. Joseph, of Michigan. A low moraine separates the two basins.

Vide, Call, "Fifth Contribution to a Knowledge of the Fresh-water Mollusca of Kansas," Bull. Washburn College Laboratory of Natural History, vol. i, No. 6, pp. 178, 179, 1886.

**Simpson, "On the Mississippi Valley Unionidæ Found in the St. Lawrence and Atlantic Drainage Areas," American Naturalist, vol. xxx, pp. 379-384, 1896.

THE ECONOMIC USES OF INDIANA MOLLUSCA.

To what extent, if any, the former inhabitants of Indiana used these animals for food purposes can never be known. In many instances the aborigines made some use of the larger forms of mussels, as is abundantly witnessed by the shells found in mounds and in piles on the sites of ancient villages. But it is mere guess that they formed any considerable part of their food. The interiors of many species are highly colored and very beautiful, and this fact may have appealed to the primitive inhabitants of Indiana. Near the village of Lawrenceburg, Dearborn County, in the great triangular plain formed by the junction of the Miami and the Ohio rivers, are several large mounds, now well worn down by cultivation, in which thousands of these shells are still to be seen. It is certain that there is no historic record of their use by the red men for food. But there is no good reason why, with abundance of condiment and proper preparation, a really serviceable food article could not be made out of them. The large white "foot" is tough, and becomes more so when well cooked, but many of the smaller shells have a tender animal which could be eaten, if necessary. Trial attempts made by the writer to use these as food show that they are better than common report makes them.

But two economic uses for these shells are now known. One of these is the manufacture of a good grade of pearl button, an industry which is prosecuted with some success at Muscatine, Iowa, where there are large button factories. The great possibility that pertains to these animals in this direction can be best appreciated by those who know their habits and know of the immense beds, miles in length, in the Mississippi and other large rivers. The shells are easily taken by dredging with steam dredges, and the thick disks of certain species made into button blanks, to be perforated and finally polished. Many gross are thus annually made. In rivers like the Wabash and the Ohio, where the writer knows of *Unio* beds miles in length, enormous quantities of these animals may be found as raw material. Not all the forms in Indiana rivers are suitable for this purpose, but many thousands of bushels may be obtained which are entirely suitable.

Throughout the Northwest, and even into the Southern States, a few years ago, swept a pearl-hunting craze which has resulted in the loss of thousands of these animals in an uncertain search for pearls. One who has long studied these animals soon comes to know the forms which commonly produce pearls and how they are formed. In every case of a pearl forming it marks a pathologic condition of the animal. Usually the introduction of some foreign matter, like small

gravel grains or sand or other object, is a sufficient irritation to the shell-forming portion, the mantle, and the animal seeks to cover over the intrusion with a layer of pearl. Often the object remains detached from the shell; often it is cemented to the inner face of the valve as an excrescence. In this way the pearls begin to be formed. Most of them are irregular in shape and often lack the lustre which gives them the value of gems. But they are by no means uncommon in certain species. In the Raccoon River, in Iowa, occurs a species, *Unio wardii*, which is closely related to *Unio metanevrus*, so common in the Ohio and Wabash rivers of Indiana. It is rare indeed to find an individual of this species, and they are numerous, which does not contain from one to three or four pearls, of varying sizes. The writer has had, at times, as many as two hundred pearls taken from this species alone. Observation has shown that the large, heavy forms which live on gravel bars in swiftly running waters produce most of these objects. It would appear that under these conditions small sand grains which act as a nucleus are swept into the body of the shell and are the prime cause of the pearl formation. Some species never produce them, at least they have never appeared in the course of over twenty years of collection and study of these forms. Among these are those forms which live in mud and in deep and sluggishly flowing waters.

Mr. George F. Kunz has placed on record* about all that is known of the "pearl-hunting industry" and its results in this country. It is hardly in such condition as to warrant the name of "industry," being carried on spasmodically and without any very scientific or business-like methods. Occasionally pearls of excellent quality have been found, and for them good prices have been obtained, Mr. Kunz reporting that two large pearls from Florida brought $850 and $600, respectively. Many of lesser value have been taken in various parts of the United States, notably in Tennessee, Wisconsin and Iowa, but it is not yet an "industry," and with the present grade of intelligence employed in its prosecution is not likely to become such. The usual employments for embellishment and for jewelry purposes common to the pearls of the Orient are also made of these fresh-water forms.

The use of the soft inmate of *Unio* shells for bait for fishing purposes destroys many and gives an additional small economic use for these animals. In the earlier days the shells were sometimes burned for lime making, but this has long since been abandoned. Their chief value now is as food for fishes and for the manufacture of buttons, as above noted. In some places, especially about the summer

*The Fresh-water Pearls and Pearl Fisheries of the United States. Bulletin U.S. Fish Commission, 1897, pp. 373-426, 1898.

resorts of the West and South, *Unio* shells are polished, the epidermis being entirely removed and the polished shells mounted as pincushions and cardcases, making very attractive and useful souvenirs. Some species, like *Unio coccineus, Unio crassidens* and *Unio purpuratus,* have exceedingly rich nacres of light or dark purple and warm pink, which take a high polish and make very rich ornaments. But this industry is fitful and as yet in unskilled hands. What could be done with these shells by people of mechanical skill who understand the weaknesses of human nature for ornamentation can only be surmised.

THE NOMENCLATURE ADOPTED IN THIS CATALOGUE.

There have been several attempts of late to devise new systems of classification for nearly all the groups of American land and freshwater mollusks, most of which have little besides novelty to compel acceptance. It has been the bane of natural history studies that "closet naturalists" periodically get to work on well-known groups and propose something new in the way of classification. Indiana shells have proven no exception to this rule. It has been a matter of some concern to us just how to approach this phase of our task. A coterie of Philadelphia naturalists have recently proposed a new system of classification for American land shells which is little, if any, less novel than one proposed many years ago by Tryon, also of Philadelphia. But the proposed system does such violence to natural affinities, and brings together in single groups such widely different species of mollusks, that we are unable to accept the scheme proposed. It were as well to accept the Linnean genus *Helix* and place everything under it as to accept *Polygyra,* now done in some sections, and put about everything under it. These ephemeral schemes of grouping but render more difficult any correct understanding of our forms; they are intended to be helpful, but really interpose almost insuperable difficulties. About once in a decade some of these "genus jugglers" get to work at natural groups and when they are through with them little that is familiar is left.

The system adopted in this catalogue is that of W. G. Binney, as set forth in his later publications. His "Manual of American Land Shells" has been made the basis of our work, as containing, in all respects, the most scientific and best treatment of these forms, though one can not always agree with his opinions in the matter of synonymy. But his classification is, in most respects, very natural and quite satisfactory.

In the matter of the *Unionidæ* there has also been a recent attempt to divide this great group into subgenera which certainly have no

existence in nature. Species of the widest differences are brought together in a single subgenus, and most violent adjustments have been attempted. For these subgroups it has been attempted to recognize the names proposed long ago by Rafinesque, a procedure which would be right if, first, the groups really existed in nature, and if, second, any one now knew more than three or four of Rafinesque's species and the subgenera he founded on them. Many years ago Agassiz attempted this same treatment, and was followed by Stimpson, in his "Testaceous Shells of New England," but the attempt was so unnatural that it speedily found its place in the limbo of neglected genius. Very recently Baker, following Simpson, in his "Mollusca of the Chicago Area; The Pelecypoda," has attempted to recognize these Rafinesquian names, and some remarkable groupings of forms, unknown in nature, have been attempted. Thus the subgenus *Quadrula* is made to cover all forms like *Unio trigonus*, and also includes the totally different forms of shells that may be typified by *Unio plicatus*. It is very difficult to conceive that such systems are proposed in sober seriousness. We are promised a fuller exposition of these anomalous classifications later on.

There are recognized in this catalogue the three long and well-known subgenera of *Anodonta, Margaritana* and *Unio*. Not only are these names altogether familiar to American students, but they really represent natural divisions of the pelecypod mollusca of this country. Not only are their conchologic distinctions clearly indicated by this grouping, but after more than twenty years of study of this group, as a particular object, during which time all the known species have passed in review, there have been found embryologic reasons for accepting this time-honored classification. It should be remembered by the student that novelty is not alone a sufficient reason for acceptance. There are so many forms of the *Unionidæ* now known that exceptional difficulty is experienced in identification of critical forms, but when one remembers that many synonyms exist, these difficulties resolve themselves into specific identities rather than in systems of classification. So, in recognizing genera or subgenera, in the *Unionidæ* the writer declines to follow the lead of these recent writers, as tending to "worse confound confusion," and allows the three long honored subgroups to stand.

In the matter of the *Corbiculadæ*, which have not escaped the systematists, I have followed Prime's Monograph of that group, as presented in the Smithsonian Institution's publications, and later in the "Annals of the New York Lyceum of Natural History." Later writers have described many new forms, most or all of which are

based upon the young and immature specimens of well-known forms. Many of these have been presented through the pages of the "Nautilus," a paper devoted to the interests of amateur conchologists and published in Philadelphia. Careful study of the facts of geographic distribution and the descriptions together will convince any but those who trade in species for the purpose of enriching their own cabinets that the already extensive synonymy of this family is being greatly augmented. We recognize but the two genera *Sphærium* and *Pisidium,* because we believe other recently recognized groups are fictitious and find no expression in nature.

Since this catalogue is designed not to present the classification of Indiana mollusca, but as a means of becoming acquainted with the shell fauna of the State, all questions of classification have been eliminated and well-known names only have been employed. The classification adopted is one generally accepted.

THE LITERATURE OF INDIANA MOLLUSCA.

The books, papers, memoirs and published notes which deal with the mollusca of Indiana are considerable in number. It is largely due to the long residence at New Harmony of Say that so many papers appeared, for his personal work directed the attention of many students to the richness of this fauna. These papers cover all branches of conchologic science, from original descriptive papers to those which deal with local or general distribution problems. The list accompanying this paper, made up wholly from private resources, is practically complete, few if any papers existing which will be helpful to students of Indiana mollusca that are not included. The arrangement of titles is by authors, alphabetically, and then in chronological order under each writer. In most cases some mention of the ground covered has been included with the title, but the limits of this report precluded a full resume of contents. It has been our aim to present titles of all literature which the special student of the State's fauna must consult to fully understand the nature of the problems with which he will be confronted.

Anonymous. (Investigator.) Remarks on the article contained in Silliman's Journal for April, 1832, entitled, "Mr. Lea on the Naiades," by Investigator. Monthly American Journal of Geology and Natural Science, Vol. I, No. 8, pp. 370-377, 1832.

Anonymous. Catalogue of the Unios, Alasmodontas and Anodontas of the Ohio River and its Northern Tributaries, Adopted by the Western Academy of Natural Sciences of Cincinnati, January, 1849.

There are listed in the 19 pages of this rare little brochure 56 species of *Unio*, six of *Margaritana* and five of *Anodonta*. The catalogue is remarkable as being the first open expression of hostility to both the claims of Say and of Rafinesque. It marks the beginning of a long and bitter controversy, from the effects of which American malacology has not yet fully recovered.

Anthony, J. G. Descriptions of New Melanians. Proceedings of the Boston Society of Natural History, Vol. III, pp. 361-363, 1850.

Contains descriptions of a number of Indiana forms.

Anthony, J. G. Descriptions of New Fluviatile Shells of the Genus Melania of Lamarck from the Western States of North America. Annals of the New York Lyceum of Natural History, Vol. VI, pp. 83-129, March, 1854.

Baker, Frank Collins. The Mollusca of the Chicago Area. The Pelecypoda. Bulletin No. III, Chicago Academy of Sciences, pp. 1-130, plates i-xxvii, 1898.

This is a valuable paper, but it is not well illustrated; the process employed fails to bring out the characters of the several shells. The synonymy adopted for the *Unionidæ* is taken almost entirely from Call's Arkansas Report.

Barnes, D. H. On the Genera Unio and Alasmodonta; with Introductory Remarks. American Journal of Science and Art, First Series, Vol. VI, No. 1, pp. 107-127; No. 2, pp. 258-280, 1823.

This is a very valuable paper since it contains Barnes's original descriptions and figures of Ohio and Indiana shells.

Barnes, D. H. Reclamation of Unios. American Journal of Science and Art, First Series, Vol. XIII, No. 2, pp. 358-364, 1828.

Binney, Amos. The Terrestrial Air-Breathing Mollusca of the United States, and the Adjacent Territories of North America. Vols. I, II (text), 1851; Vol. III (plates), 1857.

This work is now very rare, but is yet indispensable to all workers in land mollusca. The anatomy of many species was worked out by Dr. J. Leidy, and is illustrated with many beautiful plates.

Binney, W. G. The Complete Writings of Thomas Say on the Conchology of the United States, 1858.

Dr. Binney has collected in this volume all of Say's papers, with reproductions of his plates, from the early articles in Nicholson's Encyclopedia to his latest work.

Binney, W. G. Supplement to the Terrestrial Mollusca of North America. Boston Journal of Natural History, Vol. VII, pp. 6-196, 1859.

Brings down to that date, 1859, the work of the elder Binney, with plates of the new forms described. Very rare; was published, separately, from oversheets, as Vol. IV of the Terrestrial Mollusca.

Binney, W. G. Check-list of the Shells of North America. Terrestrial Gasteropoda. Washington, 1860; second edition.

List Number II of this title is general for that portion of the United States which includes Indiana.

Binney, W. G. Land and Fresh-water Shells of North America. Part 1, Pulmonata Geophila. Smithsonian Misc. Coll., No. 194, 1869.

This is the earliest of Binney's series to be out of print, and is now rare. It covers the land mollusca of North America very fully, with illustrations of all the forms to be found in Indiana.

Binney, W. G. Land and Fresh-water Shells of North America. Part II, Pulmonata Limnophila and Thallasophila. Smithsonian Misc. Coll., No. 143, 1865.

Binney, W. G. Land and Fresh-water Shells of North America. Part III, Viviparidæ and Rissoidæ. Smithsonian Misc. Coll., No. 144, 1865.

The two preceding titles cover all the univalve shells of Indiana except the *Strepomatidæ,* and most of the forms are well illustrated.

Binney, W. G. Terrestrial Air-Breathing Mollusks of the United States and the Adjacent Territories of North America. Bulletin Mus. Comp. Zool., Vol. IV, text and plates in two volumes, 1878.

This important work brings down to its date all information connected with land shells of North America. It is now rare.

Binney, W. G. A Manual of American Land Shells. Bulletin United States National Museum, No. XXVIII, 1885.

This valuable volume brings down to its date all information connected with land mollusca which the indefatigable labors of Dr. Binney had brought to light. It contains illustrations of all the accepted forms, and is especially valuable to students of Indiana mollusca.

Call, R. Ellsworth. Note on the Genus Campeloma of Rafinesque. American Naturalist, June, 1883, pp. 603-608, 1883.

This paper gives the history of the generic names applied to this interesting group.

Call, R. Ellsworth. A Geographic Catalogue of the Unionidæ of the Mississippi Valley. Bulletin Des Moines Academy of Science, Vol. I, No. 1, pp. 5-57, 1885.

Contains full notes on geographic distribution of all forms found in Indiana, with bibliographic reference to the original figures.

Call, R. Ellsworth. On the Genus Campeloma, Rafinesque, with a Revision of the Species, Recent and Fossil. Bulletin of the Washburn College Laboratory of Natural History, Vol. I, No. 5, pp. 149-165, plates ii-vi, 1886.

Contains descriptions of all the forms found in Indiana, with illustrations. Gives full notes on geographic distribution.

Call, R. Ellsworth. On the Gross Anatomy of Campeloma. American Naturalist, June, 1887, pp. 491-497, 1887.

Gives description of the soft parts and notes sexual differences. Gives characters by which sexes may be distinguished.

Call, R. Ellsworth. A Contribution to a Knowledge of Indiana Mollusca. Proceedings Indiana Academy of Science, Vol. III, pp. 140-160, 1893 (1894).

Lists all the forms certainly known from the State, and gives a short bibliography of the most important papers.

Call, R. Ellsworth. On the Geographic and Hypsometric Distribution of North American Viviparidæ. American Journal of Science, Third Series, Vol. XLVIII, pp. 132-141, with map, 1894.

Contains full data relating to the distribution of all the members of this group.

Call, R. Ellsworth. The Unionidæ of the Ohio River. Proceedings of the Indiana Academy of Science, Vol. IV, pp. 139-140, 1894.

This is a brief paper, in abstract, correlating certain facts of geographic distribution with geologic data.

Call, R. Ellsworth. The Strepomatidæ of the Falls of the Ohio. Proceedings of the Indiana Academy of Science, Vol. IV, pp. 140-143, 1894.

This short paper has notes on the abundance and biologic surroundings of the shells of this great group found on the falls of the Ohio. It has nothing of value to the systematist.

Call, R. Ellsworth. A Revision and Synonymy of the Parvus Group of Unionidæ. With six plates. Proceedings of the Indiana Academy of Science, for 1895, pp. 109-119, 1896.

All the forms of this very difficult group are passed in review in this paper, and all accepted ones are figured, together with most of the synonyms. The two forms of the group from Indiana stand as types of sub-groups.

Call, R. Ellsworth. Second Contribution to a Knowledge of Indiana Mollusca. Proceedings Indiana Academy of Science, for 1895, pp. 135-146, 1896.

This paper contains full notes on synonymy of many species, together with their geographic distribution within the State. All forms known to be in the State collections at Indianapolis are specially indicated.

Call, R. Ellsworth. On a Small Collection of Mollusks from Northern Indiana. Proceedings Indiana Academy of Science for 1895, pp. 246-250, 1896.

This is a report on the mollusca collected at the station of the Indiana University Biological Laboratory, by members of the University. It deals chiefly with the mollusks of Turkey Lake.

Call, R. Ellsworth. Illustrations of Little Known Unionidæ. Journal Cincinnati Society of Natural History, Vol. XVIII, pp. 157-160, pl. vi, 1896.

Description, emended, with figures, of *Unio æsopus* Green. The synonymy of the species is also indicated and the belief stated that Green's shell is the *Obliquaria cyphia* Rafinesque.

Call, R. Ellsworth. Fishes and Shells of the Falls of the Ohio. Memorial History of Louisville, Vol. I, Chapter II, pp. 9-20, quarto, 1896.

This is the first paper to treat of this single limited area and lists all the mollusca known from the Falls.

Call, R. Ellsworth. A Study of the Unionidæ of Arkansas, with Incidental Reference to their Distribution in the Mississippi Valley. Transactions of the Academy of Sciences of St. Louis, Vol. VII, No. 1, pp. 1-64, plates i-xxi, 1895.

This paper gives much synonymy and lists many forms common in Indiana. It describes fully, with figures, all of the species usually ascribed to Lamarck and gives the full history of all such forms.

Call, R. Ellsworth. The Hydrographic Basins of Indiana and their Molluscan Fauna. Proceedings Indiana Academy of Science, for 1896, pp. 247-258, with hydrographic map, 1897.

Contains succinct geographic distribution of all the fresh-water forms found in the State.

Chenu, J. C.. Bibliotheque Conchyliologique, Tome III, 1845.

This rare volume contains reprints, with all the plates, of Rafinesque, Say, and Conrad's several important works on American mollusca. Though in French, the matter appears unchanged.

Conrad, T. A. New Fresh-Water Shells of the United States, with Colored Illustrations, and a Monograph of the Genus Anculotus of Say; also A Synopsis of the American Naiades, 1834.

This book was the cause of a long and unfortunate personal controversy with Dr. Isaac Lea.

Conrad, T. A. Monography of the Family Unionidæ, or Naiades of Lamarck, of North America, 1835-1839.

After publishing 117 pages of text and 66 plates the work was discontinued and left incomplete. It is now rare, but necessary for extended study of Uniones.

Conrad, T. A. Synopsis of the Family of Naiades of North America, with Notes, and a Table of Some of the Genera and Subgenera of the Family, According to their Geographic Distribution, and Descriptions of Genera and Subgenera. Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. VI, pp. 244-269. Also issued in the form of a pamphlet, 1853.

Conrad, T. A. Descriptions of New Species of Unio. Journal of the Academy of Natural Sciences, Philadelphia, Vol. II, Part 4, pp. 295-298, 1854.

This paper describes *Unio arquatus* and *Unio pectitus,* both from the Wabash River.

Cooper, William. List of Shells Collected by Mr. Schoolcraft in the Western and Northwestern Territory. Narrative of an Expedition through the Upper Missouri to Itasca Lake, etc., pp. 153-156, appendix, 1834.

This is little more than a list with some valuable suggestions bearing on synonymy.

Drew, Gilman. The Anatomy of Sphaerium sulcatum Lamarck. Proceedings Iowa Academy of Science, Vol. III, pp. 173-182, plates i-iii, 1896.

This is a most valuable and suggestive paper and is one of the first of its kind to be published in this country.

Eaton, H. H. *Vide* Short, C. W., and Eaton, H. H.

Ferussac, Baron de. Observations addressees en Forme de Lettre a MM. Th. Say, C. S. Rafinesque, Is. Lea, S. P. Hildreth, T. A. Conrad et C. A. Poulson sur la Synonymie des Coquilles bivalves de l'Amerique Septentrionale, et Essai d'une Table de Concordance a ce Sujet. Magasin de Zoologie, Classe V, Nos. 59, 60, pp. 1-36, 1835.

Green, Jacob. Some Remarks on the Unios of the United States, with a Description of a New Species. Contributions of the Maclurian Lyceum to the Arts and Sciences, Vol. I, No. 2, p. 41, 1827.

This title contains a description of a form of shell *(Unio æsopus)* found in both the Ohio and Wabash Rivers, with a good figure, the type coming from Pittsburg.

Green, Jacob. Notes on the American Shells Figured in the Supplement to the Index Testaceologicus. Transactions of the Albany Institute, Vol. I, pp. 134-136, 1830.

Contains notes on synonymy of several of Barnes's Unios and other matters.

Haldemann, S. S. A Monograph of the Limniades and Other Fresh-Water Univalve Shells of North America, 1840-1846.

Haldemann, S. S. Observations on the Melanians of Lamarck. American Journal of Science and Arts, First Series, Vol. XLI, No. 1, pp. 21-23, 1841.

Haldemann, S. S. Correction (to article on Melanians, American Journal of Science, Vol. XLI, p. 21). American Journal of Science and Arts, First Series, Vol. XLII, p. 216, 1841.

Haldemann, S. S. The Iconographic Encyclopedia of Science, Literature and Art, Systematically Arranged. Translated from the German, Vol. II, pp. 69-90, 1857.

Haldemann, S. S. Illustrations Conchyliologiques, Par M. Chenu. No date. One (Liv. 73) of a series of many reprints in French.

Hildreth, S. P. Observations on and Descriptions of the Shells found in the Waters of the Muskingum River, Little Muskingum and Duck Creek, in the Vicinity of Marietta, Ohio. American Journal of Science and Arts, First Series, Vol. XIV, pp. 276-291, 1828.

This paper rudely figures many of the common forms of the Ohio Valley and contains the original description of the remarkable *Unio foliatus* Hildreth.

Hildreth, S. P. Disease among Shell Fish. American Journal of Science and Arts, First Series, Vol. XXXII, pp. 97-98, 1837.

Relates a curious epidemic among Uniones in the Muskingum River; the note is hidden away securely in the midst of some meteorological notes made at Marietta, Ohio.

Kirtland, J. P. Observations on the Sexual Characters of the Animals Belonging to Lamarck's Family of Naiades. American Journal of Science and Arts, First Series, Vol. XXVI, No. 1, pp. 117-120, 1834.

This interesting article is accompanied by rude outline figures of sexual shapes of shells which are the first to be published in this country.

Kirtland, J. P. Second Annual Report of the Geological Survey of Ohio, pp. 170-175 and 197-200, 1838.

This volume contains a list of Ohio mollusca and at its end several pages of notes which have valuable suggestions on synonymy.

Kirtland, J. P. Fragments of Natural History. No. 1, Habits of the Naiades. American Journal of Science and Arts, First Series, Vol. XXXIX, No. 1, pp. 164-168, 1840.

Kirtland, J. P. Remarks on the Sexes and Habits of Some of the Acephalous Bivalve Mollusca. Proceedings of the American Association for the Advancement of Science, Vol. V, pp. 85-91, 1851.

Lea, Isaac. Observations on the Genus Unio, 1830-1874.

These volumes, thirteen in number, were originally published as portions of the Transactions of the American Philosophical Society and of the Journal of the Academy of Natural Sciences of Philadelphia. They were afterwards collated and issued under the above title. They are absolutely indispensable to all students of American fresh-water mollusca.

Lea, Isaac. A Synopsis of the Family of Naiades, 1830-1870.

This work has passed through four editions. The first appeared as a portion of Vol. I of the quarto series of Observations. The second was published in octavo form in 1836. The third edition appeared in 1852, while the fourth and last was published in 1870.

The latest edition contains many useful hints on synonymy which it is to be regretted Dr. Lea did not himself fully follow to conclusion.

Lea, Isaac. Rectification of Mr. T. A. Conrad's Synopsis of the Family of Naiades. Proceedings of the Philadelphia Academy of Natural Science, Vol. VII, pp. 236 et seq., 1854.

Lewis, James,, M. D. On Unio subrostratus Say. Proceedings Philadelphia Academy of Natural Science, for 1878; reprint, pp. 4.

This brochure contains some valuable notes on the synonymy of a shell which was originally described from Indiana.

Levette, G. M. Observations on the Depth and Temperature of Some of the Lakes of Northern Indiana. Annual Report Indiana Geological Survey for 1875, pp. 496-499, 1876.

This paper contains a list of the mollusca of northern Indiana prepared by J. W. Byrkit, of Indianapolis. Thirty-eight forms are mentioned.

Moore, D. R., and Butler, A. W. Land and Fresh-Water Mollusca Observed in Franklin County, Indiana. Bulletin Brookville Society of Natural History, No. 1, pp. 41-44, 1885.

This valuable paper gives the best extant account of the mollusca of southeastern Indiana. Sixty-three species in all departments are listed.

M'Murtrie, H. Sketches of Louisville and its Environs, etc., First Edition, 1819.

This very rare work contains on pages 65-66 a list of mollusca from the vicinity of Louisville, many of which are from the Falls of the Ohio. The author, M'Murtrie, states that for the list he is indebted to "the politeness of that accomplished and skillful naturalist, Mr. Rafinesque."

Menke, C. T. Synopsis methodica Molluscorum, etc., quae in Museo-Menkeano adservantur; cum synonymia critica et novarum specieorum diagnosibus. Pyrmonti, 1830.

This very scarce book contains a number of descriptions of Melanians from the Ohio River at Cincinnati.

Nicklin, P. H. Conchological Observations on Lamarck's Family of Naiades. Transactions American Philosophical Society, New Series, Vol. III, pp. 395-399, 1829.

Nicklin, P. H. Des Moulins' General Considerations on Restricting the Number of Species of the Genera Unio and Anodonta. From the French. American Journal of Science and Arts, First Series, Vol. XLI, No. 1, pp. 104-116, 1841.

Pleas, E. Shells of Henry County. The Nautilus, Vol. VII, No. 6, pp. 68-70, 1893.

This excellent paper lists 59 species and varieties of land mollusks and 64 species and varieties of fresh-water forms, all found within a radius of five miles of Dunreith.

Plummer, Dr. John T. Scraps in Natural History (Mollusca). American Journal of Science and Arts, First Series, Vol. XLVIII, No. 1, pp. 93-96, 1844.

This paper gives a list of the shells found about Richmond, Wayne County. The list contains the names of 21 species of land shells, eight univalve fresh-water forms, one *Anodon,* two *Margaritanas* and one *Sphaerium.*

Poulson, C. A. A Monograph of the Fluviatile Bivalve Shells of the River Ohio, Containing Twelve Genera and Sixty-Eight Species, 1832.

This work is a translation of Rafinesque's work, which is mentioned below. The frontispiece, under the name of *Unio verrucosa* Rafinesque, has a fine plate of the purple nacred variety of *Unio tuberculatus* Barnes.

Prime, Temple. Descriptions of Cycladidae. Proceedings Boston Society of Natural History, Vol. IV, pp. 155-165, 1852.

Prime, Temple. Notes on the Species of Cyclas Found in the United States; with Descriptions and Woodcuts. Proceedings of the Boston Society of Natural History, Vol. IV, pp. 271-285, 1853.

Prime, Temple. A Monograph of American Corbiculadae, Recent and Fossil. Smithsonian Miscellaneous Collections, No. 145, 1865.

This work is indispensable to all students of American mollusca.

Rafinesque, C. S. Discoveries in Natural History in the Western States. American Monthly Magazine and Critical Review, Vol. III, p. 354, 1818.

Rafinesque, C. S. Further Account of Discoveries in Natural History in the Western States. American Monthly Magazine and Critical Review, Vol. IV, p. 38, 1818.

Rafinesque, C. S. General Account of the Discoveries Made in the Zoology of the Western States. American Monthly Review and Critical Magazine, Vol. IV, p. 106, 1818.

Rafinesque, C. S. Prodrome de 70 nouveaux Genres d'Animaux decouverts dans l'Interieur des Etats-Unis d'Amerique, durant l'Annee 1818. Journal de Physique, de Chemie, d'Histoire Naturelle et des Arts, Tome LXXXVIII, p. 417, 1819.

Rafinesque, C. S. Description of a New Genus of Fluviatile Bivalve Shell of the Brachiopoda, Notrema Fissurella, etc. American Monthly Magazine and Critical Review, Vol. IV, p. 356, 1819.

Rafinesque, C. S. Apolosia, the Mollusca. The Annals of Nature, No. 1, pp. 10, 11, 1820.

This short article appeared in one of the numerous journals which Rafinesque started in Philadelphia.

Rafinesque, C. S. Monographie des Coquilles bivalves et fluviatiles de la Riviere Ohio, contenant douze Genres et soixante-huit Especes: par M. C. S. Rafinesque, Prof. de Bot. et d'Hist. nat. a l'Uni. Transylvane de Lexington. Extrait de la 15me Livraison du 5me Tome des Annales Generales des Sciences Physiques, September, 1820, Bruxelles.

Rafinesque, C. S. Enumeration and Account of Some Remarkable Natural Objects in the Cabinet of Professor Rafinesque, in Philadelphia, 1831.

This paper proposes several new genera of land shells, some of which are yet recognized, very properly.

Rafinesque, C. S. Odatelia: New Genus of North American Fluviatile Bivalve Shells. Atlantic Journal and Friend of Knowledge, No. 4, p. 154, 1832.

Rafinesque, C. S. Complete Writings of, on Recent and Fossil Conchology. Edited by Wm. G. Binney and George W. Tryon, Jr., New York, 1864.

This work, which gives all of the published papers of Rafinesque, is indispensable to any student who seeks to clear up the historical sequence of species and their descriptions.

Say, Thomas. Conchology. Nicholson's Encyclopedia, Vol. II, four plates, no pagination. First edition, 1816.

A second edition of this work was published in 1818, also unpaged; a third edition in 1819, Vol. IV, which contains a number of

forms not included in the two earlier editions. A separate edition of the article was issued under the title "Descriptions of the Land and Fresh-Water Shells of the United States," from the first edition. A copy is now in my possession.

Say, Thomas. American Conchology; or, Descriptions of the Shells of North America, 1830-1834.

This was Say's chief work on American mollusca and was prepared and printed at New Harmony. The work was published in parts, seven in all appearing, the last part being a posthumous work under the editorship of T. A. Conrad.

Say, Thomas. Descriptions of Some New Terrestrial and Fluviatile Shells of North America. New Harmony Disseminator of Useful Knowledge, Vol. II, July, 1829, to January, 1831.

Say, Thomas. Descriptions of Several New Species of Shells and of a new Species of Lumbricus. Transylvania Journal of Medicine, Vol. IV, pp. 525-528, 1831.

Say, Thomas. A Glossary to Say's Conchology, 1832.

This is a good specimen of the printing of that date in Indiana, the work being all done at New Harmony.

Say, Thomas. Descriptions of Some New Terrestrial and Fluviatile Shells of North America, 1829, 1830, 1831, New Harmony, Indiana, 1840.

This title reprints the earlier articles under the editorship of Mrs. Say.

Say, Thomas. Complete Writings on American Conchology. See under Binney, W. G. 1858.

Shaeffer, D. F. A Complete List of the Land and Fresh-Water Shells Found in the Immediate Vicinity of Cincinnati, Ohio.

This brochure is without date. There are no descriptions, but some synonymy is suggested.

Short, C. W., and Eaton, H. H. Notices of Western Botany and Conchology. Transylvania Journal of Medicine, February, pp, 74-82, 1831.

Shumard, B. F. Catalogue of the Naiades of Jefferson County, Kentucky. The Naturalist and Journal of Agriculture, Horticulture, Education and Literature, Franklin College, Tennessee, Vol. I, No. 3, pp. 105, 106, 1846.

This paper contains a list of species, with supposed synonyms; the writer shows evident confusion as to specific facts and values. The article contains most of the names of shells found in the Ohio at Louisville.

Simpson, C. T. On the Mississippi Valley Unionidæ Found in the St. Lawrence and Atlantic Drainage Areas. American Naturalist, Vol. XXX, pp. 379-384, 1896.

Stein, Fred. The Molluscous Fauna of Indiana. Annual Report of the Indiana Geological Survey for the year 1880, pp. 451-467, 1881.

This is the first published list to try and include all the shells of the State.

Stimpson, William. Researches upon the Hydrobiinae and Allied Forms. Smithsonian Miscellaneous Collections, No. 201, 1865.

Tryon, George W., Jr. A Monograph of the Terrestrial Mollusca Inhabiting the United States, New York, 1866.

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SYSTEMATIC CATALOGUE.

PULMONATA GEOPHILA.*

ARTIFICIAL KEY TO THE LAND MOLLUSCA.

A. Animal without external shell. *Limax, Tebennophorus.*

B. Animal with external shell.

a. Shell large, lip reflected, one parietal tooth. *Mesodon.*

b. Shell large, lip reflected, one parietal and two peritremal teeth. *Triodopsis.*

c. Shell small, lip reflected, aperture contracted, with a parietal tooth. *Stenotrema.*

d. Shell with simple lip, umbilicated, epidermis striate, usually colored with bands or spots. *Patula.*

e. Shell with simple lip, polished epidermis, with or without umbilicus. *Zonites; Macrocyclis.*

f. Shell small, conical, coarsely striate, lip reflected. *Strobila.*

g. Shell very small, discoidal, lip reflected, ribbed or smooth. *Vallonia.*

h. Shell minute, elongated, lip reflected, pupiform. *Pupa.*

i. Shell minute, lip not reflected, conical, brown. *Vertigo.*

j. Shell long, whorls loosely coiled, aperture very large and effuse, peritreme acute. *Succinea.*

*The systematic arrangement here adopted for the land shells of Indiana follows that of Dr. Binney in "A Manual of American Land Shells," pp. 57-59, which constitutes Bulletin No. 28, United States National Museum. Not only has his arrangement been closely followed, but his descriptions of the several forms have been employed, modified occasionally in view of the large series which the writer has personally collected and studied. All notes concerning habits, distribution, and other characters, are original and the writer should be held responsible therefor.

FAMILY SELENITIDÆ.

MACROCYCLIS CONCAVA Say. Plate 4, figs. 4, 7.

Shell depressed, very slightly convex on the upper surface; epidermis whitish horn color, sometimes with a tinge of green; whorls five, above flattened, below rounded, finely striate obliquely, and sometimes with microscopic revolving lines, the outer whorl spreading a little towards the aperture; suture rather deeply impressed; umbilicus wide, deep, exhibiting all the volutions to the apex; aperture rounded, somewhat flattened above, its edge frequently tinged with reddish brown; peristome subreflected at its columellar extremity, simple above, and in some specimens considerably depressed near its junction with the outer whorl; columella with a thin callus, the edge of which connects the upper and lower extremities of the peristome. (Binney.)

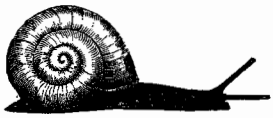

Fig. 1.

Large specimens occasionally reach the following dimensions: Greater diameter 24, lesser 18 mm.; height, 7-8 mm. A considerable difference in height exists among specimens from different localities, since this character appears to depend on rate of growth and the nature of the habitat. Among rocks the forms are more flat than those which are taken in the open woods under logs and debris.

This species is a voracious feeder and destroys others of its kind as well as other helices. It may be sought for on open hillsides, where there is constant moisture, and under leaves, logs and sticks. I have sometimes taken them in the apertures of the larger helices, into which they had entered, probably to find food. This species is common all over the southern portions of Indiana, and has been found as far north as Wabash and Huntington. It probably occurs all over the State.

FAMILY LIMACIDÆ.

LIMAX CAMPESTRIS Binney. Plate 4, fig. 18.

Color usually of various shades of amber, 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, concentrical lines;

back covered with prominent elongated tubercles and furrows; foot narrow, whitish; respiratory foramen on the posterior dextral margin of the mantle; body covered with a thin, watery mucus. (Binney.)

This species is easily recognized among all that dwell in this State. It is the lightest colored of all the small forms, in some individuals being darker only towards the anterior portion of the body. Its length varies from 20 to 25 mm. when stretched to full length in crawling about. It is to be sought for under boards, flat stones, bark, fallen trees, in the woods and about dwellings, and is one of the most common of the slugs. It may be readily traced to its hiding places by the abundant trail of shining white mucus which it leaves behind it in progressing.

LIMAX FLAVUS Linnæus. Plate 7, fig. 5.

Color brownish, yellowish brown or ashy brown, with oblong-oval, uncolored spots, which have a longitudinal disposition; mantle with rounded spots; head, neck and eye-peduncles blue, semi-transparent; tentacles white; base of foot sallow white. Body when extended cylindrical, elongated, terminating acutely with a short but prominent keel; upper part covered with long and narrow, prominent tubercles. Mantle ample, oval, rounded at both ends, with numerous very fine, concentrical striae. Sides paler and without spots. Respiratory foramen large, placed near the posterior lateral margin of the mantle and cleft to the edge. Generative orifice indicated by a white spot a little behind the eye-peduncle of the right side.

This is the largest slug which is found in this State, but is not indigenous. It is introduced from Europe, and has been seen by me only at Lawrenceburg, in the southeastern part of the State. It is common in cellars and about well curbs in Louisville, Kentucky, and should be found in New Albany and Jeffersonville, Indiana. The Lawrenceburg examples probably found their way here through the large German population, which introduced them by accident. Careful search about well curbs, in damp cellars, and under refuse piles, such as old bricks, may bring many specimens to light. The writer collected over two thousand specimens in 1884 in the heart of the city of Washington, not far from the Smithsonian Institution, in whose collections more than a thousand were placed. They were found in the greatest abundance under old brick piles on the site of an old dwelling; associated with them were thousands of specimens of *Triodopsis tridentata*, of which two cigar boxes full were collected! The slug may prove to be abundant in southern Indiana. Binney mentions the attainment of a length, in captivity, of 200 mm., thus rivaling all

American forms except the great *Ariolimax columbianus* of the west coast.

ZONITES FULIGINOSUS Griffith. Plate 4, fig. 13.

Shell thin, depressed on the upper surface, epidermis dark, approaching to chestnut color, sometimes almost black, shining and wrinkled; whorls four and one-half, rapidly increasing, with irregular, oblique wrinkles, the last whorl very voluminous and expanding transversely toward the aperture; suture very little impressed; aperture very oblique, ample, lunate-ovate, within pearly or iridescent; peristome simple, thin, brittle, with a light, testaceous deposit within, the two terminations approaching each other very nearly, that of the columella somewhat reflected; umbilicus deep, not much expanded. (Binney.)

This species is one of the more uncommon forms which occur on favorable hillsides, under leaves, and half buried in the moist soil. It is usually a dark mahogany brown, smooth, highly polished shell. I have taken it at Corydon, Madison, and near Bloomington; it is rare at Lawrenceburg and at Brookville. But on the south side of the Ohio, in Kentucky opposite Lawrenceburg, Indiana, it is both common and large. It can not well be mistaken for any other species. It is usually solitary, being unlike others of its congeners in this respect. The lines of growth are sometimes very black and are sometimes wrinkled, but usually the shell is quite smooth. I do not know of any localities in the northern portion of the State where this form has been found.

ZONITES FRIABILIS W. G. Binney. Plate 4, fig. 10.

Shell very globose, transparent, brittle, thin, sometimes thick, shining, reddish; spire very short, conic; whorls five, convex, lightly wrinkled, rapidly increasing, the last very large and ventricose; suture moderate; aperture circular, equally high and broad, within bluish and slightly thickened by a very thin white callus; peristome simple, sharp, thin, at its junction with the body whorl violet-colored and reflected, so as to cover a portion of the small and deep umbilicus; the parietal wall of the aperture is covered with a light violet-colored callus. (Binney.)

I have never found this species in Indiana, and enter it on the authority of Mr. Binney, who has it from some Indiana localities. It is, however, a common shell in parts of Kentucky, where I have collected it. The species may be very easily separated from the preceding form by its greater height and by its color being always far more light

than any variety of *Zonites fuliginosus* which I have seen. The more globose character of the shell will alone distinguish it; add to this the size and shape of the aperture and of the body whorl, and no mistake need be made. Mr. Binney gives the same measurements for the two forms, but I have never seen one as flat as *Z. fuliginosus*, but it does not attain the diameter of that species.

ZONITES LIGERUS Say. Plate 4, fig. 11.

Shell perforated, orbicularly convex; epidermis yellowish horn color, shining; whorls seven, finely and thickly striated transversely, smooth below; suture not much impressed; aperture semi-lunate, rounded; peristome thin, acute; base and side of the outer whorl, within the aperture, thickened and white; perforation very small; umbilical region impressed. (Binney.)

This form is very common all over the southern portions of the State, having been taken by me in most of the river counties and as far north as Indianapolis and Bloomington. It is abundant under flat rocks on hillsides with southern exposure about Madison and Corydon, rare about Lawrenceburg, abundant about Brookville. It is closely related to the following form, from which it is with difficulty distinguished and which may perhaps be justly regarded as a synonym. The older specimens are said by W. G. Binney to be flatter at the base and to have a thicker and whiter callus within the aperture, but these differences are hardly specific; both facts may be explained on the basis of habitat and food opportunities. The animals are so much alike that they can not be used for separation. I have often received the immature forms of *Mesodon elevatus* under this name, as well as under that of the following species, but the character of the whorls and the generally immature character of the aperture of *M. elevatus* will serve any careful student to separate them.

ZONITES INTERTEXTUS Binney. Plate 4, fig. 12.

Shell perforated, subpyramidal; epidermis yellowish horn color; whorls six or seven, with numerous fine, oblique striae and very minute, spiral striae, intersecting each other; outer whorl with a narrow, light-colored band and an ill-defined, brownish band below it; aperture rounded, a little transverse; peristome thin, somewhat thickened within by a deposition of testaceous matter, its columellar extremity slightly reflected at its junction with the base of the shell; perforation small, sometimes nearly obsolete; base whiter than the upper surface. (Binney.)

This shell is very close to the preceding and may not, perhaps, be justly separated from it. The light-colored band is by no means the rule, while the darker colored band is seen in but few of the specimens. I have taken a number in the vicinity of Cincinnati, Ohio, with this band well marked, but have seen no Indiana specimens with it. The distribution is about the same as for the above; in short, locality which affords one species will generally afford the other. Mr. Binney states that the genitalia differ in a marked manner from those of the preceding species, a fact the value of which depends altogether on the time when they are collected. It has been noticed that when the reproductive functions are active the characters of the genitalia differ very much indeed in the same species if examined during the close season. I am not disposed to attach much importance to these characters as affording specific differences. The two species attain to the same relative dimensions, the greater diameter being about 15, the lesser 13 mm.; the height is about 10 mm.

ZONITES INORNATUS Say. Plate 4, figs. 14, 15.

Shell depressed; epidermis yellowish horn color, smooth, shining, with very minute lines, not breaking the smoothness of the surface; whorls five; suture not much impressed; aperture transverse, scarcely oblique, obliquely lunar, with a thick, white testaceous deposit around its whole inner surface, a little distant from the margin; peristome thin, acute, fragile, its ends somewhat converging, the columellar margin reaching to the center of the base, subdilated above; umbilicus small; base rather flattened, indented in the center. (Binney.)

This is a widely distributed species over the eastern United States, but does not seem to be abundant in the central west. In Indiana I have taken specimens at Corydon, at Madison, and at Lawrenceburg. I do not know how far it may range to the northwards. This species will afford a good illustration of the kind and amount of work yet to be done on Indiana mollusca. There is no other species in this State with which this form may be confused, unless it be the half-grown of *Zonites fuliginosus*. But it is easily distinguished by all the signs of maturity and by the very small umbilicus, that of juvenile *Z. fuliginosus* being quite large. The animal is a dark slate color, slender, and is very active in its movements. The size of three-fourths of an inch in diameter is rarely attained, the shell being usually somewhat less than that.

ZONITES (HYALINIA) ARBOREUS Say. Plate 4, fig. 1.

Shell umbilicated, depressed, very slightly convex, thin, pellucid; epidermis amber-colored, smooth, shining; whorls four to five, with

very minute, oblique striae, apparent when viewed with the microscope; aperture transversely rounded; peristome thin, acute; umbilical region indented; umbilicus moderate, well developed, round and deep. (Binney.)

This is one of the smallest members of this genus, its diameter being about five mm., or one-eighth of an inch. In noting the color of the epidermis it will be necessary to examine the shell after the animal is removed, since the animal is very dark, almost or quite black, which makes the shell seem darker than it really is. The species is found all over Indiana, under boards about dwellings, under sticks, flat stones, under bark and logs, but especially hidden away between the bark and wood of old fallen trees. It is usually somewhat gregarious; when one specimen is found many others are sure to be in the immediate neighborhood, hidden away in cracks or crevices. From the next species, which it resembles in size, it is readily separated by its color, more depressed spire and shape of the aperture, while it has a much smaller umbilicus.

ZONITES (HYALINIA) LIMATULUS. Ward. Plate 4, fig. 16.

Shell widely umbilicated, small, depressed, thin; epidermis whitish, immaculate; suture distinctly impressed; whorls more than four, convex, with very fine, oblique, parallel striae, which become obsolete on the base; aperture oblique, subcircular, slightly modified by the penultimate whorl; peristome thin, acute, its ends approaching; umbilicus rounded, large and deep, not exhibiting all the volutions. (Binney.)

This species has been found near Wabash, Terre Haute, and Indianapolis, and is likely to occur throughout the State. It could only be confused with the preceding form.

ZONITES (CONULUS) FULVUS Draparnaud. Plate 4, fig. 2.

Shell imperforate, subconical, thin, pellucid; epidermis smooth, shining, minutely striated, amber-colored; whorls five or six, rounded, very narrow; suture distinct and deep; aperture transverse, narrow; peristome simple, acute; base convex; umbilical region indented, umbilicus closed.

Fig 2.

This is a very small shell, having a diameter of only some four mm. and a height of three mm. Binney's description, above quoted, gives all the characters which the species presents except the color of the animal, which is very dark, almost black. The shell is so thin that

the color of the animal striking through it makes the living form appear almost black; only on examination of shells cleared of the animal can the real amber color be noted.

This species occurs all over the State in favorable localities, and is one of the circumpolar species. Under logs which lie in damp places, in the cracks of bark, between the bark and wood of fallen trees, are all stations in which it delights to dwell. It can be confused with no other form.

ZONITES (GASTRODONTA) INTERNUS Say. Plate 4, fig. 17.

Shell very narrowly perforated, depressed, slightly convex; epidermis reddish brown, shining; whorls eight, with regular, equidistant, elevated, oblique, rounded ribs, separated by distinct grooves; suture deeply impressed; aperture flattened, transverse, narrow; peristome thin, acute, thickened internally; within the base of the aperture, somewhat distant from the margin, are two prominent, sublamelliform, white teeth, not reaching the edge of the peristome; base smooth, polished, umbilical region indented. (Binney.)

This shell occurs in numbers on the hillsides of southeastern Indiana, but is most abundant in the vicinity of Cincinnati, Ohio. Hundreds of examples were collected by the writer, in Eden Park, after a warm rain, many of the animals of which were pinkish in color, a fact which Mr. Binney has noted. In this State no other forms occur with which it may be confounded except by careless collectors who sometimes mistake very young *Mesodon clausus*, or related forms, for it. Its identity may be readily established by breaking open the peristomal margin, when the several consecutive thickenings, resembling tooth-like processes, may be seen on the outer wall. The species has also been taken at Madison, under flat stones on the hillsides high above the town.

FAMILY PHILOMYCIDÆ.

TEBENNOPHORUS CAROLINENSIS Bosc.

Color of upper surface whitish or yellowish white, variegated with clouds and spots of brownish and blackish, so arranged as to form three ill-defined longitudinal bands, one on the center of the back and one on each flank, extending from the head to the posterior extremity, anastomosing more or less with each other, and having smaller spots of the same color between them; inferior margin white or yellowish;

foot whitish. Mouth surrounded with a circular row of papillae. Body elongated, subcylindrical, flattened towards its posterior extremity, which is obtuse; eye-peduncles one-fourth of an inch long, brownish or blackish, stout, terminating in a bulb; ocular points on the superior part of the bulb; tentacles immediately below the eye-peduncles, white, very short, nearly conical. Mantle fleshy, covering the whole body, its anterior edge tinged with brownish, and falling in a slight curve between the two eye-peduncles, reaching on the sides to the margin of the foot; posterior extremity rounded; cuticle covered with irregular vermiform glands, anastomosing with each other, and having a general tendency to a longitudinal direction, with shallow furrows between, lubricated with a watery mucus, and susceptible of contractions which produce a slow, undulatory motion, like the flowing of water, over the whole surface. Foot whitish, extending a little beyond the mantle posteriorly, showing a whitish, flattened border. Orifice of the organs of generation on the right side, at a little distance behind and below the eye-peduncles. Respiratory orifice large, on the right side, one-fourth of an inch behind the origin of the eye-peduncle; anal orifice in close contact, a little above and in front of it; above the respiratory orifice, on the back, is a deep, curved furrow, running upwards and backwards. Locomotive band not distinguished from the lower surface of the foot. (Binney.)

