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A Revision of the Mollusca of Indiana

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Constantine Smaltz Rafinesque mentioned Indiana once and the Wabash River three times in his writings on the mollusks of the trans-Appalachian region, and so must be considered the first of the naturalists to be interested in the shell-life of the state. No doubt he was frequently along the Indiana shores while he was searching the Ohio River for material, especially at the Falls, but in assigning so many of his finds to Kentucky he appears to have been quite aware that the political border line did not follow the center of the stream. The serious weakness of Rafinesque, as has been repeatedly recited, was the stark brevity of his descriptions. For example, in 1818 he defined *Ellipstoma gibbosa* as having "4 spires, a large knob behind the outward lip. From the Ohio and Wabash, length half an inch." What he meant has inspired ingenious guessing, but nothing better.

Trustworthy beginnings of the study of the subject were with Thomas Say, twice a traveler in the area and finally a resident. His first sight of Indiana was from a steamboat carrying him down the Ohio River with the Long's Expedition of 1819. While stops were made for fuel or provisions or repairs, Say went ashore, and as he did so in Ohio doubtless he made collections at Indiana landings also. On the second of the expeditions, in 1823, he came into the country overland through Wheeling and Columbus to Fort Wayne. Thence the journey was over the trail that struck the Great Sauk Trail in southwestern Michigan and branched off from this dim and soggy path to the shores of Lake Michigan and to Chicago, then commonly spoken of as Fort Dearborn. One or two species described or mentioned in the report on this expedition as found in the North-West Territory may have been taken in this part of the journey. Three years later, Say came with the "Boat-load of Knowledge" to the communal experiment of New Harmony, and here he was to remain through the varying periods of prosperity and depression, unity and bickerings, of the colony until his death. R. E. Call printed a list of twenty-three species of shells of Indiana which were named by Say, and this constituted only a small part of his work. Say has been put forth as the "Father of American Entomology." He was sire as well of molluscan studies in America.

In the period of accumulation of information on the zoology of the United States, disconnected and casual in the nature of things, numbers of mollusks of Indiana were described by J. G. Anthony, T. A. Conrad and Isaac Lea. Professor S. S. Haldeman dealt with certain shells which came to him from

Mrs. Say after the death of Thomas Say. Dr. John T. Plummer listed the forms occurring about Richmond in Wayne County. D. R. Moore and A. W. Butler made the same kind of examination in Franklin County and E. Pleas in Henry County. The first attempt to bring together data concerning the Mollusca of the whole state was by Fred Stein. This was published in the report of the State Geological Survey for 1880. A work carrying descriptions of species and embodying distribution was by Dr. R. E. Call. This was made a part of the report of the Indiana Department of Geology and Natural Resources for 1899. The paper is particularly valuable for the original plates which accompany it. Announced as a supplementary paper to this catalogue was one *On Some Mollusca Known to Occur in Indiana* by W. S. Blatchley and L. E. Daniels, issued in 1903. With it was *A Check List of Indiana Mollusca, with Localities*, a compilation by Daniels alone. It contains information about the fauna of northern Indiana, little of which had been known to Call. A report by Blatchley upon the Mollusca of Lake Maxinkuckee was expanded in *Lake Maxinkuckee, a Physical and Biological Survey*, B. W. Evermann and Howard W. Clark, 1920, volume 2, pages 41-75. There are evidences that in this production, certain mollusks not of the lake although of Indiana were included. *A Supplemental Check List of Indiana Mollusca* by Daniels followed his first compilation. Of later writers upon the general subject, A. C. Billups wrote about Mollusca in the vicinity of Lawrenceburg, A. A. Hinkley of findings in the lower Wabash River and Frank Collins Baker of those in Cedar and Bass lakes of north Indiana.

It can be taken for granted that the Mollusca of Indiana are entirely post-glacial. At least no species has been observed in the non-glaciated area of the state which can be considered as having occupied the region before the ice age and carried over into the post-glacial period. It is of interest in this connection that the same negative evidence obtains for the mollusks of the driftless section of Illinois, Wisconsin and Iowa. Means by which reinvasion was accomplished have received some speculative attention, the surmises, as they must be called, being based upon what is known of ways of distribution at present and the knowledge of ecological factors which appear to govern dispersal—a mass of somewhat chaotic material constantly undergoing revision. Some of the small land shells have been found in situations to which seemingly they could have been borne only by winds, some possibly as ova. Indications are that larger land forms have followed up the damp and wooded banks of streams by slow movement from molluscan generation to generation. Some of the Planorbidae, appearing even in temporary field and woods pools, in watering troughs and reservoirs, can be explained as distribution by birds. Living *Succinea*, as another example, have been discovered among the feathers of wildfowl. The extremely restricted oviposition in the Pleuroceridae is reflected in the fact that in this group there is no sign whatever of dissemination overland. Thus while streams of different drainage basins may very nearly approach one another, each occupied by pleurocerids, their fauna may be entirely distinct. In the case of the Unionidae, dispersion is linked with that of fishes upon which the glochidia are parasitic. Whatever the mode of distribution, it has to be remembered that continued existence of a mollusk in any

spot to which it may penetrate depends upon whether that spot is environmentally favorable, particularly for reproduction. It is to be suspected that in times without number migration has proved a failure.

That varying aquatic ecology is attended by a variation in molluscan populations is illustrated by the Pleuroceridae of the Wabash River. The names of the species upstream to downstream are here given:

Five miles w. of Celina, Mercer Co., Ohio
Goniobasis livescens
Bluffton, Wells Co., Indiana
Goniobasis livescens
Pleurocera acuta
Logansport, Cass Co.
Goniobasis livescens
Pleurocera acuta
Lafayette, Tippecanoe Co.
Goniobasis livescens
Pleurocera acuta
Pleurocera canaliculatum
Montezuma, Parke Co.
Pleurocera canaliculatum
Pleurocera canaliculatum undulatum
Vincennes, Knox Co.
Pleurocera canaliculatum
Pleurocera canaliculatum undulatum
Lithasia obovata
Mt. Carmel, Wabash Co., Illinois
Pleurocera canaliculatum
Lithasia obovata biconica
Lithasia armigera
New Harmony, Posey Co., Indiana
Pleurocera canaliculatum
Pleurocera canaliculatum undulatum
Pleurocera canaliculatum excuratum
Lithasia obovata
Lithasia armigera
Lithasia verrucosa
Grand Chains, Posey County
Pleurocera canaliculatum
Pleurocera canaliculatum undulatum
Pleurocera alveare
Lithasia obovata microlineata
Lithasia armigera
Lithasia verrucosa
Anculosa praerosa

It will be seen by this list that Lafayette is a transition point, a situation in which conditions are favorable for both the upstream forms that may be called northern and forms representative more of the southern molluscan fauna. The southern aspect is most noticeable at the Grand Chains where all the Pleurocidae are species that are common to Kentucky and Tennessee rather than to states north of the Ohio River, three occur in the Ohio River but make a northern invasion only into the Wabash River, and one is known only to the Wabash and a tributary of the Green River of Kentucky. (Species and subspecies are here treated of as on the same taxonomic plane.)

Adaptiveness varies among the Mollusca as among other organisms. Those species the remains of which are found in Pleistocene deposits were unquestionably very adaptive, and physiologically can be thought of as pioneers. Such of them as exist today display this quality by occupying a very wide range of habitats. Of more limited adaptiveness are those terrestrial species that live along the bluffs of the Ohio River and indicate no tendency to get beyond them. Examining the distributional data for Indiana, it is observed that twenty-four species of gastropods, terrestrial and freshwater, are restricted to counties on the Ohio River or close to it, that thirty-eight do not occur north of the broad bend of the Wabash, and that thirty-three, mostly of the order Pulmonata, appear (so far as information shows) to belong exclusively to the areas north of the bend.

The more recent papers on the Unionidae of Indiana have been concerned largely with the ecological conditions under which these mussels live and

which determine their distribution. T. J. Headlee (1906) wrote about the ecology of the mussels in Winona, Pike and Center lakes of Kosciusko County; C. B. Wilson and H. W. Clark (1912) in two separate papers reported on the mussel fauna of the Maumee and Kankakee rivers; B. W. Evermann and H. W. Clark (1918) discussed the "Unionidae of Lake Maxinkuckee"; W. R. Allen (1914, 1921, 1922, 1923) contributed several outstanding papers on the biology of mussels in Winona Lake; F. Wenninger (1921) and H. van der Schalie (1936) discussed the naiades of the St. Joseph River of northwestern Indiana.

As a result of the stimulus given by the careful studies of the late Dr. A. E. Ortmann considerable information has accumulated regarding the succession of mussels throughout various drainage basins. Sufficient information has accumulated through the efforts of several malacologists within the last quarter century to indicate that this sequence in a stream follows a definite pattern. This order of succession apparently is established not only for mussels, but, as has been discussed previously, holds for many of the freshwater gastropods as well. It is interesting in this connection to find that a tabulation (see Table 1) of the mussels recorded for the Wabash River indicates that there is a definite and radical change in the species of naiades, as there is of pleurocerid gastropods, in the region of Lafayette. Unfortunately, the amount of material available for charting the distribution of the mussels in this stream is all too scant. The ranges of distribution within such a stream would be more exact and perhaps more striking if one could collect with just such a mapping program in mind. However, in taking the records from several sources there is more certainty that the resulting tabulation is based on facts and not on preconceived notions. The records are of collections made long enough ago to suggest that they may never be duplicated when we consider the changes that sewage and industrial wastes have brought about in the Wabash River.

