

A REVIEW OF OUR PRESENT KNOWLEDGE CONCERNING THE CHARACTER AND DISTRIBUTION OF THE PLEISTOCENE AQUATIC MOLLUSCAN LIFE OF ILLINOIS*

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In Volume XX of the Transactions of the Illinois State Academy of Science, page 269, an account was given of the character and distribution of the molluscan life of the Loess deposits in the state. In the present paper a like study is made of the aquatic fauna of the Pleistocene of the state. As in the case of the land mollusks, the recognition of apparently small variations among both recent and fossil forms has added some species and varieties not formerly recognized. The modern study of the effect of the environment in directing evolutionary changes makes the recognition of these apparently minor characteristics necessary.

The fossil record of the aquatic fauna is not as complete as that of the land fauna. This paucity of information is largely due to lack of field work in localities where these deposits occur. It may also be true that some of the lacking species are really absent from the early strata. The tables accompanying this paper indicate in a striking manner the condition of our present knowledge concerning the fresh water fauna of the Pleistocene. Of the 73 species and varieties listed, 12 species or 16 per cent, are believed to be extinct or represented in the recent fauna by different variations of enough diversity to receive distinct names. Nearly all of these extinct forms are believed to be the ancestors of certain species now living in the recent fauna, and the tables show that the change from fossil to recent form has usually taken place in Late Wisconsin time. Many of the species occur in Glacial Lake Chicago deposits and in several forms this change can be seen gradually taking place through the time in which the Great Lakes were evolving in the Chicago region. These changes and the relationships of the fossil to the recent species are mentioned under each species in this paper.

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The geological distribution of each species during Pleistocene time is interesting and somewhat puzzling. Only eight aquatic species have been seen in deposits referable to Yarmouth time, and none are known from Illinois during Aftonian time. Shimek records 13 species of aquatic gastropods from the Aftonian of Iowa, and doubtless the same number should be found in Illinois. Twenty-six species have been listed as from the Yarmouth interval (see Baker, Life of the Pleistocene, p. 280) but some of the deposits examined may belong to other intervals. Fifteen species are herein recorded from the Sangamon interval of Illinois. Only three species are recorded from the Peorian interval, and these are associated with loess deposits containing land mollusks. Just why there should be this striking paucity of aquatic species in this interval is not apparent, for there were certainly streams and lakes at this time, as at present, in Illinois. It is probable that there is difficulty in accurately placing some deposits which may belong either to the Peorian or to the Sangamon interval. In southern

DISTRIBUTION OF CTENOBRANCHIATES

	Ym.	Sg.	Pe.	E. Wis.	L. Wis.	Rec.
<i>Valvata tricarinata</i>			
<i>V. tricarinata perconfusa</i>						
<i>V. tricarinata unicarinata</i>						
<i>V. tricarinata infracarinata</i>						
<i>V. tricarinata simplex</i>						
<i>Valvata bicarinata</i>						
<i>V. bicarinata normalis</i>						
<i>V. perdepressa walkeri</i>						
<i>Valvata sincera</i>						
• <i>V. sincera illinoisensis</i>						
<i>Valvata lewisi</i>						
• <i>V. lewisi precursor</i>			
<i>Lioplax subcarinata</i>						
<i>Campeloma rufum</i>						
<i>Campeloma integrum</i>						
<i>Fleurocera acuta</i>						
<i>Fleurocera acuta tracta</i>						
<i>Goniobasis livescens</i>						
<i>G. livescens correcta</i>						
<i>B. tentaculatus magnalacustris</i> ..						
<i>Amnicola limosa</i>						
• <i>Amnicola leightoni</i>						
<i>Amnicola lustrica</i>						
• <i>Amnicola gelida</i>						
<i>Amnicola walkeri</i>						
<i>Amnicola walkeri foxensis</i>						
• <i>Amnicola walkeri precursor</i>						
<i>Cincinnatia cincinnatiensis</i>						
<i>C. c. chicagoensis</i>						
<i>C. emarginata canadensis</i>						
<i>Pyrgulopsis scalariformis</i>						
<i>Pyrgulopsis letsoni</i>						
<i>Somatogyryus tryoni</i>						
<i>Birgella subglobosa</i>						
• <i>Pomatiopsis lapidaria</i>						
• <i>Pomatiopsis scalaris</i>						
	4	6	1	16	31	29

FIG. 1.

and central Illinois this might be the case because of the absence of an Iowan drift sheet or glacial deposit. Great care is needed to work out accurately the stratigraphy of the deposits between the Yarmouth and Early Wisconsin, and many errors have been made in this connection. Some deposits in Ohio and Indiana previously referred to the Sangamon are without doubt of Early Wisconsin age. Accurately determined deposits containing aquatic life from the Sangamon and Peorian intervals are greatly desired, and a comprehensive review of the life of these two intervals is impossible until such material is available.

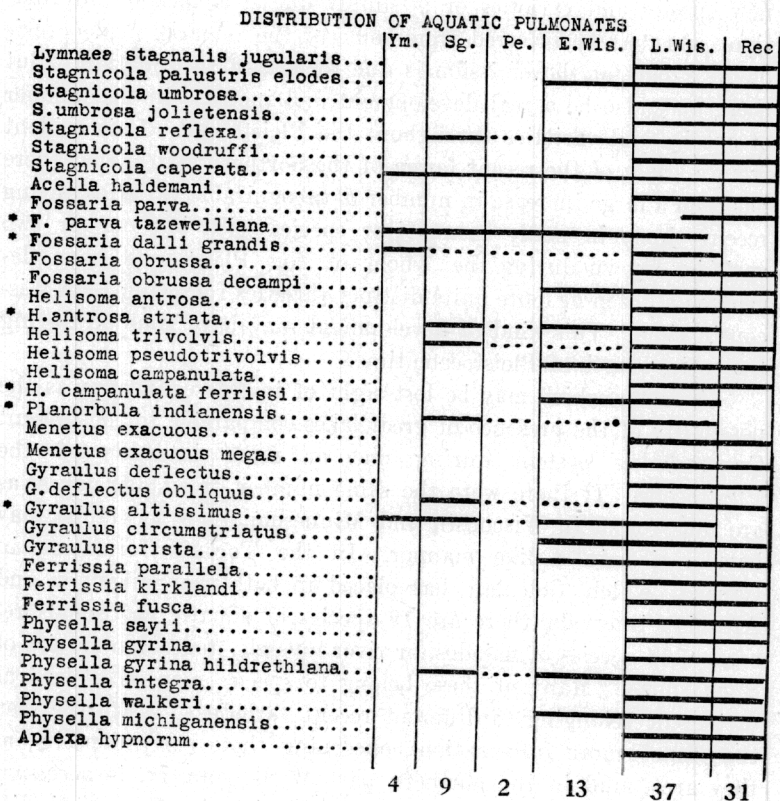


FIG. 2.