This species of slug is very common all over middle and southern Indiana, in suitable situations. I have found it abundantly in southeastern Indiana, under bark, in wet places, clinging to the wood where the bark had been slightly raised. It is protectively colored and the pattern described by Binney is by no means the most common one. It is impossible to assign any particular color pattern to the species, for it is very variable. But ashy gray colors appear to predominate. The animal, when stretched out to full length, is often more than 100 mm. in length, and is the largest slug native to the eastern United States. When collected living and thrown into alcohol, the animal soon becomes covered with a very dense coating of thickened and hardened mucus, which obscures all color markings. It may be easily traced to its hiding place under bark by the very broad line of shining mucus which it leaves in its track. The species can be confounded with no other occurring in the State. I have often taken this form on the sides of trees, after rains, climbing slowly along the creases of the bark. On one occasion several specimens were taken from the same tree, on a wooded hillside on the Ohio River, opposite Lawrenceburg. In this situation the protective value of its coloration may be fully appreciated.

TEBENNOPHORUS DORSALIS Binney, Plate 4, fig. 19.

Color of upper surface ashy, with a shade of blue, an interrupted black line extending down the center 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 being 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. (Binney.)

This species, as above described by Binny, is doubtless the most common slug in Indiana, a dozen or more being often found under the same log or plank. It is found in the woods, and on the margins of forests, in driftwood lodged on the banks of rivers, under flat rocks, and, in short, in every location which offers protection. Its small size, pointed posterior when fully extended, dark coloration, and white creeping disk serve to separate it from all other slugs likely to fall in the way of Indiana collectors.

FAMILY HELICIDÆ.

PATULA SOLITARIA Say. Plate 4, fig. 20, and Plate 5, fig. 1.

Shell broadly umbilicated, globosely depressed, coarse, solid, diaphanous, obliquely and crowdedly wrinkled, from white to dark reddish horn color, with from two to three brownish revolving bands; whorls six, convex; suture deep; aperture roundedly lunate, pearly white and banded within; peristome simple, acute, its ends joined by a thin, transparent callus, that of the columella dilated, subreflected. (Binney.)

This species occurs all over the southern two-thirds of the State, and usually in very great numbers. But the extreme abundance of this form in the Ohio drainage basin, as shown by extensive collections, places its metropolis along the Ohio River. It is one of the earliest of the larger species to come out of hibernation, and the earliest specimens found betray its winter habits. The animal buries itself from five to six or more inches in the soft soil of moist hillsides, to issue forth when first the warm rays of the vernal sun penetrate to its hiding place. In the vicinity of Indianapolis the species is said to be abundant, while in southeastern Indiana and around Cincinnati it is most abundant. I have taken four thousand, and over, specimens

of this species in a single afternoon on the slopes of the hills facing the Little Miami River, near Cincinnati! To one who has never collected this species in its metropolis the great numbers found, under leaves and partly buried, an inch or two, in the soft soil, will almost pass belief. Many albino examples, that is, without lines of color, have been taken and are in the Call Collection, in Harvard University. A few were found entirely wine-colored, being a rich, deep red. Some were found whose greater diameter exceeded 35 mm., while there is a very great variation in height. In all old specimens the shell is greatly wrinkled, coarsely so, about the apertural opening. In most cases of mature shells the aperture has been broken and repaired, very few having escaped injury of this kind. No other shell can be mistaken for it.

PATULA ALTERNATA Say. Plate 5, figs. 2, 3.

Shell broadly umbilicated, orbicularly depressed, thin, smoky horn color, varied with red, interrupted, obliquely arranged patches and spots, roughened by crowded, elevated, rib-like striae, smoother below; whorls five and one-half, flattened, the last sometimes obtusely carinated at its periphery; umbilicus large, pervious; aperture very oblique, lunately rounded, banded within; peristome simple, acute, its terminations joined by a very thin, transparent callus, that of the columella subreflected. (Binney.)

This is the most common shell and the most widely distributed one in Indiana. It is found in almost every conceivable station, even where all other forms are absent, but loves best hillsides with old timbers, sticks, stones, and similar debris. Under flat rocks it often congregates in great numbers in the late fall, when the frosts come, and hibernates in such situations. The species is gregarious, and when one specimen is found others will almost certainly be secured.

Many animals of this species are reddish, and when collected, exude a reddish and abundant mucus from the aperture. The color patches are highly characteristic, and no other Indiana shell shares this feature. Numerous specimens have been taken which are entirely white, while others of a deep cream color have been found; occasionally a wine colored one may be found. There is a great variation in the coarseness of the ribs which mark the surface, occasional specimens being found which are almost smooth. Carinated specimens often occur, and sometimes races of these carinate varieties are found; they have been separately described under the name of *Patula mordax*. While the shell is very common, it is also one of the prettiest we have and attains a size somewhat greater than that given by Mr. Binney,

who says the greater diameter is 21 mm.; I have numerous examples which are over that dimension. Attention should also be called to the variation in height, which is considerable, one race of high-spired forms having been recently given a new name by a Philadelphia naturalist. Many have been collected by me which are very flat, ranging to extreme conical forms, all on the same hillside, at Cincinnati, Ohio.

PATULA PERSPECTIVA Say. Plate 5, fig. 4.

Shell broadly and perspectively umbilicated, orbicular, scarcely convex above, excavated below, thin, reddish horn-color, regularly ribbed; whorls six and one-half, gradually increasing; aperture small, lunately subcircular; within furnished with a single, subprominent tooth on the base of the shell; peristome simple, acute, its extremities separated widely. (Binney.)

This is a very small species, and has been found by me in Indiana only at Madison, Corydon and Lawrenceburg. It is easily distinguished from its small congener which also has wider distribution, by the wide and perspective umbilicus. Its deep red color will also serve to distinguish it. The habitats of this form are not so general as those of other shells, but it selects drier stations and is commonly found under dead trees, under the bark, close to the ground, or between the bark and wood. It is occasionally found under flat stones. Southern Indiana is by no means the metropolis of this species, but is rather on the northern limit of its distribution. Tennessee and Kentucky furnish hundreds of examples in all suitable places.

PATULA STRIATELLA Anthony. Plate 4, fig. 3.

Shell umbilicated, orbicularly convex, thin, brownish horn-color, with crowded ribs; whorls four, scarcely convex, the last inflated below, rather wide; umbilicus large, pervious; aperture subcircular; peristome simple, acute, its terminations approached. (Binney.)

This little shell occurs on moist sand flats, with vegetation, in river and creek bottoms, under old logs, trees, and even under stones, in damp stations, and usually in numbers. After a warm rain it may be found crawling around on the moist sands of creek bottoms, or crawling on the upper surfaces of fallen logs, but always in stations of considerable moisture. It is much less widely umbilicated than the preceding form, and the sculpturing of the surface easily aids in separating it. I have collected it at Indianapolis, Madison, Corydon, Evansville, Bloomington, Wabash, and Lawrenceburgh. It doubtless occurs all over the State.

HELICODISCUS LINEATUS Say. Plate 4, figs. 5, 6.

Shell widely umbilicated, discoidal; epidermis greenish; whorls about four, visible on the base of the shell as well as above, with numerous equidistant, parallel, raised lines revolving upon them; suture much impressed; aperture remote from the axis, semi-lunate, narrow, not expanding; peristome acute, thin; umbilicus wide, forming a concave depression of the base, each volution visible to the apex; within the aperture, on the external circumference, are placed from one to three pairs of minute, conical, white teeth, the first pair in sight when looking into the aperture, the others more remote. (Binney.)

The very flat appearance of this shell will at once attract attention and serve to distinguish it. It is common, but not abundant, in most parts of the State, under bark, in cracks or creases of bark on fallen trees, and sometimes under stones. The little teeth within the aperture are also a highly characteristic mark. At Lawrenceburgh and Madison a number of examples were taken in the spring of 1895 and 1896.

STROBILA LABYRINTHICA Say. Plate 5, figs. 5, 5a.

Shell umbilicated, globose-conic, brownish-horn color, with stout ribs above, and below lighter, with arborescent wrinkles; spire obtuse; umbilicus narrow, pervious; aperture scarcely oblique, lunately rounded; peristome briefly reflected, thickened; parietal wall with three revolving, deeply entering, parallel laminæ, the central further within the aperture and less developed, and around the axis one stout, lamella-like rib, not reaching the columella; on the base of the outer whorl are two short, deeply seated, internal revolving, rib-like laminæ. (Binney.)

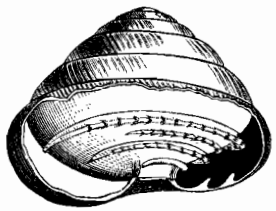

Fig. 3.

This little shell is sometimes confounded with *Zonites (Conulus) fulvus*, but is distinguished, in mature specimens, by the slightly reflected lip, or peristome. The younger forms may also be distinguished by breaking away the outside whorl when the characteristic parietal laminæ will be seen as narrow bands of white. The external texture of this species is much coarser than that of *Z. fulvus*.

This is by no means an abundant shell, but is common. It is to be sought under old logs, trees, between the bark and wood of half-rotted logs, and in similar situations, but usually in the woods. It is rare indeed to find specimens far from the edge of the forest.

STENOTREMA STENOTREMUM Férussac. Plate 5, fig. 6.

Shell imperforate, globose, diaphanous, reddish, hirsute, convex above, inflated below; spire elevated; whorls five, somewhat convex, the last anteriorly gibbous, angularly deflected; aperture irregularly transversely lunar, almost linear, contracted by a long, stout, elevated lamelliform tooth along the whole length of the parietal wall, furnished far within, on the base of the last whorl, with a transverse tubercle, springing from the axis; peristome scarcely expanded above, thickened by a heavy, regularly curving callus, its basal margin with a small notch. (Binney.)

The aperture of this species is frequently purple colored, especially on the inner margins of the narrow opening. The hairs which cover the epidermis are short and thick, and rather stiff, and are arranged in regular lines. Smooth specimens are never found with a perfect epidermis, but in old age many or most of the hairs are lost except in the region of the sutures, where they are protected against rubbing. I have found this species at only two localities in southern Indiana, Madison and Lawrenceburg. It is likely to be found all over the southern half of the State. The chief character which at once distinguishes it from any other Indiana *Stenotrema* is the notch near the umbilical region of the lower lip and by its larger size. The only other form it is likely to be confounded with is *Stenotrema hirsutum*, which is, however, a much smaller shell. This shell must be looked for under wood, chips, bark and similar debris, and commonly remains clinging to them when they are overturned. It is a solitary species, rarely more than one or two being found under the same log.

STENOTREMA HIRSUTUM Say. Plate 5, fig. 7.

Shell imperforate, subglobose; epidermis brownish or chestnut, covered with numerous, sharp, rigid hairs; whorls five, rounded; suture distinct; aperture contracted, very narrow, almost closed by an elongated, lamelliform tooth situated on the parietal wall and extending from the center of the base, within the junction of the peristome with the outer whorl, into the edge of the aperture; peristome narrow, very much depressed, and reflected against the outer whorl, with a deep cleft or fissure near the center of the basal margin; umbilicus wholly covered; base convex; far within the base of the shell is a transverse tubercle, starting from the axis. (Binney.)

This is an abundant form all over southern Indiana, and has been taken as far north as Indianapolis and North Manchester. It may occur still farther northwards. It is to be sought under flat stones

on hillsides, under bark, logs and fallen trees, and under leaves on damp hillsides, close to the ground. The shell is commonly thickly covered with minute small, straight hairs, which are not shown in the figure, and entangled in these hairs is so much mud and dirt that the animal often escapes observation. The notch is quite near the basal or umbilical end of the aperture, while the apertural opening is exceedingly small. The animal is slate colored and is very active.

STENOTREMA MONODON Rackett. Plate 5, fig. 8.

Shell imperforate, or umbilicated, globose-depressed, diaphanous, reddish horn colored, covered with short hairs; spire rather convex; whorls five and one-half, the upper ones flattened, the two last convex, the last anteriorly gibbous, constricted at the aperture; umbilicus more or less opened or completely closed; aperture widely lunar, somewhat narrowed by a lamelliform tooth on the parietal wall; peristome acute, reflected, thickened with white callus within; a transverse internal tubercle on the base of the shell. (Binney.)

Fig. 5.

This species is widely distributed all over Indiana, and may be expected to occur where land shells are found at all. Its favorite hiding places are under logs, old stumps, and under flat stones, in all possible situations, sometimes even in the open fields. Many specimens are very small, about one-half the size ordinarily attained, and to these the name of *Stenotrema leaii* has been given, but it is properly only a depauperate race. Another rather smaller form than the type occurs under logs and sticks, often in open fields, to which Say gave the name of *Helix fraterna*, describing it from Pennsylvania.

Say's description of *Helix fraterna* is now rare, having been published in "A Narrative of an Expedition to the Source of the St. Peter's River," Vol. II, p. 6 of Appendix, figured on plate 15, figure 3. Because of this fact it has been deemed best to reproduce his original description, which now follows:

"*H. fraterna.* Shell convex, brownish horn-color, minutely hirsute; whorls five, rounded; umbilicus partially or entirely closed by the termination of the labrum; region of the umbilicus indented; aperture much contracted by the labrum; labrum reflected, white, unarmed; its outer edge not projecting beyond the curve of the whorl; its inferior angle extends to the center of the base of the shell; labium with a strong, prominent, oblique, compressed, white tooth. Breadth, one-third of an inch. Inhabits Pennsylvania."

The young of this species is very thickly covered with hairs which entangle many small particles of mud, and which must be removed to

discover the real color of the epidermis. In those specimens in which the peristome has not yet been reflected a rather deep violet or reddish color may be noticed which becomes less conspicuous with age. There is a wide range of variation in the character of the umbilicus; in some specimens that structure is entirely open, and in others partially or entirely closed. These differences are not, as some have supposed, of specific value, but only indicative of a wide range of variation. The typical form of *Stenotrema monodon* is gregarious. I have taken under a large single log, in the flatlands along the Rock River, near Rock Island, Illinois, several hundred fine examples; under other pieces of drift wood in the immediate vicinity many other examples were taken at the same time. It is a very common form all over the Central West.

TRIODOPSIS PALLIATA Say.

Shell with the umbilicus closed, thin, depressed; epidermis dark brown or chestnut-color, and rough with minute, acute projections and stiff hairs; whorls five, flattened above and rounded below, with numerous very fine, oblique striæ; aperture three-lobed, much contracted by the peristome and teeth; peristome white, sometimes edged with brown, widely reflected, with two projecting teeth on the inner margin, the one near its junction with the body-whorl acute and prominent; the other, on the basal portion, long, lamellar, and but little prominent; parietal wall with a very prominent, white, curved tooth, projecting nearly perpendicularly from the shell, and forming one boundary of the aperture; umbilicus covered with a white callus, the continuation of the reflected peristome; base convex. (Binney.)

Fig. 6.

Large examples occur in southern Indiana that measure over 30 mm. in diameter. The entire shell is sometimes rufous, while the aperture is almost or quite purple, but it is commonly white. Under old trees and under flat stones on moist hillsides this form is likely to be found in some abundance. The writer has collected it at Corydon, Madison, Lawrenceburg, Brookville, and has seen it from several other places within the State. It probably occurs all over Indiana, but will be found to be more common in the southern portions of the State.

The animal is a dark slate color and when crawling is very narrow, with foot pointed behind. It usually leaves an abundant trail of mucus in its path. The outer lip of the peristome has, on its inner margin, two large and thick deposits of calcareous matter which, in some specimens, almost entirely closes the aperture, leaving only a thin and narrow opening. Through this the animal extrudes itself, without

apparent difficulty. In most old specimens the stiff hairs of the epidermis are broken off, but in specimens in which the lip has just formed and the peristome been well reflected the hairs are present and are numerous and characteristic. Numerous pathologic individuals are found on hillsides where the species frequents rocks. Then the aperture is often distorted and other peculiarities are apparent.

TRIODOPSIS OBSTRICTA Say. Plate 5, fig. 10.

Shell with the umbilicus closed, depressed, with heavy, rib-like striae and interstitial, minute, revolving lines, reddish horn color; spire flattened; whorls five, depressed, the last convex below, with a prominent, acute carina above; aperture oblique, subtriangular, narrowed by a tongue-shaped, arcuately entering tooth on the parietal wall; peristome thin, broadly expanded, its inner edge with a heavy thickening of white callus, its right portion with a stout, erect denticle, its basal portion straight, dilated, reflected, with a long, lamellar, less prominent denticle. (Binney.)

I have not personally collected this species in Indiana, nor have I ever seen an Indiana specimen, but introduce the form in this catalogue because Mr. Binney has given Indiana as a habitat for it. It resembles *Triodopsis palliata* quite closely except in the sharp carina with which *T. obstricta* is marked. It has, at least in the young form, abundant minute, short hairs, but it is far more coarsely striate than is *T. palliata*. It is a southern form and finds greatest expression in the shell fauna of east Tennessee and Kentucky; its metropolis appears to be among the Cumberland Mountains. The sculpturing of the upper surface will readily serve to separate it from any other form found in Indiana.

TRIODOPSIS APPRESSA Say. Plate 5, figs. 11, 11a, 11b.

Shell with the umbilicus covered, orbicularly depressed, pellucid, with rib-like striae and minute revolving lines, reddish horn-colored; spire flattened; whorls five, flattened above, the last obtusely angular (the angle obsolete anteriorly); aperture oblique, compressed, subtriangular; peristome angularly broadly reflected, thickened within, its terminations joined by a thin callus, on which is an obliquely entering, erect, curved, tongue-shaped tooth, the basal margin with a lamellar-like, long denticle, the right margin sometimes with an erect, tooth-like callus. (Binney.)

This shell is often light horn-colored, rather than reddish, and is by no means abundant in Indiana. I have taken it at Brookville, Lawrenceburg and Madison, and have seen specimens which came from

other portions of the State, but all of them were from the southern portion. In Kentucky and Tennessee the form reaches its greatest development, both in respect to size and numbers. It is commonly found under flat rocks on wooded hillsides. Very young specimens have an abundant development of hairs on the epidermis, but these all appear to be lost after maturity. It more nearly resembles *Triodopsis palliata* than any other of the genus, but is very distinct.

TRIODOPSIS INFLECTA Say. Plate 5, fig. 12.

Shell with the umbilicus closed, depressed; epidermis brownish horn color, with very fine, hair-like projections; whorls five, with very minute, transverse striæ; suture not much impressed; aperture three-lobed, very much contracted; peristome white, narrow, reflected, with a deep groove or indentation behind the reflection, contracting the opening so that the outer edge of the peristome does not project beyond the surface of the 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 with the body-whorl, with a circular sinus between them, forming one of the lobes of the aperture; parietal wall with a long, arcuated, white tooth; umbilicus covered, its place considerably impressed. (Binney.)

Fig. 7.

This little species, which attains a diameter of about 10 to 12 mm., is very common over all of southeastern Indiana. At Madison and Lawrenceburg, as well as at Brookville, I have taken it in abundance. It is common on stony hillsides under flat rocks, but is also taken in numbers in wooded tracts under logs and sticks. It is abundantly covered with minute hairs.

TRIODOPSIS TRIDENTATA Say. Plate 5, figs. 13, 13a.

Shell umbilicated, orbicularly depressed, with crowded, rib-like striae, light horn or chestnut-colored; spire very short; whorls five and one-half, rather convex, the last scarcely deflected in front; aperture lunar, subtriangular; peristome white, reflected, its outer contour rounded, thickened within, its terminations converging, joined by a light deposition of callus, bearing a tongue-like, erect, entering tooth, both the right and basal portions bearing on the inner margin a stout, acute denticle. (Binney.)

This is an exceedingly abundant shell all over Indiana and especially so over southern parts of the State. It is found in a variety of situations, under logs, sticks, bark, stones, and under leaves on damp hillsides. There is a very beautiful variety common in Eden Park,

Cincinnati, under the flat stones of a quarry on its eastern edge, which is characterized by its smoothness and light horn color. It is found in collections under its proper name, but is almost entitled to rank as a variety. The typical form is rare in this locality. On one occasion, under flat rocks, in early April, 1896, I collected several thousands of this species in the locality above named, where it is the most abundant shell. With it were associated large numbers of *Triodopsis appressa.* In Indiana I have found the form to be abundant. On the hillsides above Madison are to be found large numbers, and in Dearborn County it occurs nearly everywhere. Many specimens quite white occur, and seem to indicate that epidermal coloration can not be regarded as having any specific value.

Near Milan, in a small ravine which crosses the roadway leading to Moore's Hill, and at North Vernon I collected a small form of this species which certainly was not half the size the shell usually attains; these specimens are now in the Call collection in the Museum of Comparative Zoology, Cambridge.

Fig. 8.

TRIODOPSIS FALLAX Say. Plate 5, fig. 14.

Shell umbilicated, depressed-globose, with rib-like striae, reddish horn-colored; spire convex; whorls six, rather convex, the last deflected anteriorly, constricted; aperture trilobed, contracted by a large, oblique, tongue-shaped, arcuately entering tooth on the parietal wall; peristome reflected, thickened within, white, with two teeth, the upper one bending inward not on the edge, the other sub-basal. (Binney.)

This shell is closely allied to the preceding, and I do not think ought to be separated from it. It is one of those survivals in zoology which, however, one must suffer. There is no difference in habitat, in color, in general markings, or in the genitalia which justifies separation. The chief character which collectors rely on that serves to distinguish it from *Triodopsis tridentata* is the narrow constriction just behind the margin of the aperture; the six full volutions alone are not of specific value, for the nearly allied form above mentioned sometimes has that many! It would be far more to the point to indicate the resemblances, rather than the differences, and put this name as a synonym under *T. tridentata,* where it properly belongs. It has the same general habitats, is found under the same conditions, and occurs in all collections made on any day in the woods of southeastern Indiana. It is supposed to be a little more elevated in the spire than its near ally, but as this is a very variable feature almost any form may be selected from a number of individuals.

MESODON ALBOLABRIS Say. Plate 5, figs. 15, 15a.

Shell imperforate, convex; epidermis immaculate, of a uniform yellowish-brown russet or light chestnut color; whorls five to six, with fine parallel striæ running obliquely across them, and spirally striated with very minute and delicate, but distinct, wavy, impressed lines, which are most apparent on the back of the reflected peristome; suture well marked and distinct; aperture contracted by the peristome; peristome white, flattened in the plane of the mouth, abruptly and very widely reflected; umbilicus of the mature shell covered by the reflected peristome, which is continued to the base of the shell. (Binney.)

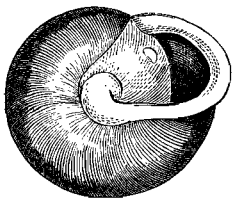

Fig. 9.

This is the largest species with reflected peristome to be found in Indiana, and is a highly characteristic shell. It is found in open woodlands, and on wooded hillsides, under logs, or crawling over the ground in the shelter afforded by the thick vegetation which abounds on wet hillsides. After a warm rain this species, and indeed all of the species of the subgenus *Mesodon*, come out and crawl freely about, and such times are the best in which to collect them. They may be found in æstivation, clinging to the under sides of fallen logs, not buried in the ground, with a thin membrane, the epiphragm, which is the dried mucus secreted across the aperture, closing it against further loss of moisture by excluding the air. This same secretion glues them, lightly, to trees, and is always ruptured when they are taken.

This species occurs over all of Indiana, but is largest and most perfectly developed in the lower Wabash Valley and along the Ohio. It is abundant at Madison, Corydon, Bloomington, Lawrenceburg, and Brookville; on the northern slopes of the Kentucky hills facing the Ohio, opposite Madison and Lawrenceburg, this shell is found in great numbers and in great perfection. Among many there collected were a large number of the mahogany or light coffee-colored forms, with pink aperture. Many specimens had the parietal tooth well developed, a feature which is seen in about five or six specimens in a hundred, but in these localities the dentate forms seem to be abundant. It will be noticed by the collector that only the old forms present this character, which gives origin to the subgeneric name. Most of the specimens which I have taken have a reddish or cream-colored animal; I have never seen an animal of this species which was black, or anywhere near black, though Mr. Binney declares the animal varies to blackish.

The eggs of this species are easily collected for study and are found under logs, in moist situations, deposited in clusters or clumps of two

or three dozen, or more. I have had them deposit their eggs in captivity, in cigar boxes, pending opportunity to remove the animal from the shell. The eggs are very large and somewhat cream-colored. Perhaps it should be here mentioned that the forms with almost white epidermis are the most common in Indiana, russet-colored ones being rare.

MESODON MULTILINEATUS Say. Plate 5, figs. 16, 16a.

Shell imperforate, depressed-subglobose; spire convex, rather thin; epidermis yellowish brown or russet color, with numerous reddish brown, finely undulated, revolving lines and bands; whorls between five and six, convex, with delicate, parallel, oblique striae, the last ventricose; suture distinctly marked; aperture lunate, slightly contracted by the peristome; peristome white, not much expanded, reflected, rather thin; umbilical region depressed (Binney.)

This species has been found in suitable localities all over southern Indiana and as far north as North Manchester. About Brookville, Indianapolis and Edinburg it is very common. The greatest variety in coloration is seen on examination of large series of specimens. This is essentially a species of the lowlands and delights in swampy and moist stations. The margins of bogs which have a bordering of bushes and trees that furnish, when the leaves fall, a good protection are excellent places in which to collect them. In the swampy or boggy places that mark so much of the bottom lands of the Wabash this species occurs in numbers. It is usually found crawling about, even in the warm sunshine, and appears to withstand the summer's heat better than does the majority of helices. I have seen many albino specimens and also a number which were entirely wine-colored, there being only a general uniformity in color pattern. The number of narrow color bands will serve to separate this species from all other mesodons. In its winter habits it appears to be gregarious where it occurs at all, many examples being sometimes collected together in a single mass. It is one of the commonest of forms in river drift, and, in these situations, the epidermis is usually peeled off, when the color bands are seen to be in the mass of the shell and not epidermal in character. I have collected this form in the loess of Iowa and Illinois, and also noted it in the loess at Vicksburg, Mississippi. Its wide distribution shows that it has long formed an integral part of the shell fauna of eastern North America. Rare individuals are found which have the central parietal tooth, but they are very uncommon.

MESODON PENNSYLVANICUS Green. Plate 6, fig. 1.

Shell imperforate, convex, elevated; epidermis yellowish horn color or russet; whorls six, convex, with crowded, elevated, oblique striae; suture distinctly marked; aperture subtriangular, contracted by the peristome; peristome white, narrow, reflected, not flattened, with sometimes a slight thickening on the inner side near the base; umbilical region indented. (Binney.)

This species has occurred in my collecting only at Lawrenceburg and Brookville, in southeastern Indiana. It is fairly common at the latter place and rare at the first named. Around Cincinnati, in favorable localities, it is common, a hundred being collected in one spot a few feet square in a single afternoon. It is one of the three small species of *Mesodon*, but is quite easily distinguished from the others by its greater solidity, the shell being much thicker and heavier. The peculiar shape of the aperture, due to a thickening on the lower portion of the peristomal margin, will also serve to separate it. Its usual habitat is on hillsides, in grass which is thickly covered with leaves, on the margins of forests or in open forests. It is found in contact with the earth, commonly in a snug little hole made in the ground. The color of the epidermis is by no means a constant feature, but ranges from very light horn color to a fairly dark russet. A feature which the collector will not enjoy is the tenacity with which the animal adheres to the shell even after the usual boiling process employed to remove it. Nearly half the animals break off in trying to extract them.

MESODON MITCHELLIANUS Lea. Plate 6, fig. 2.

Shell imperforate, depressed, conoid-globose, thin, with crowded, striae and very crowded, decussating, microscopic lines, pellucid, horn-color, polished; spire briefly conoid; whorls five, moderately convex, gradually increasing, the last ventricose, subconstricted and briefly deflected anteriorly; aperture diagonal, lunate, subperlaceous within; peristome white, thickened, its terminations slightly converging, subequally reflected, that of the columella narrow, adherent, or subdilated and spreading. (Binney.)

This is a rather small species, the smallest of the group in Indiana. I have noticed it only in southeastern Indiana, about Brookville, where it is found on a low hillside on the borders of a swampy area near the Whitewater River. About Cincinnati, Ohio, it is common enough, but does not appear to be very widely distributed. It is a very beautiful little shell, with bright and shining epidermis, and is very light-colored in all the specimens which I have seen. It should be looked for

in rather low or damp ground, in grassy stations; after heavy warm rains it often ascends the stems of plants and may be found clinging to the lower surfaces of the leaves. It is not easily confounded with any other form except *Mesodon clausus*, depauperate specimens of which I have frequently received under this name.

MESODON CLAUSUS Say. Plate 6, figs. 6, 6a.

Shell subimperforate, conoidly semiglobose, rather solid, with crowded, rib-like striae, yellowish horn color; spire subregularly conoid; whorls five and one-half, rather convex, gradually increasing, the penultimate subangular, the last rounded, anteriorly subconstricted, and briefly deflected; umbilicus narrow, almost covered by the reflected peristome; aperture diagonal, subregularly lunate; peristome with a heavy white thickening, uniformly subangularly reflected, its columellar portion subdilated. (Binney.)

This is a widely distributed species in Indiana, ranging from Covington, Wabash and North Manchester over all the southern portion of the State. It is whiter than *Mesodon pennsylvanicus* and larger than *Mesodon mitchellianus,* but is closely related to them in all essential characters. It is found in a variety of habitats, but best loves low ground where are abundant growths of weeds. After heavy storms it may frequently be taken clinging to stems and the under side of leaves. It is very active and crawls about in the grass of damp stations very freely, even in fairly dry weather. It is a delicate and graceful shell, less heavy than the larger *Mesodon pennsylvanicus.* It is abundant over all of southeastern Iowa, southern Illinois as far north as Rockford, and abounds in all the river counties of Indiana. It is also abundant in the Wabash Valley as far north as Covington, and probably ranges to the northern boundary of the State. Mr. A. W. Butler and Professor H. S. Voorhees have sent me fine examples from Brookville, where I have also collected it. On the Kentucky side of the Ohio it is abundant in favorable localities and is rather larger than common. Occasional specimens have been found that were over 20 mm. in diameter. I have never seen a specimen, in all the hundreds I have collected, with a parietal tooth.

MESODON ELEVATUS Say. Plate 6, fig. 3.

Shell imperforate, very convex, elevated, almost conical; epidermis yellowish horn color; whorls nearly seven, rounded, with fine, oblique, transverse striae, the last ventricose; suture distinct; aperture contracted by the peristome, somewhat triangular; peristome white, thick-

ened, reflected, its basal portion with an obsolete, lamellar denticle; parietal wall with a large, white, robust, obliquely curved tooth; umbilicus covered. (Binney.)

Shells of this species may be found all over Indiana, but its metropolis is in the river counties on the south. In favorable localities on hillsides it is a most abundant shell, hundreds being collected in an hour or two on favorable days. The large size of the shell, its high, conical shape, and the very heavy oblique parietal tooth will readily distinguish it at once from all other mesodons. There is a great variety of shape to the aperture, and in many old shells there is a thickening of the peristome towards the basal margin that no other closely related form seems to have. This is one of the earliest shells to come out of winter quarters and, since it burrows far into the mud of wet hillsides, when it emerges it is heavily coated with mud and dirt. It burrows as deeply as six or seven inches. It is always found crawling, even in dry weather, on its favorite hillsides, but after a warm and heavy rain it comes out in swarms. Early morning, or late evening, will disclose hundreds of this animal, and it can then be collected in great numbers. On the hillsides of the Ohio, on the Kentucky side, opposite Lawrenceburg, and opposite Madison, it is very abundant, associated always with the following species, which is also abundant. I have taken a number at Bloomington, on Bean Blossom Creek, on the wooded hillsides, where it is common but not so abundant. The fall is the most favorable time to collect this shell, since those which survive the winter and come out in the early spring are devoid of much of their epidermis.

MESODON EXOLETUS Binney. Plate 6, fig. 4.

Shell imperforate, convex, somewhat ventricose; epidermis of a uniform yellowish horn or russet color; whorls between five and six, with fine parallel striae crossing them obliquely; body whorl large and ventricose; suture well marked and distinct; aperture rounded, contracted by the peristome, the plane of the aperture making a considerable angle with the plane of the base; peristome thickened, white, reflected, its basal portion subdentate; parietal wall with a prominent, white, oblique tooth; umbilicus covered. (Binney.)

This species is common over all the southern two-thirds of Indiana, and is especially so in the wooded bluffs along the Ohio River. At Madison and Lawrenceburg it is very abundant, and is scarcely less so in the bluffs along the creeks at Corydon. It is always found in association with *Mesodon elevatus,* but is easily distinguished from that form by its more flattened spire, somewhat greater diameter, and

the entirely different character of the parietal tooth, which is never so large and thick or so much curved as in *M. elevatus*. The animal is often yellowish to ashy gray in color and extrudes itself far from its shell in crawling about. The habits are not essentially different from those of the preceding species, but it appears to bury itself some deeper in the loose soil of hillsides when it goes into winter quarters. Binney calls attention to the habit of this species in laying its large eggs, in clusters, deeply into the earth, "as deep as the body of the animal will extend." On damp or very moist hillsides, of a springy nature, this shell may be found in abundance.

MESODON THYROIDEUS Say. Plate 6, figs. 5, 5a, 5b.

Shell narrowly umbilicated, depressed globose; spire convex; epidermis of a uniform yellowish-brown or russet color; whorls five, with fine parallel striae running obliquely across them; spire more or less elevated; suture distinctly impressed; aperture lunate, contracted by the peristome, the plane of the aperture making a considerable angle with the plane of the base of the shell; parietal wall with a prominent, white, tooth-like process placed obliquely to the axis of the shell; peristome white, thickened, widely reflected, and sometimes grooved on its face, its exterior yellowish; umbilicus exhibiting only one volution, partially covered by the reflected peristome where it unites with the base of the shell. (Binney.)

I have found this species to be the most widely distributed *Mesodon* in Indiana, since it ranges all over the State. It is one of those forms which may always be found in low, marshy stations, under leaves bordering swamps, in the low bottom lands of streams like the Wabash in its lower part, and on wet hillsides where abundant plants grow. In southeastern Indiana it is found everywhere where snails can be expected to occur at all. The animal is yellowish-white, sometimes almost brown, and is very active. The eggs are laid in either the moist earth or under leaves next the ground, or under fallen trees and logs. This species also may be found on fairly dry hillsides under flat stones or clinging to trees in bottom lands at a height of from two to six feet above the ground. It sometimes may be taken in alder swamps, attached to the leaves of the plants, on the under side. It is an active species after rains and may then be taken as it crawls around in numbers. The epidermis ranges in coloration from rather dark reddish to white, and is beautifully polished. Its umbilicus, always present, will aid in distinguishing it from all others of the subgenus.

MESODON PROFUNDUS Say. Plate 6, fig. 7.

Shell broadly umbilicated, orbicularly depressed; epidermis yellowish horn color, with reddish-brown revolving lines and bands, sometimes uniformly brown or albino; whorls from five to six, convex, obliquely striated with delicate and regular raised striae; suture distinct; aperture almost circular, a little contracted by the peristome, flattened towards the plane of the base; peristome white, thickened, reflected, with a slightly prominent callus or obtuse tooth on the inner edge near the base; umbilicus rather large and profound, exhibiting all the volutions to the apex; base convex, with the striae converging into the umbilicus. (Binney.)

This is an easily distinguished species. The bands of color are usually two in number, but sometimes there are three or more; occasionally all are merged into one when a deep reddish or brownish color is given to the whole shell. Albino specimens are very common. At Bloomington, Brookville, Indianapolis, Madison, Corydon and Lawrenceburg, as well as over all the lower Wabash Valley, this is a most common species, in the same stations as are occupied by *Mesodon elevatus,* and *Mesodon exoletus.* The thickening of the peristomal margin, near the base, is highly characteristic, while the coarse striae make the surface quite rough, more so than is the case with any other Indiana shell.

This species also has the habit of climbing far up on the sides of trees in the low lands, fastening itself by the epiphragm. I have taken specimens as high as 10 feet above the ground. I have received the immature shells under the name of *Patula solitaria* from a number of correspondents, but the plain marks of juvenility should serve to separate it from immature, or mature, shells of that species. The eggs are laid similarly to those of *Mesodon elevatus,* and number thirty or more, cream-white in color, and nearly one-tenth of an inch in diameter. The size of the eggs rapidly changes after a day or two as the development processes progress; the size I have indicated is that of freshly laid eggs.

VALLONIA PULCHELLA Müller. Plate 4, fig. 9.

Shell widely umbilicated, depressed, slightly convex above, thin and transparent; epidermis colorless; whorls four, very minutely striated, the last large and spreading at the aperture like a trumpet; aperture orbicular, a little dilated; peristome much thickened, white, reflected, making nearly a continuous circle, ends approaching; umbilicus large, exhibiting all the volutions. (Binney.)

This is a most abundant species in southeastern Indiana, in suitable locations. I have found it abundantly at Lawrenceburg in debris of gardens along fences and even at the base of grass clumps in the open lawns. It is an introduced species, or is circumpolar. It is very minute and should be confused with no other likely to be found in the State. The reflected aperture is a feature which no other small flat species shares. The diameter of the shell is from two and one-half to 3 mm. After a rain the weeds and dead sticks which are found along the margins of most gardens will be found to have hundreds of these tiny shells adhering to them. I have never found it in the woods, though I suppose it so occurs. Almost nothing is known of its habits and nothing of its embryology. It doubtless occurs over all of the State. It is a most abundant shell in Eden Park, Cincinnati, the dirt collected under bunches of dead stems of plants, when sifted, containing hundreds of examples.

The collector will not fail to observe that the markings of the shell range from perfectly smooth and shining to strongly ribbed or costate forms. To the costate shells the name of *Vallonia costata* has been given, but no careful observer will now separate them. Every variety of sculpturing may be seen in a quantity taken from the same locality.

Family PUPIDÆ.

Pupilla pentodon Say. Plate 6, figs. 8, 8a.

Shell subperforate, of an elongated-ovate form, minutely striated, and of a spermaceti or whitish horn color; whorls about five, well rounded, and separated by a deep suture; apex rather acute; aperture oblique, nearly semicircular; peristome sharp and somewhat expanded, but not reflexed; the submargin of the throat is thickened by a ridge of white callus on which the denticles are situated; one of these, and sometimes two, is on the parietal wall, two on the columella portion of the peristome, and two constantly, and from one to five others occasionally, on the outer portion of the peristome; of these, that near the middle of the parietal wall is largest, that at the upper part of the columella is next, and one opposite the first, on base of the aperture, is the third in size. (Binney.)

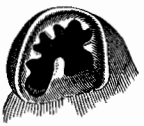

Fig. 10.

All the members of this family are very minute and are to be collected with difficulty and only after careful search. This species in particular may be found all over Indiana, under bark, logs, fallen

trees, and often under flat stones, on the edges of forests and in the open lands in river bottoms. It is also to be found in gardens, about dwellings, under old boards, stones, and under refuse piles of plant stems. A most favorable time to collect this and other very small species is after a rain, on the upper sides of the fallen trees, in well shaded bottom lands, such as those of the lower Wabash. It may then be found in numbers crawling along on the bark, having been driven from the cracks and crevices by the water. The shells are often coated with mud, especially when taken from under logs and sticks, and are then with great difficulty distinguished from merest little mud-lumps, or from the small earthy pellets or castings from earthworms. Several species and varieties have beeen based on the variable characters of the little denticles within the aperture, but they have no valid basis in structural differences, and rather lead to confusion than to a better understanding of these delicate and small objects. I have the species from Indianapolis, Lawrenceburg, and North Manchester.

LEUCOCHILA FALLAX Say. Plate 6, fig. 9.

Fig. 11.

Shell fusiform, regularly diminishing in volume from the body-whorl to the apex, smooth; epidermis brownish horn-color; whorls six, very convex, striæ of growth hardly apparent; suture well impressed; aperture lateral, rounded-oval; peristome white, rather broadly reflected, lined within with white callus, its right termination strongly curved; umbilicus perforated. (Binney.)

This little shell, which is from five to five and one-half mm. in length, is unlike any other found in the State. It is common over all of the southern half of the State and likely occurs to the northward. It is a beautiful mahogany-brown species, and has a glistening epidermis. It is found at the base of grass clumps in gardens and lawns, and under chips, sticks, flat stones, and occasionally leaves in woods. It can not be confused with any other member of the family. The rimate character of the aperture, its transverse striae, and the absence of denticles in the aperture or on the throat will serve to distinguish it at once. The animal is entirely black.

LEUCOCHILA ARMIFERA Say. Plate 6, figs. 11, 11a, 11b, 11c.

Shell cylindrical, subfusiform, smooth; whorls six to seven, convex, the three next the aperture of about equal diameter, the posterior three diminishing and forming a rather obtuse apex; suture impressed; peristome white, thin, subreflected, forming the whole outline of the aperture, except a small portion of the body-whorl, where a thin, testaceous deposit connects its two extremities; aperture lateral, nearly

oval, deep, cup-shaped, and narrowing towards the throat, which is almost filled up by projecting teeth, white within; teeth commonly four, one of which, affixed to the body-whorl, commences at the superior margin of the aperture, near the junction of the peristome and ultimate whorl, and runs backward and downward into the aperture; it is prominent, lamelliform, irregular, has one or more sharp, projecting points, and is sometimes bifid; another, thick and massive, is situated deep in the throat, and marks internally the place of the umbilicus, and two others, projecting and tooth-like, are placed on the peristome at the base of the aperture, and point towards the center of the aperture; base of the shell, from the umbilicus to the edge of the aperture, compressed, forming a short and obtuse keel; umbilicus a little expanded and slightly perforate. (Binney.)

From this description it may be seen that there is a great degree of variation in the arrangement and characters of the denticles which partially close the aperture of this species. The shell itself is not separated by these characters, which are but trifling at most, from other small forms, but is easily distinguished by the outline of the shell and its size, being the largest of the Indiana *Pupidæ*. The epidermis is always white. The species is very common and is found in almost all stations, but especially is likely to occur under flat stones, on wooded hillsides. I have taken it on my lawn in Lawrenceburg, in great numbers, at the base of grass clumps. It is gregarious in its habits and may sometimes be found by dozens, especially in the fall, under stones in pastures.

There is also a great variation in the form and continuity of the aperture in this species; about one-third of the specimens collected will be found to have the aperture complete and the opening will appear to be almost rimate. It is often more reflected in some specimens than in others. But the size of the shell and the sculpturing seem to be quite uniform.

LEUCOCHILA CONTRACTA Say. Plate 6, fig. 10.

Shell subconical; epidermis whitish horn-color; whorls between five and six, very convex, diminishing regularly from the last whorl, which is somewhat ventricose, to the apex; suture well impressed; peristome white, thickened, somewhat reflected, its extremities connected by a raised, testaceous fold, making the margin of the aperture entire; aperture lateral, rather triangular or trilobate, more than half as wide as the body whorl, expanded above and diminishing regularly

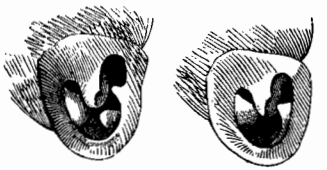

Fig. 12.

into a very narrow throat, with four teeth, one upon the columella, large, coarse, and irregular, projecting into and very much filling up the aperture, and having a concavity on the side towards the peristome; another tuberculous, not large, more or less near the margin of the peristome; and two others, massive and prominent, deep-seated in the throat, one being in the base behind the columellar tooth and the other on the side of the umbilicus and apparently produced by the umbilical fold; umbilicus with a minute perforation; base of the shell with a sharp keel between the umbilicus and margin; last whorl impresssed behind the peristome. (Binney.)

The same remarks apply, in nearly all particulars, as were made above in the case of *Leucochila armifera*. The characters of the denticles are very variable, and besides the fact that they are present there is no apparent order observable in their arrangement. This species ranges all over Indiana and is found in the usual situations of these small forms; I have also taken it in gardens. The short and thick-set character of the shell, which sometimes attains a length of three mm., will readily distinguish it.

LEUCOCHILA CORTICARIA Say. Plate 6, figs. 12, 12a, 12b, 12c.

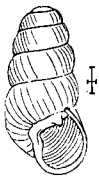

Fig. 13.

Shell whitish, shining, cylindrical, obtuse at the apex; whorls rather more than five, convex; suture well impressed; aperture lateral, two-thirds as wide as the last whorl, suborbicular, with a single tooth (sometimes two) on the parietal wall near the center, and a tooth-like enlargement near the umbilical termination of the peristome, which is white, reflected; umbilicus very minutely perforated. (Binney.)

This little shell, which attains the length of two and one-half mm., has a form similar to that of *Leucochila fallax*, but is a much smaller shell and is always white or waxy-white. It is found under sticks, stones, driftwood, and under the bark of fallen trees. It can be easily distinguished by the one or two little white parietal denticles.

This little species was described by Say in Nicholson's Encyclopedia, a work now very rare, and from which I copy the following original description:

"*P. Corticaria.* Shell dextral, cylindrical, obtuse at the apex; whorls five, not perceptibly wrinkled or striate. Aperture suborbicular, lip reflected; a single tooth on the pillar lip near the outer angle; inner angle with an angular projection resembling a second tooth, sometimes obsolete.

"Length about the tenth of an inch."

ISTHMIA (VERTIGO) MILIUM Gould.

Shell very minute, subcylindrical, diminishing equally to both extremities; epidermis dark-amber or chestnut color; whorls five, rounded, very minutely striated, decreasing slightly to the apex, which is obtuse; suture deep; peristome white, slightly reflected; aperture lateral, half the width of the last whorl, within brownish, general shape semicircular, truncated abruptly and directly by the last whorl, a testaceous deposit upon which forms the transverse margin and connects the two extremities of the peristome; circumference made up of two curves of different radius uniting in the peristome, where the junction causes an angle projecting inwards, the smaller curve comprising about one-fourth part and forming the superior portion of the peristome; teeth six, two on the transverse margin, sharp, projecting, and tooth-like; one in the angle between the columella and transverse margins, broad, massive, and prominent, with occasionally one or more tubercles about its base; one on the lower part of the columellar margin; two on the peristome, in the base of the aperture, and at the junction of the two curves; umbilicus rather wide. (Binney.)

This little species is found under boards and sticks, bark and stones, in low grounds generally, but also may be taken on hillsides under leaves. Many are often found together. I have seen specimens from Brookville and from Lawrenceburg, and it ought to occur in many localities in the State. It is one of the smallest of our land shells, but the rich and deep mahogany color, shining, will enable its detection. It can not possibly be confounded with any other than the following species, but it is less than a single millimeter in length, while the following form is three millimeters, occasionally more, in length. It is a beautiful object under high magnification.

ISTHMIA (VERTIGO) OVATA Say. Plate 6, fig. 13, and plate 7, fig. 1.

Shell minute, ovate-conic, ventricose, dark amber-colored; whorls five, very convex, the last much inflated, diminishing rather rapidly to a somewhat acute apex, with an indentation towards the aperture; suture rather deep; peristome thin, somewhat expanded, with a groove behind and a thickening within; aperture in general outline semicircular, the curve consisting of segments of two different-sized but well-defined circles, the smaller on the right at the junction of the peristome and body-whorl, comprising about one-fourth of the whole contour, and forming an angle at their junction; teeth generally six, two on the transverse margin, two on the columellar margin, the upper of which is massive, the lower pointed, and two on the peri-

stome, in the base and at the junction of the two curves, sharp and prominent; umbilicus expanded. (Binney.)

The dark amber-color which this shell exhibits, when alive, is due to the color of the animal, which is a deep reddish. The shell is mahogany-colored when the animal has been placed in alcohol and allowed to dry up. The species is to be found in swampy areas, along streams, under sticks and flat stones, and seems best to love very wet stations. In meadows which have swampy areas in which *Carex* grows, this shell may be trapped abundantly by placing a few boards near the margins of the wettest places. On turning them over, after a few days, a number of individuals may be taken. The form is gregarious. I have seen it only from Lawrenceburg and Indianapolis, but it doubtless is of wide distribution all over the State. The characters of the denticles are not constant, since many individuals may be found with every possible variation of angle and arrangement. In some specimens the aperture appears to be almost closed by them.

Family STENOGYRIDÆ.

Ferussacia subcylindrica Linnæus. Plate 4, fig. 8.

Shell small, thin, transparent, oblong-oval; epidermis smoky horn-color, smooth, very bright and shining; whorls five or six, somewhat rounded, the last equaling two-fifths the shell's length, rounded at the base; apex obtuse; suture somewhat impressed; aperture lateral, oval, its plane nearly parallel with the axis of the shell; peristome simple, thickened, often slightly rufous; umbilicus imperforate; columella obsoletely truncated at base. (Binney.)