It has been shown repeatedly that the number of species of both mussels and freshwater gastropods increases as one passes from the headwaters to the mouth of a river. The figures (Table 1) in the total column for the Wabash River drainage also indicate this numerical increase. However, at a point located somewhere near the center of the main stream in the region of juncture between what may be called small-river and large-river conditions, the total number of species is frequently surprisingly high. This observation is not generally emphasized although it is revealed repeatedly in distribution tables of individual drainage systems. Such a zone of transition with its great numerical increase of species is shown for the Wabash River (Table 1) where the number recorded for the region of Lafayette is forty-eight, only two less than that given for the lower river at New Harmony.

The tabulation of species recorded for the Wabash River (Table 1) suggests that the following four zones occur as delimited by the distribution of the mussels in that river:

1. Headwaters—covering roughly the main stream from Adams County through Cass County. This region usually produces in abundance the following species:

Alasmidonta marginata
Amblema costata
Anodonta grandis
Anodonta imbecillis
Anodontoides ferussacianus
Carunculina parva
Elliptio dilatatus
Fusconaia flava
Lampsilis fasciola
Lampsilis siliquoidea
Lampsilis ventricosa
Lasmigona compressa
Lasmigona costata
Micromya iris
Pleurobema cordatum coccineum
Strophitus rugosus

2. Zone of Transition—covers the area from Cass County to Warren County. The number of species is large because one often finds in the zone species common to the headwaters together with others classified with the next, or large-river region. No special list need be given for this section of the stream, but it should be emphasized that the number of species in any one locality is apt to be comparatively high. Actually forty-eight species have been listed from Lafayette, in Tippecanoe County. This is a composite of species listed for Zones 1 and 2.

3. Large River Zone—largely between Tippecanoe County and Posey County near the mouth of the Wabash. The following species are common to this region:

Actinonaias carinata
Amblema peruviana
Arcidens confragosus
Cyclonaias tuberculata granifera
Cyprogenia irrorata
Elliptio crassidens
Fusconaia ebenus
Fusconaia subrotunda
Fusconaia undata
Lampsilis anodontoides
Lampsilis ventricosa
Lasmigona complanata
Lastena lata
Leptodea fragilis
Leptodea leptodon
Ligumia recta latissima
Megalonaias gigantea
Obliquaria reflexa
Obovaria olivaria
Obovaria subrotunda
Obovaria retusa
Plagiola lineolata
Plethobasus cyphyus
Pleurobema cordatum + *catillus* + *pyramidatum*
Proptera alata
Quadrula cylindrica
Quadrula metanevra
Quadrula nodulata
Quadrula pustulosa
Quadrula quadrula
Tritogonia verrucosa
Truncilla donaciformis
Truncilla truncata

4. Zone of Influx—from Grand Chains to the mouth of the stream. In this region several species, otherwise associated with the Ohio River and not typically a part of the Wabash drainage, invade the lower portion of the river. They are:

Cumberlandia monodonta
Dysnomia foliata
Dysnomia personata
Dysnomia sampsoni
Proptera capax
Simpsoniconcha ambigua

The above six species are found in addition to those listed in the previous zone as common to large-river conditions, bringing the total number in this region of the Wabash to fifty-two.

There is an increasing need for careful tabulations of species in the various drainage basins. Such information not only enables the zoologist to delimit the distribution of a species, but also aids greatly in accounting for the possible route taken by the animals in arriving at the places now found. It is knowledge of this kind that enables one to appreciate the importance of stream con-

TABLE 1.—Mussel Distribution in the Wabash River, Indiana

Species	Localities: Geneva—Adams Co.	Bluffton—Wells Co.	Peru—Miami Co.	Logansport—Cass Co.	Lafayette—Tippecanoe Co.	Independence—Warren Co.	Eugene—Fountain Co.	Montezuma—Parke Co.	Terre Haute—Vigo Co.	Merom—Sullivan Co.	Vincennes—Knox Co.	Gibson Co.	New Harmony—Posey Co.
1. *Actinonaias carinata*			×		×	×	×		×		×		×
2. *Alasmidonta marginata*					×								
3. *Amblema costata*	×	×			×	×			×			×	×
4. *Amblema peruviana*									×			×	×
5. *Anodonta grandis*	×				×								×
6. *Anodonta imbecillis*		×			×								×
7. *Anodonta suborbiculata*						×							
8. *Anodontoides ferussacianus*									×				×
9. *Arcidens confragosus*													×
10. *Carunculina glans*							×						×
11. *Carunculina parva*	×												×
12. *Cumberlandia monodonta*					×	×				×			×
13. *Cyclonaias tuberculata*												×	×
14. *Cyclonaias tuberculata granifera*										×			×
15. *Cyprogenia irrorata*													×
16. *Dysnomia flexuosa*						×							
17. *Dysnomia perplexa rangiana*													×
18. *Dysnomia personata*													×
19. *Dysnomia sampsoni*						×							×
20. *Dysnomia sulcata*													
21. *Dysnomia torulosa*													
22. *Elliptio crassidens*		×								×			
23. *Elliptio dilatatus*		×			×	×	×						×
24. *Fusconaia ebenus*		×		×		×							
25. *Fusconaia flava*						×				×			
26. *Fusconaia subrotunda*							×		×	×	×		×
27. *Fusconaia undata*							×					×	×
28. *Lampsilis anodontoides*						×				×			
29. *Lampsilis anodontoides fallaciosa*						×				×			
30. *Lampsilis fasciola*						×							
31. *Lampsilis orbiculata*						×							
32. *Lampsilis ovata*						×				×			
33. *Lampsilis siliquoidea*		×		×		×						×	×
34. *Lampsilis ventricosa*		×		×	×	×							

TABLE 1. (Continued)—Mussel Distribution in the Wabash River, Indiana

Species \ Localities	Geneva—Adams Co.	Bluffton—Wells Co.	Peru—Miami Co.	Logansport—Cass Co.	Lafayette—Tippecanoe Co.	Independence—Warren Co.	Eugene—Fountain Co.	Montezuma—Parke Co.	Terre Haute—Vigo Co.	Merom—Sullivan Co.	Vincennes—Knox Co.	Gibson Co.	New Harmony—Posey Co.
35. *Lasmigona complanata*	×		×		×				×		×		×
36. *Lasmigona compressa*					×								
37. *Lasmigona costata*	×		×		×				×				
38. *Lastena lata*					×								×
39. *Leptodea blatchleyi*													×
40. *Leptodea fragilis*				×	×	×			×		×		×
41. *Leptodea laevissima*		×											×
42. *Leptodea leptodon*					×				×				×
43. *Ligumia recta latissima*				×	×								
44. *Megalonaias gigantea*									×				×
45. *Micromya iris*					×				×				
46. *Obliquaria reflexa*		×			×				×				×
47. *Obovaria olivaria*					×				×		×		×
48. *Obovaria retusa*					×				×			×	×
49. *Obovaria subrotunda*					×	×		×	×				×
50. *Plagiola lineolata*					×				×				×
51. *Plethobasus cicatricosum*					×								
52. *Plethobasus cyphyus*					×				×				×
53. *Pleurobema clavum*		×			×								
54. *Pleurobema cordatum*					×				×		×		×
55. *Pleurobema cordatum coccineum*	×	×		×	×				×				×
56. *Proptera alata*					×								×
57. *Proptera capax*													×
58. *Ptychobranchus fasciolaris*					×	×			×				
59. *Quadrula cylindrica*					×				×				×
60. *Quadrula metanevra*					×	×			×		×		×
61. *Quadrula nodulata*					×							×	×
62. *Quadrula pustulosa*				×	×	×			×	×		×	×
63. *Quadrula quadrula*		×				×			×				×
64. *Simpsoniconcha ambigua*													×
65. *Strophitus rugosus*				×	×	×		×	×				×
66. *Tritogonia verrucosa*					×				×				×
67. *Truncilla donaciformis*		×			×				×				×
68. *Truncilla truncata*					×				×		×	×	×
Totals	11	8	6	8	48	13	1	3	36	2	9	7	50

fluence in bringing the Mississippi River species common to the Maumee River, Lake Erie, and streams flowing into that lake, across the Wabash-Maumee divide. Aided by the related fields of glacial geology and geomorphology, it explains why species, such as *Lampsilis fasciola* and *Ptychobranchus fasciolaris* are found in northeastern Indiana, but are absent in the northwestern part of the state; or, vice versa, why *Actinonaias ellipsiformis* occurs in northwestern Indiana, but is not found in the northeastern portion.

Several names have been proposed and used for the two classes of mollusks represented in inland America, but none apears to improve upon the simple and familiar terms, univalves and bivalves. So after careful consideration, the writers of this paper have decided to employ these non-technical names.