EXPLANATION OF FIGURES

Abbreviations: Ym, Yarmouth; Sg, Sangamon; Pe, Peorian; E. Wis, Early Wisconsin; L. Wis, Late Wisconsin; Rec, Recent. The solid lines indicate the range of the species throughout the different intervals. The dotted line indicates that the species has not been found as yet in this interval, but is likely to be found. The figures at the bottom of the interval columns indicate the number of species at present known from each interval.

With the advent of the Early Wisconsin, aquatic life appears to have flourished abundantly, 29 species being recorded from accurately determined deposits. In the Late Wisconsin this number is more than doubled (68 species), indicating, probably, that conditions were becoming more favorable to the existence of many forms of aquatic life. The rapid jump in the number of species in the later Pleistocene is noteworthy.

A study of the tables at once raises the question as to whether the rapid increase in the number of species from early to late Pleistocene time is in reality an increase in the development of new species and varieties or is simply due to a lack of information. As may be inferred from some of the remarks made previously, a part of the omission is due to lack of information. But there may also be a real development and increase in the number of species and varieties throughout the Pleistocene. It is evident from a study of the recent fauna of the northern states, that there has been a large increase in number of recognizable varieties during recent time; in many cases, river species with but one or two varieties known during the whole of the Pleistocene have developed a dozen or more quite distinct varieties following Late Wisconsin time. This kind of development may have gone on during the entire length of Pleistocene time.

A factor which may be lost sight of in this connection is the possibility of the presence of great lakes comparable to the present Great Lakes system during one or more intervals of the Pleistocene. If there were the same number of smaller lakes, as are now found in Wisconsin and Minnesota, then the fauna may have varied in a like manner. In the Toronto formation in Canada, which Coleman has placed in both the Sangamon and Aftonian intervals, there are 19 species of aquatic gastropods recorded, 14 species of naiades, or river mussels, and seven species of Sphaeriidae. Many of these belong to species now recognized as extinct or belonging to different recent varieties. It will be seen that much more information concerning these early deposits, as they are found in the northern part of the country, is necessary before we are in a position to accurately visualize the aquatic life of the early Pleistocene.

The aquatic life does not tell us much concerning climatic conditions, as does the land fauna. Aquatic life is able to adapt itself to a varying degree of heat and cold, as attested by the present distribution of some species from the Ohio River to middle

Canada, or even the Arctic Circle. In general, many of the species are related to those which enjoy a greater development in the northern part of the United States and Canada, and hence a shifting of the temperature curve northward during recent time is inferred, as well as a southward shift during Pleistocene time, especially during the early and later part of each interval. The middle of each interval may have been quite as congenial as that enjoyed at the present time.

This paper is an attempt to bring together all that we know at present concerning the geological distribution of the aquatic life of the state during the Pleistocene. To insure greater accuracy, only data from undoubted horizons have been used. The tables bring out rather forcefully the places where additional information is needed, and it is hoped that this deficiency in our knowledge may be supplied at an early date. The reasons for the use of the nomenclature herein presented are explained in the recent volumes by the writer issued as Bulletin 70 of the Wisconsin Geological and Natural History Survey, "The Fresh Water Mollusca of Wisconsin." The material used for the present paper was collected by the staff of the Illinois State Geological Survey, and the thanks of the writer are due Dr. M. M. Leighton, Chief of the Survey, for the opportunity of making this study.

FAMILY VALVATIDAE

Four species and eight varieties of this family, all of the genus *Valvata*, have been recorded from Pleistocene deposits in Illinois. It is noteworthy that but two species, *tricarinata* and *lewisii precursor*, occur as far back as the Yarmouth interval, and that thus far none have been found in Peorian deposits, which appear to contain for the most part species of terrestrial habits. Six species have been seen in deposits of Early Wisconsin age, ten in strata of Late Wisconsin age, and two have thus far been seen only in deposits of Early Wisconsin age. The recent *lewisi* is undoubtedly a direct descendent of the form called *precursor*, and *sincera* would appear to be a recent variation of the variety called *illinoisensis*. *Valvata bicarinata* doubtless extends far back in the Pleistocene, but its presence in early deposits has not yet been detected.

Valvata tricarinata (Say)

This species is more or less abundant in all intervals excepting the Peorian, and its absence from this interval is probably due

to rarity of aquatic deposits in the region examined. In all of the fossil deposits it is typically tricarinate, exhibiting little variation. Its distribution in Illinois, as at present known, is as follows: *Yarmouth*: Fulton Co.; *Sangamon*: Montgomery Co.; *Early Wisconsin*: Fulton, Gallatin, Champaign Co.; *Late Wisconsin*: Will, Grundy, Iroquois, Kendall, LaSalle, McHenry, and Cook Co.

Valvata tricarinata perconfusa Walker

Typical *tricarinata* is a species of rivers, where it is usually strongly triacrinata. The variations in carination are most marked in the smaller and larger lakes and in the fossils is restricted to the northern part of the glaciated territory. Curiously enough, the variations as known do not appear until the Early Wisconsin interval. The present distribution is as follows: *Early Wisconsin*: Fulton Co.; *Late Wisconsin*: Cook, Will, Grundy, Kendall, McHenry, LaSalle Co.

Valvata tricarinata unicarinata De Kay

Late Wisconsin Interval: Cook, Lake, and Grundy Co., mostly abundant.

Valvata tricarinata infracarinata Vanatta

Known only from the *Late Wisconsin* in Cook, Lake, and Grundy counties. Rare in all deposits.

Valvata tricarinata basalis Vanatta

Not yet observed in Illinois deposits but known from *Late Wisconsin* deposits in Wisconsin near Oconomowoc Lake.