This beautiful and glossy shell is circumpolar in its distribution and is the sole representative of its genus in America. It occurs quite commonly over the northern parts of Indiana, on hillsides, under leaves and sticks and stones, and in forests under bark, between the bark and the wood of fallen trees. Its epidermis is the most brilliant of any form in the State. I have never seen an example from the southern portions of the State, but there is no reason why it should not occur there. It attains a length of about five and one-half mm.

Family SUCCINIDÆ.

Succinea ovalis Gould. Plate 7, fig. 4.

Shell ovate, somewhat conic, very thin, pellucid, watery horn-color, sometimes tinted roseate; periostraca shining, very minutely striate; whorls three, the last compressed and elongate when viewed above;

spire short but acute; suture impressed; aperture produced by a deep truncation of the shell, elongated more than three-fourths the length of the shell, patulous, expanding anteriorly, exhibiting the interior of the volutions; when viewed on the side of the aperture the conical shape of the shell appears; the broadest part of the cone is below the center of the aperture and it tapers gradually to the apex. (Binney.)

This species occurs over all the State, and is especially common among the reeds on the margins of the lakes in the northern portions of the State. It hides in great numbers at the foot of Carex clumps, in swampy areas, and may often be taken on the stems and leaves of plants which grow near the water. Its shape is unlike that of any other species in the State, and it is easily distinguished thereby. The epidermis is often darker colored than Binney's description would indicate. The shell has been noticed in nearly all piles of river drift, indicating that its habitats may be the low and swampy areas of river bottoms. I have collected a number of specimens clinging to the lower surfaces of "wild sunflowers"—*Helianthus*.

SUCCINEA AVARA Say. Plate 7, fig. 3.

Shell rather small, thin and fragile, straw-colored, rosy, amber-colored, or greenish; periostraca shining, or presenting minute hairy processes in the young; whorls three, very convex, separated by a deep suture; last whorl rather large, not much expanded; spire very prominent, acute; aperture ovate, rounded at both extremities, about half as long as the shell. Extreme length, about six mm. (Binney.)

This is the smallest form of *Succinea* in the State, and is found in a variety of situations, under sticks, stones, on trees, under logs, in wet and in dry stations, in lowlands and on hillsides. In fact, nearly every station will yield specimens of this shell. Its whorls are more conspicuously rounded than any other form. It has been seen from New Albany, Madison, Bloomington, Indianapolis, Lawrenceburg, North Manchester, Brookville and Wabash. It delights to secrete itself under wet logs, in river bottoms, in sandy stations, and I have frequently so found it. The animal is darker in coloration than the other Indiana species.

SUCCINEA OBLIQUA Say. Plate 7, fig. 2.

Shell ovate, pale green, yellowish-green, amber-colored, or cinereous, very thin and fragile, pellucid, sometimes roseate at apex; periostraca shining, minutely wrinkled or striated; whorls rather more than three, 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, more or less oblique; columellar margin with a slight testaceous glazing; columella thin, sharp, narrow; peristome thin, its edge blunted by the reflection of the periostraca. Greatest length, 25 mm.; ordinary length, 18 mm. (Binney.)

This species is the largest of the Indiana forms and is found in open fields, under sticks, planks, and stones, on the banks of rivers, under the bark which has fallen from half-rotted trees, on the stems of aquatic plants, and under the leaves of the swamp alder. I have found hundreds of specimens in a swampy location, on reeds and stems of plants, after a rain, the animals having been evidently driven from the ground to these places for safety. They are found on the margins of swamps, at times, but commonly love best those stations which are more dry. None of the species are amphibious, as is commonly supposed.

A form which Dr. Lea called *Succinea totteniana* is sometimes noticed in collections and may always be seen in the exchange lists of tyros who desire to get "full collections" without being particular in the matter of synonymy; this form is synonymous with Say's older species.

The habits of the *Succineæ* are interesting. They are unable, especially during the nidification season, to withdraw themselves wholly within their shells, and some considerable portion of the animal appears protruding beyond the apertural margin. While they do not ever retract themselves very far within the shells, it is common to find them, in dry weather, so far within the shells that over half of the body-whorl is empty; this is the usual condition when they go into hibernation. They are often found adhering, in dry weather, to leaves and plant stems, with a tenacious epiphragm which holds them in place and which entirely covers the aperture. The animals are commonly some shade of light yellow, with occasional darker blotches, and the heads are often the darkest portion of the body. The tentacles are rather large and thick, club-shaped, and are often the home of a stage in the development of a planarian.

To facilitate the systematic study of these interesting forms, there is added below a classified table of the species thus far known in Indiana. It is by no means a fact that all the varieties to be found in the State have yet come to light, but such additional forms as may from time to time be discovered are likely to fall within the arrangement of forms as exhibited in this table. The reader will note that seven families, fourteen genera, and eight subgenera are represented, by a total of fifty species. The variety is not great, when one con-

siders the favorable characters of Indiana forests and plains, but the paucity of groups is compensated by the great numbers of individuals, some forms of which find here their metropolis.

PULMONATA GEOPHILA.

FAMILY.	GENUS.	SUBGENUS.	SPECIES.
Selenitidæ	Macrocyclis		concava.
Limacidæ	Limax		flavus.
			campestris.
	Zonites	Mesomphix	fuliginosus.
			friabilis.
			ligerus.
			intertextus.
			inornatus.
		Hyalinia	arboreus.
			limatulus.
		Conulus	fulvus.
		Gastrodonta	internus.
Philomycidæ	Tebennophorus		carolinensis.
			dorsalis.
Helicidæ	Patula		solitaria.
			alternata.
			perspectiva.
			striatella.
	Helicodiscus		lineatus.
	Strobila		labyrinthica.
		Stenotrema	stenotremum.
			hirsutum.
			monodon.
	Triodopsis		palliata.
			obstricta.
			appressa.
			inflecta.
			tridentata.
			fallax.
	Mesodon		albolabris.
			multilineatus.
			pennsylvanicus.
			mitchellianus.
			elevatus.
			exoletus.
			thyroideus.
			clausus.
			profundus.
	Vallonia		pulchella.
Pupidæ	Pupa	Pupilla	pentodon.
		Leucochila	fallax.
			armi era.
			contracta.
			corticaria.
	Vertigo	Isthmia	milium.
			ovata.
Stenogyridæ	Ferussacia		subcylindrica.
Succinidæ	Succinea		ovalis.
			avara.
			obliqua.

PULMONATA LIMNOPHILA.

ARTIFICIAL KEY TO THE LIMNÆIDÆ.

A.	Shell elongate, dextral.	*Limnophysa.*
B.	Shell ovate, sinistral or reversed.	*Physa.*
C.	Shell large, discoidal, umbilicated.	*Helisoma, etc.*
D.	Shell small, discoidal, flat, aperture simple, decurved, carinate.	*Menetus.*
E.	Shell small, discoidal, ecarinate.	*Gyraulus.*
F.	Shell minute, white, elongate.	*Carychium.**

LIMNOPHILA.

Subfamily AURICULINÆ.

CARYCHIUM.

Carychium exiguum Say.

Shell minute, elongated, tapering at both ends, white, translucent, shining; apex rather obtuse; whorls five to six, convex, very oblique, with transverse striae; suture distinct, impressed; aperture obliquely oval, white, with a prominent plait on the columellar margin, about midway between the extremities of the lip, and a slightly prominent fold near the junction of the lip with the umbilical extremity of the shell; lip thick, reflected, flattened; umbilicus perforated.

Length one and three-fifths mm., diameter three-fourths mm. Aperture one-half mm. long.

This is one of the most minute of American shells; it is common in many localities in Indiana, but must be sought for near the water or in permanently moist stations. I have taken it at Lawerenceburg, Indianapolis and New Albany; there are records of occurrence in many other localities. The form is thought by many to be a land shell, but it is not; it may be found on the under side of submerged boards on the borders of ponds and swamps, a station which a land shell could never endure. The margins of damp woods, under the leaves and close to the wet earth will usually disclose this little shell.

*This little shell is not a limnæid though belonging to the *Limnophila*; it is one of the *Auriculidæ* and is placed here for convenience merely.

FAMILY LIMNÆIDÆ.

SUBGENUS LIMNOPHYSA.

LIMNOPHYSA REFLEXA Say. Plate 8, fig. 8.

"Shell fragile, very much elongated, narrow, honey-yellow, tinctured with brownish, translucent, slightly reflected from the middle; volutions six, oblique, wrinkled transversely; spire more than one and a half times the length of the aperture, acute, two or three terminal whorls vitreous, body-whorl very much dilated; aperture rather narrow; labrum with a pale margin, and dusky red or blackish submargin." (Say.)

This limnæid is common in northern Indiana and occurs in all the lakes and swamp-streams as well as ponds. It is exceedingly variable; often specimens are found which far exceed the dimensions given by Say in his original description quoted above. The form belongs to the sub-boreal fauna; the distribution in America is very wide over all the middle portions of the continent. The whorls are sometimes very ventricose, the spire shortened and stubby, the aperture dilated, and often purplish-colored within. A form was described by Tryon as *Limnæa zebra*, but it is only a local variety of this species. The most southerly point at which I have observed it in this State is Terre Haute.

LIMNOPHYSA PALUSTRIS Müller. Plate 8, fig. 5.

"Shell oblong-conic, gradually acuminated, reticulate with transverse lines and longitudinal wrinkles; whorls rather more than six; spire acutely terminated; suture moderately impressed; aperture shorter than the spire; labrum, inner submargin, reddish obscure; labium, calcareous deposit rather copious, not appressed at base, but leaving a linear umbilical aperture; body-whorl on the back longer than the spire." (Say.)

This shell is often confounded with the preceding, and indeed it does closely resemble it; however, this form is more ventricose than *reflexa* ever becomes, and the peculiarly malleated character of the body-whorl will help to separate them. Its habits are about the same as those of the preceding shell; it is, however, a more abundant shell and is confined more closely to swamps and swales. The apical whorls are often denuded of epidermis and then eroding give to the shell a very rough appearance. Specimens have been seen from Tippecanoe and Turkey lakes, from the St. Mary's River, and from swamps near

Marion, where the species is very abundant. This shell has a rather lighter colored epidermis than *reflexa,* and is rarely so purple within the aperture; it is, on the whole, a little more fragile.

LIMNOPHYSA DESIDIOSA Say. Plate 8, fig. 6.

"Shell oblong-subconic; whorls five, very convex, the fourth and fifth very small, the second rather large, suture deeply indented; aperture equal to or rather longer than the spire; labium, calcareous deposit copious, not perfectly appressed at base, but leaving a very small umbilical aperture. * * * Length seven-tenths of an inch." (Say.)

This is one of the smallest of the limnæids and is at the same time one of the most abundant; it occurs all over the State and in every variety of station; it especially should be sought on gently sloping muddy banks along the Wabash, the Ohio, or the Kankakee. I have seen examples from over twenty different localities in Indiana. The epidermis is exceedingly thin and light-colored, the aperture is rather large and the animal quite black; the whorls seem to be very loosely coiled. Water-fowl destroy thousands of these little animals, their habit of crawling on the bottom near the water's edge and in shallow places rendering them easy of access. In wet and marshy places along the Wabash it may often be taken by thousands, and in the small pools left by retreating floods many thousands are always stranded, only to die or become the food of wading birds.

LIMNOPHYSA CAPERATA Say. Plate 8, fig. 7.

"Shell suboval, a little oblong, obscurely yellowish horn-color; spire half the length of the mouth; apex acute; whorls slightly wrinkled across, and with very numerous, equal, subequidistant, elevated, minute, revolving lines; suture not very deeply impressed; aperture rather dilated; fold of the labium not profound. Inhabits Indiana." (Say.)

This is another exceedingly abundant shell in Indiana, from which State the original specimens came. It inhabits swamps, ponds, creeks, and rivers, among rushes and weeds; it is often distorted, like all others of this group, from living in close quarters in reedy swamps. The epidermis is generally reddish horn-color and is much darker than Say's description would seem to warrant. This fact, added to the fact that the aperture is often reddish or purplish within, has resulted in this shell being often found with collections of *Limnophysa reflexa,* which it somewhat resembles; especially does it resemble the half-grown form. But this species is quite a solid shell, heavier in texture

than any other found in the State, and is often quite highly polished; the reticulated character of the epidermis of the body-whorl will help to separate it. I have found it at North Vernon, Madison, Lawrenceburg, Portland, Marion, and Wabash. It will be found all over the State.

LIMNOPHYSA HUMILIS Say. Plate 8, fig. 9.

"Shell ovate-conic, thin, translucent, with slight wrinkles; volutions nearly six, convex, terminal one very minute; suture well indented; aperture about equal in length to the spire; labium with an obvious plate of calcareous deposit; a distinct and rather open umbilical aperture; color pale reddish-white or yellowish-white. Total length seven-twentieths inch." (Say.)

This little shell was described from South Carolina, but is found all over the eastern United States, from Colorado and Wyoming to Georgia. In this State it is not only common but is abundant. In 1893 the writer found the sloping bank of the Ohio, on the Indiana side, near New Albany, where for a half mile or more numerous springs keep the muddy banks and shales wet, and where an abundant marshy vegetation grows, covered by hundreds of thousands of this shell. They were literally everywhere! As they crawled about in the wet mud they made the peculiar snapping noise so familiar to collectors of these forms. They were not in the water but crawling about on the very soft and wet mud. The shell is easily told from *Limnophysa desidiosa,* which it most nearly resembles, by the small and regular spire, the whorls being closely coiled together and the spire being far more regular. I have also taken it at Lawrenceburg, at Terre Haute, at Wabash and at Fort Wayne, in the Maumee River. It will be found in every part of the State on careful search.

GENUS PHYSA.

PHYSA GYRINA Say. Plate 8, fig. 1.

"Shell heterostrophe, oblong; whorls five or six, gradually acuminating to an acute apex; suture slightly impressed; aperture more than one-half, but less than two-thirds, the length of the shell; labrum a little thickened on the inner margin. Length rather less than one inch." (Say.)

Almost every stream in the State exhibits numbers of this species. It is a brown or reddish-brown shell, with a peculiarly margined aperture; it is, also, when mature, a rather solid shell. From the next species it differs in the form of the spire, being rather more acuminate, though numerous examples may be found which are

blunter; such were described by Dr. Lea under the name of *Physa hildrethiana*. The largest and finest examples from this State come from the lakes and ponds of northern Indiana, and from the Kankakee. In immature specimens the labrum is hardly thickened and the calcareous deposit on the columella is scarcely evident; but in old shells these are well marked. Numerous parallel lines of growth sometimes give the body-whorl a roughened appearance. It may almost always be found on muddy banks of rivers near the edge in the water, rapidly moving along. In walking, the animal has a peculiar gliding motion that takes it over a great amount of ground in a very short time; this form and its relatives are the most rapid travelers among the fresh-water shells. The fringed character of the mantle should also be noticed by the collector, for none but these forms present that character.

PHYSA ANCILLARIA Say. Plate 8, fig. 4.

"Shell heterostrophe, subglobose, pale yellowish; whorls rather more than four, very rapidly attenuated; spire truncated, hardly elevated beyond the general curve of the surface; suture not impressed; aperture but little shorter than the shell, dilated; labrum a little thickened on the inner margin. Length more than one-half of an inch." (Say.)

The only locality from which specimens have been seen in Indiana is Turkey Lake; four specimens were collected by the Indiana University Biological Station. The ordinary color of the shell is light honey-yellow, polished very highly; in the Turkey Lake specimens the epidermis is a milky white, is highly polished, but very thin. The very short spire, with the acuminate apex, the shouldered body-whorl, and the waved outline of the calcareous deposit on the body-whorl at the aperture will serve to distinguish it from the two remaining Indiana forms. The species will probably be found in many of the lakes and ponds of the northern part of the State.

PHYSA HETEROSTROPHA Say. Plate 8, fig. 3.

"Shell sinistral, subovated; color pale yellow, chestnut or blackish; whorls four, the first large, the others very small, terminating rather abruptly in an acute apex; aperture large, somewhat oval, three-fourths of the length of the shell, or rather more; within of a pearly lustre, often blackish; lip a little thickened on the inside, and tinged with dull red." (Say.)

This is the most widely distributed and most variable limnæid in America; it ranges from New England to Great Slave Lake, to Wash-

ington, to Texas and Georgia. In Indiana it is found everywhere; in all streams, both large and small, in ponds, lakes, pools, ditches. An extensive synonymy has been built up on this form through failure to recognize its excessive variability. It is colored like *Physa gyrina,* has the same general habits, but is more pointed and the spire is generally less conical. I found this shell very abundant in the old canal at Brookville, and in a small stream near Madison. In the Ohio, Wabash and Maumee the shells are larger and thicker than those from the lakes.

GENUS BULINUS.

BULINUS HYPNORUM Linnæus. Plate 8, fig. 2.

"Shell heterostrophe, pale yellowish, very fragile, diaphanous, oblong, whorls six or seven; spire tapering, acute at the tip; suture slightly impressed; aperture not dilated, attenuated above, about half as long as the shell; columella much narrowed near the base, so that the view may be partially extended from the base towards the apex.

"Inhabits shores of Illinois. Length seven-tenths inch; greatest breadth three-tenths nearly. Animal deep black, immaculate above and beneath; tentacula setaceous; a white annulation at base." (Say.)

This is a very highly polished form and may be distinguished by its narrow outline, acute spire, and the number of whorls; it occurs in many localities in the State. At Indianapolis, Coffee Chute, Gibson County, and in the small lakes of northern Indiana it has been taken. Usually the shell does not exceed one-half inch in length; mature specimens are rather solid than fragile. While it is sinistral, like *Physa,* its narrow aperture and long pointed spire differ entirely from any form of that genus in Indiana.

SUBGENUS PLANORBELLA.

PLANORBELLA CAMPANULATA Say. Plate 8, fig. 12.

"Shell sinistral, not depressed; whorls four, slightly striate across; longer than wide; spire hardly concave, often plane; body-whorl abruptly dilated near the aperture and not longer behind the dilatation than the penultimate whorl; suture indented, well defined to the tip, the summits of the volutions being rounded; aperture dilated; throat narrow abruptly; umbilicus profound, the view extending by a minute foramen to the apex. Greatest length of the body-whorl one-fourth of an inch; breadth from tip of the labrum one-half of an inch; at right angles to the last, two-fifths of an inch." (Say.)

Widely and commonly distributed over nearly all of the State. Distinguished by the narrow constriction behind the aperture, and

the bell-shaped character of the aperture, from which the specific name is derived. While the epidermis is usually light horn-color, specimens are often taken which are perfectly albino and highly polished. Occasionally specimens are to be had which are coarsely wrinkled, but the species is commonly smooth.

SUBGENUS HELISOMA.

HELISOMA TRIVOLVIS Say. Plate 8, fig. 11.

"Shell sinistral, pale yellow, brownish or chestnut color, subcarinate above and beneath, particularly in the young shell; whorls three or four, striate across with fine, raised, equidistant, acute lines, forming grooves between them; spire concave; aperture large, embracing a considerable portion of the body-whorl, within bluish-white; lip a little thickened internally, and of a red or brownish color, vaulted above; umbilicus large, exhibiting the volutions. Length one-fourth of an inch; breadth one-half of an inch. Animal aquatic, dark ferruginous, with very numerous, confluent, pale yellowish points; tentacula long, setaceous, with confluent points; foramen on the left side." (Say.)

This shell is common all over Indiana and is especially abundant, as indeed are most of the limnæids, in the lake region of the northern half of the State. It is the largest of the discoidal forms and can not be confounded with any other. I have personally observed it at New Albany, Bloomington, Evansville, Terre Haute, Lawrenceburg, Brookville, North Manchester, Fort Wayne, Huntington, and Winona Park. Among the reeds of the smaller lakes it is exceedingly abundant.

HELISOMA BICARINATA Say. Plate 8, fig. 10.

"Shell sinistral, pale yellow or brownish, subcarinate above, and beneath translucent. Spire retus-umbilicate, forming a cavity as deep as that of the base. Aperture large, embracing a considerable portion of the body-whorl, and much vaulted above. Within red brown, with two white lines corresponding with the carina. Whorls three, wrinkled and with minute revolving lines. Length one-fourth of an inch; breadth nearly half an inch." (Say.)

This widely distributed shell is characterized by the two rounded carinæ, one on either side of the discoidal shell; it is much smaller than any other of the subgenus and need not be confused with any except the young of *Helisoma trivolvis;* but the unfailing signs of juvenility should enable ready recognition. This form is thickened near the margin of the aperture, while half-grown *trivolvis* is very thin

and fragile all about the labrum. This shell is smoother than *trivolvis* and the outline of the aperture is angular.

SUBGENUS MENETUS.

MENETUS EXACUTUS Say. Plate 8, fig. 24.

"Shell dextral, depressed, with an acute edge; whorls four, striated across, wider than long, not elevated above the suture, but a little flattened, sides obliquely descending to an acute edge below the middle; spire not impressed; suture not profoundly indented; beneath, body-whorl flattened, on the inner edge rounded; umbilicus regular, exhibiting all the volutions to the apex; aperture transversely subtriangular; labrum angulated in the middle, arcuated near its inferior tip, the superior termination just including the acute edge of the penultimate whorl. Greatest breadth rather less than one-fourth of an inch." (Say.)

This little shell may be found on the under side of lily-pads in lakes and ponds; on sticks and stones along the margins of ponds just under the water. It is impossible to confuse it with any other shell, the very sharp carina alone distinguishing it from all others. It is commonly black or very dark horn-color; the animal being itself black and the shell being rather thin, this makes the whole a very black object against the bright green of the lily-pads. I have seen specimens from near Lawrenceburg and have taken the form at Fort Wayne. It is probably widely distributed in the State.

SUBGENUS GYRAULUS.

GYRAULUS DEFLECTUS Say. Plate 8, fig. 13.

"Shell dextral, depressed; whorls nearly five, minutely and regularly wrinkled across, wider than long, with a much depressed rotundity above, descending to an acute lateral edge below the middle; spire not impressed; suture indented, but not profoundly; beneath a little concave in the middle, exhibiting one-half of each volution to the apex; whorls flattened, slightly rounded; aperture declining very much, suboval, the superior portion of the labrum considerably surpassing the inferior portion, and taking its origin a little above the carina; inferior portion of the labrum terminating on the middle of the inferior surface of the penultimate whorl. Greatest breadth two-fifths of an inch." (Say.)

This shell has been seen by me in only one locality on lily-pads in a yard at Lawrenceburg, adjoining my home. It may have been introduced with the plants; but it naturally belongs to the western fauna and should be in this State. I have therefore included it. The

shell is smaller than any other of its group except the following; from it separation may readily be made by the deflected aperture, which feature is presented by no other shell. The shell is black and the animal likewise. Lily-pads in northern lakes should be carefully searched for this shell, which will surely occur there.

GYRAULUS PARVUS Say. Plate 8, fig. 14.

"Shell horn-color or blackish; whorls four, crossed by minute wrinkles; concave above and beneath, and equally exhibiting the volutions, body generally subcarinate on the margin; lip rounded, and not vaulted above nor thickened; mouth within bluish-white. Breadth one-fifth of an inch." (Say.)

This very short description of Say might be supplemented by the statement that the body-whorl regularly and symmetrically increases in breadth, the wrinkles which cross the body-whorl are caused by the regularly placed lines of growth, the shell has a brightly polished epidermis and the aperture is regularly and ovately rounded. The species is common all over Indiana; it is found in the same stations as the last described shell, but is only about half as large and is not at all deflected in the region of the aperture. Near Moore's Hill, in Dearborn County, is a small pond which has many hundreds of these shells attached to the stems of pond weeds. It has been observed, also, at Madison and Terre Haute. It will certainly be found in all parts of the State.

SUBFAMILY ANCYLINÆ.

GENUS ANCYLUS.

ANCYLUS TARDUS Say. Plate 8, fig. 15.

"Shell conic depressed; apex behind the middle, obtuse, rounded, inclining backward but not laterally; line from the apex to the posterior tip rectilinear; line from the apex to the anterior tip arcuated; aperture oval, not distinctly narrowed at one end. Length a little over three-twentieths, breadth one-tenth of an inch. * * * It inhabits the Wabash River." (Say.)

This little shell is very common in the Wabash, the Ohio and the Maumee rivers; it no doubt occurs in many other streams. Its limpet-like shape, though exceedingly small, will enable it to be easily detected. It should be looked for on the inside of dead *Unio* valves, and a half dozen sometimes may be taken from the same shell. A favorite place for these shells to be attached are the forms of *Pleurocera* and occasionally of *Campeloma*, but sticks, stones and submerged

boards will also yield them. There are certainly other species in the streams of Indiana, and they should be carefully searched. The inside of the shell, after removal of the animal, is often a dark brown or sometimes slightly purplish color. The striations of the epidermis show through as fine capillary lines and are concentrically placed.

RISSOIDÆ.

This is a rather large family of very small shells, and is represented in Indiana waters by only two subfamilies, the *Hydrobiinæ* and the *Pomatiopsinæ*, the latter of which is amphibious. Four genera are represented in Indiana waters, as follows: *Amnicola, Bythinella, Somatogyrus* and *Pomatiopsis.*

These little mollusks are to be sought for on muddy bottoms associated with the large *Viviparidæ;* the stations which are suited to the one agree with the habits of the other. All are rather minute shells, the largest forms being *Somatogyrus,* of which two species are known in Indiana.

KEY TO THE RISSOIDÆ.

A.	Shell rimate, pupiform, imperforate, obtuse.	*Bythinella.*
B.	Shell globose, perforate, rather large.	*Somatogyrus.*
C.	Shell small, ovate, perforate, short.	*Amnicola.*
D.	Shell long, subumbilicate, thin, amphibious.	*Pomatiopsis.*

With the exception of the last-named genus, all are fresh-water shells; but *Pomatiopsis* may be found in damp places, and, indeed, in places quite dry. Near Cincinnati, Ohio, along the Little Miami, this shell is abundant in a dry glade, but must be sought under leaves and rushes close to the ground. All the others are found in running streams and are commonly abundant; dredging for them with fine-meshed nets usually secures very many, though specimens may be taken which are crawling on the mud near the water's edge, but wholly submerged.

GENUS BYTHINELLA.

BYTHINELLA OBTUSA Lea. Plate 8, fig. 18.

"Shell subcylindrical, rather thin, dark-green, smooth, slightly perforate; spire short; at the beaks very obtuse; sutures impressed; whorls four, convex; aperture small, nearly round." (Lea.)

This little shell may be readily distinguished by the very blunt character of the apex; the whorls are also very convex and the aperture is rimate. A large number of specimens were once collected by the

writer in the Des Moines River; from them it was learned that in clean specimens the epidermis is almost white. The dark color is due to iron oxide, with which most of the shells are discolored.

Specimens have been seen only from the Ohio, but in that stream it is common. The dredge should be employed if it is desired to collect very many; then a free scraping of muddy banks will reveal multitudes of shells of this species.

Genus SOMATOGYRUS.

Somatogyrus isogonus Say. Plate 8, fig. 20.

"Subglobose, horn-color, volutions about four, rounded, obsoletely wrinkled; spire very short, about one-third the length of the aperture; suture profoundly impressed, so as to form a shoulder on the whorls; aperture much dilated, oval, being as obtusely rounded above as at base; umbilicus linear, distinct; operculum obviously spiral. Length under three-tenths of an inch." (Lea.)

This little shell is exceedingly abundant on the Falls of the Ohio at Louisville; rare specimens have been taken at Lawrenceburg, also in the Ohio. It is a regularly rounded form, and delights along the margins of the river, crawling in the soft mud. It is often half hidden in the mud, in this respect resembling the large *Campeloma*. From the following shell it may be distinguished by the round and full aperture, the next form having an angular one. This one is also very much smaller; the volutions are about the same in number, but those of *isogonus* increase less rapidly. Both shells are operculated.

Somatogyrus integer Say. Plate 8, fig. 19.

"Subglobose, horn-color; volutions rather more than three, rounded, obsoletely wrinkled; spire very short, less than half the length of the aperture; suture rather deeply impressed; body whorl large, aperture dilated, ovate, acute above; columella flattened, polished; labrum regularly rounded; base regularly rounded, without any undulations or sinus; umbilicus none; operculum obviously spiral. Length nearly one-fifth of an inch. Animal, foot longer than wide, rounded behind, with the anterior angles a little excurved; eyes black, conspicuous; tentacula rather long and slender." (Say.)

This shell was originally described from the Ohio River and said to be very abundant at the Falls by Say. In association with *Campeloma* I have found it abundantly at Lawrenceburg and at Charleston, both in the Ohio. It is a much larger and coarser shell than the preceding.

GENUS AMNICOLA.

AMNICOLA PORATA Say. Plate 8, fig. 21.

"Shell obtusely conic or subglobose; volutions four, convex, obsoletely wrinkled across; spire obtuse; labrum and labium equally rounded, meeting above in a subacute angle; the upper edge of the latter appressed to the preceding whorl; umbilicus very distinct." (Say.)

This little shell was originally described from Cayuga Lake, New York, but is one of very wide distribution. It has been mistaken for the very young of some larger forms, like *Campeloma*, but has all the marks of maturity when carefully examined. Little need be said about it; all the forms of this section are minute and very hard to determine, and the group needs revision very greatly.

AMNICOLA LIMOSA Say. Plate 8, fig. 23.

"Shell conic, subumbilicate, dark horn-colored, generally incrusted with a blackish irregular covering on the spire, and sometimes on the body, which completely obscures the obsoletely wrinkled epidermis; aperture ovate-orbicular; suture impressed.

"Length, three-twentieths; breadth, one-tenth of an inch." (Say.)

This little shell is very like the preceding, but differs in being less well umbilicated. It is found in the same situations, and only careful study can separate them.

AMNICOLA CINCINNATIENSIS Anthony. Plate 8, fig. 22.

"Shell somewhat ventricose, subumbilicate, color delicately green, whorls four, smooth; spire entire at the apex and prominent; suture deeply impressed; aperture much dilated, approaching to orbicular, nearly half the length of the shell; length one-fifth of an inch.

"Found in the canal at Cincinnati, clinging to small stones." (Anthony.)

Undoubted examples of this shell have been found at Lawrenceburg, in the Ohio. It is longer and more acute than any other form of *Amnicola*, and is more brightly green in color. Differences which it exhibits may be best seen by close comparison with the other forms. It is the largest Amnicolid in Indiana.

GENUS POMATIOPSIS.

POMATIOPSIS LAPIDARIA Say. Plate 8, fig. 16.

"Shell turreted, subumbilicate, with six volutions, which are obsoletely wrinkled across. Suture impressed. Aperture longitudinally

ovate-orbicular, operculated, rather more than one-third of the length of the shell. Length about one-fifth of an inch. * * *" (Say.)

Attention has above been directed to the peculiar habits of this species, which is common in parts of this State. It occurs sparingly near Lawrenceburg, but is abundant in the lower Wabash Valley. It is easily told by its length, the rounded character of the whorls, its peculiarly long rostrum, and its very large verge. Being found so commonly in rather dry stations also will serve to show its character as not being an *Amnicola*, the only form with which it could be confused.

Family VALVATIDÆ.

Genus VALVATA.

Valvata tricarinata Say. Plate 8, fig. 17.

"Shell with three volutions; three revolving, carinate, prominent lines, giving to the whorls a quadrate instead of a cylindric appearance. Suture canaliculate, in consequence of the whorls revolving below the second carina and leaving an interval. Spire convex, apex obtuse. Umbilicus large. Carinæ placed, one on the upper edge of the whorl, one on the lower edge, and the third on the base beneath. Breadth, one-fifth of an inch." (Say.)

So far as I know this is the only form of *Valvata* in the State; specimens have been taken at Lawrenceburg, in the Ohio, at Fort Wayne in the St. Mary's, and a single dead specimen has been seen from Tippecanoe Lake.

This shell is small, but easily known from all others by its pronounced carinæ and its generally irregular shape. It is usually much more elevated than the figure given herein would indicate, and the space between the carinæ is often hollowed out. The color is light green. The habits of the animal are much like those of the *Rissoidæ*, since it lives on muddy banks and is usually associated with *Amnicola* and other rissoids. The respiratory apparatus is, however, entirely distinct, this form breathing by means of a plumose gill which is projected over the head in moving about.

Family VIVIPARIDÆ.

The shells of this family are all operculated, large, and live in muddy situations in rivers, lakes and ponds. Favorable sites are the ponds left by retreating waters along large rivers like the Wabash; in

such places they may be collected by thousands. There are three genera represented in Indiana waters to which the following artificial key may serve as an introduction:

A. Shell large, thick, green, aperture elongate, operculum with polar point nearer one end. *Campeloma.*
B. Shell large, thin, operculum nearly round, shell banded or otherwise highly colored. *Vivipara.*
C. Shell medium, thin, light green or whitish, with spiral whorls carinated, operculum subspiral. *Lioplax.*

GENUS VIVIPARA.

VIVIPARA SUBPURPUREA Say. Plate 9, figs. 10, 11.

Shell large, thin, thicker towards the apex and in age, globosely conical, subumbilicated, smooth, polished; whorls regularly increasing, five in number counting the minute apical whorls, convex, the body whorl marked with transverse lines of growth; epidermis coffee brown or purplish, the apex always reddish purple; suture deep and regularly impressed, in some specimens excavated; peristome simple, ovately rounded, angular above, rounded below; columella white, rather thick; parietal wall with a rather thickish deposit of white calcareous matter which connects the extremities of the aperture and is inclined to be reflected over the region of the umbilicus; in old and mature specimens the body whorl is flattened near the suture, which makes the middle of the whorl to appear to be slightly angular; within chocolate color or purple.

Length, one to one and one-half inches.

This shell occurs only in the Wabash River in this State so far as my information goes; it was described by Say from "Fox River, an arm of the Wabash." In the Mississippi River at Rock Island it is very abundant and has the habit of clinging in numbers to the under sides of large flat stones, in rapidly running water. In the Wabash it appears to live mainly in muddy bottoms, having the habit of *Campeloma.*

VIVIPARA CONTECTOIDES Binney. Plate 9, figs. 13, 13a.

Shell large, globose, thin, umbilicated, spire conically elevated; whorls very convex, flattened near the sutures, five in number, regularly and symmetrically increasing in size; epidermis light yellowish horn-color with three to four brownish-red broad bands revolving with the body whorl, one on the periphery, thin; lines of growth coarse and giving to the shell a transversely striated appearance which, near the margin of the aperture become rather coarse wrinkles; sutures

very deeply impressed; aperture large, roundly ovate, subangular at juncture with body whorl, nearly complete, only a small portion being appressed to the parietal wall, simple, slightly reflected near the umbilicus in old specimens; within bluish white, the brownish color bands showing; columella thin, white, twisted.

Length, one and one-half to two inches for large and mature specimens.

Very abundant in the ponds along the Wabash and in the muddy streams of the northwestern parts of the State. In the Wabash itself the shell is extremely common from Lafayette down to its mouth. Many specimens are malleated on the body whorl, but not all are so. A few specimens have been seen from Lake Maxinkuckee, but it thrives best in ponds along rivers and in rivers. The color bands enable one to distinguish it from all others.

VIVIPARA INTERTEXTA Say. Plate 9, fig. 12.

"Shell subglobose, yellowish-green or brownish, wrinkled, and with minute, very numerous, obsolete revolving, deciduous lines; spire depressed conic, obtuse, truncated, eroded at tip; volutions nearly four; suture rather deeply indented; umbilicus closed by the lateral extension of the columella.

Greatest breadth, from four-fifths to one inch; length, about the same. * * *" (Say.)

No specimens were at hand from which to make a new description, which is greatly needed, and I therefore copy the original description of Say. As known in Indiana, from the Wabash River and from Lake Maxinkuckee, the color given by Say is not that of Indiana specimens; they are all of a rich and deep reddish or wine color; the epidermis is highly polished and altogether the shell is a beautiful one. From the ponds along the Wabash, near Mt. Carmel, Illinois, I have seen very large and fine examples; but the shell is really a southern form, reaching its greatest development both of size and in numbers in Mississippi and Louisiana.

GENUS LIOPLAX.

LIOPLAX SUBCARINATA Say. Plate 9, figs. 14, 14a, 15.

Shell rather small, elevated, spire regularly conical, operculated, obtusely carinated, especially on the spiral whorls; epidermis yellowish-white, thin, white at apex, occasionally light green, whorls five and one-half, regularly increasing, carinate, convex, flattened at the sutures; suture irregularly impressed, sometimes hollowed out; body whorl large, ventricose, with two coarse carinæ near the upper angle of the aperture, but which

Fig. A.

are not continuous across the whole whorl; aperture ovate, rounded below and slightly angulate above, sigmoid; peritreme simple, continuous over the parietal wall as a thin callus; operculum thin, light corneous.

Length, three-fourths of an inch.

This shell occurs in the White, Wabash, Ohio and Blue rivers. It is commonly associated with *Campeloma* and *Vivipara*, and has the same habits. The carinæ on the apical whorls and the subspiral aperture will alone separate it from all other viviparids in the State. It is common in the Ohio at all points.

Genus CAMPELOMA.

Campeloma ponderosum Say. Plate 10, figs. 4, 5, 6.

Paludina ponderosa, Say. Jour. Acad. Nat. Sci., Phil., Vol. II, p. 173 (1821); American Conchology, Pt. III, Pl. XXX, fig. 1 (1830).—Haldeman in "Monograph of the Fresh-Water Univalve Mollusca of the U. S.," No. 1, p. 13, Pl. IV (1840).

Paludina regularis, Lea. Trans. Am. Phil. Soc., Vol. IX, p. 13 (1844). This is the young of *ponderosum*.

Melantho ponderosa, Say. Binney in "Land and Fresh-Water Shells of N. A.," Pt. III, pp. 36-40, figs. 71-78 (1865).

Vivipara (Melantho) ponderosa, Say. Tryon. Continuation of Haldeman, p. 24, Pl. XIV, fig. 4, and Pl. XV, fig. 6 (1870).

Melantho (Vivipara) nolani, Tryon. Continuation of Haldeman, p. 25, Pl. XII, figs. 10-11 (1870).

Campeloma ponderosum, Say (Call). See Bull. Washburn College Lab'y of Nat. Hist., Vol. I, No. 5, p. 154, Pl. III (1886).

Shell imperforate, globosely ovate, very thick and heavy, smooth surface hardly broken by the wrinkles and delicate striæ of growth, often also with delicate revolving striæ; greenish horn-color, with irregularly disposed dark streaks, marking the edges of former peristomes, milky white under the epidermis; spire short, conic, convex; whorls 5-6, rapidly enlarging, very convex above, the body whorl very large, equaling one-half to two-thirds the entire length of the shell, imperforate axis; aperture large, oval, somewhat oblique, bluish white within; peristome externally margined with dark or black epidermis, simple, very sigmoid, broadly rounded before, suddenly curving behind and meeting body whorl at right angles, forming a deep well-marked suture, columellar portion much thickened and usually nearly reflected over the partial umbilicus, with a heavy deposit of callus on parietal wall, both above and below which it is, in old individuals, continuous across the whorl.

The length of adults varies from 20 to 37 mm., and breadth of body whorl from 15 to 33 mm.

In geographic distribution this species ranges throughout the region included between western New York, southward to northern Georgia and middle Alabama to Texas. Its greatest development seems to be attained in the Cumberland and Tennessee rivers, though very large representatives occur in the Ohio, Alabama, Coosa, Black Warrior, Oostanaula and Etowah rivers. In and west of the Mississippi it is rare, and has not been taken in that stream north of Davenport, Iowa. It is replaced in the upper Mississippi by *Campeloma subsolidum,* which here attains a size almost rivaling that of Say's species.

This is the heaviest shell of its genus in Indiana, but is an abundant one. So far as personal collections extend, the Wabash River and the Ohio alone have presented it. At numerous places in the Ohio it attains a very great size, but nowhere equaling the size which it reaches in the Cumberland and Tennessee rivers. At a station between Lawrenceburg and Aurora thousands of these shells were taken in one afternoon, and from them hundreds of the finest selected. In muddy bottoms, crawling on the bottom and half hidden after the fashion of the marine *Lunatia,* these shells are always to be taken at this locality. In the northern part of the State they are replaced by two of the following forms, *Campeloma integrum* and *Campeloma decisum. Campeloma rufum* also abounds in some streams.

CAMPELOMA SUBSOLIDUM Anthony. Plate 11, figs. 1 to 7.

Paludina subsolida, Anthony. Proc. Phil. Acad. Nat. Sci., p. 71 (1860). Also, Binney, "Land and Fresh-Water Shells of North America," Pt. III, p. 50, fig. 104 (1865).

Paludina exilis, Anthony. Proc. Phil. Acad. Nat. Sci., p. 71 (1860).

Paludina milesii, Lea. Proc. Phil. Acad. Nat. Sci., p. 156 (1863).

Vivipara exilis, Anthony. Tryon in Continuation of Haldeman, p. 33, Pl. XIII, fig. 7 (1870).

Vivipara (Melantho) subsolida, Anthony. Tryon in Continuation of Haldeman, p. 29, Pl. XII, figs. 1-2 (1870).

Campeloma subsolidum, Anthony. Call, in Bull. Washburn College Lab'y Nat. Hist., Vol. I, No. 5, p. 155, Pl. IV (1885).

Shell elongately ovate, imperforate, thick and heavy, sometimes malleate; epidermis light green, in old specimens horn-color or light brown; spire produced, conic, with six or seven somewhat flattened whorls, sutures distinct and deeply impressed; aperture broadly ovate, rounded before, angled posteriorly, white within; peristome continuous, with heavy callus over the parietal wall, margined with black epi-

dermal tissue, much wrinkled around umbilical axis; body whorl equaling three-fourths entire length of shell, obtusely angulated at periphery and flattened above to near the suture. The lines of growth appear to be unusually strong.

Very large specimens of this form are occasionally found. The extreme length of the largest specimen employed in framing this diagnosis was: Length, 49.30 mm.; diameter, 27.62 mm.; length of aperture, 25.40 mm.; breadth, 17.24 mm. The usual size of mature individuals is perhaps two-thirds these dimensions.

This shell is easily told from the preceding by its greater length and the flattened upper half of the body whorl; *ponderosum* has a very short spire, and the whorls are more convex. I have taken it in the Ohio, Wabash, Kankakee, and Eel rivers. It is common in similar stations to the last named.

CAMPELOMA DECISUM Say. Plate 10, figs. 1, 2, 3.

Lymnæa decisa, Say. Nicholson's Encyc. Am. ed.; first edition (1817); second edition (1818), Pl. II, fig. 6.

Paludina decisa, Say. Nicholson's Encyc. Am ed.; Corrections to ed. 1 (1817); American Conchology, No. 1, Pl. X* (1830).—Binney's edition of the same, p. 49 and p. 159, Pl. X, fig. 1, and Pl. LXX, fig. 6. —Haldeman's "Monograph of Fresh-Water Univalve Shells," p. 4, Pl. I, figs. 1-6, fig. 4 reversed.

Paludina incrassata, Lea. Proceedings Am. Phil. Soc., Vol. II, p. 243 (1842).

Paludina decapitata†, Anthony. Proc. Phil. Acad. Nat. Sci., p. 71 (1860).

Melantho decisa, Say. Binney in "Land and Fresh-Water Shells of N. A.," Pt. III, pp. 41 *et seq.*, figs. 79-83 (1865).

Melantho (Paludina) coarctata, ex auctores in partim, non Lea (=*C. subsolidum*, Anthony).

Melantho melanostoma, Currier (MSS.?).

Campeloma decisum, Say. Call, Bull. Washburn College Lab'y Nat. Hist., Vol. I, No. 5, pp. 156-157 (1886).

Shell ovately elongate, not heavy or thick, imperforate, with strongly marked lines of growth, which sometimes give a roughened appearance to the otherwise smooth surface; epidermis usually dark

*This figure is that of a typical *Campeloma ponderosum*, and, evidently, is not the same shell or species described as *decisa*. By reference to Plate XXX of the "American Conchology," where *ponderosum* is figured (fig 1), the relation of the specimens may be clearly seen. Say's original figure of *decisa*—our figure—could clearly not have been drawn from any variety of *ponderosum*.

† Mr. Binney (*loc. cit.*, p. 65, fig. 129) supposes this to be a *Lithasia!*

green with depositions of black pigment marking the locations of numerous former peristomes, in the young with numerous minute epidermal hairs; whorls five and a half to six, often truncated at apex, leaving from one and a half to three and a half whorls, very convex, the last equaling more than two-thirds entire length of shell; aperture broadly oval, much rounded anteriorly, very oblique, two-thirds the height of last whorl, bluish white within; peristome continuous, less sigmoid than in most species of the genus, slightly thickened near axis, simple, acute, margins joined by a slight callus on the parietal wall; sutures deeply and regularly impressed. Operculum as usual in the genus.

Length of mature specimens 15-40 mm., breadth of body whorl 10-21 mm.

The species is the earliest described of the genus, the types probably coming from some locality in the Middle Atlantic States. Contrary to usual custom, Say omitted to give this item in his original description. By common consent, however, the name is applied to a form which occurs abundantly east of the Appalachians, though occurring also in the drainage area of the great lakes in Michigan.

This shell is found in the northern half of the State, being especially common in the St. Mary's and St. Joseph rivers, in the Maumee, the Kankakee, and in numerous small lakes. The lake shells are very much thinner than the river forms, are lighter in color and smoother on the body whorl. The well rounded character of the aperture and the regularly convex whorls, joined to the bluish-white color of the interior, will help to separate this shell from its congeners.

CAMPELOMA RUFUM Haldeman. Plate 11, figs. 8, 9.

Paludina rufa, Haldeman. On p. 3 of wrapper to "Monograph Fresh-Water Moll.," Pt. III, Pl. III, fig. 1 (1844).—Binney in "Land and Fresh-Water Shells of N. A.," Pt. III, pp. 49-50, figs. 102-103 (1865)—as a synonym under *Melantho decisa*, Say.

Melantho gibba, Currier, American Journal of Conchology, Vol. III, p. 112, Pl. VI, fig. 3 (1867).

Vivipara (Melantho) rufa, Haldeman, Tryon in Continuation of Haldeman, p. 22, Pl. XII, fig. 12 (deformed), (1870).

Vivipara (Melantho) gibba, Currier, Tryon in Continuation of Haldeman, p. 27, Pl. XII, figs. 3-7, (1870).

Campeloma rufum, Haldeman. Call, Bull. Washburn College Lab'y of Nat. Hist., Vol. I, pp. 158-159 (1886).

Shell imperforate, elongately ovate, thick, somewhat roughened by growth lines, often malleated on body whorl near posterior angle of

aperture, with distinct and well-marked revolving striæ; epidermis dark olive shading to light green or even light horn-color on superior aspect of whorls near the suture, locations of former peristomes distinctly marked by dark brown or black sigmoid streaks, polished; shell reddish under the epidermis and with uniformly pinkish entire apex; whorls five and one-half to six and one-half, slopingly convex, most convex near the suture where they are also slightly angulated; aperture slightly oblique, ovate, two-fifths length of entire shell, reddish within, except near peristome where the aperture is bluish-white; peristome sigmoid, simple, acute, columellar portion thick and white, slightly reflected over the imperforate axis; parietal wall, in mature specimens, usually covered with a white callus which is thicker near the terminations of the peristome.

Length, 25.16—50.42 mm.; breadth, 13.74—25.12 mm.

This most characteristic form occurs in numerous localities from southwestern Connecticut to Iowa, in the Cedar River where it is abundant, and southward to the Hiawassee River, in Tennessee (Mrs. Geo. Andrews). It is very abundant locally, especially in the Erie canal, at Mohawk, New York, whence the writer collected the largest specimen indicated in the above measurements, and also in the canal at Columbus, Ohio (H. Moores). This last locality furnishes specimens nearly or quite as perfect as the New York locality. Dr. C. E. Beecher has communicated specimens from Waterbury, Conn., that are remarkable for small size and most beautiful pinkish and lustrous epidermis. They come from a region deficient in limestone, and respond accordingly, in size, to this feature of environment. The average dimensions of sixteen mature specimens from this locality were for length 17.42 mm., for breadth 11.06 mm.

Numerous specimens of *C. decisum* and the slighter forms of *C. subsolidum* have been received from collectors under the name of *C. rufum*. The majority of them indeed presented, until well cleaned, a rufous appearance when the interior was viewed by transmitted light, but such tints were evidently caused by the ferruginous deposits on the exterior of the shell. There is no need to mistake the true *C. rufum* if only care be taken to examine the substance of the shell beneath the epidermis, which is reddish, and the entire apex, which is invariably—from the embryonic to the senile form—pinkish.

This shell is common in many localities in Indiana, but is not so widely distributed as some other species; there are no specimens known to have been found in the southern portions of the State. I have seen specimens from Indianapolis, Lafayette, Huntington, and Fort Wayne, in rivers, and about thirty specimens from Tippecanoe and Turkey

lakes. The preceding remarks will serve to distinguish it from other forms of *Campeloma*.

CAMPELOMA INTEGRUM DeKay. Plate 11, figs. 10–12.

Paludina heros, DeKay *(olim)*, Natural Hist. of New York, Pt. I, Zoology, p. 86 (1843); *Paludina integra*, Say, DeKay, *ibid.*, p. 85, Pl. VII, figs. 132a, 132b. Binney in "Land and Fresh-Water Shells of N. A.," Pt. III, pp. 47-50, figs. 96 (based upon Say's typical specimens), 97-101.