KEY TO THE FAMILIES

Terrestrial Gastropods

1. Spiral shell covering body 2
   Body not covered by shell (rudimentary shell buried in tissues) 11
2. Shell without an operculum 3
   Shell with an operculum 10
3. Shell with a reflected lip 4
   Shell without a reflected lip, edge of aperture sharp 8
4. Shell large and dull, usually more than 5 mm. in diameter ..... *Polygyridae*
   Shell small, about 3 mm. or less in diameter 5
5. Shell flattened or dome shaped, more or less widely umbilicate 6
   Shell with a high spire, usually imperforate 7
6. Lamellae present on parietal wall at base of last whorl ..... *Strobilopsidae*
   No lamellae or teeth on base of last whorl ..... *Valloniidae*
7. Shell small (less than 6 mm. high), pupoid or oval in outline, often with a rounded aperture, about half as broad as high ..... *Pupillidae*
   Shell minute (less than 6 mm. high), length about twice its width, aperture long and narrow with a single plate on parietal wall ..... *Ellobiidae*
   Shell small (more than 6 mm. high), smooth, polished and shiny ..... *Cochlicopidae*
8. Shell large, dull and coarsely ribbed ..... *Endodontidae*
   Shell thin, spiral, few rapidly expanding whorls, aperture very large ..... *Succineidae*
   Shell surface shiny, usually polished and smooth 9
9. Spire more or less rounded, surface of shell vitreous, umbilicus small ..... *Zonitidae*
   Spire flattened, surface not vitreous, umbilicus very wide ..... *Haplotrematidae*
10. Shell thick, dome-shaped, aperture closed with an operculum ..... *Helicinidae*
11. Animal without external shell
    Body long when extended, mantle anterior ..... *Arionidae*
    Much smaller, mantle anterior, lobe-like ..... *Limacidae*
    Mantle covering nearly the whole slug ..... *Philomycidae*

Fresh-water Gastropods

1. Shell cap-shaped or patelliform ..... *Ancylidae*
   Shell coiled or spiral, spire flat or attenuate 2
2. Shell without an operculum 3
   Shell with an operculum 4
3. Shell thin, dextrally coiled, spire more or less attenuate ..... Physidae
   Shell thin, sinistrally coiled, spire more or less attenuate ..... *Physidae*
   Shell thin, coiled in one plane or planorboid ..... *Planorbidae*
4. Shell thick, large (usually exceeding 6 mm. in height) 5
   Shell thick but small (usually less than 6 mm. in height) 6
5. Shell large, about as wide as high, few (5) well rounded swollen whorls producing an obtuse spire, aperture large and circular ..... *Viviparidae*
   Shell large about twice or more higher than wide, with numerous flattened whorls producing an acute spire, aperture small and elliptical ..... *Pleuroceridae*

6. Shell minute, operculum multispiral and circular, shell often but not always carinate ..... *Valvatidae*
Shell minute, operculum paucispiral and more or less elliptical ..... *Amnicolidae*

Fresh-water Bivalves

1. Shell usually thin and small (not exceeding 1 cm. in length), beaks central, hinge teeth consisting of cardinal, as well as posterior and lateral, teeth..... *Sphaeriidae*
Shell usually thick and large (exceeding 1 cm. in length), beaks or umbones located in anterior half, hinge with pseudocardinals and posterior laterals only..... *Unionidae* and *Margaritanidae*
Shell elongate, arcuate, with well developed pseudocardinals but without laterals, epidermis black without rays. Gills without distinct, interlamellar septa..... *Margaritanidae*
Shell variable, with or without hinge teeth. Gills with distinct, interlamellar septa ..... *Unionidae*

Univalves

Family POLYGYRIDAE

A group of terrestrial, widely distributed snails, mostly ground-living, the genera distinguished from one another mainly upon differences in the reproductive organs. Shells resembling one another occur in different genera. The following key to forms in Indiana, based upon shell characters, is adapted from Pilsbry (1940):*

Aperture small, umbilicus wide, no lip teeth but with teeth formed by a raised parietal callus. Indiana species are small (¼ inch or less in diameter)..... *Polygyra*
Aperture basal, narrow, with a long parietal tooth and often a notch in the basal lip; shell close-whorled, subglobose to lens-shaped. Indiana species small (¼ inch or less in diameter) ..... *Stenotrema*
Aperture trilobed, with both parietal and basal teeth; umbilicate or imperforate: umbilicate species in Indiana medium size (½ inch in diameter). Imperforate species in Indiana large size (¾ to 1 inch in diameter). ..... *Triodopsis*
Aperture with 0, 1 or 2 teeth.
Depressed-globose to globose-conic, imperforate or with quite narrow umbilicus; toothless or with a small parietal or sometimes columellar teeth. Indiana species large (¾ to 1 inch in diameter) ..... *Mesodon*
Depressed, widely umbilicate, aperture rounded; small obtuse tooth on basal edge. Indiana shell large (1 inch or more in diameter) ..... *Allogona*

Genus POLYGYRA Say, 1818

Discoidal, thick, umbilicate, peristome continuous, aperture reflected and having a V-shaped parietal tooth; growth lines pronounced except on the nuclear whorls.

Polygyra leporina (Gould).—Spire slightly elevated, umbilicus partially

* For about forty years, all members of the Polygyridae were brought together under one generic name. A reclassification has been arranged by Dr. H. A. Pilsbry under which the family is split into several genera, a key to which is provided above. A key that would deal with the species necessarily lacks practicability for all students except those who have time and facilities for anatomical dissection. An illustration of the difficulties is the fact that the commonest Indiana form is outwardly *Mesodon*, but anatomically *Triodopsis*. For a key to what may be called *Polygyra* "old style," the reader is referred to F. C. Baker, *Field Book of Illinois Land Snails* (Urbana: Natural History Survey Division, 1939), pp. 41-43.

is merely a phase of this species wherein the juvenile carinae persist as keels into adult life. It involves no more than occasional individuals of a colony. *G. brevispira* (Anthony), listed by Blatchley and Daniels, is a form of *livescens* whose early whorls are tightly coiled. Variability is responsible for many synonyms in this species.

G. semicarinata (Say).—A shell of as simple characters as *livescens*, mainly distinguished from it by its somewhat triangular operculum the nucleus of which is much nearer the center and more loosely coiled. An inhabitant of the two forks of the White River and branches thereof, the Whitewater River, the upper parts of the Big Blue River and probably other streams of southern Indiana. *G. pulchella* (Anthony) and *interlineata* (Anthony) are synonymous. Christy Creek, Indiana, is given as the type locality for the latter.

G. indianensis Pilsbry.—This is a striate form which occurs in Big Blue River, Crawford County. In certain parts of the stream it is associated with *G. semicarinata*, and may be a peculiarly sculptured mutation of that species.

G. intersita (Haldeman).—A strongly plicated shell the type locality of which is given as Swan Creek, Indiana. Specimens came to Haldeman from Mrs. Say. The species has not been rediscovered or a Swan Creek of Indiana traced. There is reason to suspect that *intersita* is *G. costifera* (Haldeman), known from Hardin County, Illinois, and that Swan Creek belongs to that state rather than to Indiana.

Bivalves

For Indiana, Stein (1881) listed sixty-four species of mussels as based on our present evaluation of the naiades. Call (1900) listed about seventy which were distributed among three genera. The present list contains seventy-six species comprising thirty-three genera which are arranged alphabetically within their proper families and sub-families. The following discussion of the species is submitted not as a substitute for the work of Call (1900), Blatchley and Daniels (1903) and Daniels (1914), but rather as an addition which recent investigations make possible. To anyone not familiar with freshwater mussels, Call's plates and descriptions, to which repeated references will be made, serve as an indispensable aid. In the treatment of the species care has been taken to avoid repeating information already given in the works of these three men.

The Sphaeriidae are considered immediately following the mussels.

Family MARGARITANIDAE

Only a single species in Indiana belongs in this family which is distinct both in shell structure and anatomy. Originally, Say placed *Cumberlandia monodonta* in the genus *Unio*, but Ortmann (Nautilus 26:13-14) studied its anatomy and showed that it belongs to this family by virtue of the peculiar structure of the water tubes in the gills.

Genus CUMBERLANDIA Ortmann, 1912

Cumberlandia monodonta (Say).—This is a rare species in Indiana and has been reported only from the region of the Grand Chains of the Wabash

River. As suggested by Call (1900: 527) there is some superficial resemblance between this species and *Ligumia recta latissima*. The lack of lateral teeth and the characteristic dull black epidermis will readily separate the former from the latter.

Family UNIONIDAE

As in the Margaritanidae, the gill structure is of considerable importance as a family character. In contrast to the Margaritanidae, the Unionidae have the gills divided into septa and water tubes. Each of the subfamilies in the following arrangement of the species is based in turn on the modifications of the gill structure. The first set, *Amblema* through *Uniomerus*, belongs to the subfamily Unioninae. The species are short-term breeders, the water tubes are not divided into compartments, and the whole gill (usually all four) becomes marsupial. The genera *Alasmidonta* through *Strophitus* belong to the Anodontinae. The members of this subfamily are long-term breeders, the water tubes of the outer gills are divided into three compartments with the central one used as an ovisac. The last set of genera, *Actinonaias* through *Truncilla*, belong to the Lampsilinae, which are also long-term breeders. They have simple water tubes with only the posterior portion of the outer gill serving as an ovisac for the developing glochidia.