Valvata tricarinata simplex Gould

This ecarinate variety occurs rarely in *Early Wisconsin* deposits (Fulton Co.) and more abundantly in *Late Wisconsin* deposits (Cook, Lake, Grundy, McHenry Co.). In Lake County it is very variable, the upper whorls unusually showing rather distinct carination while the body whorl is quite rounded.

All of the variations are known from adjacent states as far east as New Jersey (White Pond, Sussex Co.). They are especially abundant in deposits in Wisconsin, Michigan, Indiana, and Ohio.

Valvata bicarinata Lea

This species occurs commonly in deposits believed to be of *Early Wisconsin* age in Gallatin Co., near Junction. There is some variation toward variety *normalis*, the lot, in fact, showing every gradation between these two extremes. In the recent fauna,

bicarinata is known from several localities, all in the southern part of the state. Most of these are referable to the variety *normalis*, which, as remarked by Walker, appears to be the normal form of the species.

Valvata bicarinata normalis Walker

Gallatin Co., *Early Wisconsin*. Of 29 specimens found in these deposits, six were *normalis* and 23 *bicarinata*. Among these fossils, the bicarinate form is the more common, reversing the ratios of the recent fauna.

Valvata perdepressa walkeri F. C. Baker

As a fossil this recently described variety is known from two deposits in Chicago, both of *Late Wisconsin* age. These are somewhat smaller than the type form which is so abundant in Lake Michigan on the Illinois side. Excepting in size they are the same as the type form. Neither *perdepressa* nor *walkeri* are known as a fossil earlier than Late Wisconsin time and it is probably a recent offshoot of some river form, perhaps, as suggested by Walker, the *bicarinata* so abundant in the rivers of southern Illinois, where it is also known as a fossil.

Valvata sincera Say

Typical *sincera* has not been found in fossil deposits of Illinois, but specimens referable to the typical form of the species occur in deposits of *Late Wisconsin* age in marl near Oconomowoc Lake, Waukesha Co., Wis. These are like the High Island specimens figured by Walker.

Valvata sincera illinoisensis F. C. Baker

This recently described variety of *sincera* was at first thought to be Walker's *danielsi*, a large form living in Cannon Lake, Minnesota. The abundant material from Illinois, however, indicates that it was erroneously referred to that variety and is, in fact, an ancestral form of *sincera*, characterized by a lengthened spire, rounder whorls, and deeper sutures. It is thus far known from *Late Wisconsin* deposits in McHenry (Crystal Lake, type locality), Cook, and Whiteside counties in Illinois, and from Milwaukee, Green Lake, and Waukesha counties, Wisconsin. The variation is toward the low-spired *sincera* form, which occurs rarely in some lots. The absence of this species and its varieties from deposits earlier than Late Wisconsin is noteworthy, and indicates, if none are found in earlier deposits, that *sincera* is a late species, perhaps the result of lake conditions.

Valvata lewisi Currier

Typical *lewisi* occurs in *Late Wisconsin* deposits in Will, Cook, and Iroquois counties, in all of which it is rare. It also occurs in Waukesha County and near Milwaukee.

Valvata lewisi precursor F. C. Baker

This apparently extinct variety, distinguished by its higher, more scalariform spire, appears to be the ancestor of the recent *lewisi*. It occurs rarely in strata of *Yarmouth age* (Fulton Co.) but has not yet been seen in deposits of *Sangamon* or *Peorian* age. It occurs abundantly in deposits of *Early Wisconsin* age (Fulton, LaSalle, Champaign Co.) and in strata of *Late Wisconsin* age (Waukesha and Green Lake counties, Wisconsin). In Green Lake and Oconomowoc Lake deposits the form is very large with large aperture and here the variation is distinctly toward the recent form of the species, especially as it occurs in western Wisconsin, particularly in the Lake Chetek region of Barron County. Typical *lewisi* is rare in Illinois and has been recorded only from the northern part of the state. The shell with coarse, almost rib-like striae found in New York state is unknown either recent or fossil in Illinois and Wisconsin.

FAMILY VIVIPARIDAE

This family is not well represented in the Pleistocene, if one can judge by the material at hand. Only two species of *Campeloma* and one of *Lioplax* have been reported from Illinois, and these do not extend very far back in the period. This is probably due to failure thus far to find deposits of aquatic origin in which this group lived. The total absence of *Viviparus* is noteworthy.

Campeloma rufum (Haldeman)

This species is fairly common in deposits of *Late Wisconsin* as well as *Early Wisconsin* age. In Iroquois County this species occurred rather commonly in a deposit earlier than *Early Wisconsin* which is either *Sangamon* or *Peorian*, probably the former. The exact stratigraphy of this section is still to be worked out. In the Chicago deposits, representing the various stages in the formation of Lake Michigan, this species is abundant and variable, appearing between the typical form of rivers and a shorter, more solid variety commonly found in lakes and especially in Lake Michigan. In the Life of the Pleistocene, these are recorded under both *subsolidum* and *integrum*, but all are undoubtedly referable to *rufum*.

Campeloma integrum (Say)

In a ditch near Junction, Gallatin County, a deposit of Mollusca was found which appears to be of *Early Wisconsin* age. This species was represented rather commonly.

Lioplax subcarinata (Say)

A few specimens occurred in strata of *Early Wisconsin* age near Junction, Gallatin County. These are like the species now living in the Saline River and in the Ohio River bordering Gallatin County. It has not been found in other deposits or intervals.

FAMILY AMNICOLIDAE

This large family of fresh water gastropods is well represented in the Pleistocene of Illinois by 15 species and varieties. Ten of these are now living in the recent fauna of Illinois, one is living in Wisconsin, and three are believed to be extinct as far as varieties are concerned. The geological distribution is interesting and especially noteworthy. Only one species is certainly known from the *Yarmouth* interval; three species are known from the *Sangamon* interval; none from the *Peorian* interval; four species are known from the *Early Wisconsin* interval; and all fifteen occur in *Late Wisconsin* time. This broken distribution indicates either that some of the variations are of recent origin or that the record is very incomplete. Both suppositions are probably partly true, for it is possible that many varieties may have arisen since the formation of the lake environments following the retreat of the last ice sheet.