Melantho integer, DeKay, Lewis in Proc. Phil. Acad. Nat. Sci., Pl. XXII, figs. 1-4 (all aberrant forms).

Campeloma integrum, DeKay, Call, Bull. Washburn Coll., Lab'y of Nat. Hist., Vol. I, No. 5, pp. 160-161 (1886).

Shell imperforate, elongate, somewhat produced, somewhat roughened by the very numerous and crowded growth lines, with indistinct revolving striæ; epidermis light horn-color or light green, transversely marked with the numerous darker lines which indicate former peristomes, polished; substance of the shell chalky white; whorls seven and eight and one-half in mature individuals, the last large, somewhat flattened on periphery, equaling two-thirds entire length of shell, slopingly convex and somewhat angled near the almost canaliculate and deep sutures; aperture nearly or quite parallel with the columellar axis, broadly ovate, milk-white within; peristome sigmoid, retreating near the broadly rounded anterior of the aperture, simple, sharp, slightly reflexed, however, over the imperforate axis, continuous over the parietal wall by chalk-white callus.

Length, 18—47.60 mm.; breadth, 18.24—24.06 mm.

There is little doubt that this is the true *heros* of DeKay and should, perhaps, bear that name. He, however, included the form which Haldeman afterwards properly separated under the name of *rufum*, for he states that his *heros* is sometimes reddish within. Say's *Paludina integra* could certainly not have been this species, which does not occur, as seen below, far west of the Appalachians, and he refers his type to the "waters of the Missouri." The length assigned the typical specimen has been justly, no doubt, assumed to be a typographical error. Binney's figure of *integra*, Say (p. 48, fig. 96, *loc. cit.*), does resemble DeKay's *integra (=heros)* and it is quite possible that the locality indicated by Say is also erroneous. If this supposition be correct, then Say's name must stand after the species, and *heros* be written as its synonym. DeKay himself was apparently convinced of the identity of *integra* and *heros*, but wrongly if the typical *integra* of Say came from west of the Mississippi. The figure above noticed,

from the typical specimen preserved in the Philadelphia Academy's collections, might refer to a somewhat globose form of *C. subsolidum* which occurs abundantly in the Missouri River at many localities.

C. integrum DeKay is found abundantly in central New York, from whence it ranges westward to Michigan and central Ohio. It appears to be numerous in the upper waters of the Ohio, but, so far as accurate records go, does not appear in that stream below the junction of the Monongahela and Alleghany rivers. In the canal at Columbus, Ohio, this form and *C. rufum* occur associated (H. Moores), as they also do in various portions of central New York, with the additional association of *C. decisum*. It is a very easy matter to separate these forms. This fact, considered in connection with constantly identical environment, should be weighed well in deciding their claims to specific value. The nearest relatives of *C. integrum* DeKay are, on the one hand, *C. ponderosum* Say, and *C. obesum* Lewis, on the other, the three appearing to constitute a natural sub-group, though not in the sense which would assign to them subgeneric value.

This species is common in the northern portions of the State; it is not found all over Indiana, and really belongs to the eastern fauna. The elongated character of the aperture is its chief distinguishing feature, but the well shouldered whorls may also aid in its elimination. The whole group of *Campeloma* is very difficult, and long study is required to become perfectly familiar with them. I am of the opinion, after 25 years of study, during which time thousands of these shells have passed through my hands, that all the five Indiana forms herein listed are good species, so far as species go. In the Call Collection, at the Museum of Comparative Zoology, Cambridge, there are several thousands of finely selected examples from all over the section of the United States in which they occur; these show many characters which smaller collections would not indicate. Any one making a monographic study of these forms should consult that collection because of the wealth of this material in it.

Family STREPOMATIDÆ.

GENERAL REMARKS.

This family is represented by five genera in the waters of Indiana, and all are common. The shells are all operculated, thick and generally heavy. Many of them are variously ornamented with colored revolving bands; others are adorned with small tubercles. Their habits are all very similar; they may be found clinging to rocks and

stones in the more swiftly flowing portions of the rivers and creeks, or they are to be taken crawling on sloping and muddy banks in shallow water. The genera *Anculosa* and *Goniobasis* especially are found clinging to rocks covered with confervoid growths; the genus *Pleurocera* is a mud-loving form; while *Lithasia* abounds on rocks at the Falls of the Ohio in swiftly flowing water. All are vegetarians. The animals progress slowly, and all have a long and retractile proboscis; this organ is, in all Indiana species, banded with orange or yellow or brownish transverse stripes; at its end is placed the mouth, which is usually marked by two lighter semicircular or lunate color bands at the margin. The animals of most species are dark slate color.

The Ohio River contains the greatest number of species and individuals; they occur by bushels on the Falls of the Ohio. As many as a half barrel of them were collected by me in 1893, and they have not yet all been worked over, though the species are comparatively few in number. During low water on the Falls these animals congregate in the pools and cracks of the rocks in which a little water remains and may be taken by dippers a quart or more at a time. Abundant as they are here, the Coosa River, Alabama, presents still greater numbers. The whole group is very extensive and is in a sad state of confusion; the synonymy is something enormous. Of all American shells these are the most variable, responding at once to temperature, food and other changes in environment.

ARTIFICIAL KEY TO THE STREPOMATIDÆ.

A. Shell conic, attenuated, thick, aperture produced into a more or less marked canal. *Pleurocera.*

B. Shell thick, heavy, tuberculate. *Angitrema.*

C. Shell body whorl large, angular, aperture small, with or without color bands, sometimes with large tuberosities on upper edge of body whorl. *Lithasia.*

D. Shell slender, whorls rounded, aperture rounded in front, banded. *Goniobasis.*

E. Shell oval, thick and heavy, columella thickened, aperture rounded angulate. *Anculosa.*

GENUS PLEUROCERA.

PLEUROCERA UNDULATUM Say. Plate 12, fig. 24.

Shell large, elevated, conic, brownish, with a broad, equally impressed band; inferior boundary of the band elevated and deeply crenate; superior boundary elevated and sometimes nodulous; volutions at least eight, not convex; suture not impressed, hardly obvious,

undulated by revolving on the inferior crenate boundary of the impressed band; labrum near the base, much protruded; sinus very obtuse. * * * Length one inch and four-tenths. (Say.)

On the Falls of the Ohio this species is very uncommon, but near Charleston Landing it is abundant. The sub-canaliculate character of the body-whorl, the coarse striations, due to the lines of growth, and the irregularly arranged nodules on the lower border of the body-whorl are the main distinguishing characters. The aperture is rhomboid and the interior is white, with an occasional brownish band near the lower border. The sutures are quite irregular. Perfect examples have nine to eleven whorls.

PLEUROCERA MONILIFERUM Lea. Plate 12, fig. 25.

Shell tuberculate, thick, pyramidal, yellowish or greenish, banded or without bands; spire high, pyramidal; sutures irregularly impressed; whorls about ten, flattened, striate below, sometimes obscurely sulcate, tuberculate on the periphery; aperture rather large, rhomboidal, within either white or salmon and generally double banded; outer lip acute, very sinuous; columella thickened below and very much twisted. (Lea.)

This shell is found in association with the preceding and is more common than it. It is also abundant in the Wabash near New Harmony, and near Terre Haute. I am not sure but that large series will compel the two forms to be united under Say's older name. The rounded tubercles are seen only on the body-whorl and are not near the suture but at the middle of the whorl, which fact will enable separation from the preceding. The nodulous character is by no means constant and is very marked in some while it is indistinct in other specimens. Most of the specimens seen are honey-yellow in color and nearly all are banded; some are unicolored. The columella is quite twisted and has a low carina near its base. In some specimens the columella is purple, but rarely so.

PLEUROCERA CANALICULATUM Say. Plate 12, figs. 19, 21, 23, 26, 27.

Shell tapering, horn-color; volutions about seven, slightly wrinkled; spire towards the apex very much eroded, whitish; body with a large obtuse groove, which is obsolete upon the whorls of the spire in consequence of the revolution of the suture on its inferior margin; this arrangement permits the superior margin of the groove only to be seen on the spire, in the form of an obtuse carina on each of the volutions; aperture bluish white within, with one or two obsolete

sanguineous lines; labrum slightly undulated by the groove and with a distinct sinus at the base of the columella. (Say.)

This shell was described from the Falls of the Ohio, where it is exceedingly abundant. It is a most variable species and has a wide range of colorings, number of volutions, size and height of spire, form of aperture, and development of the channel on the body-whorl. I have collected thousands of this shell on the Falls and have marvelled at their great range of variation. Many specimens are entirely purple, some are entirely salmon-colored, others have a single revolving band, some have three, most have two; the aperture is also variable; many have well rounded whorls without a sign of channel, hundreds are unicolored, honey-yellow being the prevailing color. The spire in some forms is conic, in others ovate, and in others still very acute and narrow; the young are mainly sharply carinate, but this feature is lost with age. Near Charleston, on the Ohio, this shell attains a very great size and is dark brown in color. In short, I know no shell which could be such a mine for the species monger as this one. It is a most fortunate circumstance that none of that ilk lives at the Falls!

PLEUROCERA SUBULARE Lea.

Shell rather small, thin, elevated and acutely turreted, horn-color; apex acute; whorls about 12, flat, carinate on the middle of the body-whorl; base angulated; aperture white and one-fourth the length of the shell. (Lea.)

This shell has been taken in the Maumee at Fort Wayne, the Wabash at Huntington, the Eel River near North Manchester, the Kankakee, and the Wabash at Terre Haute. It is exceedingly abundant in Lake Tippecanoe. It can not well be confounded with any other strepomatid, from the fact that the spiral whorls are sharply carinate; the region of the body-whorl below the angulate periphery is yellowish and much lighter than the rest of the shell. There are a number of fine revolving lines on most specimens on this portion of the shell. In the Wabash at Lafayette, on the muddy banks of the river within the city limits, this shell occurs in thousands. The color bands are not always present; and there are often taken specimens which are entirely purple. The epidermis is usually highly polished in perfect individuals.

PLEUROCERA ELEVATUM Say. Plate 12, fig. 20.

Shell gradually attenuating to the apex, slightly and irregularly wrinkled, olivaceous; suture not deeply impressed; volutions nine or

ten, with several more or less elevated revolving lines, of which one being more conspicuous gives the shell a carinated appearance; aperture oblique, equaling the length of the second, third and fourth volutions conjunctly. Length, one inch; breadth, two-fifths. (Say.)

This is another very imperfectly described strepomatid; it is impossible to tell what fact Mr. Say had in mind in stating that the aperture "equaled in length the second, third and fourth volutions conjunctly," which is most certainly not true, either of this or any other strepomatid. The shell is regularly conical, very slender, and the suture has just below it a small cord-like elevation which constitutes the carina of the body-whorl. The color varies almost as much as the last described form. Specimens have been seen from the Ohio at the Falls and from Lawrenceburg. I do not know it from other streams.

Genus ANGITREMA.

Angitrema armigera Say. Plate 12, fig. 17.

Shell tapering, brownish horn-color; volutions about six, slightly wrinkled; spire near the apex eroded, whitish; body-whorl with a revolving series of about five or six distant, prominent tubercles, which become obsolete on the spire, and are concealed by the revolution of the succeeding whorls, in consequence of which arrangement there is the appearance of a second, smaller and more obtuse subsutural series of tubercles on the body-whorl; two or three obsolete revolving reddish-brown lines; aperture bluish-white within; a distinct sinus at the base of the columella. * * * Length about one inch. (Say.)

It is impossible to get this shell confused with any other found in Indiana waters. The spinous character of the whorls will alone separate it. Thus far it is known only from the Wabash and the lower Ohio rivers. It does not occur as far up as the Falls and has never been found above them.

Angitrema verrucosa Rafinesque. Plate 12, fig. 18

"Ellipsoidal, top very obtuse, base of opening obtuse, inside lip thickly plaited; four spires, the last two flattened, the other large, with several rows of warts; back of the opening wrinkled; color olivaceous-brown, opening whitish.

"Habitat, the lower parts of the Ohio.

"Length about two-thirds of an inch, not quite double the breadth." (Rafinesque.)

Such is the original description given by Rafinesque of this interesting shell. Mr. Say also described it, from the Wabash, under the

name of *Melania nupera*; since his description is more complete, I reproduce it here:

"*Melania nupera.* Shell oblong suboval; volutions five, slightly rounded; body-whorl with about three revolving series of subequal, equidistant granules or tubercles, not higher than wide, occupying the superior portion of the surface; second volution with but two series; remaining volutions with slightly elevated, longitudinal lines instead of tubercles, often obsolete; spire decorticated towards the tip; suture not deeply impressed; aperture longer or as long as the spire; sinus of the superior angle profound; labium concave, with a callus near the superior angle; columella with a slight, obtuse, hardly prominent angle above the incipient sinus, which is obvious; labrum not abbreviated above, nor much produced near the base." (Say.)

This shell is so plainly characterized by the small tubercles, arranged in definite rows on the body-whorl and spire, that it will need no additional remark to aid in identification. Like the preceding, it does not occur in the Ohio above its lowermost portions, not being found at the Falls nor above. It is abundant in the lower Wabash. It does not occur as far up as Terre Haute in my experience.

Genus LITHASIA.

Lithasia obovata Say. Plate 12, fig. 16.

Shell subovate, dark brown or blackish, volutions nearly five; spire remarkably rounded, short; body-whorl with a very obtuse, slightly indented band or undulation, a little above the middle; aperture more than twice the length of the spire, narrow; labium polished, with a callus above; labrum not projecting near the base, subrectilinear from the shoulder to the basal curve, very convex at the shoulder; base rounded and without indentation.

Animal, foot rounded, rather longer than wide, equally rounded before and behind; above yellowish white, lineated with black lines. * * * Length three-fourths; breadth nearly half an inch. (Say.)

This species is exceedingly abundant on the Falls of the Ohio and as far up the river as Lawrenceburg; it occurs near Marietta, Ohio, but is of stunted growth and evidently beyond its optimum habitat. The specimens from southeastern Indiana are not as fine, as large, nor as numerous as those from the Falls. The original types came from the Kentucky River, Kentucky, in which State, in many streams, it is a most abundant shell. The color is rarely ever dark brown or blackish, as described by Say, except in old specimens which are discolored with sesquioxide of iron, a feature very common among fresh-

water mollusks. At the Falls, where I have collected four or five gallons of them, most are honey-yellow, and many greenish yellow, bright and clean. Fully one-half of a day's collecting with scoop-net, which would result in a couple of bushels of shells, would prove to be this species. I have taken many hundreds which are purple throughout, and these may have been the color variety which Say had before him; frequently the lower portion of the aperture is purplish in color, but generally the columella is white. From all other forms this may be distinguished by the nodulous character of the body-whorl in old specimens, the very short spire, and the two calcareous thickenings, one each at the upper and lower portions of the aperture, one on the body-whorl, one on the columella; this character is a conchologic constant.

GENUS GONIOBASIS.

GONIOBASIS CUBICOIDES Anthony. Plate 12, fig. 9.

Shell ovate, smooth, thick; whorls six to seven, flat, the upper ones rapidly enlarging to the body-whorl, which is broad and acutely angulated; sutures distinct, rendered more so by a sharp carination on the lower part of each whorl; aperture broadly ovate, within whitish; columella deeply indented; sinus small. (Anthony.)

I have found this shell to be abundant in a small creek near Corydon, and in the Wabash River at Huntington. It was described from the Wabash by Anthony, but, as was the case with the older naturalists, they kept exact localities secret, from selfish motives. I feel quite sure, however, that the types came from the upper Wabash, since I have never been able to find the species below Lafayette, where it is not numerous. The large and angulated body-whorl will help to separate this abundant shell. It occurs west of the Mississippi, in Iowa, and is one of the most common and characteristic shells of the smaller streams of the Ozarks in Missouri. Large and fine suites from those localities are in the Call Collection, at Cambridge. The shell has some features which resemble those presented by the common *Goniobasis livescens* Menke, but is, I think, entirely distinct.

GONIOBASIS DEPYGIS Say. Plate 12, figs. 3, 6, 8.

Shell oblong, conic-ovate, not remarkably thickened; spire as long as the aperture, or rather longer, often much eroded, with a broad, revolving, rufous line near the suture, occupying a considerable portion of the surface; whorls about five, hardly rounded; suture moderately impressed; body-whorl yellowish, with two rufous, revolving lines equidistant from the suture, base and each other, the superior

one broader, and its locality a little flatter than the general curvature; aperture ovate, acute above, moderately dilated; labium with calcareous deposit, particularly above; labrum not projecting near the base, nor arquated near its junction with the second volution; base regularly rounded. (Say.)

This shell was described from the Falls of the Ohio, where it is exceedingly abundant, possibly more so than *Lithasia obovata*, mentioned above. In the little crevices in the flat rocks, at low water, which alone contain running water, this shell congregates by thousands and may be collected by the handfuls. In that way I secured in 1893 over a peck of small strepomatids, the mass of the material being this little species. Many specimens occur without bands, some have a single one, others are entirely rufous; the columella is commonly white, often purple, reddish or salmon. But the general characters are constant. I have never found it elsewhere than on the Falls.

GONIOBASIS INTERSITA Haldeman. Plate 12, fig. 1.

Shell conic, plicated, with four convex whorls; aperture elliptical; color olivaceous.

Habitat, Swan Creek, Indiana; Mrs. Say. (Haldeman.)

I know nothing more of this species; the shell is a plicate one and it is very doubtful if it came from Indiana. In any event, the very imperfect description will fit equally well many other forms, most of which come from Tennessee. This shell has the facies of a more southern form. I introduce it on Haldeman's authority, though I do not believe it belongs to the Indiana fauna.

GONIOBASIS LIVESCENS Menke. Plate 12, fig. 11.

Shell ovately oblong, smooth, bluish flesh-color; spire conically acute; lip horn-color, produced in front, border purple; columella thinly callous, purplish.

Longitude, .7 in.; latitude, 3½ lines. (Menke.)

This shell was described by Menke from Lake Erie. It is common enough in the original locality and in the Niagara River; the Mohawk River, New York, abounds with specimens, this shell being the most abundant strepomatid in the eastern States. In Indiana I found it exceedingly abundant in the St. Mary's and Maumee, at Fort Wayne, on rocks in the river bed. It is an unattractive species, without much coloration, except the purplish tinge on the columella. The epidermis is a thick, heavy one, dark green or fuscous, without color bands. The young are carinate on the body-whorl, the aperture well rounded

below and angular above. The shell is dark blue within the aperture. All specimens from this State are a little longer than the eastern ones, but the carinate spire is characteristic of them all.

GONIOBASIS INFANTULA Lea. Plate 12, fig. 2.

Shell smooth, fusiform, dark horn-color, much banded; spire short; sutures slightly impressed; whorls five, flattened above; aperture rather large, ovate, banded within; outer lip acute, slightly sinuous; columella purple, thickened and twisted. (Lea.)

This little shell occurs on the Falls of the Ohio at a point in Shippingport, but not elsewhere, so far as I know. I formerly expressed the opinion that this shell was a form of *Goniobasis depygis* Say,* but I am inclined now, after more complete study of many examples, to think it distinct. There are short and stumpy forms of *depygis* which greatly resemble this shell, but the whorls are far more convex than in any *depygis* which I have seen. The shape of the aperture is different. The single locality where it occurs is a fall from the old canal into the river bed at the Louisville suburb called Shippingport. It is an abundant shell.

GONIOBASIS PULCHELLA Anthony. Plate 12, fig. 5.

Shell small, thin, elongately conical, brownish horn, banded with brown; spire conical; whorls seven to eight, convex; aperture large, equaling one-third of the shell, elongately ovate. (Anthony.)

This poorly described shell is abundant in the Blue River and in a small creek at Corydon; I have also found it in a stream near North Vernon. The long spire, double and broad brownish bands and its habit of dwelling only in the smaller streams will help to separate it. Specimens could not be secured for redescription.

GONIOBASIS INTERLINEATA Anthony. Plate 12, fig. 6.

Shell thin, elongate, slender, of a grayish horn-color, alternating with narrow, brown, hair-like lines, longitudinally and closely arranged; whorls seven to eight, subconvex, smooth; sutures distinct; aperture small, elliptical, ashen gray within; columella regularly rounded, much curved at base, and with a faint indentation or notch where the outer lip meets it. (Anthony.)

Of this shell I have no personal knowledge, never having been able to secure the species. It was described from Christy Creek, Indiana, and I have introduced it for that reason. It may be but another name for some well-known shell.

* Proceedings Indiana Academy of Science, 1893, page 151.

GONIOBASIS SEMICARINATA Say. Plate 12, fig. 10.

Shell small, conic, turreted; spire acute at the apex, the four apical volutions carinate below; volutions about eight, somewhat convex; suture moderately impressed; surface, especially of the body-whorl, slightly wrinkled; labrum a little prominent near the base; within slightly tinged with reddish brown. (Say.)

Described from an unknown stream in Kentucky. It is a common shell in many streams of southern Indiana, having a close resemblance to *Goniobasis pulchella.* It is exceedingly variable, and has been many times described. From Richmond comes a form which Dr. Lea called *Melania kirtlandiana,* but it is certainly this shell. I found it in a small stream near Charleston, and in a creek near North Vernon. It probably occurs abundantly in other localities.

A number of other names have been given to Indiana shells of the goniobasic section, but they are all synonyms. To aid in properly placing them, the following list of synonyms is prepared:

Goniobasis spartanburgensis Lea = *depygis.*

Melania occulta Anthony = *depygis.*

Melania cuspidata Anthony = *livescens.*

Goniobasis louisvillensis Lea = *depygis.* Plate 12, fig. 6.

Goniobasis bicolorata Anthony = *livescens.* Tryon is in error in placing this under *semicarinata.*

Goniobasis informis Lea = *depygis.* Plate 12, fig. 4.

Meseschiza grosvenorii Lea. Abandoned genus; the single species came from the Wabash River, Indiana, and are all diseased specimens, according to Tryon; the genus appears, therefore, to have based upon pathologic *Goniobases!*

GENUS ANCULOSA..

ANCULOSA COSTATA Anthony. Plate 12, fig. 14.

Shell subglobose, with a depressed, convex spire; body-whorl ventricose, with about five costæ revolving around it; color olivaceous; aperture obovate; base regularly rounded; purplish within. (Anthony.)

This little shell, or one which I take to be this species, occurs on gravelly bars at Lawrenceburg, in the southeastern portion of the State, in the Ohio. The typical locality is Cincinnati, 20 miles away, and there is little doubt that the identification is correct. The carinate character of the shell allies it to *Anculosa carinata* Bruguiere, a form which is very abundant in the headwaters of the Ohio River. It is possible that close comparison of geographic series will make this a synonym of *carinata.*

ANCULOSA TRILINEATA Say. Plate 12, fig. 12.

Shell subglobose oval, yellowish, more or less tinged with brown; volutions about four, rounded, somewhat wrinkled; spire short, rather more than half the length of the aperture; suture not very deeply impressed; body-whorl with three brownish-black revolving lines, of which the two inferior ones are nearest together, the middle one widest, and the superior one placed nearest the suture and revolving on the spire; the middle one is concealed on the spire by the suture; aperture much dilated, ovate, acute above; labium a little flattened; labrum widely and regularly rounded, without any protrusion near the base; base slightly angulated, without any sinus or undulations; umbilicus none. (Say.)

This beautiful little shell was described from the Falls of the Ohio, where it is abundant. The globose character of the shell, the regularly rounded whorls, the circular and regular aperture, together with the broad and white or rose or purple columella, spreading over the body wall at the junction with it, will separate it. Many examples, probably one-half, do not possess the color bands. To them Lea gave the name of *Anculosa viridis,* but it must pass into synonymy. Besides the Falls, I have taken this little shell at Lawrenceburg, in the Ohio, clinging to pebbles on gravel bars.

ANCULOSA PRÆROSA Say. Plate 12, fig. 15

Shell subglobular, oval, horn-color; volutions three or four, wrinkled across; spire very short, much eroded in the old shell, so much so as to be sometimes not prominent above the body-whorl; body-whorl large, ventricose, with a very obtuse, slightly impressed, revolving band; aperture suboval, above acute and effuse; within on the side of the exterior lip about four revolving, purplish lines, sometimes dotted, sometimes obsolete or wanting; labium thickened, particularly at the superior termination near the angle, and tinged with purplish; base of the columella somewhat elongated and incurved, meeting the exterior lip at an angle. (Say.)

This large anculosid is very common on the Falls, at Louisville, and may be taken in great numbers at very low water, clinging to the flat rocks in swiftly running water. Very large examples were collected abundantly in 1893-94. The species has a wide range into northern Alabama, under a multitude of names given by Lea and others. At Lawrenceburg and at Cincinnati, Ohio, the form also occurs, but in small numbers and of small size; its metropolis is the Falls. All sorts of variations occur and typical forms are very rare; indeed, the species should have been described as a composite one,

that is, a large number of examples should be passed in review and their general characters stated. Honey yellow forms, without bands, are common, but these have purple columellas; it is rare indeed to find any examples without color in this part of the shell. The aperture is continuous in all large specimens, because of the great callus which grows from the two angles over the parietal wall. The lower angle is often twisted and produced, as seen in no other forms except its near ally and possible synonym, *Anculosa subglobosa,* from the Holston and Tennessee rivers. The broad color bands which are present in most specimens are often interrupted or broken, giving a spotted appearance to the shell which adds to its beauty. The shell grows to be very thick and heavy.

FAMILY CORBICULADÆ.

GENERAL NOTES ON THE CORBICULADÆ.

The little mollusks which constitute this group are to be found in all small streams, ponds, rivers, and lakes in Indiana. They are often seen crawling along in shallow water on bars and the margins of large streams like the Wabash and the Ohio. The smaller forms, which belong to the genus *Pisidium,* are to be taken in fine-meshed dredges on nearly all muddy banks and in the deeper waters of the lakes in the northern parts of the State. In the Ohio and the Wabash the larger forms abound; sandy shores and muddy banks usually yield many examples of them. In some localities they are, from their small size, thought to be the young—"seed shells," the boys call them—of the larger mussels, but only a casual study will serve to separate them. In the Ohio many hundreds of examples may be taken by dredging and sifting the mud which collects behind submerged logs at low water mark, and in these stations *Pisidium* may almost always be expected. In the deeper portions of the small lakes, like Turkey Lake, they may be taken from the dredge in numbers, but can there be found in no other way. They have not had the attention which their importance deserves, and the State offers excellent opportunities for their study. The young are found in the older shells, in the spring and again in the fall, and have recently been described, in the "Nautilus," an amateur conchological journal, under a number of names. Very little information beyond facts of geographic distribution has been added since Prime monographed them in 1865.

To aid in identifying these close species, the following artificial key has been prepared. All the genuine species now known from the State are included in it:

CORBICULADÆ.

ARTIFICIAL KEY TO GENERA AND SPECIES OF CORBICULADÆ.

X. Shell large, beak central or nearly so. *Sphærium.*
Y. Shell small, beaks terminal. *Pisidium.*

Species of Sphærium.

A. Beaks rounded, never tubercular.
  a. Large, beaks full, prominent. *sulcatum.*
  b. Beaks not prominent, hinge margin much curved. *solidulum.*
  c. Beaks full, subprominent, hinge margin nearly straight. *striatinum.*
  d. Beaks full, separated, hinge curved. *stamineum.*
  e. Beaks depressed, hinge margin nearly straight, margin of valves straw-colored. *rhomboideum.*

B. Beaks tubercular, never smooth.
  f. Shell thin, anterior margin raised, hinge margin nearly straight. *partumeium.*
  g. Shell oblong, thin, white, beaks full and prominent. *transversum.*

Species of Pisidium.

a. Shell large, oblique, hinge margin curved. *virginicum.*
b. Shell moderately convex, hinge margin straight. *abditum.*
c. Shell very ventricose, hinge margin curved. *rotundatum.*

GENUS SPHÆRIUM.

SPHÆRIUM SULCATUM Lamarck. Plate 9, fig. 8.

Shell transversely oval, nearly equilateral, light in texture for its size; posterior margin somewhat more pointed; anterior rounded, base slightly curved; valves convex; beaks full, raised above the outline of the shell; posterior portion a little longer; sulcations coarse, regular; epidermis dark chestnut brown; interior light blue; hinge margin narrow, nearly a straight line; cardinal teeth small, indistinct, situated somewhat towards the anterior side, double in both valves, and so placed as to assume the shape of the letter V reversed; lateral teeth on a line with the primary teeth, large, strong and prominent.

The young is more equilateral than the adult; more compressed; it presents the shape of a quadrilateral; it is of a light lemon color, the striations are as heavy as those of the mature shell. (Prime.)

This species has been found only in the northern portions of Indiana, so far as my personal knowledge extends. It occurs in the St. Joseph River, and in the Maumee, at Fort Wayne. It is found on muddy and sandy bottoms, crawling near the margins, and may also be dredged from deeper water. I have very large and fine specimens

from Graysville, Herkimer County, New York, which greatly exceed any others I have seen in size. It is more common in the eastern United States. The broad color bands which mark certain lines of growth will help to separate this species from all others.

SPHÆRIUM SOLIDULUM Prime. Plate 9, fig. 5.

Shell transversely inequilateral, elongated, slightly convex; beaks full, not very prominent; anterior margin rounded; posterior drawn out to an angle; base slightly curved; epidermis variable, dark chestnut or brownish yellow, with sometimes a yellow zone on the basal margin; sulcations coarse, irregular; interior dark blue; hinge-margin considerably curved; cardinal teeth double, in the shape of the letter V reversed; lateral teeth large; the anterior placed at an angle with the margin; the posterior more on a continuation of the curve. (Prime.)

This species is very abundant in the Ohio River, from Lawrenceburg to Evansville, at various points at which I have collected between those limits. Its nearest congener is the next species, from which it is easily separated by the less prominent beaks and by being less pointed posteriorly. It is also a much smoother shell. In the western States, that is, west of the Mississippi River, it is replaced by the following species. This form is abundant in the old canal at Brookville, and in Turkey Lake.

SPHÆRIUM STRIATINUM Lamarck. Plate 9, fig. 6.

Shell slight, transversely elongated, somewhat compressed, inequilateral; anterior margin rounded, posterior distended, inferior rounded; beaks full, not much raised; sulcations irregular, at times so slight as to hardly be seen with the naked eye, thus giving the shell a lustrous appearance; color varying from a slight greenish-yellow to a darker shade; valves slight; interior blue; hinge-margin slightly curved; cardinal teeth double, very small, of the same size; lateral teeth larger, not very prominent. (Prime.)

I have collected this shell in numbers in the Ohio River, at Louisville and Lawrenceburg, the Wabash, at Lafayette, and in the Maumee, at Fort Wayne. It also occurred in two lots of shells sent from some lakes in the northern portion of the State. It is a larger shell than the preceding, and has a different hinge-margin; the lines of growth are also less marked and the coloration is more uniform. The blue color of the nacre is common to most of the *Corbiculadæ*, and can not be used as a specific mark. Since this shell is found in all streams, both large and small, and in a great variety of stations, it is

not surprising that it varies greatly in many of the above characters. It is sometimes quite flat, almost as much so as *Sphærium fabale* of the southern States; the young are heavily striated, and are found in the parent shell in early spring. Usually only a single specimen is borne in the parent shell.

SPHÆRIUM STAMINEUM Conrad. Plate 9, fig. 9.

Shell oval, somewhat full, inequilateral; anterior generally abrupt; posterior slightly distended; beaks very full and prominent, widely separate at the apex, often eroded; epidermis dark brownish-yellow; striae heavy; valves strong; interior blue; hinge-margin curved; cardinal teeth double, nearly obsolete; lateral teeth distinct, strong. (Prime.)

This species is confined to ponds and sluggishly flowing brooks, with muddy bottoms. I have seen specimens only from the ponds along the Wabash, near Terre Haute. The dark color of the epidermis will serve as a character by which to separate it from other Indiana forms; though the separated beaks will furnish an additional character. The species is rare.

SPHÆRIUM RHOMBOIDEUM Say. Plate 9, fig. 4.

Shell subglobular, rhombic-orbicular, equilateral; anterior margin truncated; posterior slightly angular; basal nearly straight; beaks full, but not prominent; valves slight, convex towards the beaks, gradually decreasing in fullness towards the margins; interior blue; sulcations very delicate; epidermis olive-green, with often a straw-colored zone on the margins; young shell more compressed than the adult; hinge-margin nearly straight; cardinal teeth rudimentary; lateral teeth distinct, somewhat acute, not elongated. (Prime.)

This shell is the most beautiful of its genus in the State. It is found in ponds with gravelly bottoms and in the lake regions of the northern part of the State. The dark olive green epidermis and the yellowish zones near the basal margins always enable this species to be easily distinguished. I have seen examples from the St. Joseph River, near South Bend, and from Turkey Lake. The growth lines of the epidermis are often very slight, and the shell has a polished appearance.

SPHÆRIUM PARTUMEIUM Say.

Shell rounded-oval, thin, fragile, pellucid, somewhat inflated, nearly equilateral; anterior margin very slightly distended, rounded; posterior slightly abrupt; basal rounded; beaks central, calyculate, ap-

proximate at apex; striæ so delicate as hardly to be visible; epidermis glossy, of a light greenish horn-color, with at times a zone of different shade on the basal margin; valves delicate, moderately convex, interior light blue; hinge-margin nearly straight, passing by a regular curve into the anterior margin, but curving suddenly behind so as to form an obtuse angle, causing the posterior side to appear broader, thus giving the shell a somewhat rhombiform appearance; cardinal teeth strong, assuming the shape of the letter V reversed; lateral teeth very much elongated. (Prime.)

This is a very beautiful little shell and is widely distributed over the State, in almost all sorts of stations, but it loves muddy bottoms of slow streams best. It is very thin, quite uniformly colored, and may always be separated from other Indiana forms by the raised dorsal margin of the posterior end, which is also sharper than the dorsal margin anterior to the beaks. The animal is also characteristic in coloration, the siphons being always pinkish, while the rest of the soft parts are whitish. Specimens have been seen from Corydon, Wabash, Maumee River and North Vernon.

SPHÆRIUM TRANSVERSUM Say. Plate 9, fig. 3.

Shell transversely oblong, elongated, subinequilateral, translucent; anterior side narrow; anterior margin rounded, posterior margin subtruncate, basal very much curved; beaks placed somewhat on the anterior side, large, calyculate, very much raised above the outline of the shell; striæ very delicate; epidermis greenish yellow, of a darker shade at times in the region of the beaks; valves slight, interior bluish; hinge-margin very nearly straight, narrow; cardinal teeth compressed, in the shape of the letter V reversed, and very much expanded; lateral teeth slightly elongated. (Prime.)

This species is very abundant in the Ohio and the Wabash rivers, on mud and gravel bars and near the river's edge. It may also be taken in deep water with the dredge. It is the slightest of our forms, and is so translucent that the colors of the various parts of the internal anatomy may often be made out through the shell. It is remarkable for the length of the siphons, which often extend some distance beyond the anterior margin. At Charleston, Louisville, and Lawrenceburg this shell is very common. I have collected it from numerous localities in the eastern United States, and find the shell more commonly white than any other color. Its translucency, length, high beaks, and pink-footed animal will distinguish it from other Indiana forms.

GENUS PISIDIUM.

PISIDIUM VIRGINICUM Bourguignat. Plate 9, fig. 2.

Shell large, thick, oblique, very inequilateral; anterior side longer, narrower, rounded; posterior broader, subtruncate at end, basal margin rounded; beaks situated posteriorly, large, prominent; valves solid, moderately convex, interior light blue; striæ coarse and irregular; epidermis greenish brown or chestnut color, with zones; hinge-margin very much curved; hinge broad, two strong cardinal teeth, disposed in the shape of the letter V reversed; lateral teeth strong, short. (Prime.)

This species has been noticed by me in only one locality, the Maumee River, at Fort Wayne. It may be found in other localities in the State. It is the largest of the genus, and is coarser in general character. It occurs in running waters, in the same stations as *Sphærium,* namely, muddy bottoms and on gravelly bars. It is a rather variable shell, and may be distinguished by the general dark color of the epidermis. The beaks are not very prominent, but, like all of the genus, point towards the anterior of the shell.

PISIDIUM ABDITUM Haldeman. Plate 9, fig. 7.

Shell rounded-oval, elongated, very inequilateral, moderately convex, margins well rounded, beaks placed nearer the posterior side (?), small, slightly raised; surface smooth, striae not distinct, epidermis variable, generally light straw-color; hinge-margin very nearly straight; cardinal teeth small, separate, the anterior tooth larger, and more prominent; lateral teeth small, not much elongated. (Prime.)

This shell is very common in the Ohio and Wabash rivers, and in numerous small streams over the State. I have taken it in the old canal at Brookville. I certainly can not agree with Mr. Prime in the statement that the beaks are nearer the posterior end, and have indicated my disagreement by a mark of doubt in his original description, as quoted above. In all the thousands of specimens which I have examined, the beaks are decidedly forward of a middle line drawn through the beaks to the ventral margin. This line is to be regarded as drawn in all that part of the descriptions which speaks of the shells as being "inequilateral," not only in this species but in all the *Corbiculadæ* and the *Unionidæ.* It is unnecessary to say that the term is entirely erroneous and should not be used at all in descriptive zoology. The species will be all found to be very equilateral if the line be drawn from the anterior to the posterior margins, as it should be, and not downwards through the beaks. It is strange that this term

ever came to be used with such significance! A far better descriptive nomenclature would have been one which would employ medial, anterior, or posterior, in locating the beaks, and having reference to the true position and the true anatomy of the animal. All the bivalve mollusca found in American fresh-waters are equilateral and are properly only so described.

The usual muddy stations for the family will produce many examples of this form. It is a fact worthy of attention that a majority of the individuals which are collected will be somewhat heavily coated with iron oxide, which will disguise their true color. Shaken briskly in a small vial of water, with sand, this may be readily removed and the true colors brought out.

PISIDIUM ROTUNDATUM Prime. Plate 9, fig. 1.

Shell small, rounded-oval, globose, ventricose, inflated, subequilateral; anterior and basal margins rounded, posterior margin somewhat abrupt; anterior side a little longer; beaks nearly central, very large, prominent, rounded; surface glossy, yellow, somewhat darker in the region of the beaks; hinge-margin curved; teeth small. (Prime.)

A few examples of this beautiful little shell were dredged in Turkey Lake by the Indiana University Biological Station and were sent to me for identification. They are uncommonly dark in coloration, and have a brilliant and shining epidermis, in which the striæ are scarcely visible. It is closely allied to *Pisidium ventricosum,* of the eastern States, but is only about half the size of that species, and is far less rotund. It can not well be mistaken for any other Indiana species. Only the one locality named above is known to produce this shell in this State. The beaks are very full and round and approximating.

FAMILY UNIONIDÆ.

GENERAL NOTES.

This large family is richly represented in Indiana waters, as may be seen from the following pages. A great many of the oldest known and best characterized forms occur in our rivers and streams, our lakes and ponds. Many of them vary widely in minor details from the specimens which are figured and which have been used as the basis of these descriptions; but all really essential features are constant. It is unfortunate in the study of this great group that the earlier writers did not seek more carefully for characters which might prove

identities rather than look for differences that might justify species names. It is a notorious fact that the nomenclature of the family has been so seriously burdened with synonyms that, unless one has the complete literature of the group at his command, their study is attended with most discouraging difficulties. Too many collectors have sought to seize on these names and given them to a host of forms from different streams simply that they might have an abundance of exchange material and so entrap the unwary. In other cases well-known forms have been purposely described under new names, that "a type," or several of them, might be in their cabinets to give added value to them; it is unfortunately true that typical forms, even though shown to be synonyms, are greatly desired by those who make exhaustive studies of the group. That there is an immoral side to these transactions the gentlemen never stop to consider, and probably would not admit. But the fact remains that many forms are well-known synonyms, and the incautious student is "taken in" by these species mongers with forms which he afterwards learns occur, under other names, at his very door.

The heterogeneous character of the unionine fauna of Indiana does not admit of a completely arranged artificial key to the species. The various subgenera, of which we recognize but three, may be easily separated by the following brief diagnostic table of differences:

a. Shell with both lateral and cardinal teeth.	*Unio.*
b. Shell with cardinal teeth only.	*Margaritana.*
c. Shell without either cardinal or lateral teeth.	*Anodonta.*

So far as our forms go these facts are constant ones; attention having been elsewhere in this report called to proposed visionary classifications, it is not needful that they be here rehearsed. It need only be remarked that they mainly serve to make a difficult subject far more difficult still.

The great number of Uniones in the State may make the following partial key of some service by taking a well-known form as a type of a group. But, even here, it is expressly to be remembered that these divisions are not given as having subgeneric or other taxonomic value; they are presented solely to render species recognition a little more simple. That subdivisions can be made along these lines I firmly believe, but even then they will stand as artificial or laboratory devices rather than as representing natural distinctions.

AN ARTIFICIAL KEY TO GROUPS OF UNIO.

(Excluding Anodonta and Margaritana.)

A. Shell large, smooth, radiate, umbones finely folded, straw-colored, cardinal teeth small, dimorphic. Group of *luteolus*.

B. Shell large, smooth, radiate, straw-colored, cardinal teeth large. Group of *ligamentinus*.

C. Shell thick, heavy, nacre purple, cardinal teeth heavy, epidermis black. Group of *crassidens*.

D. Shell small, umbones coarsely folded. Group of *parvus*.

E. Shell dimorphic, thin, umbones finely wrinkled, epidermis dark, radiate. Group of *subrostratus*.

F. Shell triangular, thick, brown, nacre pinkish, umbones with few coarse apiculations. Group of *rubiginosus*.

G. Shell thick, heavy, epidermis dark, pustulate, beaks angular, cardinal teeth thick. Group of *pustulosus*.

H. Shell thick, heavy, tuberculate, short. Group of *cornutus*.

I. Shell tuberculate, long, with many tuberculations over the disks. Group of *tuberculatus*.

J. Shell thick, with scattered tubercles. Group of *lachrymosus*.

K. Shell elliptical or circular, smooth. Group of *circulus*.

L. Shell plicate, black, large, thick. Group of *plicatus*.

M. Shell triangular, rayed, light straw color, umbones angular, rays interrupted. Group of *triangularis*.

N. Shell symphynote, wings well developed. Group of *olatus*.

O. Shell long, slender, thick, polished, black or yellow, cardinal teeth small, dimorphic. Group of *rectus*.

P. Shell subcircular, posterior margin dentate. Group of *personatus*.

Q. Shell very flat, lineolate, yellow, compressed at umbones, beaks triangular. Group of *lineolatus*.

R. Shell small, coarsely undulate on umbones, radiate, straw-yellow, dimorphic. Group of *iris*.

S. Shell large, thick, heavy, triangular, sulcate, cardinal teeth very large and thick. Group of *obliquus*.

In using this simple key to species which have a more or less close resemblance, the student will, of course, be mainly guided by the descriptions and figures. If he attacks the anatomy he will not find that the conchological distinctions are reinforced by any marked anatomical ones. It is constantly to be remembered that the whole arrangement is a device, simply, to lead to species identification.

SUBGENUS UNIO.

UNIO UNDULATUS Barnes. Plate 13.

Shell somewhat quadrangular in outline, thick, heavy, thicker anteriorly, plicate posteriorly and over the disks of the valves, the undulations being coarse and wide; epidermis black, or reddish, occasionally

olive-green, but dark, thick, lighter on the beaks, faintly rayed in the very young specimens; lines of growth numerous, coarse, black, raised, crowded; dorsal margin straight, sometimes raised into a thin ala, but not very high, anterior margin rounded, ventral margin very slightly rounded, posterior margin biangulate, wrinkled by the folds which extend from the disk to it; umbonal slope raised, sharply rounded, very full; posterior umbonal slope flattened, many folded, the plications being coarse and from the middle of the disk, extending downwards and backwards, those near the dorsal margin being smaller, more curved, crossing the lines of growth at a right angle; umbones full, rounded, subangular posteriorly, rounded in front, the beaks much decurved, and directed anteriorly, with from four to six small undulations or folds, light colored, raised considerably above the dorsal margin of the shell; ligament, long, thick, black, wide, raised; lunule small, heart-shaped; cardinal teeth large, heavy, double in the left and single in the right valve, with many folds or lamellæ, erect; laterals straight, thin, plate-like, long, striate near the ends; anterior cicatrices distinct, very large, deeply impressed, exceedingly roughened to hold the powerful abductors, the protractor pedis muscular impression very deep, rough, twice longer than wide; posterior cicatrices very large, scarcely or not at all impressed, confluent; dorsal cicatrices in a row on the cardinal plate; pallial line well impressed anteriorly, crenulated, slightly impressed posteriorly; cavity of the shell large, of the beaks large, deep; nacre white, posteriorly very iridescent, with dark or copper-colored patches of discoloration, scattered over the middle of the interior; the folds are conspicuous from the inside of the shell.

Large examples are found in the Ohio, Wabash, Eel and other rivers, some of which measure over six inches in length. The shell is very close to *Unio plicatus,* which is found in the same stations and is also abundant; it may be distinguished by the fact that the dorsal margin in this form is straight, in *plicatus* curved, the teeth make a wide angle in this form, in *plicatus* a smaller one, and are directed to the posterior; *plicatus* is far more round and full, its folds are disposed differently, and its beaks are directed more to the front. The two species are so close, however, that they are often confused in collections. In the small lakes of the northern part of the State *Unio undulatus* occurs, sometimes abundantly, but is smaller and more flattened. It is essentially a river form.

UNIO PLICATUS Leseuer. Plate 14.

Shell large, thick, heavy, very thick anteriorly, broadly oval in outline; epidermis black, or reddish horn-color, thick, shining on the

umbonal slopes, striate near the margins, very much so over the whole posterior portion, and remarkably imbricated, usually eroded from the beaks, save in young specimens; lines of growth numerous, crowded, raised anteriorly, giving the shell a roughened appearance; anterior margin rounded, ventral margin slightly curved, posterior margin often produced, decurved in old specimens, biangulate, the plications of the shell showing as wavy folds; dorsal margin curved, rapidly so in the region of the beaks; umbonal slope full and rounded, plicate with coarse folds from five to seven in number, which start at the anterior third and pass obliquely backwards and downwards; posterior umbonal slope flattened, with many smaller folds which curve upwards towards the dorsal margin, darker in color, very striate; umbones large, prominent, raised above the dorsal margin, declined anteriorly, with fine undulations at the tips, two or three in number, the beaks separated; ligament large, long, thick, black, very powerful, coarse and wrinkled in old specimens; lunule large, obcordate, membranaceous, black; cardinals double in the left and single in the right valve, very large, thick, heavy, roughened, with numerous lamellæ, forming, in the left valve, an acute angle, the apex of which is directed towards the beaks and the sides directed posteriorly, a line drawn through them reaching the posterior margin; the laterals long, lamellar, curved, enlarging towards the ends, nearly parallel, striate at the tips; the anterior cicatrices very large, deep, roughened with numerous plates, the edges of which form ridges in the bottom, distinct, the protractor pedis very deep, rough, and large, the anterior retractor pedis deeply impressed under the large plate of the cardinal divisions, rough; posterior cicatrices well impressed, striate, very large, confluent, that of the retractor pedis impressed immediately under the tip of the laterals; dorsal cicatrices placed in a row on the edge of the cardinal plate, numerous; cavity of the shell very large, of the beaks not very large, triangular; nacre white, iridescent, especially towards the posterior end, occasionally with a purplish tinge on the lateral teeth, sometimes blotched with brownish spots.

Very large specimens, six and one-half inches in length, come from the Wabash and the Ohio. In the ponds of Vigo County are found very large examples of this mud-loving form, and from one of these the above description is drawn. The only Indiana form with which this species could be confused is the preceding, in the description of which attention has been called to the constant differences. This shell ranges all over the State, except in the drainage of the northeastern portion, from whence I have not yet seen it. In the Kankakee and the region surrounding it is common and large. A depauperate variety comes

from the lakes of the northern portions of the State. It is a river form.

UNIO MULTIPLICATUS Lea Plate 15

Shell large, thick, heavy, plicate, broadly elliptical in outline, compressed at umbones, with the anterior umbonal slope somewhat flattened; epidermis thick, black, striate, especially so on the posterior slopes near the margin, imbricated posteriorly, olivaceous and frequetly radiate in the young; lines of growth coarse, numerous, conspicuous, overlapping on the posterior slope; dorsal-posterior margin nearly straight, or but slightly curved, with ligament scarcely showing above the margin; posterior umbonal slope slightly swollen, especially in the female, subangular, coarsely and broadly plicate, siphonal openings indicated by tendency of the valves to gape; ventral margin broadly rounded, never sulcate; anterior margin circularly rounded, produced well beyond the umbonal tips, thick, heavy; umbones small, very much plicated, with irregularly placed folds which are small, usually somewhat eroded, so that embryonic shell has entirely disappeared, the beaks approximated and concentrically folded, scarcely raised above the dorsal margin; ligament large, thick, black, hidden partially between the epidermal edges of the valves, which have a tendency to be symphynote, curved parallel with the dorsal margin; lunule very small, deeply set, much lower than the ligament; cardinal teeth double in the left, single in the right valve, coarsely lamellate and striate, very large and strong, usually with a tendency to a purplish coloration, with major depression or pit immediately under the umbones; plate joining cardinals with the laterals short but thick, with numerous pit-like depressions for insertion of dorsal muscles; lateral teeth long, nearly straight, or but slightly curved, double in the left and single in the right valve, striate towards the tips only; anterior adductor cicatrix distinct from the protractor pedis, very deep, very rough, pitted, more than half anterior to the cardinals, circular in outline, the protractor pedis impression being deep, rough and rather large; posterior cicatrices confluent, very slightly impressed or not at all, with distinct growth lines; pallial line deeply and irregularly impressed anteriorly; dorsal cicatrices not in cavity of the beaks but a deep pit on the cardinals; cavity of the shell very large, with the beaks well excavated; nacre usually silver white, with purplish tinge, very iridescent posteriorly, in old specimens usually blotched with brownish or copper-colored, irregular patches.