Genus AMBLEMA Rafinesque, 1819

Amblema costata Rafinesque. (Call, plate 13).—Found widely distributed throughout the state. It is reported from: headwaters of the Wabash and White Rivers, the St. Joseph northeast of Fort Wayne, the Maumee, the Big Blue and the Kankakee rivers. This species is referred to as the "Three-ridge" or "Blue-point" by clammers and is considered a valuable shell in the button industry. Usually *A. costata* inhabits headwaters and streams of small or medium size, while in the large rivers the following species replaces it.

A. peruviana (Lamarck). (Call, plate 14).—In Indiana this species is much less common than *A. costata*. In general appearance it is similar to *costata* and can usually be separated by its heavier and more anterior beaks. Ecologically the two species (if they can be considered good species) occupy the extremes within a drainage system, i.e. *A costata* is found in the smaller headwater streams while *A. peruviana* is restricted to the lower reaches of the system of large proportions.

Genus CYCLONAIAS Pilsbry, 1922

Cyclonaias tuberculata (Rafinesque). (Call, plate 49).—The common name applied to this shell by the clammer is "Purple Warty-back," a name which is very descriptive. This species inhabits most of the larger streams in the state. In passing from the mid-portion of a large stream such as the Wabash into the region at and below Terre Haute one finds that this species has coarser pustules. Formerly the name *granifera* was applied to the large-river phase of *C. tuberculata*. It is now known that *granifera* is merely an ecological form.

Genus ELLIPTIO Rafinesque, 1819

Elliptio dilatatus (Rafinesque). (Call, plate 16).—This species is among the most common in the state. For some unknown reason Call (1900, 450)

suggests that this is a large river inhabitant. In plotting the distribution of it throughout the Wabash Drainage it is obvious that it ranges throughout the system and, if anything, is apt to be most abundant in streams of smaller size. A list of the localities from which *E. dilatatus* has been reported would be altogether too long to be included here. Suffice it to say that it inhabits practically all the streams in the state.

E. crassidens (Lamarck). (Call, plate 63).—This relatively large, thick-shelled, triangular *Elliptio* with its purplish nacre is far less common than *E. dilatatus*. It is found rarely in the larger rivers that drain the southern portion of the state. There are records from the following rivers: Wabash (Grand Chains, Terre Haute), White River (Hayesville, Washington, Shoals and Rockford), and the Ohio River at Vevay.

Genus FUSCONAIA Simpson, 1900

Fusconaia ebenus (Lea). (Call, plate 58).—This high grade button shell is generally known as the "Niggerhead." It is a species found only in streams of considerable size and is never associated with a creek or small river environment. In Indiana it is reported from the Ohio River and the wider, larger portions of the Wabash and White rivers.

F. flava (Rafinesque). (Call, plate 61).—There is the same relation between *F. flava* and *F. undulata* as between *Amblema costata* and *A. peruviana* in that *F. flava* is common in headwaters of drainages and is replaced in the larger or down-river portion by *Fusconia undata*. Numerous records are available to establish *F. flava* as common to all of the smaller streams throughout Indiana. It is at times found in lakes, but is restricted to those which have a certain amount of river influence; it is not common to any of the land-locked lakes of the glaciated portion of the state.

F. subrotunda (Lea).—In Indiana this species is confined to the Ohio and tributaries of it. Records show that it is found in the Wabash and Tippecanoe rivers where it occurs in the larger portions. In the headwaters the compressed form *kirtlandiana* appears. Only a single record (Eel River, Wabash County) is available for this headwaters form. The species does not occur in the Kankakee or Maumee drainages or in any of the rivers of the northern part of the state. The bright rays of younger specimens will help to separate this species from *F. ebenus* to which it bears some resemblance.

F. undata (Barnes). (Call, plate 60).—Found in the large rivers of the state. It is recorded from the Ohio, White and Wabash rivers. Formerly it was called *trigona* and the relation between this species and *F. flava* is indicated by the fact that some zoologists still refer to large, down-river forms of *flava* as *F. flava trigona*. The range of *F. flava* in the smaller streams of headwaters and *F. undata* in the larger portions of rivers is well established, but there are zones of intergradation which often make it difficult to determine the taxonomic status of specimens taken in such intermediate zones within a drainage system.

Genus LASTENA Rafinesque, 1820

Lastena lata (Rafinesque). (Call, plate 68).—Ortmann (1915: 106-108) has studied the anatomy of this interesting naiad and has come to the conclusion that the genus belongs to the sub-family Unioninae and not to the Anodontinae as was previously supposed. Call (1900: 534) reasoned that the lack of well developed teeth on the shell of necessity made *Lastena* a member of the Anodontinae. Ortmann's work on the anatomy of this species conclusively indicates its relationship to the genus *Elliptio*. It is a rare shell throughout its range. In Indiana it has been recorded in the Ohio, Wabash, Tippecanoe and White rivers.

Genus MEGALONAIAS Utterback, 1915

Megalonaias gigantea (Barnes). (Call, plate 15).—As the name implies, this is one of the largest of mussels. It is readily distinguished from the species of *Amblema* by the ornamental patch of tubercles located on the disc just below the umbones. It inhabits large rivers and in Indiana it has been recorded for the Ohio, Wabash, and White rivers.

Genus PLETHOBASUS Simpson, 1900

Plethobasus cicatricosus (Say). (Call, plate 55).—This is a relatively rare species in Indiana. It has thus far been found only in the Wabash River. A species, *cicatricoides*, described from a specimen labelled "Wabash River" by Frierson in 1911, is now considered merely a deformed or "unique" specimen.

P. cooperianus (Lea). (Call, plate 42).—In Indiana this shell is confined to the Ohio and lower portion of the Wabash rivers. It is rare, and is most commonly confused with *Quadrula pustulosa*. The reddish-brown cast of the epidermis, the more extended posterior end, and the characteristic high pustules will help to separate *P. cooperianus* from *Q. pustulosa*.

P. cyphyus (Rafinesque). (Call, plate 52).—Of the three species of *Plethobasus* in the state, this is the most common. However, all the members of the genus are to be considered relatively rare and one is apt to find only a few specimens along with literally thousands of other forms. The range of *P. cyphyus* is consequently not well defined, although it is known to be a species (like the others) usually associated with large streams. It has been recorded from the Ohio, Wabash, White, Tippecanoe and Kankakee.

Genus PLEUROBEMA Rafinesque, 1819

Pleurobema clava (Lamarck). (Call, plate 62).—Of the species of this genus in Indiana, this is one of the smallest. It is usually found in the smaller rivers and is widely scattered througout the state. There are records of occurrence in the Wabash, White, Blue, Maumee, Tippecanoe, Eel, Mississineva, St. Joseph, Whitewater and St. Mary rivers. Records from Flat Rock Creek and Sugar Creek (both in Shelby County) emphasize that this is a species also adapted to a small stream environment.

P. cordatum (Rafinesque). (Call, plate 57).—Much confusion formerly existed concerning the relationships of this species and various forms of it which have in the past been recognized as distinct species. The late Dr. Ortmann has studied the group carefully and has shown that *cordatum* tends to vary in two directions. On the one hand, it becomes higher with an increasingly shortened posterior end. In this direction we get a series of forms that are named progressively as the specimens get higher in this order: true *cordatum*, then *cordatum catillus* (Call, plate 59), then *cordatum plenum*, and finally the highest forms are called *cordatum pyramidatum*. This series comprising the main species and its forms are associated with streams of comparatively large size. On the other hand, when *cordatum* (the typical form) loses its sinus, becomes rounded and tends to assume an elongated posterior end, then the name *cordatum coccineum* (see Call, plate 56) is applied. This form differs ecologically from the true *cordatum* and the higher forms in that it inhabits streams which are considerably smaller, getting well into the headwaters of the larger rivers. Distributionally, it is of interest to note that the true *cordatum* and the high forms are largely restricted to the big rivers in the southern portion of the state, such as the Ohio, White and Wabash. *P. cordatum coccineum*, however, is found throughout the state and continues northward into the Maumee, St. Joseph and Kankakee rivers.

Genus QUADRULA Rafinesque, 1820

Quadrula cylindrica (Say). (Call, plate 29).—Among the mussels of Indiana this species is one of the most easily recognized. It inhabits both large and small streams, but it is largely restricted to the Ohio and rivers draining into it. In the northern part of the state *Q. cylindrica* has crossed into the Maumee River drainage. The crossing of this species and other typical Ohio Basin forms into the St. Lawrence drainage across the low divide between the Maumee and Wabash drainage systems is good evidence that in the past there was a confluence between these rivers. Walker, Ortmann, Goodrich, van der Schalie and others have earlier referred to this important junction as one of the avenues by which many species have reached Lake Erie and the streams flowing into it.

Q. metanevra (Rafinesque). (Call, plate 28).—This easily identified mussel bears the common name of "Monkey-face." It is a common shell in Indiana and is associated particularly with the larger rivers. It is recorded from the Ohio, Wabash and White rivers.

Q. nodulata (Rafinesque). (Call, plate 44).—Superficially this species resembles *Q. pustulosa*. The lack of the green color band usually found across the umbonal region of *Q. pustulosa* and the presence of the nodules which are restricted to a double row in *Q. nodulata* are characters which will help to identify the species. It is usually found only in larger rivers and has been reported from the Ohio, Wabash, White and Blue rivers. Call (1900: 487) reports its occurrence in the Kankakee. It has not been reported from northeastern Indiana.