Bulimus tentaculatus magnalacustris F. C. Baker

This wide-spread species appears to have been an inhabitant of the early waters of Lake Michigan, specimens having been found in apparently undoubted deposits of *Late Wisconsin* (Tolleston stage of Glacial Lake Chicago) time. For a discussion of the reasons for bestowing a varietal name on the Lake Michigan form of this species, see the Fresh Water Mollusca of Wisconsin, part I, page 88.

Amnicola limosa (Say)

One lot of three specimens of an *Amnicola* is referred to *limosa*. It has the narrow form and slight umbilicus of the typical form as it occurs in Maryland. The deposit is in La Salle County near Dayton in the Valley of the Fox River, and is of *Late*

Wisconsin age. The absence of this species from strata earlier than Late Wisconsin and its rarity in this late horizon indicates that it may be a late comer in the middle west, possibly a migrant from the eastern part of the country.

Amnicola limosa porata (Say)

As a fossil, both *Amnicola limosa* and its variety *porata* are very rare or absent in the Pleistocene of Illinois, their place being taken, apparently, by *Amnicola leightoni*. In the writer's Life of Pleistocene, the *Amnicola* from the Chicago deposits were reported as *limosa*, but these are all referable to *leightoni*.

Amnicola leightoni F. C. Baker

This is the common large *Amnicola* of the Pleistocene. It appears rare in early deposits, only one lot having been seen from the *Yarmouth* interval in Calhoun County. It is known from the *Early Wisconsin* in Gallatin County, near Shawneetown. It is one of the most abundant species in *Late Wisconsin* deposits and is widely distributed. In Illinois it has been collected in Cook, Will, Grundy, Kendall, Lake, and McHenry counties, usually in marl deposits. It is known also from many places in Michigan, Wisconsin, Indiana, and Ohio. This species may be ancestral to the large *Amnicola* so abundant in Lakes Michigan and Superior, *Amnicola limosa superiorenensis* F. C. Baker (see Moll. of Wis., I, p. 101), and if so that form should be considered a race of *leightoni* rather than *limosa*. *A. leightoni* also resembles some forms of *Amnicola limosa porata* of the lakes of Wisconsin and Michigan, and it may have been ancestral to this race.

Amnicola lustrica Pilsbry

This long-spined species is rare and has been observed in but four deposits in Will and LaSalle counties (*Late Wisconsin*). The specimens differ from the recent form, as it is found in Illinois, only in having a somewhat larger umbilicus and a wider whorl on the average. They are more like the species, as it now occurs in the rivers of Wisconsin. Two recently described varieties of *lustrica* occur in Late Wisconsin deposits in Michigan and Wisconsin, *decepta* and *perlustrica*, but these have not yet been detected in Illinois deposits (see Wis. Mon., I, pp. 108, 109).

Amnicola gelida F. C. Baker

Rare in *Sangamon* interval (Iroquois Co.). Common in *Early Wisconsin* interval (Gallatin Co.). Abundant in *Late Wisconsin*

time, and known from Cook, Will, Kendall, Lake, and McHenry counties. In the Chicago deposits variation is toward a *lustrica*-like shell, and it might be best ultimately to regard *gelida* as the ancestor of *lustrica* and a variety of the latter. However, as *lustrica* and some of its varieties are also found in Late Wisconsin deposits, and may occur in deposits of earlier date, it appears best to treat *gelida* as a species for the present. Much more material is needed from Yarmouth and Sangamon strata to more clearly interpret these two species. *Gelida* exhibits much variation but, as a whole, is clearly distinct from *lustrica* in the deposits examined. It is known as an abundant fossil in Michigan, Wisconsin, and Ohio, where it is wide-spread over the states. A large species, *Amnicola greenensis* Baker, is known from Green and Oconomowoc lakes, Wisconsin, but this has not yet been detected in Illinois deposits (see Wis. Moll., I, p. 113).

Amnicola walkeri Pilsbry

Common in *Late Wisconsin* deposits in Will County, near Joliet. Also known from deposits in Wisconsin, Michigan, and Ohio, in deposits of the same age. The fossil form is quite typical of the species as it lives in the recent fauna.

Amnicola walkeri foxensis F. C. Baker

One lot from Morris, Grundy County marls (*Late Wisconsin* time) is referable to this recently-described variety, having the narrow form and smaller umbilicus of the Fox River form (see Wis. Moll., I, p. 116).

Amnicola walkeri precursor F. C. Baker

This large, widely-umbilicated variety occurred abundantly in marl beds in McHenry County, at the west end of Crystal Lake (*Late Wisconsin* age). They are exactly like the type form which was found in Green Lake, Wisconsin. It is also known from Waukesha and Door counties, Wis. It is noteworthy that *walkeri* and its varieties are not at present known to occur in deposits earlier than *Late Wisconsin*. It is a species of the north and may be a late comer in the fauna of the Great Lake region.

Cincinnatia cincinnatiensis (Anthony)

Three lots of an Amnicoloid referred to this species occur in Illinois deposits. One is apparently of *Sangamon* age (Iroquois Co.), one of *Early Wisconsin* age (Sangamon Co.), and one is of

Late Wisconsin age (Chicago deposits). All lots differ from the species as it occurs in the recent fauna, being longer and narrower, with less distinctly shouldered whorls and longer spire. These are possibly to be considered distinct from the typical form, and when more material from widely separated localities and horizons is available it may be thought best to consider them as representing a variety of *cincinnatiensis*.

Cincinnatia cincinnatiensis chicagoensis F. C. Baker

This recently-described variety of *cincinnatiensis* occurs sparingly in the Chicago deposits, one lot from the North Shore Channel near Foster Avenue and one lot from Jeffreys Avenue and 75th Street. The individuals from the Pleistocene deposits (all *Late Wisconsin*) are somewhat smaller than the recent form so abundant in Lake Michigan but are otherwise similar. This variety is without doubt an offshoot of the river species *cincinnatiensis* which is abundant in Illinois and states south and east. In the recent fauna the shells vary from almost as long-spined as *cincinnatiensis* to a form so globose that height and diameter are equal. This variety began to change in the more open waters of Glacial Lake Chicago and finally developed into the large form so abundant in the western part of the lake.

Vancleaveia emarginata canadensis F. C. Baker.