Length seven and one-fourth inches; height five and one-eighth inches; transverse diameter two and three-fourths inches. Specimen described was from the Wabash River.

This very large and common shell is found in the Ohio and Wabash, in deep water and on muddy bottoms. The old shells are very black, and when taken from favorable stations usually present an intact epidermis. Say was familiar with this form, as will appear below, and probably obtained it from near New Harmony. It attains the largest dimensions of any shell found in American fresh waters, and is altogether interesting and beautiful.

Though Say's name of *heros* has strict priority, it can not be used, for the following reasons: It was poorly described in the beginning; it was abandoned by its author for the name of *undulatus,* which had been given to another and distinct species by Barnes, from which procedure it is clear that Say had no clearly defined view concerning this form. Lea's name and description being the first that was accompanied with figures, and being the first clearly to indicate the limits of the species, must be adopted, and his name is now in common use. Say himself said, in his description of Plate XVI, American Conchology: "I formerly considered this species, with much doubt, as distinct from the *undulatus* of Barnes, and gave to it the name of *heros,* but, notwithstanding some differences, I have concluded, after a more mature examination and comparison, that it may be with propriety referred to that species. Barnes drew his description and figure from a specimen then unique, * * * which was so eroded as not to exhibit the ornamental tubercles of the umbo and beak." To all who have seen the perfect forms of *undulatus* Barnes and *multiplicatus* Lea the marked differences in the characters of the beaks will be clear. Say abandoned his name for this form, and another student renamed it.

I have not seen a specimen of *Unio gigas* Swainson, but a specimen in the Museum Taylor, England, is figured by Reeve as coming from the Ohio River. *Vide Unio,* Plate LVI, Fig. 287, Conchologia Iconia, Vol. XVI, 1867. There can be no question that this is also *Unio multiplicatus* Lea, and that it should be placed under the above synonymy.

Reeve describes and figures a shell under the name of *Unio perplicatus* Conrad, in Conchologia Iconica, Vol. XVI, *Unio,* Plate IX, Fig. 35, which had been labeled by J. G. Anthony, but which is most certainly a specimen of *Unio multiplicatus* Lea. This specimen was then in the Museum Cuming.

UNIO GIBBOSUS Barnes. Plate 16.

Shell elongated, depressed oval, thick, very thick anteriorly and in the region of the umbones, much thinner posteriorly, pointed behind; epidermis dark horn-color, sometimes reddish, sometimes blackish, polished, rather thin, faintly radiate, with rays which are usually placed, when present, over the whole disk, but point posteriorly, sometimes numerous enough and broad enough to give the epidermis a greenish tinge on the umbonal slope, striate posteriorly; lines of growth numerous, coarse, darker, roughening the disk; dorsal margin very slightly curved, anterior margin well rounded, forming a decided angle with the dorsal margin, ventral margin commonly emarginate, sometimes oblique, posterior margin pointed, biangulate, thin; anterior umbonal slope very much rounded, sometimes almost angular, posterior umbonal slope long, decurved, with an angular carina extending to the posterior margin, lateral umbonal slope long, inflated, regularly rounded; umbones large, prominent, flattened, eroded, pointed, with two or three coarse folds which are arranged concentrically; ligament large, thick, wrinkled, light-brown in color; lunule large, oval, membranaceous; cardinal teeth double in the left and single in the right valve, short, thick, erect, wrinkled; lateral teeth thick, heavy, straight, striate, parallel in the left valve; anterior muscular impressions distinct, very deep and pit-like; posterior impressions confluent, deep, roughened, that of the retractor pedis deeply impressed at the tip of the lateral tooth; dorsal cicatrices six or seven, arranged in a row in the middle of the cavity of the beaks; pallial cicatrix well impressed anteriorly, crenulated; cavity of the shell small and narrow, of the beaks very shallow, scarcely any; nacre purple, salmon, white or livid, a most variable feature in this species. Not very iridescent.

This is a most abundant species in the larger streams of the State. In the Ohio and Wabash it is one of the commonest of shells, and in both of them is singularly thick and heavy. I have received shells from the lakes in the northern parts of the State which were flatter, thinner, and in other respects resembled the common *Unio complanatus* of the eastern United States, but the characters of the beaks and the teeth are constant factors which distinguish it. It is impossible for a careful student to confuse the two forms. The river forms are all larger than those which came from the lakes. Additional localities are the Whitewater River, the Great Miami, the White, the Blue, the Kankakee and the Eel.. At Lawrenceburg it is the most common form on the bars in the Ohio.

I quote Mr. Barnes's original description:

"Shell much elongated transversely, thick and heavy, rapidly narrowed and rostrate before, narrow and rounded behind,* subcylindrical, disks somewhat compressed; anterior side very much produced; beaks flat; ligament elevated; anterior dorsal margin depressed and flattened; basal margin nearly straight; epidermis blackish brown, finely striated and deeply wrinkled transversely; nacre purple of different shades, often with a purple center and white margin. Teeth crenate; lateral tooth rough, very thick, bending downward, terminating abruptly and folded over towards the anterior of the shell." (American Journal of Science, first series, Vol. VI, pp. 262, 263, pl. 11, fig. 12, 1823.)

Mr. Lea described this form from the Ohio, with a white nacre, under the name of *Unio arctior:* he again described a slightly thinner form from the Stone River, Tennessee, as *Unio stonensis.* It will therefore be seen that the range of its variation is very great. From *Unio rectus,* the only form it is likely to be confused with, the shell may be distinguished by the character of its radiation and the coarse folds on the umbones, coupled with the very heavy lateral teeth.

UNIO RECTUS Lamarck. Plate 17.

This shell was described in 1819, by Lamarck, in the Histoire Naturelle des Animaux sans Vertebres, Vol. VI, p. 74, as coming from Lake Erie. His description runs as follows:

"*U. testa transversim elongata, angusto, convexa, anterius, subangulata; latere antico striis longitudinalibus obliquis, remotis obsoletis. * * * Habite le lac Erie, Michaud. Elle a presque la forme du mytilus lithophagus, Son test est blanc, recouvert d' un épiderme brun noiratre. Largeur, 100 millimetres.*"

Abundant materials from several sources, some of them Indiana specimens, permit the following description:

Shell large, smooth, elongate, compressed laterally, thick, very thick anteriorly, rounded before, pointed posteriorly, epidermis thick, black, or reddish corneous, shining, obscurely rayed with dark green, the broad rays not very apparent in old specimens, lines of growth numerous, well marked, imbricated posteriorly, and often so on ventral margin; dorso-posterior margin straight, or nearly so; posterior umbonal slopes gently rounded, becoming more angular near the beaks,

* In comparing these descriptions it must be remembered that Barnes and Say, as did some other writers, confused the two extremities of the shells, calling the anterior the posterior, and conversely. This will explain some differences in the descriptions which would otherwise be irreconcilable. I do not know how this error came to exist, but it occurred, as may be seen from this description.

much imbricated towards posterior margin; umbones small, scarcely approximating, marked, in non-eroded specimens, by many minute, fine, concentric crenulations or folds; ligament long, thick, black, sometimes dark brown; cardinal teeth double in the left, and disposed to be double in the right valve, the larger portion erect, sometimes sharp, sometimes blunt, and commonly gently posteriorly recurved, the characters of the double portion in left valve various, sometimes sharp, often blunt, or smooth rounded; lateral teeth long, lamellar, straight, finely crenulate on margins; anterior cicatrices very large, deep, striate, distinct, that of the protractor pedis impression considerably above the lower margin of the large and deep adductor cicatrix; posterior cicatrices not deeply impressed, confluent, very large, pallial cicatrix very deep anteriorly, irregularly impressed throughout, crenulate; dorsal cicatrices impressed deeply in the center of the cavity of the beaks, large, often pit-like, in old shells exhibiting two or three large scars, circular in outline, and as deep as the *protractor pedis* impression, though the posterior one is commonly oval; plate connecting the cardinal and lateral teeth not well developed; nacre usually dark purple, often pink, white or salmon; frequently the coloration is confined to the region of the cardinal and lateral teeth, the remainder of the interior being pure white.

Length, 171 mm.; breadth, 60 mm.; height, 70 mm.

This fine and large species is common in the Wabash and in the Ohio; large specimens were also taken in the Eel River, near North Manchester; smaller ones have been seen from the Kankakee, in the northwestern part of the State. The female is rather thinner in texture than the male, but it is higher from the dorsal margin to the ventral, especially at the posterior portion of the shell. In many specimens the disk is slightly wrinkled, marking the position of the ctenidia, which act as gestatory sacs. Young specimens are sometimes found in collections with the name of *Unio gibbosus*, but a glance at the beaks will serve to separate them. The epidermis is usually highly polished over the umbonal slopes; old individuals are often eradiate.

UNIO TERES Rafinesque. Plate 18.

Shell oblong, two and one-half times longer than high, smooth, rather thick, thicker anteriorly; epidermis yellow straw-colored, radiate or eradiate, reddish brown in very old specimens, lemon-yellow in the young, smooth, shining, striate only on the dorsal border posteriorly, where it is darker, thin; lines of growth pronounced but widely separated, darker in color, raised anteriorly; dorsal margin

nearly straight, anterior margin rounded, forming an obtuse angle with the dorsal margin, ventral margin emarginate, especially in the female, posterior margin acutely angulated; anterior umbonal slope rounded, posterior umbonal slope subangular, becoming inflated towards the ventral margin in the female, and produced below the ventral margin, making it arcuate; umbones small, slightly raised above the dorsal line, pointed, approximating, minutely wrinkled, with very fine folds, disposed as a very flat letter V, with its apex pointing towards the beaks, the embryonic shell showing distinctly; ligament long, thick, light brown, smooth; lunule long and very narrow; cardinal teeth double in the left and single in the right valve, triangular, small, erect; lateral teeth long, slightly curved, thin, lamellar, very iridescent, striate at the tips; anterior cicatrices large, deeply impressed, distinct; posterior cicatrices confluent, well impressed; pallial line well impressed throughout, crenulated anteriorly; dorsal cicatrices minute, disposed in a group in the center of the cavity of the beaks; cavity of the shell wide, of the beaks rather shallow; nacre silvery white and very iridescent.

Length, three to five inches; height, one and one-half to two inches; breadth, one and one-fourth to one and three-fourths inches. The females are more inflated than the males.

This dimorphic species is abundant in both the Wabash and the Ohio. It is a mud-loving form, but is very active and may be taken in shallow water on the margins of both rivers; it delights to anchor itself in the mud, a foot or two from shore, in which situations it may be taken in numbers. In outline and general shape this shell resembles *Unio rectus*, but is entirely straw-yellow in color, which alone will separate it from all other Indiana shells.

The name bestowed by Rafinesque has been given to this species, which is commonly known as *Unio anodontoides* Lea, because there can be no doubt that Rafinesque had this species before him in drawing up his description. I have deemed it wise to quote, in full, Rafinesque's description of this form, which he did not figure. Conrad, in his Monography of Unio, Plate XXVIII, figures this species under the name of *Unio teres*, and states that the figure was taken from a specimen in the cabinet of Mr. Poulson, a resident of Philadelphia, to whom Rafinesque had given it after himself labeling it. It would seem the history of this shell is so complete that we are no longer justified in withholding from Rafinesque the right to the name of this shell. His description is as follows:

"66. Espece, Unio teres (Elliptio teres). Mulette ronde. Test peu épais, bombé, elliptique, élargi, tronqué inférieurement, postéri-

eurement et obliquement; épiderme presque lisse, corné; nacre blanche, iridescente; lengueur environ $\frac{2}{5}$, diamètre $\frac{2}{3}$, axe $\frac{1}{5}$ de la largeur. Appartient au sous-genre *Eurynia*. Largeur environ trois pouces. Dans la rivière Wabash; légèrement sinuée inférieurement; sommets effacés; lame longue, mince; dent crénelée décurrente." (Monographie des Coquilles bivalves fluviatiles de la rivière Ohio, Chenus reprint, Paris, 1845, supplement, pp. 29, 30.)

I do not think that an unprejudiced mind could see other than Rafinesque's species in this shell. It was described from the Wabash by that writer; under Lea's name it was described from the Ohio, as well as from the Mississippi and from the Alabama.

UNIO PHASEOLUS Hildreth. Plate 19.

Shell elliptical, nearly twice longer than high, rather thick, thinner posteriorly, very much flattened laterally; epidermis straw-colored, striate, especially near the margins, with a few broad, uninterrupted, green rays extending from the beaks and covering the whole disk, sometimes many very fine and crowded green rays take their place, thin; lines of growth coarse, numerous, raised, posteriorly imbricated; dorsal margin slightly curved, anterior margin rounded, ventral margin slightly rounded, posterior margin somewhat pointed and subbiangular, gaping at the region of the siphons; umbonal slope very flat, the anterior umbonal slope scarcely raised, the posterior umbonal slope obtusely angular, decurved, with two depressed lines extending from the beaks to the posterior margin; umbones small, minutely wrinkled, with very fine crenulations, lighter colored than balance of shell, often eroded, scarcely raised above the dorsal margin; ligament long, pointed at both extremities, scarcely elevated, dark brown in color, rather narrow; lunule distinct, long, membranaceous; cardinal teeth small, compressed, double in the right and single in the left valve, striate, thick; lateral teeth long, decurved, double in the right valve, separating towards the extremity, thinner at same point, very striate, in old specimens very thick and heavy; anterior muscular impressions distinct, deep, that of the anterior retractor pedis deeply pitted and immediately under the anterior portion of the cardinals, the adductor deep, rather large, striate; posterior muscular impressions rather deep, distinct, that of the retractor pedis at extreme tip of the laterals; dorsal cicatrices small, in a group, pit-like, on the plate of the cardinal tooth; pallial cicatrix well impressed and crenulate anteriorly, slightly impressed and very iridescent posteriorly; cavity of the shell narrow, shallow, of the beaks very shallow; nacre pure

white, somewhat iridescent posteriorly, occasionally blotched with brownish or yellowish spots.

Length, three to four and one-half inches; height, two inches; width, three-fourths to one inch. The shell is usually very much compressed laterally.

This is an abundant shell in both the Wabash and the Ohio; it has also been taken, of very large size, in the Eel River at North Manchester. A "humped" variety was described by Mr. Lea under the name of *Unio camelus*, and again another form under the name of *Unio planulatus*, from the Ohio at Cincinnati.

Dr. S. P. Hildreth, of Marietta, Ohio, described this species from the Muskingum River, in 1828, in the American Journal of Science, First Series, Vol. XIV, pp. 283, 284. His descriptions were submitted by Professor Silliman, the editor, to Mr. D. H. Barnes, who, in a note, thought that this form was "a white variety of *cuneatus*," described by himself. It has long been known that Barnes's *Unio cuneatus* was a species which had been long before described by Lamarck under the name of *Unio crassidens;* even if this were not true, the present shell must stand as distinct under the name which Dr. Hildreth gave it. To facilitate the study of the synonymy, I reproduce here the original description:

"Shell thick and ponderous; anterior side narrowed, thin, angulated; beaks low; anterior lunule, carinated; basal margin, arcuated; anterior margin, narrow and rounded; dorsal margin, higher than the beaks; posterior margin, rounded and slightly gaping; epidermis, light olive and finely wrinkled transversely; cardinal teeth, rather small, lightly sulcated, and finely crenated; lateral teeth, very broad and thick; posterior muscular impression rough and deep; anterior one, deep and striated; nacre, pearly; cavity of the beaks, shallow, and inner surface marked with several deep folds, running obliquely from the cardinal teeth to the anterior margin."

It is to be remembered in reading this and other descriptions by Dr. Hildreth that he followed the custom of his time and called the anterior part of the shell the posterior, and conversely.

UNIO SPATULATUS Lea. Plate 20.

Shell small, elliptical, compressed laterally, about twice longer than high, thin, slightly thicker anteriorly, smooth, or slightly striate anteriorly; epidermis light straw-color, reddish on the umbones, thin, rayed with numerous wavy lines which are especially so on the posterior slope; lines of growth numerous, distant, imbricated posteriorly, crowded anteriorly; dorsal margin slightly curved, anterior margin

rounded, posterior margin biangulate, ventral margin rounded; anterior umbonal slope flattened, posterior umbonal slope flattened, scarcely subangulate near the beaks; umbones rather depressed, scarcely elevated above the dorsal line; small, decorticated, with a few rather coarse concentric and wavy crenulations; ligament long, narrow, rather thick, dark horn-color; lunule long, slender, black, membranaceous; cardinals small, thick, erect, double in the left and single in the right valve; laterals long, slender, slightly curved, thin, striate; anterior cicatrices distinct, deeply impressed, rather large; posterior cicatrices confluent, not deeply impressed, large; dorsal small, in the center of the cavity of the beaks; pallial line distinct, well impressed anteriorly; cavity of the shell small, of the beaks shallow, triangular; nacre white, iridescent, sometimes with a tinge of salmon or pink in the cavity of the beaks.

Length, from two to two and one-half inches; height, one and one-eighth to one and one-fourth inches; width, one-half to three-fourths of an inch.

This small shell occurs in most of the streams and the lakes of Indiana. In the Ohio and Wabash it is common. I have collected large specimens in the Eel River at North Manchester. It is often mistaken for the immature shell of *Unio ligamentinus*; indeed, young *ligamentinus* has often been sent to me for this species. The characters of the beak and the peculiar character of the rays will separate this form.

Unio iris Lea. Plate 21.

Shell elliptically oval, thin, small, somewhat thicker anteriorly, compressed transversely; epidermis light straw color, smooth, somewhat glossy, striate near the margins, very beautifully rayed with green, the rays departing from the umbones and proceeding postero-ventrally in a straight line, becoming broader below, sometimes broad, sometimes mere pencil lines, more or less interrupted, especially at the lines of growth, thin; lines of growth conspicuous, not very close together, slightly darker than the disk of the shell; dorsal margin somewhat curved, anterior margin well rounded, ventral margin nearly straight, posterior margin biangulate, rather pointed; umbonal slopes all somewhat compressed, the lateral flattened, the posterior subangular; umbones small, slightly raised above the dorsal margin, small, angular, rather coarsely folded, lighter in color than the rest of the shell; ligament long, thin, narrow, light brown; lunule long, narrow, black; cardinal teeth small, erect, triangular, double in the left, single in the right valve, that of the right valve plate-like, slightly

curved anteriorly; lateral teeth long, thin, straight, not much elevated; anterior cicatrices distinct, deeply impressed; posterior cicatrices slightly impressed, confluent, very iridescent; dorsal cicatrices small, in the center of the cavity of the beaks; pallial impression very faint; cavity of the shell small, narrow; of the beaks shallow, small, somewhat triangular; nacre silvery white, iridescent posteriorly.

Length, two and one-half inches to three inches; height, one and one-fourth to one and one-half inches; width, five-eighths to three-fourths of an inch.

The dimensions given above are sometimes slightly exceeded, but the majority of the specimens found will fall within these limits. The species is found in all portions of the State, and is characterized by its beautiful nacre, the short, erect teeth, and the beautiful bands of green, together with the foldings on the beaks. *Unio spatulatus* is often mistaken for this shell, and does indeed resemble it in many particulars, but the differences will be seen by comparing the two descriptions which I give. The largest and finest specimens I ever saw, in many hundreds of examples, came from the Eel River, near North Manchester, and were collected by me in the spring of 1896. They are now in the Call Collection in the Museum of Comparative Zoology.

UNIO SUBROSTRATUS Say. Plate 22.

Shell dimorphic, inflated in the female, pointed in the male, thin, laterally compressed, narrowly elliptical; epidermis dark brown, or reddish, much redder on the beaks, thin, polished on the umbonal slopes, striate on the margins, much rayed, especially on the posterior half, by broad dark-green rays, most conspicuous over the basal half of the posterior slope, sometimes interrupted by the lines of growth; growth lines very evident, darker, crowded anteriorly; dorsal margin slightly curved, in the male nearly straight, in the female somewhat elevated; anterior margin small, rounded; ventral margin emarginate in the female, nearly straight in the male; posterior sharp or pointed in the male and biangulate, in the female emarginate, much longer, extending farther towards the dorsal margin; anterior umbonal slope rounded in both male and female; posterior and lateral umbonal slopes much inflated in the female, in both subangular; umbones small, placed well forward, pointed, approximating, lighter in color, sometimes reddish brown, with many fine concentrical and curved lines that are wavy, the points extending towards the umbones; ligament long, thin, light brown, narrow, slightly raised above the dorsal margin; lunule inconspicuous, long, narrow; cardinals small, erect, thin

and plate-like, disposed to be double in both valves; laterals long, thin, lamellar, straight, not much elevated; anterior cicatrices well impressed, distinct; posterior cicatrices fairly well impressed, confluent, striate, very iridescent; dorsal cicatrices small, pit-like, in a row in the center of the cavity of the beaks; pallial line faintly impressed; cavity of shell small, narrow, of the beaks very shallow; nacre white, pearly, iridescent posteriorly.

Length, two and one-half to three inches; height, in the male little more than one inch, in the female often one ond one-half inches; diameter, from three-fourths of an inch to nearly one inch, the female being somewhat more inflated, especially in the posterior half.

The shells on which this description is based came from the Wabash River; the species occurs over all that part of Indiana the drainage of which is into the Ohio. A form of the Atlantic drainage, *Unio nasutus*, is very commonly given the honor of belonging to the Indiana fauna, but no authentic specimens have yet been seen from this State. The markings on this species are quite different from those of the eastern species, and the beaks differ. Examples have been seen of *Unio subrostratus* from the Eel River, the Wabash, the White, the Blue and the Ohio. It is a mud-loving form and is often found in association with *Unio teres* and similar shells. This species occurs in a number of other States, and has been described by Mr. Lea from several of them under different names; there can, however, be no doubt of identity.

UNIO FABALIS Lea. Plate 23, figs. 1–4.

Shell very small, elliptical-oval, pointed posteriorly, compressed laterally, thick, heavy, very thick anteriorly and in the region of the umbones; epidermis olive green, thin, very light on the umbones, somewhat glossy, striate on the margins, thin, with numerous fine capillary rays extending to the the margins, most marked posteriorly; lines of growth large, darker, not numerous; anterior dorsal margin very short, oblique, posterior dorsal margin long, curved downwards in the female, straight and oblique in the male, the shell being dimorphic; anterior margin subangulate rounded, ventral margin rounded, inclined to be emarginate in the female near the posterior end; posterior margin pointed, subbiangulate; anterior umbonal slope rounded, angulate towards the beaks, posterior umbonal slope subangulate; flattened on the dorsal surface; umbones very small, triangular, smooth, light-colored, somewhat decurved, approximate, embryonic shell usually retained save in eroded specimens; ligament short, narrow, thin, light brown, polished; anterior lunule long, black, membranaceous;

cardinals short, thick, heavy, erect, double in the left and single in the right valve; laterals short, thick, very heavy, curved downwards, thicker near the extremities; anterior cicatrices distinct, small, deeply impressed; posterior cicatrices small, well impressed, distinct; pallial impression very slight; dorsal cicatrices minute, in the center of the cavity of the beaks; cavity of the shell very small, narrow; of the beaks shallow or scarcely any; nacre pearly white, occasionally pink in the regions of the beaks, iridescent posteriorly.

Length, one inch to one and one-half inches; height, five-eighths to three-fourths of an inch; width, of males three-eighths of an inch, of females half an inch.

This very beautiful shell was described by Dr. Lea from the Ohio River, where it is very common. The White and Wabash rivers furnish numerous specimens; some of the lakes of northern Indiana furnish many specimens, notably Tippecanoe Lake, from which I have seen twelve specimens. There is no other species which can be confused with it except *Unio parvus* Barnes and *Unio glans* Lea, both of which are small species. From *parvus* it can readily be told by the lack of undulations on the beaks; from *glans* it may easily be distinguished by the color of the nacre, *glans* being dark purple.

Mr. Say described this shell in 1831, in the Transylvania Journal of Medicine, as *Unio lapillus;* Lea's description was made in 1830.

UNIO PRESSUS Lea. Plate 24.

Shell thin, rather large, very much compressed transversely, disks flattened, oval in outline, symphynote or partly so, the ligament being but partially hidden in most forms that are old, never covered in the young shell, often alate posteriorly; epidermis thin, striate anteriorly, polished over the umbonal slopes and on the disks, light horn or straw-color, with numerous capillary green rays, often disposed in very broad bands that are more or less irregular, covering the entire disk and giving the shell a bright green appearance, darker and greener posteriorly; lines of growth coarse, well marked, distant, darker than rest of epidermis; dorsal margin raised, thin, curved, alate in many specimens, in old ones the ala is commonly broken off; anterior margin well rounded, forming a very obtuse angle with the dorsal margin; ventral margin rounded; posterior margin biangulate, sometimes somewhat sinuous; anterior umbonal slope scarcely raised, flattened; posterior umbonal slope somewhat raised or swollen, especially in the female, the dorsal portion with two depressed lines extending from the beaks to the margin; umbones small, scarcely raised, angulate, with numerous coarse, wavy folds or plications, these are sometimes

apiculate, lighter colored than the rest of the shell; ligament light brown, long, thin, sometimes partially covered by the shelly matter of the valves in those specimens which are partially symphynote, i. e., in those specimens in which the valves are united above the ligament; lunule very long, narrow, light colored; cardinal teeth small, double in the left and single in the right valve, the posterior division of the left cardinal inclined to divide into two portions, thin and plate-like, the two main divisions widely separated; the laterals small, straight, thin, the lower plate often incomplete; both hinge teeth are often greatly roughened or nearly aborted through disease; anterior muscular impressed shallow, large, distinct, smooth; posterior cicatrices very lightly impressed, confluent; pallial cicatrix scarcely evident; dorsal cicatrices small, impressed on the cardinal plate; cavity of the shell large, narrow, of the beaks rounded and shallow; nacre usually white, but often tinged with salmon in the middle of the disk and the region of the beaks, often roughed through some pathological condition, when perfect quite iridescent.

Length, three to four inches; height, two and one-half inches; width, three-fourths to one inch.

This species is distributed over all of Indiana, in the rivers, creeks and in many lakes. It is not easily confounded with any other species, the characters of the teeth and the outline, coupled with the rays, will separate it. The above description is based upon specimens from the Wabash River.

This shell has been greatly misunderstood by recent writers, and some of them have attempted to place it among the *Margaritanas* under the older name of *Alasmodonta*. I find it so placed in two late papers, one of which deals with the mollusca of the Chicago area, but without warrant of fact either so far as relates to the shell or to the soft parts. It is the bane of the student of shells that some systematists seize upon novel views and accept them as true; after wider acquaintance with species and their variable forms, and closer attention to habits they abandon these wouldbe guides and take a common sense view of things. The recent attempt to revive many long forgotten names as of subgeneric value, especially those of Rafinesque, an attempt made many years ago by Agassiz and by Stimpson, which failed, and the fact that inadequate materials seem to be at hand for this purpose in most museums, should teach us to be conservative in these matters. The most heterogeneous conglomerations are presented as being "scientific"! *Unio rectus, Unio alatus,* and *Unio parvus* are all being "scientific!" *Unio rectus, Unio alatus,* and *Unio parvus* are all presented in one subgenus—*Lampsilis*—in utter ignorance, it must be

conceded, of the radical differences between the soft parts. If *Unio* must be broken up to facilitate its study—which is by no means certain—these infractions will certainly not be the ones which will last.

UNIO ALATUS Say. Plate 25

Shell large, oval, inflated, alate, symphynote, rather thin, slightly thicker before, gaping posteriorly; epidermis dark olive, or brown, sometimes black, thick, striate posteriorly, coarsely so on the dorsal slope, rayed inconspicuously, the green rays extending from the beaks to the ventral margin and being directed posteriorly; lines of growth very coarse, rough, often raised into low ridges, black; dorsal margin triangularly alate in perfect specimens, the valves connate, including the ligament; anterior margin rounded; ventral margin slightly rounded; posterior margin biangulate, not regular, usually incurved near the siphons, very long; anterior umbonal slope compressed; posterior umbonal slope inflated, full, rounded, the dorsal portion with two or three carinæ which extend from the beaks to the posterior margin in the region of the siphons and where the epidermis is thick and coarsely striate, becoming very flat on the alæ; umbones very small, slightly raised above the dorsal margin, smooth or very finely wrinkled, when not decortricated which is the rule, in color lighter than rest of umbones, placed well towards the anterior; ligament long, thick, light horn-color, hidden by the connate valves in perfect specimens; lunule not evident; cardinals double in both valves, the teeth of the left valve being somewhat thicker, all erect, roughened, usually somewhat curved anteriorly, short; lateral teeth long, curved, double in the left and single in the right valve, becoming thin and plate-like near the posterior ends; anterior muscular cicatrices large, distinct, well impressed, that of the anterior retractor pedis being especially well marked, that of the protractor pedis very large, round, deep; posterior cicatrices slightly impressed, confluent, very large, beautifully iridescent; dorsal cicatrices numerous, large, placed in a straight line in the middle of the cavity of the beaks; pallial cicatrix well impressed anteriorly; cavity of the shell large, of the beaks shallow; nacre purple or pinkish, sometimes with copper-colored blotches, iridescent, especially posteriorly.

Specimens are occasionally taken which are seven inches in length, with corresponding other dimensions. Usually as seen in the Ohio, Wabash and Kankakee rivers the shell is about five inches in length.

There are several forms of the alate *Unionidæ* in the Wabash and the Ohio, but they are easily separable from this form of Say's. *Unio lævissimus* Lea is thinner, darker, and flatter; it also has slighter teeth

and never attains the large size of Say's species. *Unio gracilis* Barnes is a light-colored shell, with light green rays, is less alate, has a white nacre and different beaks. The habits of all these shells are very similar, being found in soft muddy bottoms and in deep and still waters; they are mud-loving forms.

The specimen figured came from the Wabash, and is a diseased specimen, the ligament being distributed all over the inside of the connate alæ. Pink pearls are common in this species.

UNIO LÆVISSIMUS Lea. Not figured.

Shell large, thin, laterally compressed, fragile, gaping posteriorly, symphynote or connate, bialate, smooth, broadly oval in outline, rayed indistinctly; epidermis smooth, brilliantly polished, dark horn-color, lighter on the umbones, sometimes lighter horn-colored, with faint capillary rays which become striations on the posterior marginal slope, epidermis thin, usually eroded from the apices; subbiangular behind, rounded before, ventral margin nearly straight; lines of growth very distinct, darker, sometimes black, impressed, in old specimens inclined to be imbricated posteriorly; ligament inclosed, thin, light horn-color; lunule none; lateral and anterior umbonal slopes depressed and flattened, scarcely rounded; posterior umbonal slope flat, flattened on the margin dorsad, darker in color, with two or three faint carinæ extending to the siphonal openings; cardinal teeth small, depressed, thin, plate-like, striate, single in both valves, in the left valve the main tooth is reinforced by two minute ridges on either side, in the right valve by one minute ridge dorsad to the main tooth; lateral teeth long, slightly curved, not connected by a plate with cardinals, thin, plate-like, faintly striate near the ends; anterior cicatrices distinct, large, scarcely impressed, smooth; posterior cicatrices very large, confluent, not at all impressed, smooth, iridescent; pallial line scarcely evident; dorsal cicatrices large, slightly impressed, arranged in an irregular row in the cavity of the umbones posterior to the beaks; nacre rosy, or purplish, beautifully iridescent, especially posteriorly; umbones small and scarcely elevated above the margin of the shell, approximated, subbiangular behind, with very fine crenulations in the very young specimens.

Four to five and one-half inches long; three and one-half to four and one-fourth inches high.

This shell is common in the Ohio in muddy stations associated with *Unio alatus* and *Margaritana complanata*, and other mud-loving shells. The bialate character is a constant one, the valves being connate both in front and behind the small umbones. The chief char-

acter, additional to these, is the one afforded by the peculiar cardinal teeth which are quite unlike those of any other Unio. They are directed close to the dorsal margin and are not connected with the laterals by any sort of plate, a circumstance which few Uniones present. The only shell that this one could be confounded with is *Unio alatus*, which is, however, a much heavier and far coarser shell; the polished epidermis will alone distinguish it from that form; from *Unio gracilis* the absence of bright green rays will separate it.

The specimen described came from the Ohio, and is number J1770 in the Collections of the American Museum of Natural History, New York City. It was loaned for description by courtesy of Professor R. P. Whitfield.

Unio tenuissimus Lea. Not figured.

Shell small, thin, smooth, elongately-elliptical in outline, very greatly compressed transversely, symphynote, epidermis greenish horn-color, radiate, striate near the margins; lines of growth inconspicuous, slightly darker; dorsal margin straight; anterior margin abruptly rounded; ventral margin broadly rounded; posterior margin pointed, subangular, oblique towards the dorsal margin, gaping in the region of the siphonal openings; anterior umbonal slope scarcely rounded, lateral slope flattened; posterior umbonal slope subangular, greatly compressed laterally near the alæ; umbones very minute, scarcely projecting above the dorsal margin, approximate, subangular; ligament small, short, thin, hidden by the valves, light horn-color; cardinal teeth scarcely evident in the left valve, single in the right valve, short, thin, sharp in the right valve; lateral teeth single in both valves in the specimen from which this description is drawn, long, thin, straight; anterior cicatrices distinct, well impressed, except the protractor pedis, which is scarcely evident; posterior cicatrices confluent, not at all impressed, very iridescent; pallial line not evident; dorsal cicatrices large but scarcely evident in the cavity of the beaks; cavity of the shell shallow, of the beaks scarcely any; nacre bluish white and very iridescent.

This is one of the thinnest of shells, as its name implies; it is found in muddy bottoms in the Ohio and Wabash rivers. It is fairly common, but is not an abundant species. It has no close relative, and can not be mistaken for any other species in the State; notwithstanding this, it is occasionally seen in collections mixed with *Anodontas*, so very like that genus do some specimens seem to be from the poorly developed character of the teeth.

UNIO GRACILIS Barnes. Not figured.

Shell large, symphynote, rather thin, slightly thicker anteriorly, broadly elliptical in outline, compressed laterally, a little higher posteriorly; epidermis light horn or straw-color, indistinctly radiate (in young specimens the rays are much more distinct), smooth, shining on the umbones, striate near the margins; lines of growth coarse, raised, giving old shells a rough appearance, often irregular through breakage and repair; dorsal margin somewhat curved; anterior margin a little produced, rounded, subangular; ventral margin ovately rounded; posterior margin circularly rounded; anterior umbonal slope flattened, lateral umbonal slope compressed; posterior umbonal slope rounded, somewhat inflated, compressed near the dorsal margin, darker in color, with two indistinct carinæ extending from the beaks to the margin; umbones very small, scarcely raised above the dorsal margin, approximated, with a very few fine folds or crenulations in perfect specimens, about one-third the length of the shell from the anterior margin; ligament thick, included between the symphynote valves, light horn-color; lunule long and thin; cardinal teeth very small, smooth, double in the left and single in the right valve, in some specimens almost wanting; lateral teeth curved, becoming evident as teeth only near the posterior margin, elsewhere they are but rounded folds, perfectly smooth; anterior cicatrices very large, distinct, well impressed; posterior cicatrices very large, confluent, slightly impressed, crenately striate; pallial line iridescent, faintly impressed, very broad; cavity of the shell large, of the beaks very shallow; dorsal cicatrices large, in a row in the cavity of the umbones, but not under the beaks, extending anteriorly; nacre pink to rose color, very iridescent, especially on the dorsal and posterior margins.

Length, five and one-half inches; height, three and one-half to four inches; width, one and three-fourths inches.

This large and fine shell is very fragile, and does not well stand the changing temperature of cabinets; as a result the valves crack and become disfigured. It is a very common shell in many Indiana streams. The specimen described came from the Ohio River. It is, like all the symphynote shells, a lover of the mud, and is found in quiet and deep waters in association with many of the common species. It is rare to find a full-grown specimen in which the symphynote character is to be seen, since the alæ are most often broken off. But the young shells show the character well, and occasional large specimens show it in greater or less degree. The characters of the cardinal teeth will alone separate it from any other American shell. Mr. Barnes described his species from the Wisconsin River;

it would seem that Say originally regarded this as a variety of *Unio alatus,* but it is widely distinct.

UNIO TUBERCULATUS Barnes. Plate 26.

Shell quadrate-elongate, thick, large, heavy, very thick anteriorly, rather thin posteriorly, numerous elongated pustules all over anterior half of disk, resembling in form that which would be assumed by some thick fluid which was flowing in drops over the disk, flattened transversely, the female the more inflated; epidermis reddish horn-color, thick, striate, eradiate; lines of growth large, coarse, separated, darker in color; dorsal margin nearly straight posterior to the beaks, but oblique, anterior portion curved; anterior margin rounded, forming an obtuse angle with the dorsal margin; the ventral margin emarginate, posteriorly decurved; posterior margin irregular, biangulate, shape various, more irregular in the female, subtruncate in the male; anterior umbonal slope rounded, subangular towards the beaks; lateral umbonal slope long, flattened, slightly excavated; posterior umbonal slope very angular, long, especially in the female, with a number of swollen bosses on the angle which give rise to large, variously formed tubercles, inflated, especially in the female, the dorsal portion with numerous parallel fine ridges which extend to the dorsal margin, flattened near the ligament; umbones somewhat elevated, angular, pointed, separated, placed well towards the anterior margin, decurved, decorticated, with many small tubercles which, when not eroded, are rather sharp, with a strong angle which passes to the postero-ventral margin; ligament long, thick, black, very much raised above the dorsal margin; lunule long, rather broad, black, membranaceous; cardinal teeth massive, thick, heavy, very striate, double in both valves, erect; lateral teeth long, thick, straight, striate; anterior cicatrices distinct, large, deep, roughened; posterior cicatrices confluent, large, slightly impressed; pallial cicatrix well impressed anteriorly and crenulate; dorsal cicatrices small, pit-like, in the center of the cavity of the beaks; cavity of the shell large, of the beaks deep and triangular; nacre dead white, iridescent posteriorly.

Length, five to six inches, occasional specimens having been taken nearly seven inches in length; the females are longer than the males, but less high; the highest portion of the shell is just posterior to the beaks.

Abundant in all the large streams in the southern half of Indiana, especially the Wabash and the Ohio. The animal delights in muddy bottoms, and it should there be looked for, in rather deep and slug-

gishly flowing water. It can not be confused with any other species. The specimens figured came from the Wabash.

Mr. Barnes's original description appeared in the American Journal of Science, First Series, Vol. VI, pp. 125, 126, Plate 7, Fig. 8, 1823; it is reproduced below:

"Shell thick and rugged; anterior side compressed, narrrowed thin; posterior side rounded, short, obtuse, and broader than the anterior. Beaks flat, placed about two-ninths from the posterior end; ligament higher than the beaks; hinge-margin nearly straight, elevated, compressed and carinate before; basal margin compressed, falcated; anterior dorsal emarginate, anterior basal projecting; anterior margin narrow and rounded. Epidermis dark brown or horn-color. Surface thickly and irregularly tuberculated, tubercles elongated longitudinally; those near the base larger; an elevated ridge extending from the beaks and projecting on the anterior basal edge; irregular profound, nodulous undulations radiating from the elevated ridge to the hinge and anterior margin. Cardinal teeth crenated; lateral teeth long and striated; posterior muscular impression deep, and the anterior half of it rough. Cavity angular compressed, directed backward under the cardinal tooth, admitting the end of the finger. Nacre pearly white, with irregular spots of greenish, iridescent on the fore part."

Unio cornutus Barnes. Plate 27.

Shell subcircular in outline, thick, heavy, very thick anteriorly, emarginate, tuberculate, subglobose; epidermis light horn-color, or straw-color, smooth, thin, minutely and beautifully rayed, the rays appearing as if made up of a succession of minute green spots, wavy; lines of growth distinct, separated widely, raised into low ridges anteriorly, where they are crowded; dorsal margin thick, curved; anterior margin rounded, sometimes oblique, ventral margin full anteriorly, emarginate posteriorly, posterior margin irregularly sinuate, biangulate; anterior umbonal slope full, round, angular towards the beaks; lateral umbonal slope rounded, with four or five rather large tubercles, occasionally appearing like tears flowing over the disk; posterior slope sulcate, angular, thinner and flattened near the dorsal margin, with a number of fine, curved wrinkles or folds which pass upwards towards the dorsal margin; umbones high, prominent, triangular, decurved, with one small tubercle on each, that on the right valve being formed first and placed highest; ligament short, thick, wide, usually black; lunule small, cordate; cardinal teeth large, thick, heavy, not much elevated, very crenate, double in the left and single

in the right valve; lateral teeth thick, slightly curved, short, striate; anterior cicatrices distinct, deep, small, that of the anterior retractor pedis deeply impressed on the base of the cardinal teeth; posterior cicatrices deep, distinct, that of the retractor pedis just below the end of the lateral teeth; dorsal cicatrices small, in a row on the cardinal plate; pallial line well impressed anteriorly and crenulate; cavity of the shell small, of the beaks deep and wide; nacre dead white, inclined to be iridescent posteriorly.

Length, two to two and one-half inches; height, two inches; width, exclusive of the tubercles, one and one-half inch.

This is one of the commonest Unios in Indiana and in all the western streams; in the Ohio it is very abundant, as it is also in the Wabash and the White. It can not be confused with any other Indiana shell. The large tubercles alone will separate it. They are arranged in alternation from the beaks down, and commonly number about four on each valve. Its nearest congener is *Unio metanevrus.* The original description of Mr. Barnes is given below:

"Shell thick, rounded behind, subbiangulate before. Beaks somewhat elevated and nearly central, with the ligament passing between them; anterior lunule long-heart-shaped, compressed, distinct by a roundish elevated ridge which ends in a projection on the anterior margin, and marked by small transverse, subnodulous wrinkles, and obsolete longitudinal furrows; surface waved and on the fore part compressed; a regular row of large, distant, elevated and transversely compressed tubercles, extends from the beaks to the basal edge, dividing the shell into two nearly equal parts. Cardinal teeth sulcated. Nacre pearly white, and iridescent." (American Journal of Science, Vol. VI, page 123, Plate IV, Fig. 5, 1823.)

The habits of this shell are peculiar in that it is to be found in almost all stations where *Unio* occurs at all, on bars, gravel beds, mud banks, deep and shallow water, in short, it is almost ubiquitous. On shallow bars it is, like *Unio cylindricus,* very active, and is commonly found crawling about. It is a common form in swiftly flowing waters, its very thick shell adapting it to such stations.

Unio metanevrus Rafinesque. Plate 28.

Shell rather large, very thick, heavy, especially thick anteriorly and in the region of the beaks, trapezoidal in outline, roughly tuberculate, with large tuberosities on the posterior slope, somewhat inflated; epidermis striate, thick, dark horn-color, in many specimens with numerous arrow-shaped spots of green over the disk, between the tubercles, in some specimens the epidermis is light yellow in color; lines

of growth coarse, very numerous, imbricated posteriorly where the striations of the epidermis are most marked, very crowded anteriorly, which renders the shell very rough; dorsal margin curved, anterior margin roundly curved, long; ventral margin long, emarginate; posterior margin oblique, emarginate; anterior umbonal slope rounded, full; lateral umbonal slope inflated, tuberculate; posterior umbonal slope much raised into an increasingly wide ridge, which is nodulous, with from five to six large tubercles, that portion of the slope which is near the dorsal margin imbricated, with a number of rounded nodules arranged more or less regularly in rows; umbones large, inflated, thick, triangular, tuberculate, plicate, generally eroded, placed well forward; ligament thick, short, black, wide; cardinal teeth very large, thick, heavy, not elevated, striate, double in the left and disposed to be trifid in the right valve; lateral teeth very short, thick, curved, striate, separated from the cardinals by a rather broad plate; anterior adductors distinct, deeply and roughly impressed; posterior cicatrices distinct, deeply impressed, concentrically striate; dorsal cicatrices on the cardinal plate; pallial line deeply and crenately impressed anteriorly; cavity of the shell not large, of the beaks very deep and triangular, being excavated very deeply into the beaks; nacre white, with occasional patches of brownish or copper-colored matter.

Specimens have been taken in the Wabash, White, Eel, Kankakee, Ohio, Blue and Whitewater rivers. The shell is very common in almost all stations in the streams where it occurs at all. The figure is made from a specimen taken in the Wabash, by Professor Evermann, at Terre Haute, and is one of the most beautiful and perfect I have ever seen. It is impossible to mistake this shell; no other Indiana form compares with it. The shells that are taken on gravel bars in waters that flow rapidly are always much eroded; shells from deep water and muddy stations are usually perfect. At the Falls of the Ohio this shell is found in some numbers, its great thickness protecting it from injury. It is capable of withstanding very severe blows, but is one of the quickest to die when exposed to the air and sun when removed from the water. It is not at all tenacious of life.

UNIO CYLINDRICUS Say Plate 29.

Shell somewhat rectangular, elongate, laterally compressed, thick, especially so before, nodulous, smooth anterior to nodules, large; epidermis light yellowish, thin, with many small, triangular arrow-shaped spots of green, with apex pointing ventrad; lines of growth narrow, impressed, line-like; dorsal margin straight; anterior margin abruptly rounded; ventral margin long, slightly emarginate; poste-

rior margin emarginate, slightly oblique; anterior umbonal slope angular, full; lateral umbonal slope straight, flattened; posterior umbonal slope forming about one-half the disk, with five or six large nodules on the angle which extends from the umbones to the margin, the dorsal portion of this slope is greatly compressed laterally and viewed from the dorsal line is sinuous, made so by the position of the several large folds on this portion of the shell, which alternate and give to the valve margins a wavy character; these folds are of the same number as the large nodules, formed at the same time, and are highly characteristic; umbones prominent, angular, with numerous coarse folds or wrinkles and with numerous small tubercles which give to the shell a very rough appearance, decurved, approximate; ligament thin, long, light-colored, wavy; lunule ovate; cardinal teeth very oblique, trifid in both valves, striate, not very large, the several divisions rather thin; lateral teeth very long, slightly curved, rather thick, striate, especially at the extremity; anterior cicatrices small, deep, distinct; posterior cicatrices confluent, slightly impressed, very iridescent; pallial line well impressed, especially so anteriorly; dorsal cicatrices small, on the margin of the plate which extends from the cardinal to the lateral teeth; cavity of the shell shallow, of the beaks very deep, long, triangular; nacre white, with brownish patches in the region of the beaks.

Large specimens of this species sometimes reach a length of five inches; the characters of the color patches are like those of *Unio metanevrus*, with which this form groups. The shell is common in the Ohio, Wabash, White and Blue rivers. The specimen illustrated was collected by Professor Evermann in the Wabash at Terre Haute and is perfect in every detail.

Unio lineolatus Rafinesque. **Plate 30.**

Shell triangular in outline, transversely very much compressed, thick, heavy, very thick anteriorly and in the region of the dorsal margin, securiform, smooth; epidermis light straw-colored, smooth, polished, beautifully rayed with interrupted brownish lines, extending in a wide curve anteriorly from beaks to the ventral margin, some broad, others hair-like, the broader lines sometimes formed of a number of spots, close together, which are V-shaped; lines of growth distinct, somewhat raised, crowded anteriorly; dorsal margin very much curved, anterior margin rounded, projecting, excavated somewhat at the beaks; ventral margin rounded; posterior margin acutely angular, regularly curved on its dorsal part to the ligament; anterior umbonal slope rounded, lateral umbonal slope flat; posterior umbonal slope

sharply angulate, flattened or somewhat excavated on its dorsal aspect; umbones triangular, acute, sharp, decurved, separated, sometimes decorticated; ligament short, thick, black; lunule rather large, roundish, black, membranaceous; cardinal teeth short, heavy, very striate, double in the left and single in the right valve; lateral teeth double in both valves, or disposed to be so, short, slightly curved downwards, thick, heavy, striate; anterior cicatrices distinct, irregular, rough; posterior cicatrices distinct, that of the retractor pedis on the tip of the lateral teeth; anterior portion of pallial line well impressed and crenulate; dorsal cicatrices in the center of the cavity of the beaks; cavity of the shell small, of the beaks rather deep and triangular; nacre pearly white, iridescent posteriorly.

Length, two and one-half to three inches; height, two to two and one-fourth inches; width, one inch. The females are a little more swollen than the males and are less acute posteriorly.

This shell has long been known under the name of *Unio securis* Lea, who described it from the Ohio River, in which it is abundant. But Rafinesque had anticipated him in the description of this form, which he also had from the Ohio, on the Falls at Louisville, where it is a most abundant shell. There can be no doubt of the identity of Rafinesque's species with the later described one of Lea, and I do not hesitate to use Rafinesque's name. Not only did Rafinesque place a specimen in the cabinet of Poulson, of Philadelphia, with his name of *lineolatus,* but his original description must convince any fair-minded student that this and no other shell could have been before him when he drew up his account. I quote it in full below, as reprinted by Chenu in the "Coquilles bivalves fluviatiles de la Riviere Ohio," page 17. Rafinesque did not figure this species.