Q. pustulosa (Lea). (Call, plates 45, 46 and 47).—The general shape

and the pustules covering the valves of this species readily distinguish it. However, the sculpture is often poorly developed (particularly in young specimens); a condition which increases the difficulty of determination. It is associated with larger streams and has been found in practically all of the important rivers in the state.

Q. quadrula (Rafinesque). (Call, plate 48).—A broad smooth furrow across the pustulose valves of this species readily identifies it. It is a good botton shell and is found in practically all of the larger streams in Indiana. It is known to clammers by the picturesque name of "Maple-leaf." The *Q. fragosus* of Conrad is certainly only a form of *Q. quadrula* and need not be discussed as a distinct species.

Genus TRITOGONIA Agassiz, 1852

Tritogonia verrucosa (Barnes). (Call, plate 26).—In Indiana this species is found only in larger rivers of the southern part of the state which drain towards the Ohio. This species is unusual in that it is sexually dimorphic which is quite unusual in members of the Unioninae. Males are as a rule short with the ribs on the posterior slope well developed, while the females are attenuate posteriorly, laterally flattened and the ribs on the posterior slope are poorly developed.

Genus UNIOMERUS Conrad, 1853

Uniomerus tetralasmus (Say). (Call, plates 66 and 67).—This is a relatively rare species in Indiana. The characteristic concentric beak sculpture serves well as an aid in identification. It has been recorded (Call, 1900: 519) for the Ohio and Wabash rivers. Daniels (1914: 650) gives Montour's Pond in Knox County for the locality of a form known as *sayi*. With more intensive collecting *U. tetralasmus* will probably be found inhabiting ponds, abandoned canals, etc. This species is unique in its ability to survive by aestivation in ponds that may be dry for from three to six months (see van der Schalie, 1940: 137-38).

Genus ALASMIDONTA Say, 1818

Alasmidonta calceolus (Lea). (Call, plate 68, figs. 4-6).—This relatively small species is common in creeks all over the state. Occasionally specimens are found in large streams or in lakes, but such environmental conditions are not typical for the species. When occasionally found in lakes the shells become small and stunted; while in larger streams the few specimens found are often considerably larger than similar forms of creeks.

A. marginata (Say). (Call, plate 70).—This is a common shell in headwaters of streams throughout the state. It is usually not present in larger rivers such as the Ohio, although at times occasional stragglers turn up in larger streams. However, on the whole, the larger populations inhabit what may be called small-river conditions. Records such as: Eel River, branch of Blue River, Salamonia River, etc., emphasize its predilection for smaller streams. It is not common to lakes, and if found in such a body one will invariably find that it is associated with what should be termed a river-lake, i.e., a lake with strong river influence.

Genus ANODONTA Lamarck, 1799

Anodonta grandis Say. (Call, plate 77).—Because of its ability to live in a wide variety of habitats this is one of the most common species of the state. Its wide range of habitat has resulted in an equally large variation in size and shape. There is a swollen form called *A. g. footiana* adapted to "floating" on soft mud and peat in lakes — an environment in which other species would bog down and smother. In rivers this species is less swollen and usually more attenuate and it is to these forms that the typical *A. grandis* name is applied. In larger streams the shells often become huge so that the form name *A. g. gigantea* may be used to distinguish them.

A. imbecillis Say. (Call, plate73).—The straight hinge line with its striking lack of swollen beaks readily separates this *Anodonta* from the other two species common to Indiana. F. C. Baker suggested that *imbecillis* should be placed in a new genus *Uterbackia* because it supposedly passed through its life history without parasitism. Subsequent research by Miss Tucker under the direction of Professor Van Cleave showed conclusively that the green sunfish (*Lepomis cyanellus*) served as host to the glochidia of *A. imbecillis*. As in other parts of its range, the *A. imbecillis* in Indiana, although found in practically all of the drainage systems in the state, is rather sporadic in its distribution. The tendency for this species to live in ponded regions such as occur above dams, at outlets of lakes, quiet mud banks in bends of rivers, etc., may partially explain the discontinuity in its distribution pattern.

A. suborbiculata Say (Call, plate 78).—In Indiana this species is not at all common nor widespread. It is reported (Call, 1900: 533) from the Wabash River in "muddy bayous and small lakes left by the changing of the river's course." Daniels (1914: 649) reported it from the White River at Rockford.

Genus ANODONTOIDES Simpson, 1898

Anodontoides ferussacianus (Lea). (Call, plate 76).—In Indiana as elsewhere this species is most commonly found in creeks and small headwater streams. It ranges widely and can be found in practically all of the river systems of the state. There is considerable variation in the shape and size of the shells from the various habitats. This variation has resulted in the application of several form names, of which *subcylindraceus* is one of the most common. The tendency in the past has been to over-emphasize the importance of such names.

Genus ARCIDENS Simpson, 1900

Arcidens confragosus (Say). (Call, plate 69).—This very striking shell with prominent tubercles across its umbones has been reported only from southern Indiana. As suggested by Call (1900: 521) it is very similar in distribution to *Anodonta suborbiculata*. The records available limit *A. confragosus* to the lower portion of the Wabash and White rivers where it shows a preference for a muddy environment in deep water.

Genus LASMIGONA Rafinesque, 1831

Lasmigona complanata (Barnes). (Call plate 71).—This rather large plate-like species is known commonly as the "White-Heel-splitter" or "Elephant's Ear." It is abundant mainly in streams and canals throughout the state. It has crossed from the Wabash into the Maumee River drainage, but according to Wilson and Clark it is not a particularly common shell there. It is mainly a species of larger streams and is not often found in creeks. Usually it lives on a muddy bottom where there is little current.

L. compressa (Lea). (Call, plate 24).—Of the three species of *Lasmigona* in Indiana this one can be distinguished by its hinge tooth structure, with its large and well developed interdentum and the presence of thin but definite lateral teeth. Ecologically it is a species of small streams although an occasional specimen is at times found in rivers. As a rule, *L. compressa* may be found in a stream too small to harbor any other species. It is widely distributed in Indiana and has been recorded from practically all of the drainage systems.

L. costata (Rafinesque). (Call, plate 72).—The rugose nature of the posterior slope of this species is a rather useful aid in identifying it. In Indiana *L. costata* inhabits the headwaters of most of the streams. Occasionally it is found in the larger portions of a river, but it is not usually common there. The ability of this species to adapt itself to a wide range of ecological conditions partly accounts for its unusually wide distribution.

Genus SIMPSONICONCHA Frierson, 1914

Simpsoniconcha ambigua (Say).—In Indiana, as elsewhere in its range, this species is very sporadic in distribution. Thus far the records in Indiana limit *S. ambigua* to the White and Wabash rivers. B. Shimek (Nautilus, 2: 114) as early as 1888 pointed out that this small species is often found under large slabs of limestone in soft mud. Some years later (1915) A. D. Howard (Nautilus, 29: 6-8) showed experimentally that it completes its larval development on the mud-puppy (*Necturus maculosus*). The environmental conditions reported by Howard were similar to those reported earlier by Shimek, but the former found a mud-puppy under the same flag-stone beneath which the infected *Simpsoniconcha* was taken.

Genus STROPHITUS Rafinesque, 1820

Strophitus rugosus (Swainson). (Call, plate 75).—The heavier concentric beak sculpture, the thicker shell with usually a salmon nacre, and the rudimentary pseudocardinal teeth, are characters which will aid in separating this species from *Anodontoides ferussacianus* which somewhat resembles it. In Indiana, *S. rugosus* is found throughout the state in practically every drainage. As a rule, it is most abundant in the headwaters and is relatively rare in large rivers. It is found also in lakes, but only in those that have some degree of stream influence.

Genus ACTINONAIAS Fischer and Crosse, 1893

Actinonaias carinata (Barnes). (Call, plate 41).—This species, commonly known as the "mucket," is one of the most useful and desirable shells for the manufacture of pearl buttons. It inhabits mainly large rivers and is found in all of the major drainage systems in the state. As a rule, it prefers gravel bars in a current. It is not found in lakes; an observation that has an important bearing in zoogeographical studies.

A. ellipsiformis (Conrad). (Call, plate 20).—Earlier reports on the mussels of Indiana suggest that this species is found widely scattered throughout the state. In the light of more recent work there is reason to believe that actually *A. ellipsiformis* is found only in the northwestern portion where it inhabits the St. Joseph River and the headwaters of the Kankakee River drainage. There is a record for "Lake Maxinkuckee," but this is obviously in error since Evermann and Clark (1917) failed to find it there. This species is abundant in small headwater streams and is rather uncommon in large rivers. It is at times confused with old specimens of *Micromya iris*, but the thickened shell and heavy hinge teeth, the lack of prominent sculpture on the beak, the mass of fine green rays concentrated just anterior to the posterior ridge, and the tendency to have a wide but definite angle along the posterior ventral margin—these are all characters that will help to separate *A. ellipsiformis* from *Micromya iris*.

Genus CARUNCULINA Simpson, 1898

Carunculina glans (Lea). (Call, plate 65, figs. 5-7).—This small species is common to most of the streams in Indiana. Records show that although it is at times found in larger rivers such as the Wabash and White rivers, it is mainly an inhabitant of smaller rivers throughout the state. Call (1900: 517) has given a useful table to show the characters that separate *C. glans* from *C. parva*. The more globose form, the smoother and rayed epidermis, and particularly the purple nacre will help to distinguish *C. glans* from *C. parva*.