The northern variety of *emarginata* has been detected in three Pleistocene deposits; one of *Early Wisconsin* age (Gallatin Co.), and two of *Late Wisconsin* age (LaSalle County and Chicago deposits). The Gallatin and LaSalle County specimens are like those from the Mackenzie River, but the Chicago deposits contain material varying toward the typical river form. It is surprising that no material representing the typical river form has been found as yet in Pleistocene deposits in Illinois or adjacent states. The variety still lives in Lake Michigan in great abundance and the fossil material from the Chicago deposits indicate a variation from a smaller, more typical form to the large umbilicated Lake Michigan variety.

Pyrgulopsis scalariformis (Wolf)

Known from two Pleistocene deposits in Illinois, Tazewell County on the Illinois River and Rock Island Co., near the Mississippi River. Neither of these deposits has been stratigraphically examined, and it is not yet known from what interval the speci-

mens came. The species is not now living in Illinois, but the same, or a closely related species, has been found in Shoal Creek, Alabama. There is reason to believe that the recent form should be considered a variety of *scalariformis*.

Pyrgulopsis letsoni (Walker)

This small species occurs only in the Chicago deposits and is hence a species of *Late Wisconsin* time. A related form now living in several places in Michigan should probably be considered a variety, having the whorls much rounder with deeper sutures and a more rounded aperture. The typical form is not now living in either Illinois or Wisconsin.

Somatogyrus tryoni Pilsbry & Baker

This species, first observed in the recent fauna near Milwaukee and later in abundance in Rock River, Wis., also occurs in Pleistocene deposits. In Iroquois County near Milford, it occurred in strata believed to be of *Sangamon* age and was also found living in Sugar Creek. The material differs in no wise from the species as it occurs in Rock River and elsewhere in Wisconsin. Four specimens were also found in material from Flat Rock River, Bartholomew Co., Indiana, in deposits believed to be of *Early Wisconsin* age. The occurrence of this species in the mid Pleistocene indicates a long period of existence without change. It will doubtless be found in other, possibly still earlier, deposits in this and other states.

Birgella subglobosa (Say)

This species occurs more or less commonly in the Chicago deposits (*Late Wisconsin* age). It has been found, though rarely, as a recent species in Lake Michigan, these being the lineal descendants of the forms living in old Glacial Lake Chicago. Curiously enough, no representatives of this species, or of its river form *isogona*, have been found in any other Pleistocene deposits as yet examined. The river form is rather abundant in parts of Illinois and it should be found as a fossil.

FAMILY POMATIOPSIDAE

Two species of this amphibious family of gastropods occur in the Pleistocene deposits of Illinois. Another species, *Pomatiopsis cincinnatiensis*, occurs in Indiana, but has not yet been found in Illinois, although it occurs in the recent fauna. The species

scalaris is abundant in loess and other deposits as far back as Yarmouth time and probably extends backward into Pliocene time. The advent of *lapidaria* in Early Wisconsin time and the final dying out of *scalaris* in Late Wisconsin time are of interest in the study of the evolution of species in geological time.

Pomatiopsis lapidaria (Say)

Occurs in Fulton Co. (*Early Wisconsin*) and Stephenson Co. (*Late Wisconsin*) in loess deposits. Early Wisconsin specimens vary somewhat toward the *scalaris* form of shell.

Pomatiopsis scalaris F. C. Baker

Occurs more or less abundantly in the following intervals, usually associated with loess deposits: *Yarmouth* interval (Clark, Sangamon, Fulton, Effingham, and Madison counties); *Peorian* interval (Fulton Co.); *Early Wisconsin* interval (Fulton Co.); *Late Wisconsin* time (Will Co.). The species as a whole is remarkably uniform in the long, scalariform spire and open umbilicus. It is obviously closely related to *lapidaria* and is without doubt the ancestor of that species.

FAMILY PLEUROCERIDAE

Two species and two varieties of this family occur in the Pleistocene of Illinois, as far as now known. The evidence indicates that they are for the most part late comers, and while this is probably true as regards the lake forms, it should not be the case with the river forms, which have doubtless existed far back into the Pleistocene or even the Pliocene. *Goniobasis* is known from the Sangamon interval. The record is obviously quite incomplete.

Pleurocera acuta Rafinesque

Typical *acuta* occurs rarely in the Chicago deposits (*Late Wisconsin*) and is also found living in the recent fauna of Lake Michigan.

Pleurocera acuta tracta (Anthony)

This river variety of the lake form listed above occurs abundantly in two deposits of *Early Wisconsin* age, Gallatin County near Junction and Champaign County near Mahomet. The shells vary from almost smooth to heavily spirally lined, especially below the periphery. The Gallatin County shells are larger than those from Mahomet.

Goniobasis livescens (Menke)

Common in the Chicago deposits. Variable, but mostly with long spire characteristic of the typical form. The Lake Chicago form now lives in Lake Michigan.

Goniobasis livescens correcta (Brot)

Three lots of a *Goniobasis* are referable to this river variety, one in the *Sangamon* interval (Iroquois Co.) and two in *Late Wisconsin* time (Will County). All are rather small specimens of the variety.

FAMILY LYMNAEIDAE

Thirteen species and varieties of this family occur in the Pleistocene of Illinois. Of these, only four are known from intervals earlier than Late Wisconsin time; three are known from the *Yarmouth*, three from the *Sangamon*, two from the *Peorian*, and five from the *Early Wisconsin*. Just why some of these species have not yet been found in earlier strata is not now apparent. It is evident that much more field work is necessary before a complete account can be written of the geological history of this, as well as of other families of fresh water mollusks in Illinois.

Lymnaea stagnalis jugularis Say

More or less common in *Late Wisconsin* deposits in Cook, Will, and McHenry counties. The fossil *jugularis* does not differ in any particular from the species as it is found in the recent fauna. It is possible that this large *Lymnaea* is a post-Wisconsin migrant from the northwest, the only place where it could find refuge in suitable habitats during the glacial conditions. Possibly *Lymnaea stearnsi* Hannibal (*maxima* Stearns), a middle Miocene species, may be an ancestor. It is significant that no material earlier than Late Wisconsin time has been thus far seen in the Pleistocene of the middle west.

Stagnicola palustris elodes (Say)

Common in *Early Wisconsin* deposits in Fulton Co., and in *Late Wisconsin* deposits in Cook, Will, and Whiteside counties. The fossil examples are like those now living. It is worthy of note that no material has yet been found in deposits earlier than Early Wisconsin time.