"23. Espèce, Obliquaria lineolata (U. lineolata). Obliquaire linéolée.

"Test presque arrondi, épais, peu bombé, un peu tronqué postérieurement; épiderme roussâtre, peu ridé, à quelques lignes brunes; nacre blanche. Longueur quatre cinquiemes, diamétre un moitie, axe un tiers de la largeur. Sommets un peu saillants.

"Aux chutes de l'Ohio; largeur environ deux pouces; portion tronquée postérieure, plane, étroite; impressions profondes, rugueuses, lamellaires, courtes, épaisses, carénées, presque droites."

This shell occurs in great numbers at the Falls of the Ohio, being the most abundant *Unio* there; its flat shape allows it to anchor itself in the cracks between the large rocks of the Falls, and it is not swept

therefrom by the floods. It is common throughout the Ohio, and also is found abundantly in the Wabash. It does not appear in the waters of the northern portion of the State, and is not found in small streams. Its station is on sand, gravel and mud bars, but it best loves mud bottoms; here it buries itself deeply, and may be taken in some places, as near Lawrenceburg, by hundreds. The female is more inflated than the male. It can not be mistaken for any other species.

UNIO ELEGANS Lea. Plate 31.

Shell triangular in outline, rather thick, inflated, smooth, carinated, quite thick anteriorly; epidermis olive or brownish, smooth, polished, beautifully radiated, the color lines being either capillary or broad ones made of capillary lines, placed close together, in many specimens arranged in a kind of zigzag manner, thin; lines of growth numerous, raised, often lighter in color than balance of disk, but sometimes darker; dorsal margin very much curved; anterior margin well rounded; ventral margin at first rounded, then emarginate towards the posterior; the posterior margin pointed, acutely biangular, the dorsal portion straight and placed obliquely; anterior umbonal slope very full and much rounded, angular towards the tips; lateral umbonal slope full, slightly sulcate; posterior umbonal slope angular, inflated, on the dorsal aspect nearly flat and but slightly raised near the margin; umbones greatly elevated, triangular, pointed, decurved, approximated, smooth; ligament short, thick, black; lunule short, broad, black, cordate; cardinal teeth double in the left and single in the right valve, short, thick, heavy, striate, erect; lateral teeth rather short, curved, thick, striate near the ends; anterior cicatrices distinct, deep, roughened, placed near the anterior margin; posterior cicatrices well impressed, distinct, that of the retractor pedis at extreme end of lateral teeth; dorsal cicatrices in a row rather more on the cardinal plate than in the cavity of the beaks; pallial cicatrix well impressed anteriorly, and slightly crenulated; cavity of the shell small, wide, triangular; of the beaks rather large, full, rounded; nacre white, iridescent posteriorly.

Length, two to three inches; height, from one and three-fourths to two inches; width, about one and one-half inches. The females are a little more inflated than the males; they are also more produced posteriorly.

This shell is one of the most beautiful of fresh-water forms, and is usually brilliantly colored. It is abundant in the Ohio, Wabash and White rivers; it also occurs in the Kankakee and other streams in the northwestern parts of the State, but not in the perfection that is seen

in the other streams named. The largest and most beautiful examples which I have ever seen are from the Wabash, where the shell is rarely ever eroded. The zigzag character of the color rays and their capillary nature add to the beauty of the shell.

UNIO DONACIFORMIS Lea. Plate 23, figs. 5–7.

Shell small, thick, very thick anteriorly and in the region of the beaks, ovately triangular in outline, smooth, subinflated laterally, pointed posteriorly; epidermis light straw-yellow to greenish, thin, polished, smooth, beautifully rayed with dark green, the rays departing from the umbones and covering the entire disk, often zigzag, the coloring being disposed as W's or as M's, but commonly in broad bands; lines of growth inconspicuous, darker, raised anteriorly and crowded; dorsal margin curved; anterior margin rounded, making a marked angle with the dorsal margin, posterior margin pointed, biangulate occasionally; ventral margin very much rounded, long; anterior umbonal slope rounded, full; lateral umbonal slope full, subinflated, especially in the female; posterior umbonal slope compressed, angular, flattened near the dorsal margin, sometimes faintly carinate, and with very minute folds; umbones elevated, angular, pointed, decurved, touching, the posterior portion developed into a carina; ligament short, thick, dark or light brown; lunule variable, large in some and small in other specimens; cardinal teeth small, erect, flattened or plate-like, double in the left and single in the right valve, crenate; lateral teeth rather long, thin, plate-like, generally quite straight; anterior cicatrices distinct, well impressed, small; posterior cicatrices distinct, well impressed, the retractor pedis on the tip of the lateral teeth; dorsal cicatrices small, pit-like, in the center of the cavity of the beaks; pallial line faint throughout; cavity of shell wide, small, of the beaks shallow, rounded; nacre white, iridescent posteriorly.

Length, one and one-half inches to two inches; height, one and one-fourth inches; width, three-fourths of an inch, in the female, somewhat less in large males.

Mr. Lea, who described this shell, gave it another name two years after, when, in describing some supposed new forms, he found this shell in the lot. To it he then gave the name of *Unio zigzag,* in allusion to the peculiar markings of the rays. Their identity is now regarded as perfect. This little shell is found in the Ohio, the Wabash and the White rivers, on the gravel bars, crawling actively about. It is very common in all three streams. The larger specimens come from muddy stations and are scarcely eroded when taken from such situations. The shell belongs to the same group as *Unio elegans,* and has

many features in common with that form. The Wabash furnishes the most beautiful examples known. The specific name was bestowed in allusion to its remarkable resemblance to the marine genus *Donax*.

UNIO TRIANGULARIS Barnes. Plate 32.

Shell of medium size, thick, thicker before, smooth, inflated, somewhat triangular in outline, truncated posteriorly; epidermis light yellowish or straw-colored, thin, striate at the ventral and anterior margins, the disk with numerous triangular or arrow-shaped greenish spots, with apex downwards, passing into either broad color lines or into capillary lines towards the ventral margin; lines of growth very distinct, posteriorly impressed, anteriorly raised; dorsal margin curved, anterior margin well rounded, and somewhat produced, ventral margin well rounded, posterior margin oblique and straight in the female, slightly rounded in the male; umbonal slope anteriorly rounded; lateral umbonal slope inflated; posterior umbonal slope inflated very greatly, especially in the female, truncate, flattened from above, with the lines of growth forming imbrications, these imbrications, especially in the female, being dentate, these dentations visible as small and wavy grooves over the entire surface of the upper portion of the posterior slope; the slope is also lighter colored than the balance of the shell and scarcely rayed; umbones very large, prominent, smooth, rounded or faintly angular, very light in color, almost white, decurved, tips not touching; ligament very short, thick, light brown; lunule large, rather long; cardinal teeth double in both valves, erect, thin and plate-like, somewhat curved, serrated; lateral teeth very short, rather thick, striate, the lower one seeming to start well in towards the cavity of the beaks; anterior cicatrices distinct, deeply impressed; posterior cicatrices distinct, slightly impressed, that of the retractor pedis on the tip of the lateral plate; dorsal cicatrices numerous, small, on the plate of the cardinal tooth; pallial line deeply impressed anteriorly; cavity of the shell large, wide, of the beaks wide and subtriangular; nacre white, iridescent on the posterior border.

Length, two and one-fourth to two and three-fourths of an inch; height, one and three-eighths inches; width of female across the posterior slope, nearly one and three-fourths inches; the male is less.

This most beautiful shell is abundant in the White and Wabash rivers; it is also found in the Ohio, but rather rarely.

Dr. Lea described it under the name of *Unio formosus*, from the Ohio River at Cincinnati, in 1831, but his name long since passed into synonymy. The finest specimens which have passed through my

hand in the past twenty-five years came from the White River, near Indianapolis. They are brilliantly colored and absolutely perfect on the apex, showing all the characters of that important region. The shell belongs to a large and well-defined group, of which Lea's *Unio arcæformis* has been regarded the leading form.

The only Indiana shell with which this form can be confounded is the *Margaritana marginata* Barnes, but that shell lacks the lateral teeth, and has, besides, rough folds on the beaks; these characters will alone distinguish them.

Mr. Barnes originally described this species from the Detroit River, Michigan. His description was as follows:

"Shell moderately thick, acutely angulated before, obtuse and somewhat angulated behind; disks inflated; anterior slope flattened and forming a right angle with the disk, ribbed longitudinally and wrinkled transversely; beaks one-third from the posterior extremity, decorticated, approximate and somewhat elevated; anterior lunule oval heart-shaped; posterior lunule not distinct; basal margin a little depressed near the anterior extremity; anterior margin straight, and its edge not entire; epidermis yellowish green, rayed with dark green, finely striated transversely, and with from three to six more conspicuous transverse wrinkles. Anterior slope marked with longitudinal ribs which are beautifully cancellated by the striæ and wrinkles passing over them, ribs projecting and forming a dentated edge; shell slightly gaping at both extremities; cardinal teeth two in each valve, compressed and crenulate, lamellar teeth short, projecting, finely crenulate, and terminating abruptly; nacre bluish white iridescent." (American Journal of Science, Vol. VI, page 273, Plate XV, Fig. 17, 1823.) I think that this well-known shell, described in 1823, should form the type member of the large group to which it belongs, and not *Unio arcæformis* Lea, as above suggested.

UNIO PERSONATUS Say. Plate 33.

Shell circular in outline, inflated, rather thick, thicker before, smooth, small; epidermis dark horn-color, thin, the entire posterior half covered with fine capillary lines which pass from the beaks to the ventro-posterior margin, polished, decorticated on the beaks; lines of growth well marked, numerous, darker, crowded anteriorly, with a tendency to become imbricated on the posterior portion; dorsal margin curved, anterior rounded or obtusely angular; ventral margin round, with slight sinus near the posterior end; posterior margin truncated, emarginate, thin, sometimes dentate, gaping; anterior umbonal slope rounded; lateral umbonal slope subinflated; posterior

umbonal slope swollen in the female, very closely rayed with capillary lines, the lines of growth denticulate, giving a cancellated appearance to a considerable portion; umbones full, rounded, smooth, much elevated above the dorsal margin, decorticated; ligament short, thick, light brown in color; lunule small, wide; cardinal teeth short, thick, solid, double in the left and disposed to be trifid in the right valve, striated; lateral teeth short, thick, curved upwards, striate; anterior cicatrices distinct, small, deeply impressed; posterior cicatrices confluent, large, not deeply impressed; dorsal cicatrices not well marked; pallial line very faintly impressed; cavity of the shell wide, rather large, of the beaks full, round, fairly deep; nacre pure white, iridescent posteriorly.

Length, one and one-half inches to two inches; height, one and five-eighths inches; width, one and one-eighth inches.

This description is based upon a specimen now in the State collection at Indianapolis, which came from the Wabash River, but was received by the State from the Museum of Comparative Zoology, at Cambridge. It is now a very rare shell; indeed, in all the collecting which I have done in Indiana I never found a specimen. It also occurs in the Ohio, but I can give no facts in the matter of its habits.

Mr. Lea described this same species, having the male before him, after Say described it, giving it the name of *Unio capillaris,* in allusion to the fine capillary rays which cover the posterior portions His specimens came from the Ohio. There are larger specimens in the Call Collection, at Harvard, which were labelled by Say, and still have, or had when the collection was transmitted, his original label. They were secured from Dr. J. Berrien Lindsley, of Nashville, Tennessee, who had them from Dr. Troost, one-time a resident of New Harmony, afterwards State Geologist of Tennessee. It is to be hoped that the species will be rediscovered in the State. It is a member of the *sulcatus* group.

UNIO PERPLEXUS Lea. Plate 34.

Shell rather large, lenticular, thick, thicker anteriorly, usually smooth, occasionally with two or three low and depressed bosses on the posterior slope, sometimes with hints of very low tubercles on the lateral slope, striate near the margins, sulcate on both posterior slopes; epidermis very light yellow or straw-color, with numerous capillary rays over the whole disk, but especially numerous near the posterior end, wavy, sometimes joined together to form a broad green line from the beaks to the margin; lines of growth not close, darker, raised, giving the shell a slightly roughened appearance, very light-colored

on the umbones, thin; dorsal margin slightly curved; anterior margin well rounded; ventral margin rounded anteriorly, emarginate posteriorly where the sulcus of the disk reaches it; biangular posteriorly, and curved; anterior umbonal slope rounded, lateral umbonal slope with distant low swellings or low bosses, indicative of tubercles; posterior slope flattened, subangulate, lighter colored; umbones small, rather full, somewhat raised above the dorsal margin, decurved, approximate, smooth, light-colored; ligament short, thick, light brown; lunule small, black; cardinal teeth small, short, thick, erect, double in the left and disposed to be double in the right valve; if double in the right valve then the anterior portion is much the smaller, roughened; lateral teeth rather long, slightly curved, thick, strong, striate; anterior cicatrices distinct, deeply impressed; posterior cicatrices well impressed, confluent, that of the retractor pedis muscle on the tip of the lateral tooth; pallial line faintly impressed; dorsal cicatrices small, in the center of the cavity of the beaks; cavity of shell rather small, of the beaks wide and shallow; nacre pure white, scarcely iridescent.

Length, two to two and one-half inches; height, one and one-fourth to one and one-half inches; width, three-fourths of an inch. The female is quite different in outline, the ventral margin being decurved and not emarginate, while the whole posterior slope is wider and far more inflated. That portion of the disk is often rough and lumpy in the female form.

This species is abundant in the White, Ohio, Wabash and Eel rivers, in all of which it has been personally collected. The shell is very variable; but all the main specific characters seem quite constant. Mr. Lea described this same shell from two Indiana localities, giving it other names, as follows: *Unio sampsonii*, with the bosses of our description much more developed, and *Unio rangianus*, which is a very sulcate male form. The species described first must, of course, have priority; from it the whole group, which is very extensive, takes its name. Members of this group occur as far south as Alabama and have a variety of names which have elsewhere been indicated.*

Unio sulcatus Lea. Plate 35.

Shell small, subquadrate, inflated, smooth, rather thick, a little longer than high in the female; epidermis thin, usually light yellowish in color, sometimes olive-green polished, striate at margins, with numerous dark-green capillary rays over the whole disk, light-colored on the umbones; lines of growth distinctly impressed, imbricated

*See A Geographic Catalogue of the Unionidæ of the Mississippi Valley, Bulletin Des Moines Academy of Science, Vol. I, No. 1, pp. 41, 42, 1885.

posteriorly and denticulate in the female; dorsal margin somewhat curved, oblique anteriorly; anterior margin rounded; posterior margin emarginate denticulate, the teeth fitting into interspaces on opposite valve, but only so in the female, the male being without denticulations; anterior umbonal slope full and round, lateral umbonal slope subinflated, posterior umbonal slope sulcate, inflated and especially so towards the ventral margins, the lower division usually projecting farthest, denticulate, with numerous imbricated older denticulations over the marginal third left from former margins, which give a cancellated appearance to some specimens, a narrow groove or sulcus extending from two-thirds of the disk to the margin, the groove dividing the posterior inflation so that the lower division is the more swollen; the posterior dorsal margin is depressed; umbones small, full, rounded, decurved, not touching, lighter colored; ligament short, narrow, thick, light brown; lunule short, wide, membranaceous, oval; cardinal teeth short, thick, erect, slightly curved anteriorly, double in the left valve and disposed to be trifid in the right valve, irregular, triangular; lateral teeth short, thick, straight, crenately striate; anterior cicatrices small, very deeply impressed, distinct; posterior cicatrices distinct, large, very deeply impressed, the small retractor pedis at tip of the laterals and pit-like; dorsal cicatrices very small, in the center of the cavity of the beaks; pallial cicatrix faintly impressed; cavity of the shell small, rather wide; of the beaks shallow; nacre pearly white, iridescent posteriorly.

Length, one and one-fourth inches; height, one inch; width, three-fourths of an inch.

This description is based solely on two females, the male not being at hand when it was made, though it was afterwards received for figuring. In the male the shell is less rotund, and the emargination is wanting, as well as the posterior denticulations. The male is much longer and much flatter. Accompanying the two that are described was a male specimen of *Unio rangianus* (=*Unio perplexus* Lea), and my experience has been that these are often confused.

This beautiful little shell is found in the Wabash and the Ohio, and less commonly in the White River; the specimens described came from the last named. The very large circular shape of the posterior adductor impression is unlike anything presented by another Indiana shell, and will help to separate it. The species is usually regarded as being rare.

UNIO LUTEOLUS Lamarck. Plate 36.

Shell large, elongate, somewhat inflated, rather thin, circularly rounded before, elliptically rounded behind, the male often somewhat pointed posteriorly, female more tumid posteriorly, emarginate ventrally; epidermis light horn-color, polished and shining, usually abundantly rayed with narrow, bright, green, crenulate, somewhat curved rays, which depart from the beaks and cover more or less closely the posterior three-fourths of the disk; these are often wanting, especially in old specimens; lunule long, narrow; ligament long, thin, light horn-color; hinge margin nearly straight or very slightly arcuate; umbones prominent, approximate, concentrically wrinkled, the wrinkles being angulate and the apices of each pointing toward apex of the umbone, light, nearly white, in color, when the epidermis is perfect; cardinal teeth double in both valves, equal only in the left valve, rather small, thin, acutely serrate, all directed anteriorly; lateral teeth long, thin, lamellar, striate, nearly or quite straight; dorsal plate smooth, short, rounded, thin; anterior cicatrices distinct, that of the adductor rather deep, large, striate, irregularly impressed, that of the protractor pedis well impressed but not deep; posterior cicatrices confluent, very slightly impressed, smooth, iridescent; pallial cicatrix well impressed before, broad and shallow, or scarcely impressed, behind; dorsal cicatrices numerous, impressed as deep pits in an irregular row in the center of the cavity of the beaks; cavity of the beaks rather shallow; nacre pure white, sometimes somewhat iridescent posteriorly.

This form is widely distributed throughout the central west, and is not only abundant but is frequently the only form found. It is usually of a darker color when it inhabits muddy river beds. The females are the most numerous and the most variable in outline, which fact accounts for their use in the several descriptions of shells that now form synonyms of this species. Mr. Barnes has described the large and swollen female, such as is often found in the Wabash and the Ohio, under the name of *Unio siliquoideus.*

The original description of Lamarck was as follows:

"*U. testa oblongo-ovata, tenui subpellucida, luteo-virente, radiata; latere antico majore, latiore, rotundato.*

"*Habite la riviere Susquehana et celle Mohancks, dans les Etats Unis.* * * * *La ligament passe entre le crochet et la charniere. Largeur, 69 millimetres.*"

This short and imperfect description was not known to the earlier students of American mollusca, and there is little wonder that considerable synonymy has been established on this shell. It has a very wide range, extending from Winnipeg and Slave lakes and the Sas-

katchewan River, British America, to central New York, south to Georgia, Alabama, Texas; west to Kansas, Montana and Dakota. In all this range it is abundant in favorable localities and often attains a great size. Lamarck's original specimens did not approach the maximum dimensions which this shell sometimes reaches.

A very beautiful and somewhat depauperate form occurs in the lakes of northern Indiana. It was a specimen of this sort that constituted the basis of Anthony's description of *Unio distans*. Though sometimes confounded with *Unio ligamentinus* Lamarck, there is really no excuse for the confusion of the two forms, since they are more dissimilar than alike.

The character of the undulations on the beaks of this form will serve to separate it from all others. It is often confused with *Unio ligamentinus*, as suggested above, but the beaks alone will serve to distinguish them.

UNIO MULTIRADIATUS Lea. Plate 37.

Shell subrotundate, rather thick, slightly thicker anteriorly, smooth, compressed laterally, medium in size; epidermis thin, light straw-color, lighter on the umbones, brilliantly rayed with green rays, many of which are capillary, extending from the middle of the first-formed shell to the ventral margin, the lines wavy, interrupted at the lines of growth, sometimes broader by the union of several capillary rays; lines of growth numerous, raised; dorsal margin curved, anterior margin produced, rounded; ventral margin well rounded, posterior margin subbiangulate, in females emarginate, pointed somewhat in the male; anterior umbonal slope flattened, lateral umbonal slope rounded, posterior umbonal slope inflated, somewhat angulated near the beaks, especially in the male; covered with minute capillary rays; umbones depressed, full, rounded, decurved, approximate, light-colored, with several fine undulations which are indistinct; ligament large, short, high, thick, dark reddish horn-color; lunule long, linear, membranaceous; cardinal teeth double in the left valve and disposed to be double in the right, specimens varying in this particular, short, thick, erect, the posterior division being the larger, triangular; lateral teeth short, rather thick, striate, curved; anterior cicatrices large, well impressed, distinct; posterior cicatrices confluent, large, slightly impressed; dorsal cicatrices in the center of the cavity of the beaks; cavity of the shell large, inflated, of the beaks rounded, excavated, subtriangular; nacre white and beautifully iridescent posteriorly, so thin near the posterior margins that the color lines or rays show through without transmitted light.

Length, two and one-half to three inches; height, one and one-half to two inches; width, one inch, the female sometimes larger.

The specimens described came from the Wabash River, in which stream it is an abundant species. It is also found in some of the small lakes in northern Indiana, in the Ohio, and in the White rivers. Fine, but rare, examples were obtained in 1896 in the Eel River, near North Manchester. It has been received from various people under the names of *Unio ligamentinus* Lamarck and *Unio ventricosus* Barnes, but is easily distinguished by the characters of the rays alone. It is usually an abundant shell.

Unio ventricosus Barnes. Plate 38.

Shell large, rather thin, ventricose, smooth, subelliptical in outline; epidermis thin, polished, smooth, striate near the margins occasionally but rarely, with numerous broad and green rays extending to the ventral margin from the middle of the umbonal slope, light straw-colored, lighter on the beaks; lines of growth widely separated, well impressed, darker, interrupting the rays; dorsal margin well curved; anterior margin well rounded, projecting; ventral margin slightly curved; posterior margin inclined to be emarginate in the female, pointed in the male, subangular; anterior umbonal slope well rounded, full, swollen; posterior umbonal slope full, subangular, with many green rays which makes this slope the darkest portion of the shell; lateral slope rounded; umbones large, full, decurved, triangular, with three or four coarse undulations near the apex, lighter colored than balance of the shell, approximating; ligament large, short, thick, powerful, dark reddish or horn-color, much raised above the dorsal margin; lunule small, dark; cardinal teeth short, erect, thin and plate-like, sometimes more thickened, double in the left and single in the right valve, serrate; lateral teeth fairly long, curved, plate-like, striate; anterior cicatrices large, distinct, deeply impressed, concentrically striate; posterior cicatrices not at all impressed, confluent; dorsal cicatrices on the cardinal plate small; pallial line hardly impressed; cavity of the shell very large, of the beaks large, rounded, deeply excavated into the umbones; nacre pure white, iridescent posteriorly.

Length, three to four or five inches; height, three inches; width, one and one-half to two inches, varying with the sex.

Unio ventricosus is one of the most common shells in Indiana, and has been found in nearly every part of the State. Large and fine examples have come from the Ohio, the Wabash, the Eel and the Kankakee. It is a variable shell, and this may be the reason why it has had so many names given it by descriptive naturalists. Mr. Lea de-

scribed a beautifully rayed and polished form from the Ohio under the name of *Unio occidens;* from Canada he described a similar shell under the name of *Unio canadensis,* and from other localities still other forms came in for names. But Mr. Barnes first described the shell, and his name must stand for it. It can not be well confounded with any other species; its beaks alone will serve to separate it from all other Indiana shells; its nearest congener is the following, but the umbones of *ventricosus* are rounded, of *subovatus* quite angular. The specimen described and figured herein is from the Mankato River.

UNIO SUBOVATUS Say. Plate 39.

Shell very large, rather thick, thicker anteriorly, ovate in outline, smooth, ventricose, greatly compressed on the posterior dorsal margin, gaping; epidermis yellowish straw-color, thin, smooth, polished, radiate, darker on the posterior umbonal slope, where it is not only striate but the epidermis is often modified into a kind of short, brown wool which is especially marked near the margin; lines of growth distant, coarse, crowded anteriorly, more or less irregular; dorsal margin greatly curved, thickened, anterior margin full and round; posterior margin widely rounded, somewhat emarginate in the female, but inclined to be pointed in the male; ventral margin long, slightly curved; anterior umbonal slope full, large, round, somewhat excavated in the region of the beaks; posterior umbonal slope very much inflated, angular, very flat near the beaks, darker, much roughened; lateral umbonal slope full, polished; umbones very much raised, triangular, full, angulate, usually decorticated, separated, decurved, lighter colored; ligament short, wide, very thick and powerful, dark horn-color or brown, much raised above the dorsal margin and sometimes higher than the beaks; lunule none; cardinals short, thick, but not remarkably so, double in both valves, serrate, crenate; laterals short, thick, not much elevated, striate, slightly curved; anterior cicatrices very large, deeply impressed, irregular in outline; posterior cicatrices not at all impressed, confluent, concentrically striate, iridescent; anterior portion of the pallial line crenately impressed; dorsal cicatrices numerous, large, in a row on the plate of the cardinal tooth; cavity of the shell very large, wide, deep; of the beaks very deeply excavated, full, triangularly rounded; nacre pearly white, iridescent posteriorly.

Length, four and one-half to six inches, the last being that of the more pointed males; height, three and one-half to four inches; width of females, from two and one-fourth to two and one-half inches. Larger specimens sometimes occur.

This species is one of the largest that are found in American waters. It is often confused with *Unio ventricosus* Barnes, but may easily be distinguished by the characters of the posterior slope and of the beaks; it also attains a much greater size than Barnes's form. The specimen figured and described herein is a female, from the Wabash, and belongs to the State collection. The species occurs also in the White and Ohio rivers, somewhat abundantly, and rarely in the Eel River, near North Manchester. No other large *Unio* in Indiana has so peculiarly angulated a posterior slope.

UNIO CAPAX Green. Plate 40.

Shell large, rather thick, very ventricose, higher and inflated posteriorly, circularly oval in outline, viewed posteriorly shaped like the marine *Cardium*; epidermis dark drab to brownish, lighter on the beaks, smooth, polished, eradiate, or faintly rayed with darker brown rays especially on the dorsal portion of the posterior umbonal slope, striate near the margins; lines of growth coarse, numerous, somewhat raised, lighter colored; dorsal margin very much curved, even sinuous; anterior margin somewhat angulated, produced, about one-half as long as the posterior margin; the posterior margin roundly augulated, very long, sometimes emarginate in the female, much elevated above the laterals, ventral margin straight; the umbonal slopes all very much inflated, very large, all rounded, that of the anterior portion excavated under the beaks, the female is especially inflated in this region; umbones very large, very much raised, rounded, curved, touching, as the shell gets old the beaks wear each other away, viewed from either the anterior or posterior the outline is very much like that of *Cardium*; ligament large, thick, coarse, dark brown, raised; lunule large, black, elliptical; cardinal teeth single in the left and double in the right valve, depressed, thick plate-like, very serrate; lateral teeth rather short, thin, striate, curved, double in the left and single in the right valve; anterior cicatrices very large, deep, that of the adductor deeply impressed quite near the margin; posterior cicatrices very large, slightly impressed, very iridescent; pallial line deeply impressed anteriorly, iridescent throughout; dorsal cicatrices numerous, large, in a row on the cardinal plate; cavity of the shell very large, deep, broad; of the beaks very wide, deep, round, excavated into the decurved portion; nacre pure white, somewhat iridescent posteriorly.

This description is based upon a single large female, which measures four and one-half inches in length; three and one-fourth inches in height; two and three-fourths inches in width. The specimen came from the Wabash.

This is by no means a common shell in Indiana, and is only known from the two large streams, the Ohio and the Wabash. Its greatly swollen character will enable it to be easily separated from all other shells.

UNIO LIGAMENTINUS Lamarck. Plate 41.

This, one of the oldest and best known Unios, was described from the Ohio River by Lamarck, Animaux sans Vertebres, edition of 1838, Vol. VI, page 533, as follows:

"*U. testa ovali tumida, sub epiderme candida; ligamento subduplici: unico externo detecto; allero intra natem et cardinem obtecto.*

"*Habite la riviére de l'Ohio. A. Michaud. La coquille a sur chaque valve un angle obtus au cote antérieur. Son test est tres blanc. Son corselet est un peu eleve en carène. Dent cardinale fort épaisse. Largeur, 77 millimetres.*"

It is quite possible that the very extensive synonymy that is exhibited by this species is due largely to the incomplete description which Lamarck gave to this form. It is widely distributed over the United States from western New York to Michigan, Minnesota, Dakota, and Kansas; south to Texas, Louisiana, Alabama, and Tennessee. In this vast range, throughout which it is common or abundant, it has a wonderfully diversified environment. Its home may be in sluggish and muddy bayous, where it delights to dwell in mud and sand; in rapidly flowing mountain streams, like the upper Cumberland and the Holston rivers, where it may be found on gravel bars or wedged in between the larger rocks in the middle of the channels; in the muddy or gravelly rivers of the western prairie States, as in Iowa and Illinois, where it dwells indifferently in mud or gravel. It follows, therefore, that these great differences in environment will be influential in determining its coloration and its form. So it is among the most variable, in minor details, of any of the common river-mussels of the western States, sharing in this regard the changes in form incident to *Unio luteolus* Lamarck and *Unio complanatus* Solander, the last named being a form which has never yet been found in any stream west of the Appalachians, outside the drainage of the Great Lakes. These very variable shells have been described many times by those who look for differences rather than resemblances, and so the great burden of synonymy has arisen.

Shell large, elliptical, compressed, rounded before, subbiangulate behind, smooth or striate, thickened anteriorly, thin and iridescent posteriorly; epidermis yellowish straw-color, rayed with numerous,

broad, green rays, extending from the umbones ventrad; the rays are indistinct or wanting anteriorly; lines of growth numerous and often, especially in old specimens, raised into ridges which are concentric with the ventral margin; ligament long, thick, black, nearly straight; umbones scarcely prominent approximating, with many very fine, concentric folds, apparent only in young specimens with perfect epidermis; from the posterior edge of the umbones an obtuse angle extends over the disk posteriorly to the margin where it is apparent at one of the angles which renders the outline biangulate; cardinal teeth double in the left, and disposed to be double in the right valve, triangular, crenulate, roughened; lateral teeth long, lamellar, slightly curved ventrad, crenulate; plate between cardinal and lateral teeth incrassate, arched, smooth; anterior cicatrices large, deeply impressed, distinct; posterior cicatrices large, slightly impressed, confluent, that of the retractor pedis muscle impressed at the extreme end of the lateral teeth; dorsal cicatrices in the cavity of the umbones as deep pits disposed in a straight line, which ends near the margin of the plate; pallial cicatrix crenulate, deeply impressed anteriorly; nacre pure white, iridescent, in many specimens with a blush of pink or with decided pink coloration.

Length, 125 mm.; height, 75 mm.; breadth, 52 mm.

The measurements given are those of a large specimen from the Des Moines River, at Des Moines, Iowa. The species often exceeds these dimensions, but is commonly found smaller. In the female the posterior margin is much more rounded than in the male, and the biangulate character quite disappears. The general outline is more flowingly rounded, and the transverse measurements somewhat greater, in the female than in the male shell.

Say's description of *Unio crassus*, which is a synonym, does not agree with his figure, as has already been pointed out by Dr. Lea. He says his species has waves, while the figure, which shows the interior of the shell only, does not give any hint of that character. It is doubtful that the description and figure were made from the same species. Moreover, it will be noticed, from the dates assigned to these several forms in their synonymy, that Say's species was described long before Lamarck framed his description. But there had already been described from Europe, by Retzius, 1788, a species with the name Say employed. Say's name, therefore, falls into synonymy. This shell is often received from correspondents under the name of *Unio luteolus* Lamarck, which form it very closely, in some respects, resembles.

This species is very abundant all over Indiana, and especially so in the Ohio, Wabash and Kankakee. It is a mud-loving species and

may commonly be found in association with *Unio luteolus, Unio multiplicatus* and *Unio undulatus.* It is easily identified; from related forms like *Unio ventricosus* the beaks will separate it.

UNIO COOPERIANUS Lea. Plate 42.

Shell circular in outline, large, very thick, nodulate, laterally compressed; epidermis dark brown, striate, somewhat polished on the umbones, radiate, lighter in color on the posterior slope, rather thick; lines of growth numerous, raised, darker, somewhat inclined to be imbricated on the posterior slope, dorsal margin curved, anterior margin somewhat angulate; ventral margin roundly curved; posterior margin rounded, with a tendency to be biangulate; anterior umbonal slope round and full, with a few very small folds just anterior to the beaks; lateral umbonal slope rounded, with a number of large nodules or pustules on its middle portion; posterior umbonal slope compressed, with scattered nodules which are not very large, near the dorsal margin the nodules are very small and arranged more or less definitely in rows which extend to the dorsal margin; umbones full, fairly prominent, eroded, dark colored when perfect; ligament short, thick, wide, very dark brown; lunule elliptical, almost black, membranaceous; cardinals double in the left and single in the right valve, short, erect, thick, very much striated, serrate; lateral teeth short, thick, straight, striate; anterior cicatrices large, deeply impressed, distinct; posterior cicatrices distinct, deeply impressed, concentrically striate; pallial cicatrix very crenate anteriorly, scarcely visible posteriorly; dorsal cicatrices on the cardinal plate; cavity of the shell narrow, of the beaks deep, triangular, narrow; nacre very white and iridescent.

This shell often attains a length of four inches, and is quite three inches in height. The females are sometimes inclined to be emarginate, and are more convex than the males. It is a common shell in the Ohio and the Wabash, but has been noticed by me in no other Indiana streams. It is commonly mistaken for *Unio pustulosus* Lea, from which it differs in the color and markings of the epidermis, the number, character and disposition of the nodules, the characters of the hinge teeth and in general outline; nevertheless it often is seen with specimens of that form under a common label.

UNIO IRRORATUS Lea. Plate 43.

Shell small, thick, convex, round or circular, very thick anteriorly and in the region of the beaks, nodulate; epidermis light yellow, thin, lighter on the beaks, beautifully and densely rayed with bright green capillary rays over the whole disk, the rays being sometimes made up

of a succession of linear green spots, sometimes the capillary lines are so crowded together that they form either a broad ray or cover a large portion of the disk with green, shining; lines of growth very much impressed, giving the shells a roughened appearance, interrupting the rays; dorsal margin greatly curved; anterior margin scarcely produced, nearly straight; ventral margin long, greatly rounded; posterior margin biangulately rounded, emarginate in female, produced in the male; umbonal slope convex, full rounded; the lateral slope either flattened or somewhat sulcate, with many large and small nodules arranged without definite order; posterior slope subangulate, sometimes markedly so, the angle extending from the umbones to the margin, the dorsal portion having numerous linear and curved lines of folds which extend to its margin; umbones very much raised, triangular, pointed, decurved, approximating, apiculate in the young, angulated; ligament short, thick, black; lunule heart-shaped, very well marked, black; cardinal teeth short, very thick, very rough, serrate; lateral teeth short, very wide and thick, coarsely striate, slightly curved; anterior cicatrices distinct, very deeply impressed, that of the anterior retractor pedis as a pit in the lower portion of the anterior division of the cardinal teeth; posterior cicatrices distinct, well impressed, that of the retractor pedis deep, as a pit at the end of the lateral; pallial cicatrix well impressed, especially anteriorly; dorsal cicatrices very small, on the cardinal plate; cavity of the shell small, narrow; of the beaks broadly triangular; nacre silvery white, occasional specimens being found with a tinge of salmon.

Specimens have been seen which were from two and one-half to three inches in both length and height, these two dimensions being nearly equal. Width, from one and one-fourth to one and one-half inches, depending on the sex. Shell common.

Numerous specimens may be taken in the White, the Wabash and the Ohio. The general green appearance of the shell and its circular outline, with its nodules, will enable any one to separate it from all others. The Wabash specimens are especially fine since the beaks are rarely ever eroded when taken from that stream.

UNIO PUSTULATUS Lea. Plate 44.

Shell subquadrate in outline, thick, thicker before, nearly as high as long, pustulate, inflated; epidermis thin, polished on the umbones, striate elsewhere, dark horn-color, sometimes greenish yellow, the pustules much lighter in color; lines of growth conspicuous, far apart, darker, cencentric; dorsal margin straight behind the umbones, rounded before; anterior margin well rounded; ventral margin

rounded, sometimes emarginate; posterior margin truncate, straight, forming a right angle with the dorsal margin; anterior umbonal slope rounded; lateral umbonal slope full, rounded, with three to five large pustules arranged in a row from the beaks to the margin, and another row of large pustules on the border line of the posterior slope which is flattened, raised to the margin on the dorsal aspect, and has a number of small pustules crowded together, without order, on the slope; umbones rather full, rounded, decurved, with a few coarse wrinkles or folds; ligament short, thick, narrow, dark-brown; lunule conspicuous, small, black; cardinals large, thick, heavy, double in the left and single in the right valve crenulate; lateral teeth short, straight, lamellar, forming a right angle with the plate of the cardinal tooth; anterior cicatrices distinct, deeply impressed; posterior cicatrices confluent, slightly impressed, concentrically striate and very iridescent; dorsal cicatrices in the center of the cavity of the beaks; pallial cicatrix very much crenulated anteriorly; cavity of the shell small, of the beaks triangularly-rounded; nacre dead white.

This shell is often mistaken for the following one, but is entirely different in the number, kind and arrangement of the pustules; the characters of the teeth differ also. In the present species the large tubercles are arranged in two rows from the beaks to the ventral margin; they often are partially formed, as in the specimen figured, on the ventral margin and are then seen to be produced by a fold of the mantle, the animal appearing to be too large for its shell and thus forming the pustules which are, at first, simply folds in the margin of the shell; afterwards the mantle completely fills the under side with nacre, thus lifting the fold into prominence as a pustule. The outline of the shell is different from that of *pustulosus* with which it is often confused. In both species, in the young, rather large, quadrate, green spots appear on the umbones and the upper portions of the lateral umbonal slope; these are highly characteristic.

Unio pustulatus occurs in the Ohio, Wabash, White, Blue, Eel and Kankakee rivers, and is a fairly common shell. It is to be found in muddy bottoms and in still waters; poor specimens may be taken, as at the Falls of the Ohio, on gravel beds.

UNIO PUSTULOSUS Lea. Plates 45, 46, 47.

Shell large, thick, heavy, pustulate, rounded in outline, ventricose; epidermis striate, especially so towards the margins, yellowish green in color, thin, with numerous fairly large green spots on the umbonal slope, especially above the region where the pustules begin; lines of growth numerous, impressed, imbricated posteriorly, darker in the

middle umbonal region; dorsal margin nearly straight, anterior margin forming an obtuse angle with it; anterior margin nearly straight, ventral margin rounded, posterior margin produced, slightly biangulate, sometimes emarginate; umbonal slopes all rounded and full, the superior portion of the posterior slope being covered with minute pustules, and being somewhat sulcate; umbones full, elevated, round, free from pustules, separated, greenish colored or with large spots of green; ligament long, thick, wide, dark brown color; lunule large, ovate, membranaceous; cardinal teeth large, heavy, short, striate, rough, double in the left valve and single in the right valve; lateral teeth thick, heavy, straight, crenately striate; anterior cicatrices deep, distinct, rough; posterior cicatrices distinct, deeply impressed; pallial line crenate, well impressed; dorsal cicatrices on the cardinal plate, small, numerous; cavity of shell shallow, of the beaks deep and triangular; nacre white, with occasional blotches of brownish color.

The shell which forms the basis of this description is a fair type of the form which Dr. Lea called *Unio dorfeuillianus,* from the Ohio River. It is a large example of typical *pustulosus,* which name will, properly, include many which Dr. Lea has given this shell from other localities. In Indiana the species occurs very abundantly in the Ohio and Wabash rivers, and in the White and Eel rivers, but in the two last named it is not as large a shell as in the Ohio River. It dwells in muddy bottoms, but is quite active, and may always be taken crawling around on sand and gravel bars, especially when the rivers are receding from floods. The species as seen in the Wabash and Ohio presents very constant features, but in the White and Eel rivers it is a flatter shell than is indicated in the above description.

UNIO GRANIFERUS Lea.

Shell circular in outline, inflated, thick, heavy, very thick anteriorly and in the region of the umbones, pustulate, the knobs being rather sharp and most numerous over the lateral umbonal slope; epidermis chocolate brown, shining on the umbonal slopes, striate, especially so near the margins, rather thin, eradiate; dorsal margin nearly straight, anterior and ventral margins well rounded, posterior margin rounded-emarginate, especially emarginate in the female; ligament large, thick, reddish brown, ovate, raised much above the dorsal margin; lunule large, black, membranaceous, oval; anterior umbonal slope abruptly rounded, lateral umbonal slope full, inflated, covered with many small tubercles which are often eroded at the tips; posterior umbonal slope subangulate near the beaks, compressed below, somewhat sulcate, with a number of small tubercles which are rather

pointed and two obtuse carinæ which extend to the siphonal openings; cardinal teeth heavy, thick, erect, much divided, double in the left and disposed to be trifid in the right valve, very striate and serrate on the margins, the cardinal plate massive; lateral teeth short, thin, striated near ends, plate-like, joined to cardinal by a broad plate; anterior cicatrices deep, rough, concentrically striate, distinct, that of the anterior retractor pedis placed well under the lobe of the cardinal tooth; posterior cicatrices deep, distinct, striate concentrically, that of the retractor pedis at tip of the laterals; anterior portion of the pallial line very deeply and crenately impressed; dorsal cicatrices numerous, pit-like, placed on the cardinal plate near its margin; cavity of shell large, of the beaks very deep and roundly triangular; nacre purple or bluish, margined sometimes with white.

This description is based upon Number H1672 of the collections of the American Museum of Natural History, and it is due to the courtesy of Professor Whitfield that the shell could be used for this purpose. The series came from the Mississippi River, at Davenport, and is a most beautiful one.

The close general appearance which this shell presents to *Unio pustulosus,* coupled with its beautiful purplish nacre, will separate it from all Indiana shells except *Unio verrucosus.* The last named shell is, however, much more flat, and the pustules are larger and far more numerous; the character of the beaks is entirely different, those of *verrucosus* being triangular and covered with fine wavy lines. The umbones of this shell are inflated, large, very prominent, apiculate, and directed anteriorly. The two shells need not be confused.

Unio graniferus occurs in the White, Wabash, Blue and Ohio rivers. It is abundant in the Ohio and Wabash where it attains a large size.

Unio lachrymosus Lea. Plate 48.

Shell large, thick, heavy, thicker anteriorly and very thick in the region of the beaks; flattened in the young but fairly well inflated in the old specimens, quadrate in outline, sulcate on the disks, tuberculate, especially so on the umbonal slope, the larger tubercles appearing to run down the side of the disk as a thick liquid would flow, a fact which suggests the specific name; epidermis smooth, striate near the margins, dark horn-color, eradiate; lines of growth numerous, crowded near the anterior and other margins, impressed; dorsal margin slightly curved, anterior margin well rounded; ventral margin emarginate towards the posterior end, rounded in front; posterior margin emarginate, somewhat produced; anterior umbonal slope well rounded, full, lateral umbonal slope rounded, or sometimes sulcate, in young speci-

mens much flatter; posterior umbonal slope angular, tuberculate, compressed towards the dorsal margin and with many small tubercles; umbones large, full, triangular, full of small tubercles which are rather sharp and pointed, decurved, not approximating; ligament large, thick, black or dark brown; lunule ovate, large membranaceous; cardinal teeth large, thick, heavy, erect, striate, disposed to be double in both valves; lateral teeth long, slightly curved, striate, thick; anterior cicatrices large, rough, distinct; posterior cicatrices large, confluent, not deep, striate; anterior portion of the pallial line very deeply impressed and crenulate; dorsal cicatrices placed on the plate of the cardinal teeth; cavity of the shell large, of the beaks large, triangular, excavated well up into the beaks; nacre pearly white, iridescent.

This species is very abundant in all the larger streams of southern and northwestern Indiana, and in the Ohio; it is one of the mud-inhabiting shells. The size it attains often reaches four and one-half inches in length, and as much in height. The arrangement of the tubercles is various, no two specimens showing the same order; in some forms the shells are nearly smooth or have only a few large pustules; in others they are very numerous and arranged all over the disk, with a more or less two-lined order for the larger ones. The sulcation of the lateral umbonal slope extends from the beaks quite to the margin, becoming wider as it lengthens. Dr. Lea described his *Unio asperrimus* from a form of this species which had sharper tubercles than usual, with fewer large ones. Closely allied to it, and often mistaken for it, is the next species, specimens of which I have seen from Indiana. Indeed, the State collection at Indianapolis contains *Unio lachrymosus* with the name of Conrad's form; such a specimen was sent to me for figuring as *Unio fragosus,* but is the one used herewith in making the smaller figure illustrating Lea's shell. It remains only to say that this is a most abundant shell in all places where it is found at all. It should be easily separated from all others.

UNIO FRAGOSUS Conrad.

"Shell suborbicular, ventricose, with an indistinct narrow furrow, and two approximate series of very prominent irregular tubercles, anterior ones largest; umbonal slope angular; posterior slope slightly concave, with a few narrow rib-like tubercles, more prominent near the margin; posterior margin direct, slightly emarginate; ligament slope straight, slightly oblique; umbo narrow, prominent, beaks much incurved, pointed, tuberculated; epidermis brown, with two or three broad widely interrupted rays.

"Observations.—This fine species approaches *quadrulus* Raf., but is

much more ventricose, has more prominent tubercles, and is very distinct. I am indebted to Dr. Blanding for the splendid specimen represented by the figure; it is from the Scioto River, Ohio." (Conrad, Monography of the Family Unionidæ, page 12, Plate VI, Fig. 2, 1836.)

I have been unable to secure a specimen of this very common shell for redescription, the shell sent for this species from the State collection being the preceding form. I have, therefore, been obliged to copy Conrad's original description. Many specimens have, however, passed through my hands, from time to time; from these it may be said that the species is a much more ventricose one than *Unio lachrymosus*, it is more quadrate in outline, the posterior slope is much rougher and is commonly imbricated by the growth lines, the color of the young specimen is more green than in the allied form of Lea, and the whole facies of the shell is very much rougher. It does not seem possible that they could be confused. Large and fine specimens are in the Call Collection, at the Museum of Comparative Zoology, at Cambridge, and represent a wide distribution, from Ohio to Kansas. In this State I have seen specimens which came from the Ohio, collected by myself at Charleston, and three fine ones from the Wabash, collected by Dr. Barton W. Evermann. It is to be regretted that one could not be secured for purposes of illustration.

UNIO VERRUCOSUS Barnes. Plate 49.

Shell subcircular, pustulate, large, thick, heavy, ventricose in the young, but far more flattened in the old specimen; epidermis dark horn-color to chocolate color, thick, reddish-brown on the beaks in some specimens, striate, polished on the lateral umbonal slope; lines of growth very numerous, crowded, slightly darker; dorsal margin straight, somewhat decurved anteriorly; anterior margin rounded; ventral margin well rounded; posterior margin rounded, emarginate, oblique; anterior umbonal slope full and round; lateral umbonal slope rounded, with more or less regularly arranged tubercles, some of which are rather sharp; posterior umbonal slope somewhat compressed, pustulate, deeply furrowed from near the umbones to the margin, the furrow causing the emargination, a few small, somewhat regularly arranged pustules on either the angle or near the dorsal margin; umbones full, small, pointed, decurved and directed anteriorly, very finely and crenately plicate, approximate; ligament thick, large, dark brown, very long; lunule large, cordate; cardinal teeth double in the left and disposed to be trifid in the right valve, rough, irregular, striate; lateral teeth short, thick, straight, striate, rough,

often diseased; anterior cicatrices distinct, deep, rough, excavated under the cardinals, which project over the adductor; posterior cicatrices distinct, deeply impressed, concentrically striate; dorsal cicatrices numerous, in a row on the outer side of the cardinal plate not far from its edge; pallial line deeply impressed and crenulated anteriorly; cavity of the shell large, of the beaks large, deep, triangular, extending well up into the beaks; nacre purple or chocolate color.

Specimens of this species sometimes attain a size of five inches in length, and almost an equal height. The specimens on which the foregoing description is based came from the Wabash River. The shell is common in the Ohio and of large size. One of the three specimens before me came from the State collection under the name of *Unio graniferus* Lea, but is not that species; both have purple nacre, but *graniferus* is of the shape of *irroratus*, the pustules are quite different, the shell is far more inflated, and its outline more round than *verrucosus*. This shell is found in the Kankakee, Wabash, White and Ohio rivers; probably will occur in other parts of the State. It is common and frequently contains pearls, loose, or pearly excrescences attached to the valves. It is found on gravel bars and in mud.

UNIO ORBICULATUS Hildreth. Plate 50.