C. parva (Barnes). (Call, plate 65, figs. 1-4).—Like *C. glans*, this species is rather widely distributed throughout the rivers of Indiana. Although both *C. parva* and *C. glans* are found in the northern part of the state, both species seem to be most common in the headwaters of the streams of southern and central Indiana that drain to the Ohio River. The greenish or gray epidermis, with its lack of rays and its fine but prominent lines of growth, the elliptical (rather than oval) outline of the shell, and the white nacre—these are essential characters which help in separating *C. parva* from *C. glans*.

Genus CYPROGENIA Agassiz, 1852

Cyprogenia irrorata (Lea). (Call, plate 43).—This species is easily identified through its peculiar green, mottled epidermis, as well as by the presence of nodules on its outer surface. In Indiana, as elsewhere in its range, it is mainly a species of large rivers and is confined to the Ohio, Wabash and White rivers, with their larger tributaries.

Genus DYSNOMIA Agassiz, 1852

Dysnomia flexuosa (Rafinesque). (Call, plate 64).—In earlier lists this species is called *D. foliatus* (Hildreth). A re-examination of the Rafinesque species by Ortmann and Walker (1922: 70-71) indicates that *flexuosa* has priority over *foliatus* by eight years. In Indiana this species is relatively rare and has only been reported from the Ohio River and the lower portion of the Wabash River in Posey County. The "leaf-like" appearance of the females is very striking.

D. personata (Say). (Call, plate 33).—Like *D. flexuosa* this species is a rare shell in Indiana. It is found only in the lower reaches of the Wabash and White and invades these streams from the Ohio River where both species have their center of distribution. *D. personata* seems to be a transition form and closely resembles *D. sulcata* which will be mentioned below.

D. perplexa (Lea). (Call, plate 34).—This species and its form *rangiana* are quite well represented in the Ohio, Wabash and White drainages. The typical form, *perplexa*, inhabits the larger rivers and tends to have the nodules or "bosses" on the posterior slope well developed; the form *rangiana* is more common in small rivers and often these same nodules or "bosses" are small or entirely absent. *D. perplexa rangiana* has crossed over from the Wabash drainage into the Maumee River system and has gotten into Lake Erie where an occasional specimen is found.

D. sampsoni (Lea).—This is a rare shell in Indiana. It has managed to get established only in the lower Wabash River and may be present in the lower portion of the White River. Call (1900: 476) considers this species with *rangiana* and *torulosa*, but there are characters that may entitle it to specific rank. It differs from torulosa in the absence of knobs and the pale color of its marsupial expansion. In these characters it resembles *D. p. rangiana*, but it differs from it in the more convex shell, the greatly inflated beaks and the more distinctly developed ridges. In the future more careful study may reveal that *D. sampsoni* is a variant of *perplexa* representing a *rangiana* aspect of it as it appears in the larger rivers.

D. sulcata (Lea). (Call, plate 35).—This is a relatively rare shell in Indiana. It has been taken only from the Ohio, Wabash, White and Maumee rivers. Its characteristic round form with fine green rays on a yellowish background separates it readily from the other species of *Dysnomia* recorded from Indiana.

D. triquetra (Rafinesque). (Call, plate 32).—This is the most common species of the genus in Indiana. It is characterized chiefly by its wide and abruptly truncated posterior slope, its light green color with rays that appear across the ground color in the form of blotches and spots. There is a tendency to confuse this species with *Truncilla truncata*. Usually *D. triquetra* is considerably wider in proportion to the height of the shell than *T. truncata*. Also there is a marked difference in the texture and color of the epidermis of the two species, and *D. triquetra* has a much wider posterior slope which is covered

with fine "dentations," a character not found in *T. truncata*. In Indiana, *D. triquetra* is found in the Wabash, White, St. Joseph and Maumee drainages. It is seldom in large numbers and is associated usually with medium to large river conditions.

Genus LAMPSILIS Rafinesque, 1820

Lampsilis anodontoides (Lea). (Call, plate 18).—The common name "Yellow sand-shell" is quite descriptive of this handsome species. It is an important shell industrially, being especially desirable for the manufacture of novelties. Tons of shell of this species were formerly sent to Europe to be used for this purpose. In Indiana it is restricted to streams flowing southward to the Ohio. It has not been taken in the Maumee, St. Joseph or Kankakee drainages of the northern portion of the state. It is mainly a species inhabiting streams of medium to large size. In 1914 C. T. Simpson named a form *fallaciosa* which is smaller than the typical *L. anodontoides* and tends to be marked with prominent green rays, while typical *anodontoides* is usually a bright yellow without any rays. In Indiana *fallaciosa* is relatively rare although a few records of it have been established in the Wabash River drainage. The form seems to be more common in headwaters.

L. fasciola Rafinesque. (Call, plate 37).—This is one of the smaller species of the genus found in Indiana. It is characterized by having a general shape similar to *L. ventricosa*, but it is always smaller at a given age. A series of fine, wavy, green rays are peculiar to the species. Its distribution is of interest in that it does not occur in northwestern Indiana (neither in the St. Joseph nor in the Kankakee). It does occur in the Maumee and most of the streams that drain southward into the Ohio. As a rule, it inhabits small rivers and it is a relatively rare species under large river conditions. If found in lakes it inhabits only those with a strong river influence, i.e., lakes usually classified as "river-lakes."

L. orbiculata (Hildreth). (Call, plate 50).—This species is decidedly limited in its habitat to large rivers. In Indiana there are records from the Ohio, the Wabash and the lower White rivers. There is a superficial resemblance between this species and *Actinonaias carinata*, but the heavy shell, more rounded shape, brown color with indistinct rays, and the tendency to have a delicate pink nacre, are all characters that will help to separate the former from the latter.

L. ovata (Say).—This species is found in Indiana only in the large rivers of the southern part of the state. It has been reported from the Ohio, the Wabash and the lower White rivers. As one progresses into the headwaters the sharp posterior ridge of the true *ovata* is seen to round off and we pass gradually to the more common form of the species in Indiana, known as *L. ovata ventricosa* (Barnes) (See Call, plate 39). *L. ovata* is definitely a species that inhabits larger rivers and there are transitions into the headwaters that connect *L. ovata* through the form *L. o. ventricosa* with *L. ventricosa*.

L. siliquoidea (Barnes). (Call, plate 36).—This species is one of the most common in Indiana. It occupies a wide range of habitats and appears in prac-

tically all of the lakes and streams. It may be separated from *L. ventricosa* largely by its more rectangular shape (*L. ventricosa* is more nearly a square in outline), by its beak sculpture which consists of many fine wavy bars (in *L. ventricosa* there are a few, heavy, concentric bars), and by the less inflated beaks (in *L. ventricosa* the beaks tend to extend considerably above the hinge line). When *siliquoidea* occurs in lakes it may be stunted, and to the depauperate forms the name *L. siliquoidea rosacea* is applied (see Brown, Clark and Gleissner, 1938: 695-98).

L. ventricosa (Barnes). (Call, plate 38).—In Indiana the typical *L. ventricosa* inhabits practically all of the rivers, going well into headwaters. Commonly it is referred to as the "Pocketbook" and is considered (along the the "Mucket") to be one of the best shells for the manufacture of pearl buttons. Occasionally in lakes with a stream influence an ecological form appears which is characterized by a greater or less degree of stunting. Such stunted forms are usually referred to as *L. ventricosa canadensis*. The stunting is due to "exposure" and has been accounted for in an interesting paper by Brown, Clark and Gleissner (1938).

Genus LEPTODEA Rafinesque, 1820

Leptodea blatchleyi (Daniels). (Figured: Plate III, Blatchley and Daniels, 1903).—This rare species has been found only at the type locality: Wabash River, Grand Chains, in Posey County. The species was originally described by L. E. Daniels in the Nautilus (1902) where reference is made to the close similarity in both anatomy and shell characters to *L. leptodon*. More study is necessary to determine the relationship of *blatchleyi* to *leptodon*, which occurs with it.

L. fragilis (Rafinesque).—This species is listed by Call (1900: 464) as *Unio gracilis* and is one of the few he has not figured. It is a common shell in Indiana, but is confined largely to the Wabash and White drainages, i.e., streams that drain southward toward the Ohio River. In northern Indiana it has crossed over into the Maumee drainage and into Lake Erie (Brown, Clark and Gleissner, 1938: 692-93). The species is identified by its well developed posterior wing, its yellow or gray ground color crossed by prominent green rays, its thin shell with thin lamellar teeth. Older specimens tend to lose the winged appearance. This species is most readily confused with *L. laevissima*. Characters for separation will be given under that species.

L. laevissima (Lea).—This is a relatively rare species in Indiana and is found only in the Ohio and lower Wabash rivers. It is a very fragile shell, and is even thinner than *L. fragilis* which it resembles most closely. *L. laevissima* can be separated from *L. fragilis* by the polished appearance of the epidermis, its darker green epidermal cast, and the much thinner and more lamellar hinge teeth.