Stagnicola umbrosa (Say)

A single lot of this species occurred in the Chicago deposits, *Late Wisconsin* time.

Stagnicola umbrosa jolietensis (F. C. Baker)

One specimen from the Joliet marls (Will Co.) is exactly like the recent variety, which was first observed near Joliet. *Late Wisconsin* time.

Stagnicola reflexa (Say)

Sangamon time, Montgomery Co., rare; *Early Wisconsin* time, Champaign Co., abundant; *Late Wisconsin* time, Cook, Grundy, and Iroquois counties. The fossil forms are like the species of the recent fauna. It is noteworthy that this species, so abundant and typical in the recent Illinois fauna, was also abundant during a large part, if not the whole, of the Pleistocene.

Stagnicola woodruffi (F. C. Baker)

Occurs rarely in the Chicago deposits (*Late Wisconsin* time). There is some variation in length of spire, as in the recent fauna, but all are characteristically *woodruffi*. The species apparently evolved about the mid-Glacial Lake Chicago stage. More fossil material would help in tracing the ancestry of this peculiar species, which is one of the most characteristic of the recent fauna. *Woodruffi* is apparently an offshoot of *catascopium*, but none of the latter are known from fossil strata in Illinois, and the species is doubtful as a recent species of the Illinois fauna. *Catascopium* is known from Pleistocene (*Late Wisconsin*) deposits in Wisconsin and Michigan. Material from Oconomowoc Lake marls is exactly like Currier's *intertexta*, and it is probable that that name should be used for some of the lake varieties in the recent fauna and also for the fossil forms mentioned, as well as some from other places.

Stagnicola caperata Say

Yarmouth interval (Fulton Co.); *Sangamon* interval (Fulton Co.); *Peorian* interval (Carroll, Fulton, Whiteside counties); *Early Wisconsin* interval (Fulton and Champaign counties); *Late Wisconsin* time (Cook and Will counties). The *caperata* in the early Pleistocene is on the average shorter and wider than in the recent fauna, and the material from *Late Wisconsin* time is more like the recent than the earlier Pleistocene forms. The occurrence in loess deposits with land mollusks is interesting and is due to their amphibious habits and their ecological environment in ephemeral pools which become dry in summer and fall.

Acella haldemani ('Desh. Binney)

A few specimens of this narrowest of the *Lymnaeas* occurred in a marl deposit in Joliet, Will Co. It is known from Cedar Lake, Lake Co. in the recent fauna. This species would appear to be a recent addition to the molluscan fauna, judging by its absence from earlier strata.

Fossaria parva tazewelliana (Wolf)

Yarmouth interval (Clark, Bureau, Fulton, Madison, and Sangamon counties; *Sangamon* interval (Iroquois Co.); *Peorian* interval (Fulton, Mercer, Sangamon, Carroll, Whiteside counties); *Early Wisconsin* interval (Fulton County); *Late Wisconsin* time (Will, Fulton, Whiteside counties). As a whole, *tazewelliana* is constantly different from the recent *parva* in its narrower shell and longer spire. Certain material from Carroll and Whiteside counties (*Peorian* interval) vary strongly toward *parva* and taken alone would probably be referred to that type. Recent material from Iowa more nearly resembles the fossil form than do individuals from Ohio, the state type locality. *Tazewelliana* is more often found in loess deposits associated with typical land mollusks than in any other strata. Its habit of living on wet mud along stream margins subject to loess accumulation accounts for its inclusion in this material.

Fossaria dalli grandis Var Nov.

The *Fossaria dalli* of the Pleistocene is uniformly larger, with five to $5\frac{1}{2}$ full whorls, the sutures deeper and the whorls rounder, the whole shell wider, the aperture longer and narrower. The type specimen measures: L. 4.5; W. 2.4; Ap. L. 2.3; W. 1.3 mm. (No. P372a, Mus. Nat. Hist., collected by J. H. Ferris from marl beds in the Fair Ground in Joliet, Will Co. *Late Wisconsin* age). Referable to this variety are also specimens from the *Yarmouth* interval (Clark Co.), and three deposits in the *Late Wisconsin* (Carroll, Will, and Whiteside Co.). All are uniformly larger than the recent form, which only rarely attains any such proportions in length, and never in width and general size. The recent *dalli* is undoubtedly the descendent of the larger Pleistocene variety.

Fossaria obrussa (Say)

Typical *obrussa* occurs somewhat sparingly in four deposits of *Late Wisconsin* time, in Cook, Will, McHenry, and Stephenson counties. In all of these it is typical of the species as it now lives

in the recent fauna. None have been seen from deposits earlier than Late Wisconsin.

Fossaria obrussa decampi (Strong)

Early Wisconsin deposits (Champaign and Fulton counties); *Late Wisconsin* deposits (Cook, Grundy, McHenry counties). This variety of *obrussa* is one of the most abundant fossils of the Pleistocene. It varies greatly, and the material of the Pleistocene parallels the variations of the recent fauna. It also occurs abundantly in marl deposits in Michigan, Wisconsin, Indiana, and Ohio. No examples of the variety have been seen from strata earlier than Early Wisconsin.

FAMILY PLANORBIDAE

Fourteen species and varieties of this family have been determined from Pleistocene deposits in Illinois. All are known from Late Wisconsin strata, and there appears to be a greatly decreasing ratio as we go backward in time. Six species only are known from Early Wisconsin time, none are known from the Peorian, five occur in Sangamon time, and but one species, the common *Gyraulus altissimus*, is known from Yarmouth time. A part of this disparity in species representation is due to defective records, but a part may also be due to actual absence from the geological interval. Of the 14 species, four are believed to be extinct, or to be replaced by different varieties in the recent fauna.

Helisoma antrosa (Conrad)

Late Wisconsin time (Joliet, Will Co., LaSalle Co., in marl). Several specimens of *antrosa* appear referable to the typical river form in the lots mentioned. They have a wider umbilicus, and the dorsal carina is nearer the outer edge of the body whorl than in *striata*.