Shell rather large, thick, heavy, orbicular in outline, slightly compressed laterally, smooth; epidermis indistinctly radiate, dark horn-color, rather thin, eroded on the umbones; lines of growth well impressed, numerous; dorsal margin curved; anterior margin well rounded; ventral margin slightly rounded; posterior margin rounded in the male, emarginate in the female; anterior umbonal slope full and rounded; lateral umbonal slope flattened; posterior umbonal slope subangular, very much compressed from above; umbones large, not high, long, depressed, eroded; ligament long, reddish brown, thick, much elevated above the dorsal margin; lunule large, ovate; cardinal teeth short, thick, erect, heavy, nearly smooth, double in the left and single in the right valve, occasional specimens show a tendency to divide the right cardinal into three portions, of which the middle one is the largest; lateral teeth short, thick, crenately striate; anterior cicatrices distinct, very deep, rough, deeply excavated under the anterior division of the cardinal teeth; posterior cicatrices deeply impressed, striate, confluent, the portion occupied by the retractor pedis impression being very deep and excavated at the tip of the laterals; pallial line well impressed; dorsal cicatrices in a row and pit-like on the cardinal plate, with one or two very large and deep ones under the middle of the plate which connects the cardinals and the laterals;

cavity of the shell rather wide, deep, of the beaks fairly deep, rounded; nacre usually white, sometimes a warm pink.

Specimens four and one-half inches in length have been taken in the Ohio; the shell occurs also in the Wabash and the White rivers. It belongs to the group which is headed by *Unio ligamentinus* Lamarck. Dr. Hildreth and the earlier naturalists seem to have considered this shell as a variety of *Unio crassus* Say (=*Unio ligamentinus* Lamarck, short and thick variety found in the Ohio), but it certainly would seem to be a good species. From the Mississippi River Dr. Lea redescribed this shell under the name of *Unio higginsii,* in the Vol. IX, Observations on Unio, but there is no doubt of specific identity. The original description of Hildreth being generally inaccessible, I append it:

"Shell nearly orbicular; anterior margin broad, and slightly rounded; posterior, short and narrow; disks, much inflated; dorsal margin, lightly rounded, and basal margin the same; ligament, thick and elevated, passing between the beaks; beaks, a little projecting, distant and decorticated; epidermis, a dark chestnut on the center of the disks, passing into a light brown as it approaches the margin; surface lightly waved on the upper part of the disks, and finely wrinkled below, transversely; cardinal teeth, direct, elevated and deeply sulcated; lateral teeth thick and prominent; posterior cicatrix, deep, and rough before; anterior cicatrix, broad, finely waved; striated and beautifully iridescent; cavity, broad and deep; nacre, flesh-color, and very iridescent with purple and violet." (American Journal of Science, Vol. XIV, First Series, page 284, 1828.)

Unio circulus Lea. Plate 51.

Shell thick, small, circular in outline, inflated, in female emarginate posteriorly, smooth; epidermis greenish olive to dark brown or almost black, radiate especially on the posterior umbonal slope, thin, velvety and striate, polished or shining on the umbones; lines of growth somewhat raised; darker, concentric, causing a wrinkled appearance anteriorly; dorsal margin much curved; anterior, ventral and posterior margins well rounded in the male, in the female the posterior is often emarginate and shorter; anterior umbonal slope very full and round, nearly or quite parallel with the anterior margin; lateral umbonal slope full and round; posterior umbonal slope full and rounded, lighter colored with several indistinct rays that become capillary near the ligament; umbones full, high, round approximated, incurved with small concentric wrinkles near the tips, placed well forward nearly on a line with the anterior margin; ligament short, thick, ele-

vated, light brown; lunule lenticular; cardinal teeth double in the left and trifid in the right valve, thick, erect, rough, the middle division in the right valve being the larger, thicker, triangular; lateral teeth short, thick, straight, double in both valves or disposed to be so, forming a right angle with the plate of the cardinals, roughly striate; anterior cicatrices rough, deeply impressed, distinct; posterior cicatrices small, deeply impressed, distinct, that of the retractor pedis being placed at the tip of the lateral teeth; pallial line well impressed, crenulate anteriorly; dorsal cicatrices in a row on the cardinal plate, small, pit-like; cavity of the shell small, wide, of the beaks deep, triangular; nacre silvery white.

This shell is very common throughout the Ohio all along the Indiana shores; it is also numerous in the lower Wabash. Specimens in addition have been seen from the White and Eel rivers, and two from the St. Mary's River in the northeastern portion of the State. Several depauperate specimens were sent me by Professor Evermann, taken in some of the lakes of northern Indiana, but the locality record has been lost. Dr. Lea redescribed this form under the name of *Unio lens*, a species which one or two recent writers have professed to think distinct! A very depauperate form comes from Lake Erie; under the rolling of waves and beating on the bars along the shores the conditions of life are such that the animal exhausts all its energy in maintaining life rather than in building shell material! To this shell Lea gave the name of *leibii:* The characters of the shell are so well marked in Indiana that no one need err in determining the form.

Unio retusus Lamarck. Plate 52.

Lamarck described this shell in the following terms in the "Histoire Naturelle des Animaux sans Vertebres," 1819, Vol. VI, page 72; also, second edition, 1838, Vol. VI, page 534:

"U. testa rotundata, tumida, intus violacea; natibus retusis, erosis; dente laterali breviusculo. * * *

"Habite les rivieres de la Nouvelle-Ecosse. A. Michaud. Test epais; epiderme d'un vert jaunatre; dent cardinale grossiere, sillonnee, divisee en deux. Longueur apparente, 47 millimetres."

From specimens furnished by Professor Barton W. Evermann, and taken in the White River, Indiana, the following description is drawn:

Shell rotund, large, smooth, convex, heavy, rounded before, circular behind; epidermis rather thin, polished, striate, disposed to imbrication towards the margins, olivaceous, lines of growth numerous, crowded, darker; dorso-posterior margin curved and rounded; postero-dorsal umbonal slope lighter horn-colored, with numerous capillary

rays of green, which are especially marked near the beaks, this slope is separated from the lateral umbonal slope by a rather well marked angle, it has also two slightly marked carinæ; umbones large, prominent, aproximating closely, curved anteriorly, and projecting slightly beyond the antero-ventral margin, smooth; ligament short, thick, curved with dorsal margin, light horn-color; lunule large, cordate, scarious; cardinal teeth single in the right, double in the left valve, multi-tuberculate, striate crenule, the folds all originating at a common point immediately under the tip of the umbone, as a whole the segments are triangular, massive, thick, short; lateral teeth long, curved, commencing well toward the dorsal margin, and nearly on a line with the anterior portion of the cardinals, lamellar, somewhat thick. double in both valves, crenulate on the margins; the plate connecting the cardinals with the laterals has several folds or plications, rather thin; anterior cicatrices distinct, deep and pit-like, not very large, the adductor roughened, the protractor pedis striate; posterior cicatrices deeply impressed, large, confluent, that of the retractor pedis at the tip of lamellæ of lateral teeth; dorsal cicatrices numerous, pit-like, often confluent, placed on the plate formed by the base of the cardinal teeth; pallial cicatrix well impressed throughout, but deepest and most crenulate anteriorly; nacre rich purple, lighter to white on the margins, beyond the pallial line.

Length of a mature specimen, 70.75 mm.; breadth, 43.50 mm.; height, 74.56 mm.

In most all of the larger streams of Indiana this shell may be sought for successfully; it has passed in review from the Ohio, White, Whitewater, Wabash, Eel, Kankakee, St. Joseph's rivers, and in two or three small lakes in northern Indiana. Its characters ally it to *Unio circulus,* but the color of the nacre and the very retuse beaks, directed so prominently forwards, will separate it at sight from any other form. The nacre is commonly white near the margin; all the region of the shell within beyond the edges is dark purple or chocolate, which coloring is highly characteristic. The largest and finest specimens come from the Wabash.

Unio ellipsis Lea. Plate 53.

Shell obliquely and elliptically oval, very thick, heavy, much inflated, smooth, the region of the beaks very thick; epidermis velvety in perfect specimens, striate, radiate with numerous green color lines from beak to margin, usually to be seen all over the disks, shining on the umbones, thin, olive-green in color; lines of growth numerous, darker, far apart; dorsal margin curved, abruptly so anteriorly, form-

ing an obtuse angle under the beaks, rapidly retreating towards the ventral margin, making the anterior outline very oblique; ventral margin rounded, emarginate near the posterior end in the female; posterior margin sharply rounded; umbones very full, inflated, decurved, directed forwards, viewed from the anterior the outline is cordate like a *Cardium*, tips of umbones minutely wrinkled; ligament long, thick, curved, light-brown; lunule cordate; cardinal teeth double in the left and single in the right valve, thick, erect, very variable, the divisions usually parallel with the lateral teeth, in some examples they are triangular, in others plate-like; lateral teeth long, slightly curved, very thick and heavy, roughly striate, the lower plate usually somewhat thickened near the end; anterior cicatrices very large, rough, deep, distinct; posterior cicatrices distinct, large, deeply impressed; pallial line deep and crenulated anteriorly; dorsal cicatrices numerous, pit-like, in the center of the cavity of the beaks; cavity of the shell wide, of the beaks rounded and shallow; nacre pearly white.

The largest of four specimens on which this description is based measures two and three-fourths inches in length; two and one-eighth inches in height; one and five-eighths inches in width. Specimens are often found which are much larger. The largest come from northwestern Missouri and eastern Kansas, to which Dr. Lea gave the name of *Unio pealii*, now a recognized synonym. In Indiana specimens have been seen from the Ohio and Wabash rivers, where the form is very abundant. It is a very common species on the Falls of the Ohio at Louisville. It may be found in all kinds of bottoms, rocky, gravelly, sandy or muddy; it is the most common shell to be found around muskrat burrows on the Wabash. The peculiarly oblique character of the shell, the way the beaks project anteriorly, and the teeth will enable its ready recognition.

UNIO CYPHYUS Rafinesque. Plate 54.

Shell suboval, somewhat flattened laterally, incrassate anteriorly, thinner over posterior region, sometimes obscurely tuberculate from middle of umbonal slope to ventral margin, the obtuse tubercles being alternately disposed and usually largest about the middle of the disk; the anterior margin is regularly rounded as far as the regions of the umbonal tubercles, then usually emarginate or sulcate, a character which is particularly well marked in the old female and the very young; growth striæ numerous, crowded, and conspicuous, the lines indicating arrest of growth being darker and broader, well marked and rather deeply impressed; ligament light brown, smooth and flat-ellipitical; lunule evident and somewhat cordate; the beaks are coarsely and con-

centrically undulate, the undulations numbering three or four, with the epidermis somewhat lighter in color than that on the slopes of the umbones; cardinal teeth single in the right, and double in the left valve, triangularly pyramidal; lateral teeth double in the left, and disposed to be double in the right valve, nearly or quite straight in old specimens, or slightly curved downward in the very young shell, thick; anterior cicatrices distinct, pit-like and deeply impressed; posterior cicatrices distinct, well impressed, that of the retractor pedis being more distinctly marked than the posterior adductor, and impressed at end of lateral teeth; pallial cicatrix faintly impressed and somewhat sinuous; cavity of the beaks shallow and rounded, with numerous, linear, minute muscular impressions posterior to the base of the cardinals and often upon them; epidermis straw-yellow or honey-brown in color, the young specimens occasionally found with hair-like green rays, which are, however, confined to the umbonal slope; nacre pure white and somewhat iridescent posteriorly.

Geographical Distribution.—This shell ranges from western Pennsylvania to the Alabama River, Alabama, and westward to Iowa and Minnesota. In the rivers of the middle Ohio drainage and in Iowa it is a common and beautiful species. The animal is of a deep salmon color, which character should assist in separating it from its congeners.

In Indiana this shell is found only in the Wabash and Ohio rivers, so far as my personal knowledge extends. But it is common in the deeper waters of those streams, varying in color from dark brown to light yellow, according to age and station.

This species has a very interesting history which I have elsewhere fully given, and the main facts of which are reproduced herewith; this seems to be justified by the fact that Rafinesque's name has never been employed for this form, which is common in collections under Dr. Green's name.

In 1827 Dr. Jacob Green* obtained from "the rivers in the neighborhood of Pittsburg" an undescribed *Unio* to which he gave, with formal description, in Contributions of the Maclurian Lyceum to the Arts and Sciences, I, p. 45, July, the name *Unio æsopus*. Later investigations developed the wide distribution in the rivers of the west of this shell; but its original description is so rarely seen that nearly

*Jacob Green, M.D., was born in Philadelphia on the 26th of July, 1790; he died in that city on February 1, 1841. He was well and favorably known as an educator, and was for a number of years professor of chemistry in the Jefferson Medical College. His scientific work was not extensive, but was of a most excellent character. He was a distinguished student of mollusca and of trilobites. He was the discoverer of that small but most interesting form from the Utica Shale known as *Triarthrus beckii*.

all modern identifications are traditionary. Frequently this highly characteristic shell is received from collectors under the various names of *Unio rubiginosus* Lea. *Unio coccineus* Lea, and occasionally with specimens of *Unio ellipsis* Lea. The plate which Dr. Green designed to illustrate this species is a very fine specimen of early lithographing, and very well exhibits its characters; the male shell was employed.

The original description was as follows:

"Testa ovata, antice undato angulata, compressa, postice orbiculata, transversim sulcata et rugosa; rugis prope margines obsoletis, serie nodulorum a natibus versus margines, inferiorem decurrente, instructis; natibus decorticatis et leviter erosis; periostracha nitida, luteo fusca; intus alba iridescente; dentibus crassis, striatis. Plate 3.

"Hunched Unio.—Shell oval compressed, thin and slightly angular at the anterior end or margin, regularly rounded, convex and thick at the posterior margin, slightly incurved and but little eroded, from the beaks over the disk and near the middle of the shell there is a remarkable gibbosity or nodulous ridge, produced by the striæ becoming in this place remarkably thick and tuberculated. There appears also in some specimens the indications of a second ridge near the anterior end; both these ridges are alternately raised and depressed; periostracha much wrinkled by the striæ, of a light horn-color, and remarkably glabrous, in old and young specimens, it is darker than the perfect shell, and the young are often beautifully rayed and spotted with brown; nacre commonly white, pearly and iridescent; teeth moderately thick, length about two inches, breadth about four.

"This shell inhabits probably all the western waters; and it is a little remarkable that Professor Rafinesque, who has described and figured so many of the Unionidæ, should have omitted this remarkable species. I found eight or ten of these shells in the river in the neighborhood of Pittsburg. In old shells the anterior margin is often produced and truncated, and the young specimens seem to be peculiarly liable to a preternatural enlargement of some portions of the shell more than others."

Seven years prior to this description Professor Rafinesque had described a shell from the Falls of the Ohio River, at Louisville, Kentucky, where *Unio æsopus* is a common form, to which he gave the name *Obliquaria cyphya,** and which he has characterized as follows:

"29. Espèce. Obliquaria cyphya (Unio cyphia). Obliquaire cyphie.

"Test épais bombé, bosselé, bord flexueux, en talus postérieurement;

* *Vide:* Annales Générales des Sciences Physiques, Bruxelles, Septembre, 1820, p. 305.

épiderme brun-châtain; tubercule à rides flexueuses; nacre blanche. Longueur 8-9, diamètre et axe 5-9 de la largeur.

"Largeur 2 à 3 pouces; test plus épais antérieurement, à grosses rides et à quelques tubercules oblongs; une grosse bosse oblique longitudinale; dents épaisses striées. Aux chutes de l'Ohio."

Rafinesque did not attempt to figure this species, as he had done with most of the shells described in his memoir. In the absence of a good figure only his technically imperfect and brief description may be relied on to furnish a clue to the shell he intended in this case. There has never been much question in my mind that he had *Unio æsopus* before him when he made his diagnosis. No other Ohio River *Unio* could possibly satisfy the characters here given. The single character of "chestnut-brown epidermis" alone is not true of all specimens of this form, but such examples are often found. The original description is here repeated that the reader may himself decide whether a careful review of the species will not credit the form to Rafinesque.

In accordance with custom, the specific name of all these forms is given the masculine ending, believing that the proper form of Unio is masculine; the specific name being simply an adjective, it must conform in gender to that of the noun to which it applies.

UNIO VARICOSUS Lea. Plate 55.

Shell very large, heavy, thick, very ponderous anteriorly and in the region of the umbones, with a number of coarse longitudinal folds or varices on the lateral umbonal slope, polished on the umbones, outline elliptical-ovate, oblique anteriorly; epidermis thick, dark brown, eradiate, striate and imbricate towards the margins, lighter colored on the posterior umbonal slope; lines of growth numerous, coarse, crowded especially so anteriorly, impressed, aiding to give the shell a roughened appearance; dorsal margin obliquely curved; anterior margin abruptly rounded, short, oblique; ventral margin full, rounded; posterior margin much produced, biangular, emarginate, obliquely rounded to meet the dorsal margin; anterior umbonal slope somewhat excavated, overhanging which are the long umbones; lateral umbonal slope full, round, with seven to eight coarse folds which are placed on the lines of growth; posterior slope sulcate, then angulate, the portion nearest the dorsal margin much compressed, striate, imbricate especially near the posterior margin, with one or two very indistinct hair-line-like ridges extending from the beaks; umbones very large, full, curved anteriorly and at the same time decurved, widely separated, triangular, exceedingly thick and heavy; ligament very

large, long, curved, thick, wide, dark brown; lunule very large, triangular, black, membranaceous; cardinal teeth large, thick, heavy, erect, lines drawn through them would be mainly parallel to the dorsal margin, double in both valves, but made up of many coarse plates in the left valve, coarsely striate, serrate on the margins; lateral teeth large, thick, curved, double in the left and disposed to be trifid in the right valve, coarsely striate, thicker at extremities; anterior cicatrices large, very deep, very rough, distinct, that of the anterior retractor pedis deeply impressed on the base of the cardinal teeth; posterior cicatrices very deeply impressed, striate, that of the retractor pedis deeply impressed at the tip of the lateral teeth; pallial line deeply and crenately impressed anteriorly; dorsal cicatrices large, impressed in the umbonal cavity just posterior to the cardinal plate; cavity of the shell large and wide, cavity of the beaks rather deep, rounded, broad; nacre pearly white.

The specimen from which the above description is drawn is from the Wabash and is a very large and old shell; but its characters are permanent. The form was described from the Ohio River, at Cincinnati, by Dr. Lea; in the Ohio the shell is common. Large specimens were collected in that stream near Charleston, in 1894, rivaling the dimensions of the one herein figured. The shell is very oblique because of the way in which the beaks are placed, being so far forward that they form, when viewed from the front, the outline of a large *Cardium*. The shell is close to *Unio cyphyus* Rafinesque, and it may, indeed, be mistaken for an old specimen of that species; the animal is similarly colored. It is readily identified among all found in the Ohio or Wabash, the only Indiana streams from which I have seen this shell.

Unio coccineus Lea. Plate 56.

Shell thick, rather large, somewhat inflated, suborbicular in outline, pointed posteriorly, smooth, polished on the umbonal slopes; epidermis dark horn-color, in some specimens greenish-olive, rayed, especially so on the umbones of young specimens, thin, smooth, striate near the margins; lines of growth distinct, darker, concentrically arranged, crowded anteriorly, somewhat imbricate posteriorly; dorsal margin curved, very much so in the region of the umbones; anterior margin slightly produced, rounded; ventral margin rounded; posterior margin slightly emarginate, produced, pointed, biangular, forming an obtuse angle where it meets the dorsal margin; anterior umbonal slope rounded and full; lateral slope rounded, inflated; posterior umbonal slope somewhat angular, gradually compressed towards the dor-

sal margin, with two or three faint carinæ extending from the region of the beaks to the margin; umbones full, not greatly elevated, approximated, with two or three coarse folds which best show in young specimens; ligament large, thick, wide, black; lunule oval, large, black, membranaceous; cardinal teeth large, thick, triangular, rought serrate, double in the left and single in the right valve; lateral teeth large, long, thick, straight, striate, double in the left and single in the right valve; anterior cicatrices very large, deep, rough, distinct, excavated under the anterior portion of the cardinals; posterior cicatrices distinct, rather deeply impressed, that of the retractor pedis large and at the tip of the lateral teeth; dorsal cicatrices near the margin of the cardinal plate; pallial line impressed crenately near the anterior end; cavity of the shell large, wide, of the beaks deep and wide; nacre white or warm pink color.

This is a common shell in all portions of Indiana. Specimens have been seen from the Ohio, White, Wabash, Eel, Whitewater, Blue, Kankakee, St. Mary's, St. Joseph's rivers and from several of the lakes in northern Indiana. From the Eel river come the largest and finest specimens I have ever seen. They are the variety with white nacre to which the name *Unio gouldianus* has been given. The typical form of *coccineus* has a warm pink nacre; in all streams where one color occurs the other may also be found. The females are often much emarginate posteriorly and the males often much produced. This shell is commonly found in collections mixed in trays with *Unio rubiginosus* Lea which it greatly resembles; it lacks the marked angle on the posterior slope which is characteristic of the older known form. The markings on the beaks of the young specimens are entirely unlike and some of each should be taken to aid in separation.

Unio obliquus Lamarck. Plate 57.

Shell heavy, sulcate, thick, large, triangularly cordate, wrinkled parallel with the lines of growth, compressed on the posterior umbonal slope, turgid or swollen at the umbones, very solid and thick anteriorly; epidermis rather thick, striate, especially at the margins, black or corneous, olivaceous in the young, eradiate except in the young; lines of growth numerous, impressed, crowded; dorso-posterior margin, in the old, arcuate, almost circular in old specimens; posterior umbonal slope rounded, much produced in old specimens, with rather marked angle at junction with posterior margin; ventral margin disposed to be sulcate; anterior margin rounded, scarcely produced, not as far forward as the umbonal tips; umbones large, very thick, turgid, somewhat produced beyond the anterior margin, approximating in

perfect specimens, minutely undulated at tips; ligament large, thick, long, black, curved parallel to the dorsal margin; lunule large, cordate, black; cardinal teeth large, heavy, short, bifid in the left and disposed to be trifid in the right valve, rough, striate-crenulate, all segments departing at varying angles from a point immediately under the apex of the umbones, the dorsal division in the left valve the largest and heaviest, and parallel to the cardinal teeth; plate joining cardinal teeth with the laterals short, thick, smooth dorsally, but striate ventrally, margin somewhat crenulate; lateral teeth long, thick, slightly curved ventrad, striate-crenulate, rough; anterior cicatrices deep, rough-pitted, distinct, outline of the adductor somewhat triangular, that of the protractor pedis elliptical, behind rather than under the adductor; posterior cicatrices distinct, well and deeply impressed, the adductor concentrically striate; the retractor pedis circular, pit-like, impressed just below the ends of the lateral teeth; pallial cicatrix broad, crenulate, well impressed throughout, but not deeply impressed anteriorly; dorsal cicatrices not impressed in the cavity of the beaks, but as a broad row on the posterior margin of plate formed by the cardinal teeth, numerous and rough; nacre white, in some specimens with occasional brownish blotches, iridescent posteriorly; dimensions of average mature specimen: length, 95.56 mm.; breadth, 45.00 mm.; height, 77.40 mm.

Lamarck's original description was as follows:

"U. testa sublongitudinali, ovato-rotundata, obliqua, subepiderme candida; ligamento subduplici; dente cardinali crasso, sulcato, biparartito.

" * * * Habite la riveire de l'Ohio. A. Michaud. Distincte de la precedente par sa forme: elle est renflée vers les crochets, deprimée vers l'autre extremite, bisillonnee sur le côte antérieur. Longueur apparent, 61 millimetres." (Hist. Naturelle des Animaux sans Vertebres, 1818, Vol. VI, page 72; also ibid. edition of 1838, Vol. VI, page 534.)

I have seen specimens of this shell only from the Wabash and the Ohio; it seems to be confined to the larger streams only. It is especially abundant in the Ohio and is often found in collections with *Unio ebenus* under that name. It may be easily distinguished by the sulcation on the posterior slope and by the character of the beaks, those of the *ebenus* being much less triangular and more produced. The specimen figured is from the Cumberland River, Tennessee, where the form occurs in the greatest perfection.

UNIO EBENUS Lea. Plate 58.

Shell large, thick and heavy, especially thick anteriorly, and in the region of the beaks, striate, smooth otherwise, oval in outline, viewed anteriorly the outline is cordate; epidermis dark brown or black, especially in old specimens, thick, striate, imbricated posteriorly, in the very young a few faint lines or rays on the umbones; lines of growth numerous, raised, concentric, crowded near the margins and anteriorly; dorsal margin roundly curved, the curve passing directly into that of the anterior margin; ventral margin nearly straight; posterior margin biangular, subcircular; anterior umbonal slope very full and round, flattened towards the anterior margin; lateral umbonal slope full and round, inflated; posterior umbonal slope long, decurved, with two broad carinæ extending from the beaks to the posterior margin, the carinæ being decurved and terminating at the siphonal openings; umbones very large, full, rounded, curved greatly anteriorly and downwards, widely separating, ending in a sharp tip; ligament light brown, long, thick, greatly curved; lunule very large, triangular, membranaceous, black; cardinal teeth large, heavy, thick, not much elevated, rough, striate, double in right and single in the left valve, dorsal portion of the teeth much curved; lateral teeth long, thick, heavy, striate, especially so near the ends, double in the left and single in the right valve; anterior cicatrices very large, rough, distinct, deeply impressed; posterior cicatrices very large, well impressed, striate, beautifully iridescent, that of the retractor pedis very large and impressed back of the ending of the lateral teeth, posterior cicatrices distinct; pallial line deeply and crenately impressed; dorsal cicatrices on the plate between the cardinals and laterals and very near the margin; cavity of the shell large, of the beaks large, deep, triangular, excavated far into the umbones; nacre white, iridescent posteriorly, with occasional brownish patches on the lateral teeth or on the disk.

This shell is the largest of the subrotund shells in this State, and like the preceding, attains its maximum development in the larger streams. The specimen figured and described came from the Wabash River, at Terre Haute. It measures four inches in length, three and one-fourth inches in height, two and one-fourth inches in width; larger specimens are common in the Ohio. A large bed of this species occurs in the Ohio about half way between Aurora and Lawrenceburg, and with them are associated many of the Ohio River shells of both great size and profusion. The beaks are well produced forwards and will aid in separating the form.

UNIO SOLIDUS Lea. Plate 59.

Shell large, thick, heavy, very thick in the region of the umbones, obliquely triangular, roundly cordate when viewed in front, sulcate, smooth; epidermis dark horn-color, honey-yellow in some specimens, radiate in the young, thin, striate near the margins; lines of growth numerous, raised, crowded, imbricated near the margins all around in old shells; dorsal margin obliquely curved, the anterior portion passing almost insensibly into the straight anterior margin; ventral margin full and round, emarginate posteriorly; posterior margin biangular, oblique, produced; anterior umbonal slope full and sharply rounded, slightly excavated under the beaks; lateral umbonal slope full and inflated; posterior umbonal slope sulcate, subangular towards the umbones, with two distinct but obtuse carinæ which end at siphonal openings; umbones large, high, directed anteriorly, but on a line, or but little above it, with the ligament, smooth, triangular near the tips, which do not touch; ligament long, curved, brown, thick; lunule large, cordate, membranaceous; cardinal teeth very large, erect, thick, striate, serrate, double in the left and disposed to be trifid in the right valve, triangular; lateral teeth long, slightly curved, thick, striate, rough; anterior cicatrices distinct, very deep; posterior cicatrices distinct, deep, concentrically striate, that of the retractor pedis at the tip of the lateral teeth, very deep; pallial line well impressed anteriorly where it is crenulate; dorsal cicatrices on the plate of the cardinal teeth; cavity of the shell wide, deep, of the beaks deep and broadly triangular; nacre pink, with white towards the margins, iridescent.

One of the most difficult of the groups of *Unio* is typified by this form which belongs to the group headed by *Unio obliquus*. A number of species have been made from this and closely related shells which will certainly prove to be synonyms; but this is not the place to consider the group as a whole. *Unio solidus* is found only in the Ohio and the Wabash in this State; it is not a common species so far as my observations go. A closely related form, called by Lea *Unio plenus*, is probably this form with pure pink nacre, at least I have so considered it in this catalogue and do not describe *plenus*. The whole matter of these forms is in a state of great confusion and should be cleared up.

UNIO TRIGONUS Lea. Plate 60.

Shell thick, heavy, triangular in outline, inflated, striate, slightly sulcate; epidermis thin, greenish-yellow, sometimes honey-yellow to dark brown according to age or station, faintly radiate in the old, markedly so in the young specimen, often velvety; lines of growth

numerous and crowded, often darker; dorsal margin curved, forming an obtuse angle at junction both with anterior and posterior margins; anterior margins at first straight, then curved towards the ventral margin, which is nearly straight and sometimes emarginate; posterior margin biangular, produced, oblique; anterior umbonal slope full and round; lateral umbonal slope subsulcate, inflated anteriorly; posterior slope angular, with two slightly raised lines from the umbones to the posterior margin, viewed from the dorsal aspect greatly flattened; umbones large, prominent, triangular, decurved, placed well forward, tips with a few coarse folds, approximating; ligament short, thick, high, dark brown; lunule short, triangular, membranaceous; cardinals erect, short, serrate, thick, rough, single in both valves but so divided into smaller parts as to closely interlock; laterals long, slightly curved, thick, striate; anterior cicatrices very deep, rough, small, distinct; posterior cicatrices very deep, distinct, that of the retractor pedis at the end of the lateral teeth; pallial line fairly well impressed, crenate anteriorly; dorsal cicatrices in a group on the plate between the cardinals and laterals; cavity of shell large, deep, wide, of the beaks widely triangular, deep; nacre white or sometimes tinged with pinkish.

Both the Ohio and Wabash furnish fine and large examples of this species, which is common throughout the Mississippi Valley, and has had a variety of names affixed to it. *Unio trigonus* is a very variable shell in its shape and degree of inflation, but in other characters seems to be a well defined species. The nacre is often white, through salmon to deep pink, and sometimes has these colorings only in the region of the beaks. It is often confused with the following form, which is the type of the group to which it belongs, but is less flat, larger, thicker and more narrowly angular in the region of the umbones. At Lawrenceburg the species is abundant in muddy bottoms and sometimes is found crawling around on gravel bars; it is a less active species than the following.

Unio rubiginosus Lea. Plate 61.

Shell rather large, not very thick, thicker before, quadrate in outline, compressed laterally, striate, the females often much produced posteriorly; epidermis olive green or brown, thin, shining on the umbones, striate elsewhere, otherwise smooth, occasionally young specimens are taken with rays in the region of the umbones; lines of growth numerous, darker, sometimes raised, making faint longitudinal ridges; dorsal margin somewhat curved; anterior margin well rounded; ventral margin slightly emarginate; posterior margin decurved, biangular, oblique; anterior umbonal slope rounded, not much inflated, lateral

umbonal slope flattened from the beaks to the margin; posterior slope angulate, rapidly compressed towards the dorsal margin; umbones small, somewhat raised, triangular, decurved, placed near the middle of the shell, with a few coarse folds which are most marked along the posterior angle near the umbones, lighter in color than the rest of the shell; ligament short, thick, clavate, dark brown; lunule variable, small, ovate; cardinal teeth double in the left and single in the right valve, erect, triangular, thick, short, striate; lateral teeth long, thin and plate-like, nearly straight; anterior cicatrices distinct, rather large, deeply impressed; posterior cicatrices distinct, deeply impressed, that of the retractor pedis at end of lateral teeth; pallial line not deeply impressed; dorsal cicatrices on the base of the cardinal teeth; cavity of the shell shallow, of the beaks deep and triangular; nacre white, sometimes ruddy or pinkish.

The length of mature specimens varies from two inches to more than four inches; the width rarely exceeds one inch.

In every part of Indiana, in streams both large and small, in lakes and ponds this shell may be found. It is the most common *Unio* within its limits. It is a mud-loving form, but is very active and may be found in all kinds of stations. A very depauperate form is found in the lakes of the northern part of the State; not only are the shells depauperate but they are thinner than those which occur in rivers. *Unio rubiginosus* ranges from New York to Texas, in all stations, and is correspondingly variable. The specific name is based on the reddish-salmon colored animal; comparatively few shells have colored nacre, but they are fairly common.

Unio clavus Lamarck. Plate 62.

This shell is one of those prolific sources of synonymy with which the descriptive matter of American fresh-water conchology has become burdened. In the hope that it will subserve a useful purpose the original description of Lamarck follows, and the synonymy as now understood, excepting only those names which have not been accompanied by figures:

"*U. testa sublongitudinali, oviformi, inferne tumida, obtusa; postico latere brevissimo; dente laterali prælongo.*

Var. testa versus extremitatem lateris antici sensim depressa, magis attenuata.

Unio modioliformis Say, Amer. Conch.

*Habite dans le lac Erie. Michaud fils. * * * Test tres blanc. Longueur apparente 72 millimetres La variete b vit dans la riviere de la Nouvelle-Ecosse. * * * Longueur apparente 53 millimetres.*"

Lamarck's brief description is no doubt responsible for very much of the confusion which attends the separation of this form. To aid in its correct determination the following description has been drawn, from specimens collected in the Duck River, Tennessee. The specimen figured is one of those employed in this diagnosis.

Shell smooth, somewhat elliptical, most of its mass posterior to a line drawn vertically from the umbones, laterally subcompressed, somewhat pointed posteriorly, circularly rounded before; umbones prominent and pointed anteriorly, apiculate; ligament large, thick, light brown; epidermis honey-yellow, smooth, often polished, rayed from the tips of the umbones with green lines over the first formed half of the disk, the rays broadening downward, occasionally interrupted by the lines of growth which are numerous and strongly impressed giving to the lower third of old specimens a striate appearance; umbonal slope rounded anteriorly but compressed posteriorly; in the female, the posterior slope is rather less flattened than in the male, while the outline of the disk is less pointed; cardinal teeth single in the right, double in the left valve, rather short and incrassate, crenulate; plate connecting laterals with the cardinal teeth disposed to folding in the left and pitted in the right to correspond, thick, slightly arched; lateral teeth long-lamellar, curved ventrad, striate; anterior cicatrices confluent, deeply impressed, that of the retractor pedis impression very deep and circular and at the end and lower margin of the lateral teeth and partly on them; dorsal cicatrices numerous, small and impressed in an irregular line on the under side of the plate between the cardinal and lateral teeth; nacre pure white, with a very marked iridescence posteriorly between the pallial cicatrix and the margin.

Length, 53.00 mm.; breadth, 18.50 mm.; height, 30.00 mm.

The synonymy of this species has been but partially worked out, but it is certain that it will include the following forms:

Unio patulus Lea. 1829. Trans. Am. Philos. Soc., Vol. III, p. 409, Pl. XII, fig. 20.

Unio decisus Lea. 1830. Trans. Am. Philos. Soc., Vol. IV, p. 92, Pl. XII, fig. 23.

Unio chattanoogaensis Lea. 1858. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. IV, 1859, p. 209, Pl. XXV, fig. 90.

Unio consanguineus Lea. 1861. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. V, p. 67, Pl. VII, fig. 217.

Unio pallidofulvus Lea. 1861. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. V, pp. 83-85, Pl. XI, fig. 232.

Unio interventus Lea. 1861. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. V, p. 84, Pl. XI, fig. 233.

Unio concolor Lea. 1861. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. V, p. 89, Pl. XII, fig. 237.

Unio anaticulus Lea. 1861. Jour. Acad. Nat. Sci. Phila., 2d series, 1862, Vol. V, p. 92, Pl. XIII, fig. 240.

Unio crebrivittatus Lea. 1861. Jour. Acad. Nat. Sci. Phila., Vol. VI, 1866, p. 43, Pl. XV, fig. 41.

Unio curtus Lea. 1859. Jour. Acad. Nat. Sci. Phila., 2d series, Vol. V, 1861, pp. 92-103, Pl. XVII, fig. 253.

Both this last named form and *Unio anaticulus* were based on deformed specimens of *Uniones* and are, in a certain sense, pathologic forms. To this synonymy must be added those other names under which Say described this species a leading term of which will be *Unio modioliformis,* as has been noted by the editors of Lamarck, in 1838. Other great groups of *Uniones* there are which exhibit a far larger synonymy than does that group which this species of Lamarck heads.

So far as known this form does not occur west of the Mississippi, nor has any member of the group been found which may be located west of that stream. It has its greatest development in the mountain regions of Georgia, Alabama, Kentucky and Tennessee, though it ranges, as specimens at hand prove, from western New York to Ottawa River, Canada, thence west to Illinois and south to middle Alabama, where some of its forms are exceedingly abundant in the streams of north-central Alabama, notably in the Coosa, Alabama and Cahaba rivers.

A good illustration of this common Indiana shell may be found in Conrad's Monograph, Pl. III, fig. 1; also in Tenney's Manual of Zoology, edition of 1872, fig. 460, p. 492. Reeve, in his Conchologica Iconica, Pl. LXIX, fig. 354, also fairly well illustrates it, but the beaks are represented to be more decurved than in any specimen we have ever seen.

In Indiana the species has been collected in the Ohio, Wabash, White, Whitewater, Eel and St. Mary's rivers, and it is likely to be found in many other streams. It must be borne in mind in this case, and in the cases of all other Indiana shells, that the range which is given in this catalogue may be greatly extended on careful examination of the whole State, a study which yet remains to be made. Such a study ought to be undertaken. At Indianapolis ought to be gathered a complete and full representation of all the animals of the State; the mollusca should be fully represented in such a collection. In passing, it may be remarked that the largest and finest shells of this form ever collected personally were taken near North Manchester, in the

Eel River. They are now in the Museum of Comparative Zoology, and are magnificent examples of this species.

Unio crassidens Lamarck. Plate 63.

When Lamarck described this form he included in it a variety of shells, some of which were entirely distinct and are now recognized as other valid species. Such for example, is his variety *a*, which is said by Dr. Lea, who saw the type in Paris, to be his *Unio trapezoides;* it is therefore quite distinct from *crassidens*. The original description here follows from the *Animaux sans Vertebres, second edition,* Vol. VI, page 532, 1838:

"U. testa ovali, tumida, crassa, postice rotundata, antice, angulis binis ternsive subsinuosa, dente cardinali crassissimo lobato, angulato, striato.

"Habite l'Amerique septentrionale, dans le Mississippi, l'Ohio, et plusieurs lacs. * * *"

The remainder of the description is concerned with the diagnoses of the varieties which Lamarck considered as belonging to this form. Variety *a* is from the Mississippi; variety *b* from Lake Erie, variety *c* from the Ohio. But each variety appears to be a distinct species.

The following description is based upon specimens obtained from the Cumberland River, at Nashville, Tennessee, where the species is very abundant; also facts are included from characters exhibited by abundant material from the Etowah and Oostanaula rivers, in Georgia. The species is likewise abundant in the Cahaba, Alabama and Coosa rivers, in Alabama.

Shell smooth, elliptical, compressed, incrassate anteriorly, biangular and much thinner posteriorly; epidermis rather thick, black in old specimens and deep reddish brown in young ones, striate, often with curved, dark green rays extending ventrad from the umbones, in the young shell; the dorso-posterior margin much and quite regularly curved; posterior umbonal slope eradiate, somewhat flattened, separated from the lateral slope by a marked angle, with a prominent raised line, sometimes two, extending from the umbones and joining the posterior margin at the angles, the whole posterior slope is, commonly, strongly and coarsely striate; umbones small, scarcely prominent, slightly incurved; ligament long, thick, curved with dorsal margin, black; cardinal teeth short, heavy, triangular, striate, single in the right, double in the left valve, the posterior portion of the double left tooth nearly equal in size and shape to the single right tooth; lateral teeth long, thick, straight or nearly so, crenulate, in old specimens this is strongly marked; dorsal plate connecting the lateral with the

cardinal teeth scarcely marked, smooth, rounded; anterior cicatrices distinct, deeply impressed, that of the adductor muscle much roughened and pitted with numerous small pits arranged in a row near the edge of the plate forming its upper margin; pallial cicatrix well impressed anteriorly and markedly crenulate throughout; posterior cicatrices distinct, that of the adductor deeply impressed and extending to the posterior end of lateral teeth, striate, that of the retractor pedis muscle deep, pit-like, sometimes confluent with that of the adductor; cavity of the beaks shallow, with a row of minute pit-like dorsal cicatrices some distance within the margin of the plate; nacre rich purple, light, iridescent, the latter feature especially marked posteriorly.

Length, 111.25 mm.; height, 69.00 mm.; width, 40.00 mm.

In the State of Indiana only the Wabash and Ohio rivers have yet presented this shell, so far as personal knowledge extends. In the Mississippi the form is commonly smaller than in the Ohio, where it attains a very great size; the Wabash specimens are also smaller. The habits of this shell are very interesting; it is not a very active shell, but remains fastened in the river bottoms by its long and powerful foot; it occurs in hundreds in beds in muddy bottoms, and is sometimes swept out by great floods by bushels, as at the lower end of the Falls of the Ohio, near Louisville. A fine figure, rather too highly colored, is given by Mr. George F. Kunz in his paper on Pearls and Pearl Fisheries before alluded to. It is a coarse shell, very common, and can not be mistaken for any other species.

Unio foliatus Hildreth. Plate 64.

Shell large, thick, heavy, very thick anteriorly and in the region of the beaks, sulcate, emarginate, the female especially so, male trapezoidal in outline, female irregularly quadrate, the posterior being sinuously emarginate, compressed laterally, inflated at the middle third of the disk; epidermis dark horn-color, striate, thick, indistinctly radiate, in the absence of color the radiations take the form of slightly impressed capillary rays; lines of growth numerous, darker, somewhat imbricated posteriorly in the male and very much so in the female, particularly in old shells; dorsal margin roundly curved; anterior margin rounded, full, somewhat produced; ventral margin straight in the female, emarginate in the male; posterior margin pointed and biangular in the male, very greatly emarginate in the female, with two prolongations, one near the dorsal aspect and one near the ventral margin, which character gives the specific name to the shell; anterior umbonal slope roundly compressed; lateral umbonal slope sulcate, the sulcation passing to the ventral margin in the male, to the posterior

margin in the female, the disk raised into a pronounced angle over the lower two-thirds; posterior umbonal slope obtusely angular, the angle passing backwards very near the dorsal margin and decurved, the shell gaping at the siphons, posterior slope very greatly depressed near the dorsal margin, giving that portion of the shell a flattened appearance; umbones full, not greatly elevated, trapezoidal in outline, eroded and embryonic shell characters not observed; ligament short, brown, thick, somewhat elevated; lunule small, elliptical, pointed at both ends; cardinal teeth double in both valves, erect, thick, triangular, striate, dentate; lateral teeth short, thick, curved, striate, swollen near the extremities, double in both valves; anterior cicatrices large, distinct, deeply impressed; posterior cicatrices distinct, deep, rather large, concentrically striate; pallial cicatrix well impressed anteriorly; dorsal cicatrices in a row on the plate of the cardinals; cavity of the shell large, of the beaks shallow, broadly triangular; nacre white and iridescent.

Specimens have been seen which are somewhat larger than those figured, but they are rare. The figures are natural size and give a fairly good idea of the shell and its peculiar dimensions. It is a very rare species and is by no means common in recently formed collections. I have never seen any examples except from the Ohio River. In the Call Collection at the Museum of Comparative Zoology there are eight or ten fine examples, and to the courtesy of the officers of that institution I am indebted for the privilege of using some of my former private collection for figuring. I give illustrations of both male and female. The shell should be sought in deep and muddy bottoms, and if one or two shells in a season be found the collector may well think himself rewarded, so rare is the species. Since the orginal description is now difficult to consult, I here reproduce it, that the history of the species may be complete for Indiana students:

"Shell shaped like a grape leaf, surface waved; disks swelled; base arcuated, and anterior margin deeply emarginate.

"Length, 2.00; breadth, 2.00; diameter, 1.12. Hab. Ohio.

"Shell compressed and deeply emarginate before; rounded and projecting behind; beaks flat and eroded; ligament more elevated than the beaks, and passing between them; hinge margin broad and straight; anterior dorsal margin projecting; anterior margin, emarginate; anterior basal projecting; basal margin arcuated; two elevated ridges, extending from the beaks, and projecting on the anterior dorsal and basal margins, with a broad furrow between; epidermis dark olive; waved transversely and obscurely rayed with green, across the waves; cardinal teeth small, and that in the right valve deeply

sulcated; lateral teeth short and thick; posterior cicatrix deep and smooth; anterior one strongly impressed and rough behind; cavity broad and shallow; nacre white, tinged with a beautiful pea-green; iridescent on the fore part.

"Remarks.—Having but one specimen of this shell, I am unable to determine whether it is a new variety, or only a 'lusus naturæ.'" (American Journal of Science, Vol. XIV, page 285, plate unnumbered, Fig. 16, 1828.)

UNIO PARVUS Barnes. Plate 65, figs. 1–4.

The type of this species is a small unionine bivalve from the Fox River, Wisconsin, collected by Mr. H. R. Schoolcraft, while engaged in work on the Northwest Expedition, of the early part of the present century. The type was described by Mr. D. H. Barnes, in 1823, in the following words:*

"Shell oblong-ovate, small, convex, sides rounded; beaks slightly elevated, inside pearly white, iridescent. * * *

"Diameter, .35-.525; length, .4-.6; breadth, .75-1.2.

"Shell rather thin, beaks placed about one-fourth of the length from the posterior extremity, ligament very narrow, anterior lunule distinct and obsoletely ribbed; basal margin slightly shortened; epidermis brownish; an obtuse, slightly elevated rib from the beaks to the anterior basal margin; lateral tooth rectilinear, rounded at the end, and parallel to the base; nacre very brilliant."

Mr. Barnes completes his diagnosis of this form with the remark that it is "the smallest and most beautiful of all the genus yet discovered in America."

In geographic distribution this small mollusk ranges from western New York and Florida to Minnesota, Texas and Arkansas. In this wide range there are numerous diverse environmental conditions, and the species appears, in a definite sense, to have responded to these, and thus have been produced a number of variations, which, passing through the hands of different naturalists, have been elevated into specific rank. In some cases, indicated below, the sexes have been made to serve as the basis of new species. Full series, collected over the wide area of distribution, confirm the following synonymy, in which the geographic distribution of several of the forms conveys its own argument:

Am. Jour. of Sci. and Arts first series, Vol. VI, 1823, p. 274, Fig. 18; Lea figures the animal in Jour. Phila. Acad. Nat. Sci., second series, Vol. IV, Pl. XXIX, Figs. 102, 102a; Conrad, Monography of Unio,

*American Jour. of Sci., 1st Ser., Vol. VI, No. 2, p. 274, pl. 13, fig. 18, *outline only*.

1836, Pl. IX, Fig. 1; Reeve, Conchologia Iconica, Vol. XVI, *Unio* Pl. XXXV, Fig. 186, a very poor figure from a specimen in the Museum Cuming.

Unio paulus Lea. Trans. Am. Philos. Soc., Vol. VIII, 1840, p. 213, Pl. XV, Fig. 29. From the Chattahoochee River, Georgia.

Unio minor Lea. Trans. Am. Philos. Soc., Vol. IX, 1843, p. 276, Pl. XXXIX, Fig. 3. From Lakes Monroe and George, Florida.

Unio marginis Lea. Jour. Acad. Nat. Sci. Phila., second series, Vol. VI, p. 255, 1868, Pl. XXXI, Fig. 69. From Dougherty County, Georgia. (Pl. II, Figs. 7-9.)

Unio corvinus Lea. Jour. Acad. Nat. Sci. Phila., second series, Vol. VI, 1868, p. 310, Pl. XLVIII, Fig. 123. From Flint River, Georgia, and Neuse River, North Carolina. (Pl. I, Figs. 4-6.)

Unio vesicularis Lea. Jour. Acad. Nat. Sci. Phila., second series, Vol. VIII, 1874, p. 37, Pl. XII, Fig. 34. From Lake Okechobee, Florida. (Pl. V, Figs. 35-37.)

Unio parvus Barnes. Call, Revision and Synonymy of the Parvus Group of Unionidæ, Proc. Ind. Acad. of Sci. for 1895, pp. 109-119, 1896.

So few of the animals of the *Unionidæ* have been described that it may not be superfluous to give in this place a description of the animal of *Unio parvus* (Pl. 65, Fig. 1), based upon the examination of a fresh specimen from the Des Moines River in Central Iowa.

Color of the mass whitish; tentacular portion of (*b*) mantle dark brown, ending in a caruncle; labial palps (*a*) large, white, triangular, united at base and partially so over the posterior margin; external ctenidium (*e*) smaller than the internal, thicker and larger at the posterior extremity, which is rounded, and on the margin, which is marked by a double row of minute, (*c*) white papillæ; ctenidia united above throughout their entire length, free below; internal ctenidium (*f*) white, ovate.

The mass of the animal within the cavity of the beak is light brown, owing to the color of the large liver, which shows through the thin tissues separating it from the chamber of the ctenidia. Foot (*g*) large, yellowish white.

The chief anatomical peculiarity *is the presence of the caruncle (d) in the female.* This is somewhat separated from the main tentacular mass and is supported by a slender pedicel. Its function is unknown.

To complete the history of this species, the following redescription of the shell of *Unio parvus* is presented, based upon specimens collected in the Wabash River, Indiana:

Shell small, compressed, rather thin, elliptical, rounded anteriorly

and slightly thicker, posteriorly triangulate in the male and occasionally sulcate in the female, thinner; umbonal slope somewhat depressed; umbones rather prominent, with four to five coarse undulations; epidermis thin, olive-green over most of disk, but much lighter on the umbones, striate, especially over the middle disk thence to the margin; in the young two broadening green bands often extend from the umbones over the posterior slope to the posterior margin, otherwise eradiate; ligament small, light brown in color, thin, rather long, but very narrow; hinge teeth small, all double in the left and single in the right valve, the cardinals erect, thin, lamellar, acuminate, crenulate, separating, the laterals long, lamellar, straight, smooth, forming a very obtuse angle with the cardinals; anterior adductor cicatrices distinct, deep, that of the protractor pedis very small; posterior adductor cicatrix scarcely evident, confluent; pallial line distinct for the anterior two-thirds; dorsal cicatrices irregularly grouped in the rather large cavity of the beaks, minute; nacre white, iridescent posteriorly.