L. leptodon (Rafinesque).—In Indiana this is one of the rarest of the *Leptodea*. It is found only in the Ohio and lower Wabash rivers. It differs from the *L. fragilis* and *L. laevissima* largely by its lack of a prominent wing, although in texture the epidermis is very similar to that of *L. fragilis*. The very rounded ventral margin, lack of a dorsal wing, and the stunted hinge

teeth will aid in separating *leptodon* from *fragilis*. It differs from *L. blatchleyi* largely in size, and *blatchleyi* may be only a form of *leptodon*.

Genus LIGUMIA Swainson, 1840

Ligumia recta latissima (Rafinesque). (Call, plate 17).—In Indiana this species is found in all of the major drainage systems in the state. It is generally associated with larger rivers although occasionally specimens are found in small streams. It is not common to lakes though it does inhabit Lake Erie, which is virtually a huge "river-lake." The type was a stunted form from Lake Erie and consequently the larger, dark colored specimens common to rivers are generally referred to as *L. r. latissima*—a procedure which reverses the usual method of naming the lake forms. Brown, Clark and Gleissner (1938: 694-95) have given valuable information regarding the variation of this species in Lake Erie.

L. subrostrata (Say). (Call, plate 22).—This very characteristic species inhabits both rivers and lakes. In Indiana it seems to be confined to streams belonging to the Wabash and White drainages, and it does not seem to have gotten into drainages of the northern part of the state. It is distinctly a western species and the Indiana records mark the northeastern end of its range. In Lake Erie and on into New England it is replaced by *L. nasuta*, a closely related, but distinctly different species. In ponds and lakes *L. subrostrata* may assume a form known as *furva* which has a high posterior ridge accentuated by a depressed or grooved posterior slope.

Genus MICROMYA Simpson, 1914

Micromya fabalis (Lea). (Call, plate 23, figs. 1-4).—This small and unusually thick-shelled naiad is among the smallest species found in Indiana. It probably occurs in all of the drainage basins of the state. Records for it are scarce, which may be due to both its small size and to its habitat preference. *M. fabalis* is most common in small streams where it lives buried deep in the sand and gravel around the roots of aquatic vegetation. It is also found in lakes, but usually only those with a definite stream influence.

M. iris (Lea). (Call, plate 21).—In contrast to *M. fabalis* this species is larger and has a decidedly thinner shell and thinner, more lamellar hinge teeth. In distribution and ecology it is similar to *M. fabalis* although in its wide range throughout most of the smaller streams in the state it is far more common than *M. fabalis*.

M. lienosa (Conrad).—In Indiana this species has been reported also under another name, *M. nigerrimus*. It inhabits mainly small and medium sized rivers and has hitherto been found only in the Wabash, the White, and some of the smaller streams draining into the Ohio River. It is not found in the rivers of the northern part of the state. The species is mainly southern in distribution, and southern Indiana marks the northern limit of its range. It differs decidedly in appearance from the two other species of *Micromya* reported here and bears some resemblance to *Ligumia subrostrata*. It is a smaller species, and often the nacre is tinged with purple. It is reported, but not figured, by Blatchley and Daniels (1903: 624-25).

Genus OBLIQUARIA Rafinesque, 1820

Obliquaria reflexa Rafinesque. (Call, plate 27).—The prominent, alternating tubercles on the thickened valves of this species readily separate it from other Indiana shells. This species mainly inhabits larger rivers and is usually not found in great numbers. Its range in Indiana appears to be mainly in the larger rivers such as the Ohio, the Wabash and the White rivers. It has crossed from the Wabash into the Maumee River drainage and has found its way into Lake Erie. Records for its occurrence in the Kankakee and the St. Joseph rivers, as well as for streams in western Michigan, are lacking.

Genus OBOVARIA Rafinesque, 1819

Obovaria olivaria (Rafinesque). (Call, plate 53).—In Indiana, as elsewhere in its range, this species is clearly an inhabitant of large rivers. There are numerous records of its occurrence in the Ohio, the Wabash and the White. In northern Indiana it is a rare shell in the Maumee, the Kankakee and the St. Joseph rivers. *O. olivaria* may be confused with the "Niggerhead" (*Fusconia ebenus*) from which it differs in its "olive" color (*F. ebenus* is black) and its elliptical shape (*F. ebenus* is round, with beaks that arch far forward).

O. retusa (Lamarck). (Call, plate 52).—Like most of the genus in Indiana, this species is mainly found in the large rivers. In the Wabash it ranges from the mouth of the river up to Lafayette. It also occurs in the Ohio and lower portion of the White River drainage. The species has a characteristic purple nacre and its high form, with beaks that arch rather far forward, help to separate it from the other two species of the genus that may occur with it. It is the rarest of the three species of *Obovaria* in Indiana.

O. subrotunda (Rafinesque). (Call, plate 51).—As implied in the specific name, the rounded shape, the almost centrally placed umbones, and the light color of the periostracum help aid in identifying this species. It is mainly a species of the larger rivers, but it does go into headwaters. The small compressed [illegible] *da* is most common in streams flowing to the Ohio. Rare in the Wabash and White rivers; it has crossed over from the Wabash into the Maumee River, where it is a comparatively rare shell. Records from the Kankakee and the St. Joseph are not well established.

Genus PLAGIOLA Rafinesque, 1819

Plagiola lineolata (Rafinesque). (Call, plate 30).—Among the clammers this pretty shell is known by the name of "Butterfly" since the shell in outline and with its light brown shell crossed by linear dark blotched rays, resembles somewhat the wings of a butterfly. This species is confined largely to the Ohio, White and Wabash rivers where it has a large-river habitat. It has crossed the Wabash-Maumee divide, but is rare in the Maumee River. It is not found in northwestern Indiana.

Genus PROPTERA Rafinesque, 1819

Proptera alata (Say). (Call, plate 25).—As implied in the name this species is characterized by a prominent dorsal wing. It superficially resembles *Leptodea fragilis*, but is a heavier shell, has a darker and less conspicuously rayed epidermis; has a decidedly dark purple nacre (*L. fragilis* has a pink nacre), and has much heavier and more stunted hinge teeth. In Indiana it is mainly a species of the larger rivers, being particularly common in the Ohio, lower White and lower Wabash drainages. It is found in the streams (Maumee, Kankakee and St. Joseph) of northern Indiana, but is a relatively rare shell in that part of the state. Brown, Clark and Gleissner (1938: 691-92) have shown how this species varies in relation to exposure.

P. capax (Green). (Call, plate 40).—This is a rare species in Indiana and has hitherto been found only in the Ohio and lower Wabash (Posey County) rivers. It has a rather peculiar appearance and somewhat resembles an unusually globose *Lampsilis ventricosa*. However, the shiny appearance of the epidermis, the lack of a prominent posterior ridge, and the characteristic tooth structure of the hinge readily identify this species.

Genus PTYCHOBRANCHUS Simpson, 1900

Ptychobranchus fasciolaris (Rafinesque). (Call, plate 19).—The humpbacked outline of the shell, its yellow to brown epidermis with broad green rays, the swollen hinge teeth, and a nacre that is always white; all are characters which will help to identify this species. It is mainly found in small streams, and is relatively rare in large rivers. In Indiana it is found in practically all of the drainage basins except those in the northwestern portion of the state, i.e., the Kankakee and the St. Joseph. Apparently this species has gone northward by the Wabash-Maumee route, entering Lake Erie and the streams tributary to that lake. Brown, Clark and Gleissner (1938: 690-91) discuss the variation of this species in Lake Erie. In Indiana *P. fasciolaris* is found usually only in river-lakes.

Genus TRUNCILLA Rafinesque, 1819

Truncilla donaciformis (Lea). (Call, plate 23, figs. 5-7).—This relatively rare species has been recorded from most of the rivers of Indiana. It is somewhat more common in the Ohio, Wabash and White rivers, but there are records of it for the Maumee and St. Joseph as well. Some of the most handsome and largest specimens have been taken from the Wabash River. As a rule, *T. donaciformis* is small, does not have the high sharp posterior ridge common to *T. truncata*, and is marked with characteristic chevron-shaped rays.

T. truncata Rafinesque. (Call, plate 31).—The range of *T. truncata* is very similar to that of *T. donaciformis* and it is not uncommon to find both species in the same habitat. Their appearance together at times occasions difficulty in identification, but usually *T. truncata* can be separated from *donaciformis* by its shape which is compressed, the higher and less obese conformation, and by its darker green color. The markings, like those of *donaciformis*, are zigzag or chevron-shaped rays. Usually *T. truncata* is about twice as large

as *T. donaciformis*. In Indiana huge and handsome specimens appear in the larger rivers of the southern portion of the state. It seems to be less common in the streams of northern Indiana.

DOUBTFUL SPECIES

Dromus dromas (Lea).—The Museum of Zoology, University of Michigan, has one record of this species with unsatisfacory locality data: "White River." It is apparently the only record for *Dromus* in Indiana. It is possible that this species, which occurs in the Ohio River, may have entered the lower White River from that stream. However, until more authentic records are established *Dromus dromas* should be considered as of doubtful occurrence in Indiana.