Helisoma antrosa striata (F. C. Baker)

This characteristic Pleistocene *Helisoma* has been seen in the following deposits in Illinois: *Sangamon* (Iroquois Co.); *Early Wisconsin* (Gallatin and Champaign counties); *Late Wisconsin* (Cook, Will, Grundy, Kendall, LaSalle, Lake, and McHenry counties). It is also known from Wisconsin, Michigan, Ohio, Indiana, and New Jersey, indicating that the variety was wide-spread in Pleistocene time. The chief characteristic of this apparently extinct variety is the small umbilicus and the heavy, centrally placed dorsal carina. The spiral striation is usually very strong in

fossil shells, but in some lots there is variation from no striation to a condition in which these lines are raised into ridges. The descendent of *striata* is the *Helisoma antrosa sayi* F. C. Baker, which is abundant in lakes in Wisconsin, Michigan and Minnesota, as well as in Canada. This form is higher axially, has a somewhat smaller umbilicus, and the dorsal carina is not as heavy and is placed nearer the outer edge of the body whorl. In Pipestone Lake, Cass County, Michigan, *striata* varies toward the lake *sayi* form. *Striata* apparently lived in rivers and streams, for in Iroquois County the *antrosa* of the Sangamon deposit is undoubtedly *striata* while the form living in Sugar Creek is typical *antrosa*. *Antrosa* is a splendid example of the effect of the Glacial Period on a species. The typical form is a river species not varying to any great extent. In the lake regions of the glaciated area, there are now no less than ten varieties, showing how evolution progresses when a species enters a new kind of environment.

Helisoma trivolvis (Say)

Sangamon interval (Montgomery Co., in silt); *Late Wisconsin* time (Cook, Will, Grundy, McHenry, LaSalle, and Henry counties). *Trivolvis* in Pleistocene deposits varies little from the species as it is known in the recent fauna.

Helisoma pseudotrivolvis (F. C. Baker)

Cook, Will, Grundy counties, all *Late Wisconsin* time. One lot from the University Campus, Champaign Co., is from *Early Wisconsin* deposits. This species is now living in Salt Fork, Urbana, Champaign Co., the type locality. The fossil forms are as characteristic as are the individuals of the recent fauna. None have been seen from earlier deposits.

Helisoma campanulata (Say)

Material referable more or less to the typical form of this species has been found in deposits in Kendall, McHenry, Lake, and Will counties. All are referable to *Late Wisconsin* time. Some of the material varies toward the variety called *ferrissi*, as in the Chicago and Lake County deposits. No fossil examples of *campanulata* have been seen in strata earlier than *Late Wisconsin*.

Helisoma campanulata ferrissi (F. C. Baker)

This apparently extinct variety of *campanulata* has been seen in one deposit of *Early Wisconsin* time (Champaign Co.) and in

three deposits of *Late Wisconsin* time. *Ferrissi* is a form with less axial height than the larger typical form and the whorls are somewhat more tightly coiled. In many lots of recent *campanulata* there are individuals which could be referred to *ferrissi*, but no lots including all of the fossil type have been seen. The variation in the *campanulata* from the Chicago deposits is toward a *ferrissi* shell, and it is to be presumed that the fossil is a variant of the typical form, but whether *ferrissi* is ancestral to *campanulata* cannot at present be determined for lack of material from earlier deposits.

Planorbula indianensis F. C. Baker

Sangamon interval (Montgomery, Fulton, Iroquois counties); *Late Wisconsin* time (Chicago deposits, Cool Co.). This recently distinguished species is apparently extinct, nothing approaching it having been seen from the recent fauna. It resembles *armigera* but is larger, with a greater axial height and five full whorls. In size it is between *armigera* and Dall's *chrystyi*, a recent species of northern distribution. This species has six full whorls and is different from *indianensis*. The absence of *indianensis* from deposits between Sangamon and Early Wisconsin, and from the earlier Yarmouth interval is noteworthy. The type locality is in a deposit near Mt. Vernon, Indiana, beneath a terrace believed to be of Early Wisconsin age. It is thus either Peorian or Sangamon in age. In a deposit in Iroquois Co., the fossil species from Sangamon strata is *indianensis*, while the species living near Sugar Creek at the present time is *armigera*.

Menetus exacuus (Say)

Late Wisconsin time (Will, Grundy, and McHenry counties, in marl deposits). All typical.

Menetus exacuus megas (Dall)

Late Wisconsin time (Cook, Will, Lake, and McHenry counties, in marl deposits). This variety, known by the sharp, pinched nature of the peripheral keel, is rarely represented. It is worthy of note that no *exacuus* of any kind has been found as yet from deposits earlier than Late Wisconsin. Both the typical form and the variety *megas* are more or less common in Late Wisconsin strata of Wisconsin, Michigan, and Ohio.

Gyraulus deflectus (Say)

Late Wisconsin time (Chicago deposit and Joliet). In both deposits the form is not quite typical but varies toward *obliquus*.

Gyraulus deflectus obliquus (DeKay)

Abundantly distributed in Illinois, in deposits of *Late Wisconsin* age, principally (Cook, Will, Grundy, Kendall, McHenry, Lake Co.) Obtained also from one deposit of *Sangamon* age in Iroquois Co. Widely distributed in *Late Wisconsin* deposits in Wisconsin, Michigan, Indiana, and Ohio. In the fossil form of *obliquus* there is great variation toward the typical *deflectus* with the acutely keeled periphery, especially in some of the material from the Chicago deposits. The same variation obtains among recent material of this variety. Its rarity in deposits earlier than *Late Wisconsin*, excepting in one instance, is to be explained only by rarity of material.

Gyraulus altissimus (F. C. Baker)

Yarmouth interval (Fulton, Clark, Menard Co.); *Sangamon* interval (Iroquois, Montgomery, Boone Co.); *Early Wisconsin* interval (Fulton, Gallatin, Champaign Co.); *Late Wisconsin* time (Cook, Will, Grundy, Iroquois, Kendall, LaSalle, Lake, McHenry Co.). This is the commonest and most widely distributed species of the family in Pleistocene time. It is very distinctive and does not appear to vary toward any other species. Its large size and flat-sided whorls, in addition to the reamed-out character of the base, will usually easily determine it. This species is related to the recent *arcticus*, differing in having four full whorls (*arcticus* has but $3\frac{1}{2}$ whorls) and in its flatter and more excavated base (*arcticus* has the basal whorls rounded). As far as at present known, all references to *altissimus* from the recent fauna refer to *arcticus*. No true *altissimus* has been seen from the recent fauna. A form of *arcticus* occurs in Georgian Bay and vicinity which has been identified as *altissimus*, but while it has somewhat the same base, there are but $3\frac{1}{2}$ whorls, and the characters are those of *arcticus* and not *altissimus*. *Altissimus* appears to replace *parvus* in the Pleistocene of the Middle West; only one lot of fossils that in any way approach the recent *parvus* has been seen, and this was from what are believed to be *Early Wisconsin* deposits in Bartholomew County, Indiana, on Flat Rock River. *Altissimus* is widely distributed in *Late Wisconsin* deposits in Wisconsin, Michigan, and Ohio. The *Planorbis arcticus* recorded in Trans.