	Length.	*Height.*	*Width.*	
No. 1.	42.00 mm.	26.00 mm.	23.00 mm.	Female.
No. 2.	36.30 mm.	27.57 mm.	19.25 mm.	Female.
No. 3.	*36.10 mm.	18.00 mm.	14.60 mm.	Male.

UNIO GLANS Lea. Plate 65, figs. 5–7.

Trans. Am. Philos. Soc., Vol. IV, p. 82, Pl. VIII, Fig. 12, 1830; Observations on the *Genus Unio*, Vol. I, p. 92, Pl. VIII Fig. 12. Ohio River.

Unio glans Lea. Call, Revision and Synonymy of the Parvus Group of *Unionidæ*, Proc. Ind. Acad. of Science for 1895, pp. 113-115, 1896.

Unio pullus Conrad. Monography Family *Unionidæ*, pp. 100, 101, Pl. LV, Fig. 2, 1836. Wateree River, South Carolina (Pl. V, Figs. 32-34).

Unio granulatus Lea. Proc. Acad. Nat. Sci. Phila., Vol. XIII, p. 60, 1861. Jour. Acad. Nat. Sci. Phila., Vol. VI, p. 48, Pl. XVI, Fig. 46, 1866; Observations on the *Genus Unio*, Vol. XI, p. 52, Pl. XVI, Fig. 46. Big Prairie Creek, Alabama.

Unio germanus Lea. Proc. Acad. Nat. Sci. Phila., Vol. XIII, p. 40, 1861; Jour. Acad. Nat. Sci. Phila., Vol. VI, p. 49, Pl. XIX, Fig. 54, 1866; Observations on the *Genus Unio*, Vol. XI, p. 53, Pl. XIX, Fig. 54. Coosa River, Alabama.

*This is a large male specimen from the Wabash River, Indiana. In it the cardinal teeth are *double in both valves*; the posterior cardinal in the left valve is curved *dorsad* and is very long and thin, its edges are sharply serrate.

Unio cromwellii Lea. Proc. Acad. Nat. Sci. Phila., Vol. XVII, p. 89, 1865; Jour. Acad. Nat. Sci. Phila., Vol. VI, p. 258, Pl. XXXI, Fig. 73, 1868; Observations on the *Genus Unio*, Vol. XII, p. 18, Pl. XXXI, Fig. 73. Kiokee Creek, Albany, Georgia.

Unio cylindrellus Lea. Jour. Acad. Nat. Sci. Phila., Vol. VI, p. 308, Pl. XLVIII, Fig. 121, 1868; Observations on the *Genus Unio*, Vol. XII, p. 68, Pl. XLVIII, Fig. 121. East Tennessee, north Georgia, north Alabama.

Unio corvunculus Lea. Jour. Acad. Nat. Sci. Phila., Vol. VI, p. 314, Pl. L, Fig. 127, 1868; Observations on the *Genus Unio*, Vol. XII, p. 74, Pl. L, Fig. 127. Swamp Creek, Whitfield County, Georgia.

The following conchological description is based upon material taken in the White River, Indiana, where the species attains its maximum development, both in point of size and abundance.

Shell small, elliptical, striate, rather thick and subangulate posteriorly, much thicker anteriorly and rounded; umbones elevated, coarsely undulate, with irregularly crescent-shaped folds, three or four in number; epidermis rather thick, dark greenish, obscurely radiate over the anterior portion of the disk, a character best seen by transmitted light, somewhat polished over the umbonal slope and generally glossy, lighter colored on the umbones; posterior margin sulcate in the female, dorsal portion produced; ligament small, horn-colored, thin; both cardinal and posterior hinge teeth double in the left and single in the right valve, the cardinals short, thick, heavy, serrate; laterals rather long, striate, straight, lamellar; anterior adductor cicatrices distinct, pit-like and deep; posterior adductor cicatrices shallow, confluent, that of the retractor pedis muscle impressed at tip of the laterals and below; pallial cicatrix evident, regularly impressed and linear; dorsal cicatrices several, crowded, in the deep cavity of the umbones or on the margin of the plate joining the hinge teeth; cavity of the umbones rather deep; nacre purple, with anterior margin usually white, whole posterior region beautifully iridescent.

Number.	Length.	Height.	Breadth.	Sex.
1	34.40 mm.	22.10 mm.	19.51 mm.	Female.
2	28.00 mm.	20.00 mm.	16.12 mm.	Female.
3	28.50 mm.	20.20 mm.	17.00 mm.	Female.
4	37.10 mm.	22.32 mm.	17.24 mm.	Male.
5	37.56 mm.	23.44 mm.	18.50 mm.	Male.
6	33.00 mm.	21.50 mm.	16.88 mm.	Male.
7	30.28 mm.	20.10 mm.	16.50 mm.	Female.
8	34.60 mm.	22.92 mm.	17.10 mm.	Male.

Some interesting features connected with the comparative dimensions of the sexes may be shown from this table of measurements. If the two longest males be selected the ratio of length to height is $\frac{37.56}{23.44} = 1.60 +$ and $\frac{37.10}{22.32} = 1.66$. In these same shells the ratio of length to width is as follows: $\frac{37.56}{18.50} = 2.00$ and $\frac{37.10}{17.24} = 2.15$.

A comparison of the same dimensions for the two longest females develops the following ratios: $\frac{34\ 40}{22.10} = 1.55$ and $\frac{30.28}{20.10} = 1.50$. Comparing the lengths with the widths the ratio established is $\frac{34.40}{19.51} = 1.76 +$ and $\frac{30.28}{16.50} = 1.83$. The ratios show that the females are much wider than the males, a relation probably due to the requirements of the *ctenidia* of the female shells when functioning as gestatory sacs. So marked, even to casual observation, are these relations that it is an easy matter to select the sexes in any considerable number of shells.

The habits of *Unio glans* are somewhat different from those of *Unio parvus*. It more commonly affects gravelly beds, in shallow running water. The writer has taken the *corvunculus* form in great abundance in the typical locality, whence it was traced into nearly all the streams of north Georgia and Alabama, in the Gulf drainage. The *cylindrellus* form is very abundant in the smaller streams of south Tennessee and in the Black Warrior River of Alabama. The heaviest, largest and *glans*-like forms from the South occur in the Coosa River, a tributary to the Alabama, just above Wetumpka. Similar shells were taken in numbers in the Cahaba River, in Bibb County, also tributary to the Alabama.

These two closely related shells may be easily separated by the color of the epidermis and that of the nacre; also, *parvus* is a much smaller and much thinner shell than *glans*. I have found both species over southern Indiana and in the lakes of the northern part of the State; but the largest, and in all respects finest, specimens I have ever seen were collected near North Manchester, in the Eel River. At this locality, on a small gravelly bar on the river's bank, several hundred large and beautiful examples were collected in 1896. In the White River, near Indianapolis, the species is also common. The following table will enable ready separation of the two forms:

Topography.	Parvus.	Glans.
Outline	Elliptical, somewhat compressed.	Ovate-elliptical, inflated.
Substance of shell	Thin, slightly thicker before.	Rather thick.
Beaks	Slightly prominent, coarsely and concentrically wrinkled.	Somewhat prominent.
Ligament	Small, thin, light straw-colored.	Small.
Epidermis	Yellowish green, lighter on beaks, striated, lines of growth distant, black.	Black or dark brown, sometimes rayed.
Cardinal teeth	Small, elevated, acuminate, crenulate, double in the left, single in the right valve.	Rather large, elevated, double in left, single in right valve.
Lateral teeth	Slightly curved, long, lamellar.	Straight, lamelliform.
Anterior cicatrices	Distinct, moderately impressed.	Distinct.
Posterior cicatrices	Confluent, slightly impressed.	Confluent.
Dorsal cicatrices	Center of cavity of the beaks.	Center of cavity of the beaks.
Cavity of shell	Shallow, white.	* * * *
Cavity of beak	Shallow, rounded.	Wide, subangulated.
Nacre	White, inclined to salmon, in cavity of beaks.	Purple.
Habitat (original)	Ohio River.	Ohio River.
Width	0.6 inch.	0.7 inch.
Height	0.8 inch.	0.8 inch.
Length	1.6 inch.	1.3 inch,

The coarse undulations on the beaks will aid in separating both shells from *Unio lapillus* Say, which is the only other small *Unio* in Indiana. The complete synonymy is given because it has been carefully worked out and will serve to indicate to Indiana students the work which yet remains to be done on many forms in the State.

Unio tetralasmus Say. Plates 66, 67.

American Conchology, Pl. XXIII, 1830. Described from the Bayou St. John, Louisiana. This plate is copied in Pl. 66 herein, Figs. 4, 5.

Unio declivis Say. Transylvania Journal of Medicine, Vol. IV, 1831, p. 527; American Conchology, Pl. XXXV, 1832; Conrad, Monograph of Unio, p. 45, Pl. XXIII, Fig. 1, 1836. Described from the Bayou Teche, Louisiana.

Unio camptodon Say. American Conchology, 1832, Pl. XLII, Reeve, Conchologia Iconica, Vol. XVI, *Unio* Pl. LXX, Fig. 356. From near New Orleans, Louisiana.

Unio geometricus Lea. Trans. Am. Philos. Soc., Vol. V, 1832, p. 38, Pl. IV, Fig. 10. Described from the Bayou Teche, Louisiana.

Unio excultus Conrad. Monograph of Unio, 1836, pp. 99-100, Pl. LV, Fig. 1. Described from near New Orleans, Louisiana. A copy of this figure is given herewith, Pl. 66, Figs. 1-3.

Unio sayii Ward. So Tappan in Am. Jour. Sci. and Arts, first series, Vol. XXXV, 1839; p. 268, Pl. III, Fig. 1; Conrad, Monograph Pl. LVI, Fig. 2, as *Unio sayanus* Ward. These figures are produced herewith on Pl. 67, Figs. 3-5. Described from Circleville, Ohio.

Unio symmetricus Lea. Trans. Am. Philos. Soc., Vol. X, 1845, p. 73, Pl. IV, Fig. 11. From the Red River, Alexandria, Louisiana.

Unio subcroceus Conrad. Jour. Acad. Nat. Sci. Phila., second series, Vol. II, p. 297, 1854, Pl. XXVI, Fig. 1. Described from a stream in Arkansas, tributary to the Canadian fork of Red River.

Unio manubrius Gould. Proc. Bost. Soc. Nat. Hist., Vol. V, 1855, p. 229. From Chihuahua, Mexico.

Unio jamesianus Lea. Jour. Acad. Nat. Sci. Phila., second series, 1858, Vol. IV, p. 52, Pl. VI, Fig. 35. Described from a single specimen obtained at Jackson, Mississippi, and then in the cabinet of U. P. James, of Cincinnati. The specimen is a pathologic representative of *Unio tetralasmus* Say.

Shell large, rather thick, thicker before, twice or more longer than high, smooth, inflated, polished over the region of the umbones, faintly radiate in young specimens, eradiate in old ones, pointed posteriorly and in general outline narrowly elliptical; epidermis striate, especially near the margins and anteriorly; polished over the lateral umbonal slope, with minute capillary lines impressed but not colored, indicating rays, marked near the ventral margin where they are striate, dark olive-green to horn-color, thin; lines of growth numerous, dark, broad, sometimes almost black; ligament long, narrow, black or dark brown; lunule long, narrow; dorsal margin nearly straight, anterior margin well rounded, ventral margin straight, posterior margin pointed, biangular, slightly emarginate dorsad; anterior umbonal slope well rounded; lateral umbonal slope long, inflated; posterior umbonal slope obtusely angular, imbricated by the lines of growth, subsulcate near the dorsal margin, where are two depressed lines which extend from the beaks to the posterior margin; umbones full, somewhat inflated, approximated, decurved, pointed, angular, with five or six concentrically curved undulations which are concave anteriorly, close together; cardinal teeth suberect, thin, plate-like, directed anteriorly and making a very acute angle with the dorsal margin, double in the left and single in the right valve, striate, placed well anterior to the um-

bones; lateral teeth long, thin, narrow, slightly curved, striate, far removed from the cardinals, no plate connecting them; anterior cicatrices large, deeply impressed, distinct, concentrically striate; posterior cicatrices large, confluent, iridescent; pallial line not at all impressed; dorsal cicatrices in an irregular line, pit-like, in the center of the cavity of the beaks; cavity of the shell large; of the beaks shallow and rounded; nacre dull white, blotched with brown and copper-colored patches.

Length, four and one-half inches; height, two and one-fourth inches; width, one and five-eighths inches.

The specimen described is in the American Museum of Natural History, No. J1525, and is from the Red River, Louisiana.

I have departed from the plan adopted in this catalogue far enough to give the complete synonymy of this species. The original locality for several forms was, as may be seen above, in Louisiana, or not far away from each other. The shell occurs in the Ohio, at many places along the Indiana shore, and in the Wabash. As seen with us, it is a much smaller shell and is generally greenish yellow and not radiate at all. It used to be a very abundant shell in the canal at Cincinnati, but never attained a size much beyond half that of the southern representatives. The habits of the shell are similar to all those that are mud-loving, and in stations of such sort this species is to be sought. The beaks alone will enable the student to distinguish it from all other Indiana shells; no other one resembles it at all.

SUBGENUS MARGARITANA.

MARGARITANA DELTOIDEA Lea. Plate 68, figs. 4–6.

Shell small, about twice as long as high, compressed transversely, rhomboidal in outline, anterior margin well rounded, posterior margin somewhat biangular, but not a constant character, ventral margin rounded somewhat, dorsal margin arcuate, depressed suddenly just anterior to the beaks; epidermis greenish or bright green, in old specimens darker with oxide of iron stains, with many fine green lines extending from the beaks to the ventral margin and so closely crowded together as to make the entire epidermis appear of a bright green hue, the yellowish rays being simply the uncolored portions of the epidermis, thin; lines of growth numerous, crowded, darker bands marking the places of arrested growth; anterior umbonal slope rounded but somewhat compressed, becoming angulate as the beaks are approached; posterior umbonal slope angular, especially in the female shell, much flattened in the male, somewhat darker than the rest of

the shell because of a broad green ray which extends from the apex to the posterior margin; umbones slightly elevated, coarsely folded, very light-colored, the folds having no definite shape, being much finer in some specimens than in others and differently disposed, but usually inclined to be double; ligament short, thick, light horn-color; lunule small, membranaceous; cardinal teeth rather large, erect, double in the right and single in the left valve, placed almost directly under the tip of the beaks; lateral teeth wanting, but an occasional specimen with a single lateral fold, which is suggestive of a lateral tooth; anterior adductor muscular impressions distinct, deeply excavated, occasionally a specimen is found in which they are confluent; posterior cicatrices confluent, very slightly impressed, very iridescent; dorsal cicatrices pit-like, minute, placed in the cavity of the umbones; pallial cicatrix faintly impressed; cavity of the shell small, of the umbones very shallow; nacre white, with a tendency to bluish.

Length, one and one-half inches; height, about one inch; diameter, from one-half to five-eighths of an inch.

This species is widely spread over Indiana, specimens having been seen from the Ohio, Wabash and White Rivers, from Lake Maxinkuckee, from the canal at Brookville, and from the Eel River at North Manchester. It is easily recognized, since there is no other shell in the State which at all resembles it. The male is much larger, flatter, and less rhomboid than the female. The female is characterized by the great angularity of the posterior slope and its generally inflated form. Dr. Lea has described this species, which originally came from the Ohio at Cincinnati, under the name of *Unio calceolus,* which was the female form and came from the indefinite locality "Ohio." The species is very common, and when one specimen is taken many others are sure to be found near by.

MARGARITANA CONFRAGOSA Say. Plate 69.

Shell rather thick, thicker anteriorly, heavy, oval in outline, plicate, tuberculate, almost spinous on the umbones; epidermis black in old, dark olive-green in young specimens, eradiate, striate, glossy; lines of growth strong, crowded, raised, imbricated posteriorly; dorsal margin curved, thickened; anterior margin well rounded, forming a pronounced angle with the dorsal margin; ventral margin rounded; posterior margin biangulate, irregular; umbonal slope full but flattened transversely, somewhat rounded anteriorly, obtusely angular posteriorly, with a number of coarse parallel folds, which, beginning as small folds on the disk of the shell, sweep downwards and backwards, then upwards to the posterior margin; the disk of the valves with

numerous folds, coarse or fine, sometimes approaching tubercles, arranged without definite order or position, disappearing towards the anterior part of the shell; umbones raised, very prominent, lighter colored than the rest of the disk, with four to six large tubercles, arranged in two rows which diverge, the lower ones largest, often taking the appearance of short, thick spines, the beaks approximated, decurved, very light; ligament long, narrow, thick; dark horn-colored; lunule long, narrow, membranaceous; cardinal teeth double in the left and single in the right valve, thick, rather heavy, occasionally disposed to be trifid in the left and double in the right valve; lateral teeth wanting, but often a sharp ridge or fold extends well towards the posterior margin from near the umbones; anterior cicatrices well impressed, concentrically striate, distinct; posterior cicatrices confluent, very slightly impressed; dorsal cicatrices on the outside of the plate formed by the cardinals; pallial cicatrix very faintly impressed; cavity of the shell large, of the beaks very small; nacre white, very iridescent posteriorly, sometimes with a decided purplish tinge on the posterior margin, the cavity of the beaks often a dirty yellow.

Length, three to four inches; height, two and one-half to three inches; transverse diameter, one and one-half inches, sometimes a little more. There is little noticeable difference in the sexes.

This species is common in the Wabash, but has been seen from no other locality in this State. It is one of the rarer forms, and is restricted in distribution in about the same manner as is *Anodonta suborbiculata*. It is one of the most remarkable species of the American fresh-water shell fauna, and is not a very variable shell; the variations are mainly in the character and number of the tubercles which mark this shell and serve to easily separate it from all others. In the very young shells the tubercles are inordinately large for the balance of the shell, and give it a very spinous appearance. In later life this disparity becomes less obvious. Specimens are sometimes found which are larger than indicated by the above dimensions, but these are the average sizes. The habitat of the shell is in deep water, in muddy bottoms; it was originally described from the Wabash.

MARGARITANA MARGINATA Say. Plate 70.

Shell somewhat thick, scarcely thicker before, rudely quadrangular in outline, swollen posteriorly, cuneate or wedge-shaped anteriorly, little more than twice longer than high; epidermis light yellowish or straw-colored, much lighter on the umbones, thin, brilliantly rayed with numerous bright, green lines which extend, becoming broader, from the middle of the umbonal slope to the margin below, curving

anteriorly in the anterior half of the shell, all the posterior dorsal slope usually eradiate, polished; lines of growth broad, darker, extending well forward before curving towards the dorsal margin; dorsal margin curved, slightly thickened, forming an obtuse angle with the anterior margin, which is sharply rounded; ventral margin commonly emarginate; ventral margin rounded in a flowing curve from the dorsal margin to near the ventral border, where it is suddenly and sharply biangulate, gaping in the region of the siphons; lateral umbonal slope flattened, anterior slope rounded, becoming subangulate near the beaks, posterior umbonal slope angular, sharply so, flattened transversely, giving the shell a triangular appearance when viewed from the posterior imbricated by the coarse lines of growth, with numerous minute folds which cross the lines of growth at right angles; umbones prominent, light-colored, with three to four large and coarse wavy folds, beaks approximated, decurved; ligament rather long, thick, wide, and dark horn-colored; lunule long and narrow, lighter colored; cardinals disposed to be double in the left valve, always single in the right, rather small, lamellar, erect; laterals wanting; anterior adductors fairly well impressed, rather small, the portion occupied by the anterior retractor pedis very deep or pit-like; posterior cicatrices slightly impressed, confluent; pallial impression not visible; dorsal cicatrices minute, pit-like, in the center of cavity of the beaks; cavity of the shell large, of the beaks rather deep and wide; nacre bluish white, with white bands which mark the position of the lines of growth, not remarkably iridescent, often a dull white.

Length, three and one-half inches; height, one and one-half inches; width, male, one inch, female, one and one-fourth inches.

This form occurs in every river basin in Indiana and is often found in lakes and ponds. It is, in its markings and general outline, very much like *Unio triangularis* Barnes, but the absence of lateral teeth will immediately separate it from that species. The animal is very active, and it is often to be noticed crawling over the gravelly bars, which it commonly inhabits. It is a beautiful species. The animal is light salmon-colored, with a large and tough foot; indeed, the foot seems to make up most of the animal. I have taken it in numbers in the Ohio and Eel rivers, and usually find it difficult to remove it from its bed when anchored on a gravel bar with its long and strong foot fully extended.

MARGARITANA COMPLANATA Barnes. Plate 71.

Shell large, thick, thicker anteriorly, alate, greatly compressed transversely, generally circular in outline when the ala is intact,

broadly and faintly plicated in old specimens on the interior portion of the ala; epidermis dark horn-color, reddish brown on the disk, where it is glossy, striate near the margins, imbricated posteriorly, with occasional broad bands of greenish parallel with the growth lines, much lighter on the beaks, at times silvery white at the apex; lines of growth broad, distinct, crowded, especially towards the ventral and posterior margins; dorsal margin much curved; anterior margin rounded, forming a very obtuse angle with the dorsal margin; ventral margin slightly rounded; posterior margin biangulate, the dorsal portion straight; umbonal slopes scarcely raised, flattened, the posterior with three more or less well-marked carinæ which extend from near the region of the beaks to the posterior margin, ending at the siphonal openings and marking their position; umbones not at all elevated, on a level with the dorsal margin with three or four coarse, large, wavy folds; ligament long, thick, dark brown in color, in perfect specimens completely covered by the portion of the shell which forms the ala; lunule long, narrow, pointed at both extremities; cardinal teeth large, heavy, flattened, rather smooth, disposed to be trifid in the left and double in the right valve, often roughened by disease; laterals wanting but their position sometimes indicated by a sharp, raised ridge or carinæ on which are sometimes three to five low and rounded ridges extending posteriorly; anterior adductors large, deeply impressed, the cicatrix of the anterior retractor pedis being confluent with that of the adductor but deeply impressed behind it about the middle, the impression of the protractor pedis distinct, large, irregular; the posterior muscular impressions very faint, confluent; the dorsal cicatrices placed on the outside of the plate formed by the cardinal teeth, pit-like, deep, thence forming a short row into the cavity of the beaks; pallial cicatrix well impressed anteriorly, crenulated; cavity of the shell large, of the beaks very shallow; nacre white, scarcely any iridescence, with numerous large and small copper-colored blotches irregularly disposed over the entire interior.

Length, seven to eight inches; height, five and one-half to six inches; diameter, one and three-fourths inches. I have seen larger examples but these are the sizes for large examples which are common.

This species occurs in the Wabash, Ohio, White, Kankakee, Eel and other rivers. It frequents muddy bottoms and has much the habits of *Anodonta*. The foot is very large and powerful, like all of the genus, and when the animal is anchored in the mud is pulled out only with difficulty. It is the only alate *Margaritana* in Indiana and is therefore easily recognized. The specimen figured is a young example.

This species was described by Mr. Barnes in 1823 and the types came from the Fox River, Wisconsin. The description was published in the American Journal of Science, Vol. VI, pp. 278-279, and rudely figured on Pl. 13, fig. 22. Since this original description may be of interest, and it is now difficult to find access to this old publication, I give it below:

"Shell very short behind; disks much flattened; umbones depressed; beaks slightly projecting; ligament between the valves; anterior lunule much compressed and folded across the transverse wrinkles; hinge margin elevated into a large wing, straight and forming an obtuse angle with the posterior dorsal margin; basal margin slightly rounded, nearly straight; anteriour and posterior margins somewhat angulated; anteriour dorsal margin arcuated, or somewhat emarginate; epidermis chestnut brown, glossy; surface somewhat deeply wrinkled and striated transversely; slightly elevated ridges and furrows diverging from the beaks to the anteriour margin, and distinctly impressing the inside. Teeth elevated, sulcated and radiating from the beaks; cicatrices smooth; cavity small and angular; nacre bluish white and iridescent; surface smooth, and polished, in old specimens spotted with green."

"Remarks.—This shell resembles the *Unio alatus*, in the elevation of the wing and the connexion of the valves, and might at first sight be mistaken for a variety of that species; but it differs in generick character, in shape, and in colour." (Barnes.)

MARGARITANA RUGOSA Barnes Plate 72.

Shell large, thick, heavy, scarcely thinner posteriorly, elongated, twice longer than high, compressed on the middle umbonal slope; epidermis dark horn-color to reddish, with numerous fine, green, parallel rays extending from the umbones to the ventral margin, over the middle third of the disk, striate, shining on the umbonal slope, darker posteriorly, especially towards the dorsal margin, rather thick, much lighter to white on the beaks, grayish for some distance below them; lines of growth very numerous, often raised into low rounded ridges, crowded anteriorly and imbricated posteriorly; dorsal margin nearly straight, anterior margin well rounded, ventral margin straight, posterior margins biangulate, in some specimens decurved below the ventral margin; anterior umbonal slope flattened, posterior umbonal slope much wrinkled, with coarse folds, these being usually more marked in the young specimen, obtusely angular from the beaks to the posterior border where it meets the ventral border; umbones scarcely raised above the dorsal margin, small, directed anteriorly, with

from three to four coarse, sometimes double or wavy folds, covered with a very light epidermis; ligament long, thick, broad, black; lunule linear, long, membranaceous; cardinals disposed to be double in the left, single in the right valve, erect, large, thick, smooth, sometimes with many deep but narrow furrows which radiate from the direction of the umbones; laterals none, their place being indicated by a thick, rounded fold on the posterior portion of the dorsal margin just below it, sometimes showing a slight tendency to become double; anterior muscular scars deeply impressed, large, distinct, the posterior confluent, well impressed, usually iridescent; dorsal cicatrices numerous, small, pit-like on the plate of the cardinal tooth; pallial impression marked, deepest anteriorly, crenulated; cavity of the shell narrow but large, of the beaks very round and shallow; nacre white, bluish-white, or occasionally a pinkish or salmon tinge, not very iridescent.

Specimens are often six and one-half inches in length, and proportionately high; the females are a little more obese than the males.

This shell is found in every large stream and most of the smaller ones in Indiana. It is very common and very large in the Mississippi at Moline, Illinois, but the Ohio River specimens outrival them. Among the largest which I have collected in this State are a fine series from the Eel River, at North Manchester. These were found on a long gravel bar near the midstream and were deeply buried in the gravel, the broad, long and strong foot being thrust far down in the bottom. The animal is uniformly a dull salmon or yellow color, and quite fills the shell, the foot constituting the major portion of the soft parts.

This shell was originally described from the Fox River, Wisconsin, by Mr. Barnes, in the American Journal of Science, first series, Vol. VI, p. 278, and was figured on Pl. XV, fig. 21, 1823. For the same reasons that were given in the case of *Margaritana complanata* I append the original description, copied, and trust it will prove of historic use:

"Shell oblong-oval, about equally broad before and behind; beaks slightly elevated, wrinkled and decorticated, exhibiting a wax colour beneath; ligament external and as high as the beaks; anteriour lunule distinct with a slightly elevated ridge extending from the beaks to the ant. basal margin; basal margin a little shortened; the other margins regularly rounded; epidermis chestnut brown, with a silky lustre; surface of the anteriour part folded in a pinnate form; folds deeper above and somewhat obsolete below the ridge, curved upward and extending to the hinge and anteriour margins, indenting the edge and visible on the interiour. Teeth large and elevated with a fold

behind; cicatrices smooth; cavity small; naker pale flesh coloured in the center, pearly white on the margin with a narrow border of dark chocolate colour; surface smooth and glabrous." (Barnes.)

All the species of *Margaritana* are so distinct, as exhibited in this State, that there is no need of an artificial key to aid in their identification. Only a single other species is known besides this one that could be mistaken for it, from the size, and that is *M. complanata*, which is entirely dissimilar in outline and markings. Both are large shells and both are thick shells, but there the resemblance ends.

MARGARITANA MONODONTA Say. Not figured.

Shell oblong, three and one-half times longer than high, arcuate, rather thin posteriorly, thicker anteriorly, compressed transversely; epidermis black, thick, sometimes brownish-black, a little lighter on the umbones, eradiate in old specimens, the young not seen; lines of growth numerous, well marked, imbricated posteriorly, much crowded; dorsal margin somewhat curved, thickened, rounded, anterior margin well rounded, making an obtuse angle with the dorsal margin at point of junction, ventral margin very much arched, posterior margin rounded and slightly decurved; umbonal slope compressed anteriorly, not very evident, posteriorly somewhat inflated and subangular, with an obtuse angle extending from the umbones to the postero-ventral margin; ligament long, thick, black; umbones small, not much elevated, generally decorticated, approximated, with a few very fine folds, which are scarcely visible in middle-aged shells with perfect epidermis; cardinal teeth small, erect, thin, double in the left and single in the right valve; laterals none; anterior muscular impressions distinct, well impressed, large, sometimes roughened; posterior muscular impressions confluent, slightly impressed; cavity of the shell small, of the beaks very shallow; nacre whitish, sometimes purplish, especially in the region of the umbones, the anterior, ventral and posterior margin of the nacre is very thin and the epidermis shows through as a narrow border of dark purple, iridescent.

This species was described from the Falls of the Ohio, at Louisville, whence I have taken very large examples. I have seen specimens from the Wabash, but all agree in all the essential characters. The habits of the animal render it difficult to find and it is not common in even good collections. It buries itself far down in the gravel and mud, on the falls, under large flat rocks where water circulates freely, or alongside submerged timbers which are well buried in the mud of the river bottom. The foot is long, slender, but very powerful and serves to anchor the animal firmly in even the swift waters of the falls. Its

anatomy is worthy of special research; nor are all its habits known. A single dead shell was found on a river bar in the Ohio, at Lawrenceburg.

This species is sometimes seen in collections under the name of *Margaritana margaritifera* Linnæus, a circumpolar species, to which it has a close general resemblance. But the Linnæan form does not occur in Indiana. The only shell with which it is likely to be confounded, from its color and generally long shape, is *Unio rectus*, but the lateral teeth of that species will separate it easily. *Unio rectus* is also a much thicker shell, much heavier, more pointed, and has a highly polished epidermis, which is rayed.

MARGARITANA HILDRETHIANA Lea. Not figured

Shell narrow-elliptical, subcylindrical, very transverse, inequilateral, somewhat compressed at basal margin; substance of shell thin behind, thicker before; beaks slightly elevated; ligament long and thin; epidermis dark brown; cardinal teeth lobed, single in each valve, larger and wider in the left valve; lateral teeth none; anterior and posterior cicatrices both confluent; dorsal cicatrices in the center of the cavity of the beaks, shallow, and tinged with dull purple; nacre white and iridescent. (Lea.)

I have not been able to secure a specimen of this shell for redescription though it is very common indeed; so I am obliged to copy Lea's very incomplete original description. Many hundreds of this species have passed through my hands in the past twenty-five years and all present the same characters. The shell does not vary much. Lea described it as *Unio hildrethianus* but afterwards placed it in *Margaritana* where it certainly belongs. Recently some wonderful attempts have been made to locate this shell in a section with *Unio* and possibly making it the type of a new genus! The animal has all the characters of the ordinary *Margaritana*, and no violence is done to natural classification by letting it alone since it is in natural company. The habits are somewhat peculiar; it is sometimes found in mud and on gravel bars, but in greatest numbers and perfection hidden in the mud under flat stones; more than two hundred have been taken from under a single flat rock of about one square foot area.

It is known from the White, Wabash and Ohio rivers in Indiana, but has yet to be found elsewhere in this State.

ANODONTA IMBECILLIS Say. Plate 73.

Shell thin, rather small, two and a half times longer than high, scarcely thickened anteriorly, rounded before, biangulate behind;

epidermis greenish-yellow, with well-marked bright green zones, indistinctly rayed, with two to three green lines, becoming broader and extending from the posterior region of the umbones along the posterior umbonal slope to the posterior margin, terminating at the siphonal openings; epidermis thin throughout; lines of growth distant, distinct, broad and much darker than balance of epidermis, sometimes well impressed, giving the shell a roughened character; dorsal margin straight, ventral margin slightly curved, with a slight swelling near posterior border; anterior umbonal slope compressed, not well marked, posterior umbonal slope rounded, full, then narrowing to the margin; umbones very much depressed, on a level with the dorsal margin, minutely and concentrically plicate, the folds being exceedingly fine, silvery; ligament long, narrow, thin, light corneous, scarcely raised above the margin; lunule none; teeth of hinge joint entirely wanting; anterior adductors slightly impressed, distinct, that of the protractor pedis not evident; posterior impressions confluent, not at all impressed, but wrinkled and iridescent; pallial impression scarcely showing; cavity of the shell shallow, but large; nacre bluish-white, with many bluish zones which mark the positions of the external lines of growth.

Length, two to three inches; height, one and one-fourth inches; diameter, three-fourths of an inch.

This fragile species is the most brilliantly colored of any member of the genus; it is very common in the Ohio, Wabash, White and Blue rivers; it is also found in several small streams, as in Bennett's Creek, Vigo County. It will ultimately be found all over the State. It can not be confounded with any other Indiana shell, its extreme fragility, brilliant coloration and slender outline serving to separate it.

ANODONTA WARDIANA Lea. Plate 74.

Shell rather thin, thicker anteriorly, about twice longer than high, well rounded before, obtusely biangulate behind; epidermis light yellowish to dark horn-color, with numerous wavy, narrow or broad green lines extending from the umbones to the posterior and ventral margins, the shell having the appearance, in some specimens, of being green, with light yellow color lines, epidermis rather thick, smooth, shining or polished; lines of growth numerous, distinct, darker, slightly raised; dorsal margin slightly curved, usually slightly thickened anterior to the beaks, giving a faint suggestion of a cardinal tooth, ventral margin straight, sometimes slightly emarginate towards the posterior end, anterior margin well rounded; anterior umbonal slope well marked, full, rounded, posterior umbonal slope full,

rounded or subangular, with one or two faint carinæ extending nearly to the posterior border; umbones triangular, raised, full, prominent, with four large and coarse undulations which are lighter than the balance of umbones, the entire epidermis of which is silvery whitish; ligament short, thin, narrow, dark brown in color; lunule long, narrow, chitinous; internal dorsal margin curved, thickened anteriorly so as to almost form a single cardinal tooth (a character not equally marked in all specimens); anterior cicatrices distinct, not deeply impressed, roughened, very large; posterior cicatrices distinct, well impressed, iridescent; cavity of the shell capacious, of the umbones shallow; nacre white or bluish white, smooth, not very iridescent, growth lines showing as thickened and whiter zones parallel to the ventral margin. The pallial line is faintly impressed and is distinctly crenulate.

Length, three to three and a half inches; height, one and one-half inches; width, one and one-fourth inches.

This species occurs in the White and Blue rivers, and in smaller streams in the northern part of the State. It is synonymous with *Anodonta pavonia* Lea, which I have formerly listed under that name from Indiana, but there can be no doubt of their identity. The last named is rather more brilliantly rayed than *wardiana*, but differs in no other respect. This species is quite close to the type of the group, herein described under the name of *Anodonta edentula* Say. The wavy character of the green color lines and the bright yellow epidermis which shows between them will enable this form to be readily identified. It is abundant where found at all.

ANODONTA EDENTULA. Say. Plate 75.

Shell thin, thicker anteriorly, twice as long as high, produced and rounded anteriorly, posterior margin slightly emarginate, biangular; epidermis fuscous, lighter on the umbones, the posterior two-thirds closely and finely rayed, the rays being wavy, often thread-like, sometimes very broad, dark olive in color, epidermis striate near the inferior border; lines of growth distinct, dark, slightly raised; dorsal margin nearly straight, thickened in the region of the beaks, round, smooth, straight posterior to beaks, thickened, or somewhat dentate anterior to the beaks, declined; ventral margin straight; anterior umbonal slope rounded, full, subangular towards the beaks, posterior umbonal slope subangular, full, with one or two slightly depressed, hair-like lines extending from beak to margin in region of siphonal openings; umbones prominent, raised, biangulate, nearly or quite touching, with three to four coarse folds, covered with a grayish white

epidermis when perfect; ligament short, broad, dark horn-color, somewhat raised above the dorsal margin; lunule long, narrow, membranaceous; anterior muscular cicatrices confluent, well impressed, irregular in outline, that of the protractor pedis being large and crenulate; posterior cicatrices confluent, distinctly impressed, that of the retractor pedis at extreme end of dorsal marginal plate; pallial impression scarcely visible; cavity of the shell capacious, of the umbones shallow; nacre white, bluish-white or with a faint tinge of salmon, iridescent posteriorly.

This species is common over all of Indiana, specimens having been seen from all the large rivers and from many of the small streams and lakes. In the Ohio it is the most common *Anodon*. It has a wide range of variation, the forms from the lakes being smaller, thicker, darker in color, and less beautifully rayed. The species has a wide range over the eastern United States, and as far west as Kansas and Nebraska, and has a very large synonymy. Two of these, *Anodonta ferruginea* and *Anodonta shæfferiana*, have been reported from this State, but those names are now retained only by conchological tyros who desire to have a large exchange list to entice the unwary. Unlike many of its fellows, this species has no particular habitat, frequenting muddy and gravelly as well as rocky bottoms alike.

ANODONTA SUBCYLINDRACEA Lea. Plate 76.

Shell thin, scarcely thicker anteriorly, two and one-half times longer than high, outline somewhat resembling a rude parallelogram, rounded before, somewhat angulate behind, the male being markedly angular posteriorly, and pointed; epidermis light-corneous, with greenish tinge in broad bands parallel to the lines of growth, over the umbonal slope much lighter, often copper-colored, especially at tips of beaks, sometimes silvery, with numerous bright green rays sweeping in flowing curves towards the posterior margin from the middle of the umbonal slope, often not apparent except near the ventral margin, epidermis thin; lines of growth distinct, broad, dark-colored, widely separated; dorsal margin straight, thin, ventral margin sinuous in the female, or emarginate, the male with ventral margin straight, both subangular anteriorly; anterior umbonal slope full, much rounded, slightly compressed in the male, posterior umbonal slope full, rounded, with three green color lines extending from the beaks to the posterior margin, becoming broader and marking the positions of the siphonal openings; umbones flattened, full, light-colored, the beaks nearly touching, with three small folds or crenulations near their tips, which are decurved; ligament rather long, light horn-color or light brown,

thin, slightly raised above the dorsal margin; lunule none; both the anterior and posterior muscular impressions scarcely visible, so faintly are they impressed, confluent; cavity of the shell deep, of the umbones very shallow; nacre white, beautifully iridescent posteriorly.

Length, three and one-half inches; height, one and one-half inches; width, one and one-eighth inches.

Specimens of which the dimensions are given are the largest of those used in the description and are by no means to be taken as the greatest dimensions attained. This species is often taken with much larger dimensions than those given. It is found in the Ohio River, the Wabash, the White, and in numerous lakes in northern Indiana. A synonym of this species which occurs in many Indiana localities is *Anodonta ferussaciana* Lea, a species which we have reported from several localities within the State. The cylindrical form of this shell, its greenish tinge, its recurved and neatly folded beaks, will serve to separate it from all other shells.

ANODONTA GRANDIS Say. Plate 77.

Shell large, very thin, of uniform texture throughout, broadly oval in outline, rounded before, pointed posteriorly, and biangulate; epidermis light horn-colored in young and in half-grown specimens, darker in the maturer forms, polished over the umbones, striate at the posterior and ventral margins; lines of growth coarse, broad, darker-colored, slightly raised, coarsely crowded on the posterior umbonal slopes, where they are imbricated and give the shell a rough appearance; dorsal margin slightly curved, anterior margin rounded, with a decided angle at juncture with dorsal margin, ventral margin well rounded, posterior margin biangulate, nearly straight to the dorsal margin from the siphonal openings; anterior umbonal slope full, rounded; posterior umbonal slope rounded or subangular, darker-colored, with two or three faint, broad, and darker color bands extending from the beaks to the posterior margin, sometimes so wide as to cover the whole of this portion of the shell and then very dark olive or black in color; umbones somewhat raised, but not especially high, in perfect old and in young specimens copper-colored, the beaks being approximated, decurved, with a double row of fine, curved folds, which are much like to flattened U's joined together, four or five such folds being concentrically arranged; ligament long, thin, black, narrow, not raised above the dorsal margin; lunule none; adductors scarcely visible and lightly impressed, the protractor and retractor pedis muscles being confluent with the adductors, though occasional specimens are seen with the anterior adductors distinct; cavity of the shell very large,

of the beaks shallow; nacre white, salmon-colored or copper-colored, often with darker brownish or copper-colored patches, especially in the regions of the umbones; the growth lines are marked on the inside of the shell by raised whitish lines indicating thicker deposits of nacreous matter.

Length, seven inches; height, five inches; width, three inches, and in occasional globose specimens more.

This is the largest *Anodon* in the State, and is exceedingly abundant in ponds along the Ohio and the Wabash rivers. It occurs, also, in the rivers of the northwestern part of the State and delights in sluggishly flowing streams and muddy ponds. It is a very variable shell, both in respect to its outline and its coloration. Many synonyms have been made of its various forms; of these the following are found in Indiana: *Anodonta decora, Anodonta plana,* and a form which Mr. Lea described under the name of *Anodonta gigantea* from the southern States. In any considerable number of individuals it is possible to pick out forms which fit exactly Lea's descriptions. The colors of the epidermis and the nacre seem to depend on the ponds in which the animal lives; sometimes the whole epidermis is beautifully rayed with greenish lines, in other specimens a dark olive will predominate, with shining epidermis and faint color lines or none at all, while in still other individuals the rays are entirely wanting and the epidermis is light green or yellowish in color.

ANODONTA SUBORBICULATA Say. Plate 78.

Shell very large, thin, round in outline, compressed transversely, substance of the shell rather thin, subbiangulate anteriorly, sinuously biangular behind; epidermis dark horn-colored, polished, shining, eradiate, thin, lines of growth conspicuous, numerous, black, concentric, raised; imbricated on the posterior dorsal slope, which is sulcate; dorsal margin curved; ventral margin well rounded, in a regularly flowing curve, anterior margin well rounded; anterior umbonal slope not much raised, or depressed, inconspicuous; posterior slope roundly angular, with a decided sulcus near the dorsal margin which extends to the upper limit of the siphonal openings, shell gaping at the siphons; beaks scarcely raised above the dorsal margin, with a number of minute apiculations near the apex; ligament long, broad, thick, black; lunule none; anterior muscular impressions distinct, slightly impressed, roughened; posterior impressions confluent, very slightly impressed; pallial line sinuous and very faintly impressed; cavity of the shell very large, that of the beaks very shallow; nacre light salmon-color, very iridescent, with thickenings of nacreous matter marking

the position of the external lines of growth, occasionally roughened by disease, especially in the region of the adductors.

This species is limited in its distribution in this State to the Wabash River and the ponds along its course. In muddy bayous and the small lakes left by the changing of the river's course this species may be found. It is not a species of wide distribution, having been found only in a zone which extends westward to the Mississippi at Muscatine from the Wabash River in Indiana. Its peculiarly round outline and large size will enable one to easily separate it from all other Indiana forms. Its anatomy is unknown.

Specimens have been taken which were seven and one-half inches in length, five and three-fourths inches in height, and two and one-half inches in diameter.

ANODONTA DEHISCENS Say. Plate 68, figs. 1–3.

Shell thin, slightly thickened anteriorly, trapezoidal in outline, rounded before, and rather sharp pointed behind; the dorsal margin oblique, but straight, ventral margin slightly emarginate, posterior margin pointed and wavy, the shell gaping at posterior and anterior regions; epidermis dark brown or fuscous, sometimes approaching dark olive, polished, beautifully rayed with dark green lines which extend from the beaks to the ventral margin, being directed posteriorly, and are straight, becoming regularly broader as the ventral margin is approached; lines of growth broad, black, raised; dorsal hinge margin very obtusely angular, from beaks to posterior margin straight, scarcely thickened; anterior umbonal slope flattened, posterior umbonal slope subangular, black, with a number of small folds, which are almost inconspicuous and make an angle with the lines of growth; beaks minute, depressed, scarcely folded, the embryonic shell being retained in perfection, sometimes with a couple of rather coarse, depressed folds; ligament long, thin, black; anterior muscular impressions separate, faint, irregular, often roughened; posterior cicatrices rather deeply impressed, confluent, the pallial impression very wavy, slightly impressed, deeper anteriorly; dorsal cicatrices in the cavity of the beaks large and pit-like; cavity of the shell not large, of the beaks scarcely deeper than that of the body of the shell; nacre bluish, with many specimens purplish in the region of the umbones, very iridescent posteriorly.

This species rarely attains a length greater than three and one-half inches; a height of one and one-fourth inches; and a diameter of five-eighths of an inch. It occurs in the Ohio and Wabash rivers, but I have seen it from no other portion of Indiana. It is a rare species,

whose habits tend to keep it unknown; it buries itself deeply in the mud and gravel of bars, and rarely crawls about like most of the *Unionidæ*. Its highly polished epidermis and characteristic rays will distinguish it at once.

This shell has usually been placed in *Margaritana*, and one writer, Dr. Lea, placed it in *Unio*, describing it under the name of *Unio oriens*. The entire absence of teeth on the dorsal margin must compel its reference to *Anodonta* as now understood. In the gaping character of its shell it differs from all others of the *Unionidæ*; it is aberrant in other particulars, and would seem to invite the careful study of those who are situated so as to observe it in its habitat.

ANODONTA SALMONIA Lea. Not figured.

Shell thin, twice as long as high, slightly thickened anteriorly, elongately oval in outline; epidermis fuscous, generally eradiate, or but faintly rayed on the posterior slope, polished, with sometimes a broad band of greenish concentric with the base or ventral margin, striate near the margins all around; lines of growth inconspicuous, darker than the epidermis, imbricated on the posterior dorsal slope; dorsal margin nearly straight, anterior margin well rounded, posterior margin somewhat pointed, and biangulate; both umbonal slopes rounded, that of the posterior more full, marked by two or three broad, greenish, increasing bands or lines from beaks to posterior margin; umbones somewhat raised above the dorsal line, copper-colored, lighter than the balance of the shell, beaks approximating, small, with three rather coarse folds or wrinkles near the apex which sometimes appear double, being made up of a low and wide W; ligament long, thick, light-brown, slightly raised above the dorsal margin; anterior cicatrices distinct, not deeply impressed; posterior cicatrices very faintly impressed, confluent; dorsal cicatrices pit-like, siuated in the cavity of the beaks or just anterior; cavity of the shell large, of the beaks shallow; nacre bluish white on the margins but brilliantly salmon-color and very rough in the cavity of the shell and in the region of the attachment of the anterior adductors, sometimes reddish or yellow, giving the shell a diseased appearance.

This species is common in the White River, in the upper waters of the Wabash, and is occasionally taken in the Ohio. It is a mud-loving form. The pinkish character of the umbones near the apex, after the epidermis is worn off, and the thick, rough deposit of salmon-colored nacreous matter over the interior of the shell will alone serve to separate it from all others. The species belongs to the *grandis* group, and has much the shape of a half-matured form of that species, includ-

ing even the epidermal colorings. It is, however, a distinct species. The single specimen before me, from which the description is drawn, came to hand without locality, and that important item can not be furnished. The species is so characteristic that it does not need to be figured.

ANODONTA FOOTIANA Lea. Not figured.

Shell thin, fragile, twice longer than high, narrowly elliptical in outline, smooth, polished on the umbonal slopes, striate near the margins, somewhat inflated, eradiate, (young specimens are sometimes rayed on the umbonal slopes); epidermis dark horn-color, or greenish yellow, thin, much overlapping the shell proper at the anterior and ventral margins, occasional impressed lines, capillary, taking the place of rays; anterior umbonal slope full and rounded; lateral umbonal slope inflated, long; posterior umbonal slope rounded angular; umbones somewhat elevated, pointed, triangular, with three to four minute apiculations, arranged in two rows and usually eroded away, beaks placed about one-third of the length of the shell from the anterior extremity; dorsal margin somewhat arcuate, anterior margin well rounded, forming an obtuse angle with the dorsal margin, ventral margin straight, posterior margin biangulate, compressed towards the ligament; anterior cicatrices confluent, scarcely impressed; posterior cicatrices large, not at all impressed; dorsal cicatrices small, in the center of the cavity of the beaks; pallial line not at all evident; nacre bluish white, with brownish or copper-colored patches, in specimens which are nearly eroded through in the region of the beaks the nacre is reddish to brownish and gives to the shell a diseased appearance; ligament, long, thin, light brown; lunule none; lines of growth prominent and darker than the rest of the epidermis.

Length, three and one-half to five inches; height, from one and seven-eighths to two and one-fourth inches.

The specimen described is from Ohio, and is No. H2039 of the collections of the American Museum of Natural History, loaned for this purpose by Professor R. P. Whitfield.

This shell is very common in the lakes of northern Indiana and in the larger streams of the northern third of the State. It is very fragile, and often breaks into pieces through the changing temperatures of the cabinet. It has no near relative in the State and needs no special mention; the lake forms are usually much eroded, and the shells are reddish in color from the iron oxide in the mud in which they dwell. At Winona Park the form is exceedingly abundant in Eagle Lake.