Family SPHAERIIDAE

The animals of the three genera of this family that occur in Indiana have four gills, the inner ones being the larger ones and parts of these making up the marsupia. The group is hermaphroditic, and the young shells, varying in numbers at any one time, are carried in the parent shell for as much as a year, observation indicates. Nothing definite is known as to the ways of distribution, but since the mollusks are small and light, live in muddy or sandy shallows, and make their appearance in isolated lakes, ponds or even temporary woods and field pools, it is considered that birds play a part in the dispersal. The shells are thin. Lines and ridges on the outer surface show the steps in shell secretion. The inner surface is smooth, and sometimes highly colored, and though this surface is spoken of as nacreous the material does not correspond to the nacre of the Unionidae. The hinge teeth in general consist of more or less well pronounced cardinals and laterals, double in one vale and singe in the other. The position of the nepionic valves varies, being centrally placed, a little to one side of the center or in instances close to the terminal margins. In America, only two persons have made thorough taxonomic studies of the Sphaeriidae, Mr. Temple Prime and Dr. Victor Sterki. Upon the latter, dependance for identifications was placed for at least two decades. He named many species and subspecies, but followed no well-defined system of differentiation which could be useful to others. His work has not yet been reviewed and his findings verified. Moore and Butler mentioned only one species in their list of mollusks of Franklin County, Pleas five in Henry County. Ten are in Call's compilation. Showing the Sterki influence, Blatchley and Daniels increased the number by twenty-one and there are thirty-three in Daniels' first catalogue. It has been possible to find about seventy names of species which are accredited to Indiana. Even if faith were sufficiently strong as to believe in the existence of all these forms, descriptions of all of them would be impracticable because of confusing repetitiousness. The course that is followed here is to provide brief definitions of a few well-characterized species under each genus, and mention the others simply by name.

Genus SPHAERIUM Scopoli, 1777

Shell thick as compared with that of the other genera of the family, outer surface of the valves smooth to strongly striate. No sulcus, such as in *Mus-*

culium, causes the umbones to stand apart from subsequent growth. Two cardinals in the left valve, one in the right; laterals in pairs in the right valve, single in the left. The positions of these teeth are occasionally reversed.

Sphaerium sulcatum (Lamarck).—This is the largest member of the genus in America. It is usually inflated, but sometimes compressed. The shape alters in adolescence from oblong to ovate, this being brought about by an increase of secretion of shell material in the center without proportional increase at anterior and posterior margins. Color usually dark, the surface often silken. The striae are crowded, regular. Call speaks of the species as only to be found in the northern part of the state. It is most common in that section, but it has been collected also in Henry and Posey counties.

S. striatinum (Lamarck).—Elongate-ovate, about two-thirds the size of *S. sulcatum*. Striae of varying intensity, the stronger ridges beginning sometimes with post-embryonic growth, sometimes deferred into adolescence. The species is the characteristic one of a very large group possibly not differing specifically, but blessed generously with names. It occurs throughout the state.

S. acuminatum (Prime).—Growth lines very fine, closely set together. Shape very near that of *S. striatinum*. This is the common *Sphaerium* of the Great Lakes. It was found by Daniels in Lake Michigan, Lake and La Porte counties.

S. rhomboideum (Say).—In this species, the juvenile habit of growth is continued into maturity, and is seen to alter only in senile individuals. Commonly inflated, red or brown, rarely nearly colorless. The species appears to flourish best in small, muddy streams, but Call found it in ponds with gravelly bottom, and in lakes of the north. Daniels observed it in Lake Michigan, and in Wawassee Lake, Kosciusko County.

S. occidentale Prime.—Small, orbicular or suborbicular, very thin, surface covered with fine growth lines; color yellow to rose. Apparently a depauperate form. It inhabits ditches, pools and swamps and the marshy areas of lakes, and once in awhile is to be found under wet logs and even in water-filled cow tracks. Not observed by Call, but seen by Pleas in Henry County and by Daniels in La Porte, Kosciusko and Knox counties. It is doubtless in all areas of the state.

The following species have been reported from Indiana or are in collections with Indiana locality labels:

S. solidulum (Prime)
S. stamineum (Conrad)
S. vermontanum Chadwick
S. fluvum (Prime)
S. fabale (Prime)
S. lineatum Sterki, (type locality: Wawassee Lake.)
S. emarginatum (Prime)
S. lacum Sterki
S. notatum Sterki
S. ohioense Sterki
S. tenue Prime

Genus MUSCULIUM Link, 1907

Shell fragile, lines of growth fine, surface usually shining, nepionic shell separated by a septum from the growth which follows it; teeth delicate, tend-

ing toward obsolescence. These small bivalves inhabit pools, muddy shallows of lakes and streams, and occasionally are to be seen in temporary ponds on flood plains.

Musculium transversum (Say).—Oblong, the beaks high and a little anterior to the center of the dorsal edge. Fresh specimens are translucent, and often show the greenish color of the soft parts through the shell. The species is ordinarily in large colonies. It appears to be largely immune to sewage pollution and to flourish in waters having a low free oxygen content. Call remarked abundance in the Ohio and Wabash rivers. It appears to occur rarely in the northern part of the state.

M. partumeium (Say).—Nearly oval, the beaks high; brownish yellow to rose color. It occurs commonly in small colonies, in muddy creeks, woods pools, marshes and bogs of low pH. The Indiana records indicate that the species lives only in the northern part of the state.

M. securis (Prime).—Small, thin and fragile, yellow; orbicular. Shells very much of the same shape, texture and character of beaks have variously been identified as *M. truncatum* (Linsley), *M. rosaceum* (Prime), and *M. securis*. The species was not distinguished by Call from *M. partumeium*. Daniels found it in Kosciusko County, but it is probably in all other sections of the state.

The following Indiana mollusks in the Daniels collection were identified by Sterki under these names:

M. orbiculare Sterki
M. sphaericum (Anthony)
M. jayanum Prime
M. securis parvum Sterki
M. truncatum albidum Sterki
M. lacustre Müller

Genus PISIDIUM C. Pfeiffer, 1821

Members of this genus are small, some of them minute. The shape varies from suborbicular to trapezoidal. Beaks may be high or on a plane with the hinge line, or nearly so. The teeth vary somewhat in development and form, and some attempt has been made in Europe to set up specific differentiations upon this character. The foot relative to the size of the shell is larger than in *Sphaerium*, and in detail the siphons are different. In descriptions, stress has been laid on small variations in shell shape although in the same species this may be different at different stages of growth. The habitats are mud or sand or among aquatic plants. Some of these mollusks have been dredged from lake depths where free oxygen is scant or altogether absent, and as in the case of other organisms in such situations this has given rise to several speculations as to how the oxygen necessary for metabolism is supplied, none of them wholly satisfactory.

Pisidium compressum Prime.—Trigonal, the beaks high and rather strongly indicated; surface smooth, showing lines of growth and sometimes interruptions of growth which may be seasonal. Length seldom reaching four millimeters. Cardinal teeth strong for so small a mollusk. Daniels found it in

northern lakes of the state, but it appears to live more often in muddy shallows of streams.

P. abditum Haldeman.—Less wedge-shaped than *P. compressum* and with low beaks. A full-grown specimen from Indiana measured 3.46 mm. in length, 3.10 mm. in height and 2.10 mm. in diameter. The species was collected by Pleas in Henry County, by Call in the Ohio and Wabash rivers and the canal at Brookville and "numerous small streams over the state." It is in the Daniels collection from Lake County.

P. virginicum (Gmelin).—Large for the genus, its length sometimes seven millimeters. Bears are close to the posterior end, and give the shell a rather striking obliquity. The cardinal tooth in the right valve is triangular, stout. Call found the shell only in the Maumee River at Fort Wayne. Daniels reported it from the Kankakee River, Starke County, and his collection contains specimens from Lake Maxinkuckee and Lost Lake, Marshall County; Bass Lake, Starke County, Lake James, Steuben County, and Lake Michigan, Lake County.

P. idahoense indianense Sterki.—As large as *P. virginicum*, but ovate or subovate, the shell thick for the genus, the beaks elevated. Known from Lake Michigan, Lake County.

These species or subspecies have been listed as from Indiana or are in collections with Indiana locality data:

P. compressum laevigatum Sterki
P. compressum rostratum Sterki
P. punctatum Sterki
P. variabile Prime
P. globellum Sterki
P. adamsi Prime
P. adamsi affine Sterki
P. sargenti Sterki
P. noveboracense Prime
P. scutellatum Sterki
P. maineense Sterki
P. milium Held
P. roperi Sterki
P. strengi Sterki
P. politum Sterki
P. politum decorum Sterki
P. subrotundum Sterki
P. danielsi Sterki, type locality: spring near Lake James, Steuben County.
P. hinkleyi Sterki, type locality: Wabash River, Grand Chains, Posey County.
P. vesiculare striatellum Sterki, type locality: Lake Maxinkuckee, Marshall County.
P. medianum clarum Sterki, type locality: Clear Lake, Steuben County.
P. splendidulum Sterki
P. tenuissimum Sterki
P. pauperculum Sterki
P. pauperculum crystalense Sterki
P. rotundatum Sterki
P. peralum Sterki
P. vesiculare Sterki
P. medianum Sterki
P. obtusale C. Pfeiffer
P. kirklandi Sterki
P. ambiguum Sterki
P. concinnulum Sterki
P. nanum Sterki
P. parallelum Sterki
P. pusillum Gmelin, Jenyns
P. streatori Sterki
P. trapezoideum Sterki
P. walkeri Sterki

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