Ill. Acad. Sci., XV, p. 412, proves to be a form of *altissimus*. Thus far, no true *arcticus* has been seen from Pleistocene deposits. It is surmised that *altissimus* is ancestral to *arcticus*.

Gyraulus circumstriatus (Tryon)

Planorbis parvus urbanensis F. C. Baker, Nautilus, XXXII, p. 94, 1919.

This very distinct species has been overlooked for many years, but proves to be widely distributed, both living and fossil. The species *urbanensis* was founded on small and immature specimens of the larger recent form. Its geological distribution, as at present known, is: *Early Wisconsin* interval, Champaign County, University of Illinois campus; Fulton County, Isabel Township; *Late Wisconsin* time, McHenry County, near Crystal Lake, Cook Co., Chicago deposits, Joliet, Will Co., in marl. (See Wis. Mon., I, p. 378 for a discussion of this species.)

Gyraulus crista (Linn.)

This smallest of the Planorboids is often overlooked on account of its diminutive size, which may account for its apparent rarity. Material has been seen from *Early Wisconsin* deposits (Fulton County) and *Late Wisconsin* deposits (Will County). The fossil material is like the form now living in the recent fauna.

FAMILY ANCYLIDAE

The fresh-water limpets are but poorly represented in the Pleistocene. Much of this paucity of material is doubtless due to their being overlooked in collecting and sorting specimens in the field. However, the total absence of any member of the group from deposits earlier than *Late Wisconsin* is peculiar and difficult to account for. The family dates back to the late Tertiary and certainly must have been present in the American Pliocene. Additional material will be looked for with interest. Only four species have been seen from fossil deposits in the Middle West.

Ferrissia paralella (Say)

Rare in marl deposits in Cook, Will, and McHenry counties (*Late Wisconsin*). Also known from Michigan, Wisconsin, and Ohio, in marl deposits. The specimens are quite typical.

Ferrissia kirklandi (Walker)

A few specimens of this species occurred in a marl deposit in Lake Co., six miles north of Barrington. *Late Wisconsin*.

Ferrissia fusca (C. B. Adams)

A few specimens from the Chicago deposits. *Late Wisconsin*.

Ferrissia tarda (Say) occurs in marl deposits in Bartholomew County, Indiana, near Flat Rock River. These have a very high spire. The deposit is thought to be of *Early Wisconsin* age.

FAMILY PHYSIDAE

Six species and one variety of this family have been identified in the Pleistocene of Illinois. Only two of these occur in strata older than *Late Wisconsin*. One, *Physella gyrina hildrethiana*, is the only Physoid thus far found in early Pleistocene deposits in Illinois (in the Sangamon). The family must have been represented throughout the Pleistocene, and this scarcity or absence of the group from so many early deposits is rather puzzling. As in other groups, this is apparently due to lack of detailed work in places favorable to the preservation of this type of shell.

Physella sayii (Tappan)

This characteristic Physoid occurs in several deposits of *Late Wisconsin* time (Lake, Cook, and McHenry counties). It is also found in Wisconsin and Michigan, mostly in marl deposits of *Late Wisconsin* age. It varies greatly with age, young individuals having a short spire and wide body whorl, somewhat resembling some forms of *ancillaria*. Adult shells, however, have a long, pointed spire and are exactly like specimens in the recent fauna from Ohio, Michigan, and Wisconsin. That it has not thus far been found in deposits earlier than *Late Wisconsin* is interesting, but the record is probably not complete.

Physella gyrina (Say)

This common and variable species occurred in three marl deposits of *Late Wisconsin* age (Will, Cook, and LaSalle counties). These specimens are like material of the recent fauna from southern Illinois. There is considerable variation in the form of the spire.

Physella gyrina hildrethiana (Lea)

The swamp and marsh variety of *gyrina* appears to be more abundant than the typical form. Several immature specimens from near Litchfield, Montgomery Co., are referable to *Sangamon* time. In the deposit on the University campus, Champaign Co. (*Early*

Wisconsin) it is very abundant. In *Late Wisconsin* deposits, mostly peat, it has been found in Cook, Will, Grundy, and Iroquois counties. It is abundant in the Chicago deposits of Glacial Lake Chicago.

Physella integra (Haldeman)

Known at present only from deposits of *Late Wisconsin* age (Cook, Will, Lake and Kendall counties). The material is very variable, from very short to very long spired. This variation is especially marked in the Chicago deposits, where, doubtless, there was marked evolution as the environment changed from river to lake type. Many forms simulate the short-spired forms now living in Lake Michigan which have been named *billingsi* and *brevispira*. *Integra* is abundant in marl deposits of *Late Wisconsin* age in Wisconsin and Michigan, where the spire variation is also very marked.

Physella walkeri (Crandall)

Some material from *Late Wisconsin* deposits (Cook and McHenry counties) appears referable to this species, having a narrow shell and long spire. Two small specimens from an *Early Wisconsin* deposit (Fulton Co.) are also referred to this species, which appears to be rather rare in Pleistocene deposits.

Physella michiganensis (Clench)

A small Physa, nearer this recently-described species than any other, occurred in two deposits of *Late Wisconsin* time. At first it was thought to be Lea's *anatina*, but it is smaller and the spire is not quite as long. Lea's species, also, is a more southern one, *michiganensis* apparently taking its place in the northern states.

Aplexa hypnorum (Linn.)

A single lot of this species was found in a deposit in Carroll Co. (*Late Wisconsin* time). All were young but undoubtedly this species. The apparent scarcity of this species in Pleistocene deposits is striking and may indicate that it is a comparatively recent addition to the United States fauna.